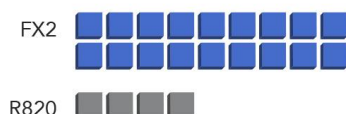


CONSOLIDATING OLDER DATABASE SERVERS ONTO DELL POWEREDGE FX2 WITH FC830 SERVERS AND FD332 STORAGE BLOCKS

HANDLE MORE VMS AND PROCESS MORE ORDERS WITH A DELL POWEREDGE™ FX2 SOLUTION INCLUDING SANDISK® DAS CACHE

up to **4.5X**
AS MANY
DATABASE VMS



up to **43X**
THE ORDERS
PER MINUTE



5X
THE AVAILABLE
DRIVE BAYS



Dell PowerEdge FX2 using SanDisk DAS Cache



**Dell PowerEdge
FC830 server**
powered by the Intel®
Xeon® Processor E5-4600
v3 product family

FD332 storage blocks

versus Dell PowerEdge R820 rack servers with CacheCade™

Enterprise data centers continually strive to run their database workloads in the most efficient way possible. Upgrading from the powerful Dell PowerEdge R820 server to the new Dell PowerEdge FX2 enclosure containing a FC830 server—powered by the Intel Xeon processor E5-4600 v3 product family—and Dell PowerEdge FD332 storage blocks can provide the data center with a significant performance and efficiency boost. Because of its flexible, high-density design capability to include quarter-, half- or full-width servers as well as direct-attached storage blocks, the Dell PowerEdge FX2 architecture can also help you make the most of valuable rack space.

During tests run in the Principled Technologies labs, the Dell PowerEdge FX2 solution supported 4.5 times as many database VMs as the rack-mounted Dell PowerEdge R820. In addition, when the Dell PowerEdge FX2 solution included the direct-attached storage (DAS) caching software from Dell, SanDisk DAS Cache, the VMs delivered a total of 43 times as many orders per minute in our database application as the VMs in the Dell PowerEdge R820 with CacheCade. These tests make the FX2 with FC830 servers with SanDisk DAS Cache and FD332 storage blocks an excellent upgrade option to replace older rack-mounted servers, as the FX2 can allow you to consolidate your VMs onto fewer servers to maximize space while also boosting performance.



A PRINCIPLED TECHNOLOGIES TEST REPORT

MAY 2015 (Revised)

Commissioned by Dell

DELL POWEREDGE FX2 CONVERGED ARCHITECTURE

The shared infrastructure approach of the Dell PowerEdge FX2 enclosure is scalable and can help you make the most of your data center space while reducing rack space. The Dell PowerEdge FX2 enclosure has a standard 2U footprint and features a modular design that can be customized with different combinations of compute and storage blocks to meet your specific goals. The PowerEdge FX2 fits two full-width, four half-width, or eight quarter-width compute nodes to increase the compute density in your rack and optimize the space in your data center. You can deploy the FX2 solution like a traditional rack-mounted server while gaining the benefits and features that more expensive, dense blade solutions can provide. Important features of the FX2 enclosure include:

- Up to eight low-profile PCIe expansion slots
- Two pass-through or optional networking FN I/O Aggregator modules
- Embedded network adapters within the server nodes
- Both chassis-based management through the Chassis Management Controller and rack-based management through Integrated Dell Remote Access (iDRAC) with Lifecycle Controller on each compute node

The Dell PowerEdge FX2 enclosure fits a number of server and storage options, including the PowerEdge FM120, FC430, FC630, and FC830 servers—all powered by Intel—and PowerEdge FD332 storage blocks. For more information on Dell Solutions, including the Dell PowerEdge FX2, visit <http://dell.to/PowerEdge>.

DELL POWEREDGE FC830 SERVER

Dell calls the PowerEdge FC830 the ultimate dense scale-up server. Powered by the Intel Xeon processor E5-4600 v3 product family, this full-width server offers power, scalability, and flexibility. The FC830 offers up to four 18-core processors, up to 3 TB of memory, and eight 2.5-inch drive bays or sixteen 1.8-inch drive bays of internal storage. Using the FC830 server, this configuration of the Dell PowerEdge FX2 chassis can contain either two FC830 servers or one FC830 server plus two FD332 storage blocks.

DELL POWEREDGE FD332 STORAGE BLOCKS

This dense direct-attach storage solution offers great flexibility. It is also the industry's first direct-attached storage to:

- Allow two servers access to non-shared storage devices with full flexibility to RAID and/or HBA modes
- Enable the pay-as-you-grow model in a 2U rack server
- Provide flexibility for scaling compute and storage in 2U rack server

SANDISK DAS CACHE ACCELERATES YOUR APPLICATIONS

Dell PowerEdge FX2 solutions containing a Dell PowerEdge FC830 server and FD332 storage blocks can benefit from further application performance acceleration by adding SanDisk DAS Cache, a server-level caching solution for direct-attached storage, offered by Dell. This software can accelerate the speed of storage input-output (I/O) operations, enabling substantial performance increases of I/O-intensive applications, including database applications and workloads such as OLTP, OLAP, HPC, and Business Analytics.

In many cases, database applications actively use only a portion of the full dataset; we refer to this subset as the “hot” data. SanDisk DAS Cache leverages SSDs of any type—PCIe, NVMe, SAS, or SATA—in the host server to create a read-write cache for the most frequently accessed or hot data. SanDisk DAS Cache software works with the application to identify this hot I/O targeted for back-end storage and acceleration. Once configured, all the writes of the application are committed at the cache layer made up of SSDs and all re-reads are from the same cache. This design not only has the potential to dramatically boost heavy I/O application performance but also helps you optimize your performance-to-cost ratio—you can expand storage capacity with HDDs while using only a few SSDs in cache for performance.

SanDisk DAS Cache software is agnostic to applications running on your server. Learn more at dell.com/dascache.

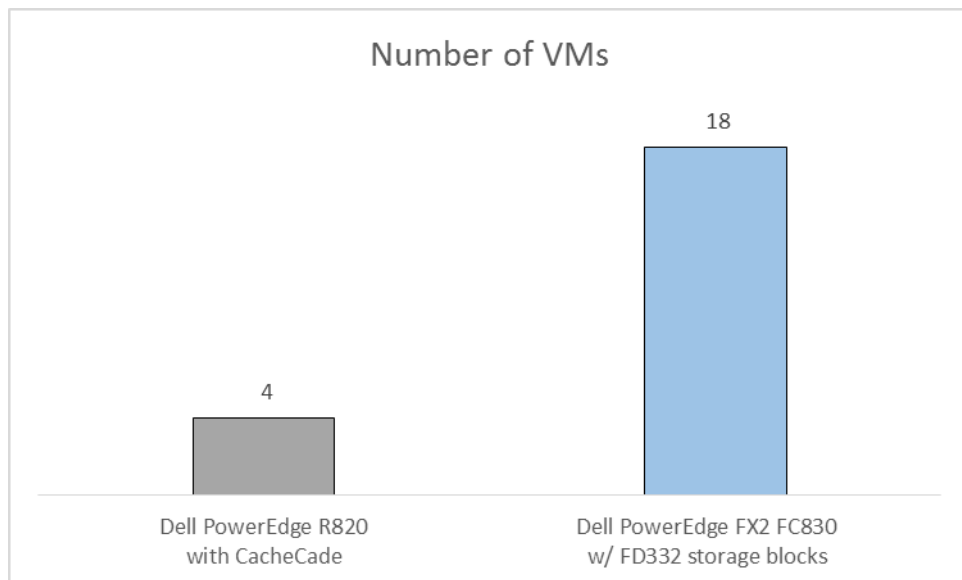
THE RESULTS OF OUR TESTING

Principled Technologies compared the database performance of the Dell PowerEdge FX2 containing a Dell PowerEdge FC830 server with SanDisk DAS Cache FD332 storage blocks to that of a Dell PowerEdge R820, with the CacheCade caching solution. (For more details on the configuration of the two solutions, see [Appendix A](#). For the specifics of our testing, see [Appendix B](#).)

To perform this comparison, we set up a Dell PowerEdge R820 with Hyper-V and ran an OLTP database workload in four VMs with CacheCade enabled on the server.

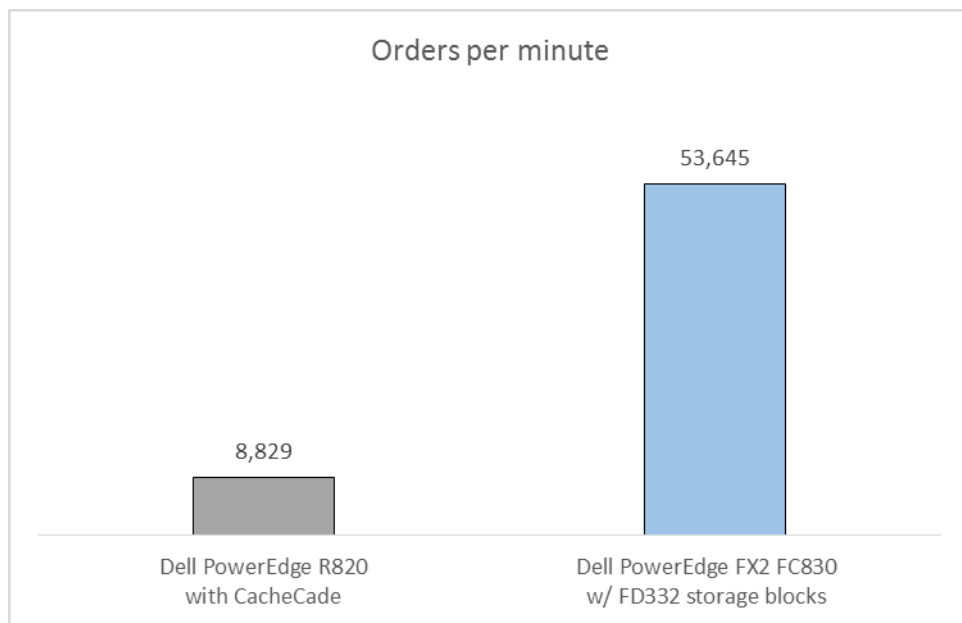
We then configured an FX2 enclosure with an FC830 server and two FD332 storage blocks with Hyper-V, deployed 18 VMs, and ran the same OLTP workload in each VM. For this test, we did not use a caching solution. As Figure 1 shows, we found that the FX2 solution supported 18 VMs, which was 4.5 times as many VMs as the Dell PowerEdge R820 with CacheCade supported.

Figure 1: The Dell PowerEdge FX2 solution supported 4.5 times the number of VMs as the Dell PowerEdge R820 with CacheCade.



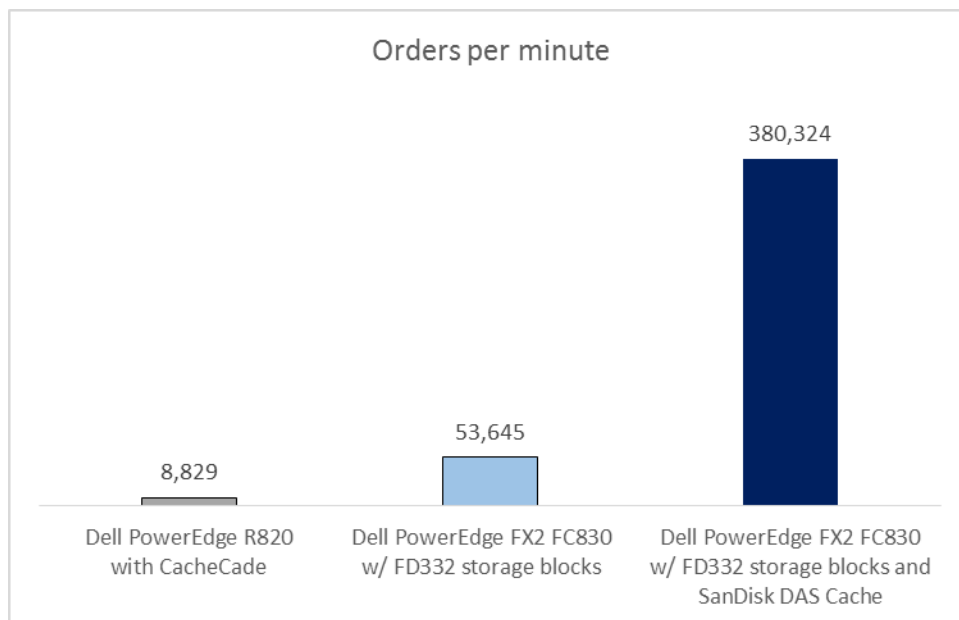
As Figure 2 below shows, simply upgrading to the Dell PowerEdge FX2 with FC830 servers, and not using SanDisk DAS Cache, delivered more than six times the overall OPMs (orders per minute in our database application) of the rack-mounted Dell PowerEdge R820 with CacheCade enabled.

Figure 2: The Dell PowerEdge FX2 solution supported 4.5 times the number of VMs as the Dell PowerEdge R820 with CacheCade.



Next, we added SanDisk DAS Cache to the FX2 solution, and found that the Dell PowerEdge FX2 solution delivered 43 times as many orders per minute in our database application (see Figure 3). Put differently, the Dell PowerEdge FX2 solution with SanDisk DAS Cache provided up to 43 times the performance of the legacy Dell PowerEdge R820 running CacheCade.

Figure 3: The Dell PowerEdge FX2 with an FC830 server and FD332 storage blocks with and without SanDisk DAS Cache outperformed the Dell PowerEdge R820 using CacheCade.



THE ADVANTAGES OF THE DELL FX2 SOLUTION

The Dell PowerEdge FX2 solution we tested included one Dell PowerEdge FC830 server powered by four Intel Xeon processors E5-4670 v3 (see Figure 4) and two half-width Dell FD332 storage blocks. Each storage block contained a mix of SSDs for data caching and HDDs for persistent data (see Figure 5).

Figure 4: The Dell PowerEdge FC830 server we tested.



Figure 5: The Dell PowerEdge FD332 storage block we tested.



Figure 5 illustrates the extreme space-efficiency of the Dell PowerEdge FX2 solution we tested. Each FD332 storage block can support up to sixteen 2.5-inch drives, in addition to the eight internal 2.5-inch drive bays in the FC830 server. Compared to the Dell PowerEdge R820 we tested, which had a total of eight 2.5-inch drive bays available, the Dell PowerEdge FX2 complete solution, including server and storage block

drive bays, provided five times as many drive bays, with a total of forty 2.5-inch drive bays of storage.

With networking, as part of the PowerEdge FX architecture, Dell Networking FN IO Aggregators have been designed to simplify FX2 connectivity and optimize east-west traffic flows by reducing cabling complexity and the number of top-of-rack (ToR) switches and physical ports needed to run server clusters.

Combining the compute power of the Intel Xeon processor E5-4600 v3 product family, the storage density of the FD332, and the networking of the Dell Networking FN IO Aggregators, the Dell PowerEdge FX2 configuration provides an all-in-one solution with the potential to save significant data center space as you upgrade your infrastructure to meet current and future needs. The modular approach of the FX2 simplifies the way that you can deploy, manage, and upgrade servers, networking, and storage. The FX2 converged architecture allows you to create the right fit for your specific workload, which can potentially save your organization thousands of dollars in hardware costs.¹

IN CONCLUSION

In the Principled Technologies labs, the space-efficient FX2 solution enabled with SanDisk DAS Cache supported over four times as many VMs than the Dell PowerEdge R820 with CacheCade supported. Because each VM delivered greater performance, this FX2 solution delivered up to 43 times the total performance of a Dell PowerEdge R820 server.

Consolidating your Dell PowerEdge R820 servers onto with a new Dell PowerEdge FX2 enclosure with an FC830 server, powered by the Intel Xeon processor E5-4600 v3, and FD332 storage blocks using SanDisk DAS Cache can give you a significant performance boost while saving precious data center space. A company can optimize precious data center space by replacing older servers with the Dell PowerEdge FX2 converged architecture, which takes up just 2U, and simultaneously achieve greater VM performance.

¹ See a previous Principled Technologies test report available at www.principledtechnologies.com/Dell/PowerEdge_FX2_networking_costs_0115.pdf

APPENDIX A—DETAILED SERVER CONFIGURATION

Figure 6 provides detailed configuration information for the test systems.

System	Dell PowerEdge R820	Dell PowerEdge FX2 FC830 Server
Power supplies		
Total number	2	2
Vendor and model number	Dell 05NF18X02	Dell D1600E-S0
Wattage of each (W)	750	1,600
Cooling fans		
Total number	6	8
Vendor and model number	San Ace® 60 9GA0612P1J611	2x PIH080Q12H / 6x JX1WX-A00
Volts	12	12
Amps	1.50	8.50 / 3.30
General		
Number of processor packages	4	4
Number of cores per processor	8	12
Number of hardware threads per core	2	2
System power management policy	Balanced	Balanced
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	E5-4650	E5-4650 v3
Stepping	7	2
Socket type	LGA2011	LGA2011-3
Core frequency (GHz)	2.70	2.10
Bus frequency (GT/s)	8.0	9.60
L1 cache (KB)	32	64
L2 cache (KB)	256	256
L3 cache (MB)	20	30
Platform		
Vendor and model number	Dell PowerEdge R820	Dell PowerEdge FC830
Motherboard model number	Dell 0X437F	Dell 0NNF5R
BIOS name and version	Dell 2.2.3	Dell 1.0.6
BIOS settings	Default	Default
Memory module(s)		
Total RAM in system (GB)	192	192
Vendor and model number	Samsung® M393B2G70BH0-YH9	Samsung M393B2G70BH0-YH9
Type	PC3L-10600R	PC3L-10600R
Speed (MHz)	1,333	1,333
Speed running in the system (MHz)	1,333	1,333
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-24	9-9-9-24
Size (GB)	16	16
Number of RAM module(s)	16	16
Chip organization	Dual-sided	Dual-sided

System	Dell PowerEdge R820	Dell PowerEdge FX2 FC830 Server
Rank	Dual	Dual
Operating system		
Name	Microsoft® Windows Server® 2012 R2	Microsoft Windows Server 2012 R2
Build number	6.3.9600	6.3.9600
File system	NTFS	NTFS
Language	English	English
Graphics		
Vendor and model number	Matrox® G200eR	Matrox® G200eR2
Graphics memory (MB)	16	16
RAID controller 1		
Vendor and model number	Dell PERC H710 Adapter	Dell PERC H730 Mini Adapter
Firmware version	21.3.0-0009	25.2.2-0004
Cache size	512MB	1,024MB
RAID controller 2		
Vendor and model number	N/A	Dell PERC FD33xD Adapter
Firmware version	N/A	25.2.2-0004
Cache size	N/A	2,048MB
RAID controller 3		
Vendor and model number	N/A	Dell PERC FD33xD Adapter
Firmware version	N/A	25.2.2-0004
Cache size	N/A	2,048MB
Storage module 1		
Vendor and model number	N/A	Dell PowerEdge FD332
Storage module 2		
Vendor and model number	N/A	Dell PowerEdge FD332
Drive type 1		
Vendor and model number	Seagate® ST300MM0006	Seagate ST300MM0006
Number of drives	7	7
Size (GB)	300	300
RPM	10K	10K
Type	2.5" SAS	2.5" SAS
Drive type 2		
Vendor and model number	Intel SSDSC2BA400G3	SanDisk 5001E820027FA4CO
Number of drives	1	12
Size (GB)	400	200
RPM	N/A	N/A
Type	2.5" SATA	2.5" SAS
Ethernet adapter 1		
Vendor and model number	Intel Gigabit 4P I350-t	Broadcom® NetXtreme II BCM57810
Type	Integrated	Integrated

System	Dell PowerEdge R820	Dell PowerEdge FX2 FC830 Server
Ethernet adapter 2		
Vendor and model number	Intel 10 Gigabit Server Adapter X540-t	Broadcom NetXtreme II BCM57810
Type	PCI-Express	Integrated
Optical drive(s)		
Vendor and model number	PLDS DVD+-RW DS-8A5SH	N/A
Type	Internal	N/A

Figure 6: System configuration information for the two test systems.

APPENDIX B—DETAILED TEST METHODOLOGY

Our test configuration consisted of one Dell PowerEdge R820 representing the older generation server, and one Dell PowerEdge FX2 solution with one FC830 server and two FD332 storage blocks. Both solutions used Windows Server 2012 R2 with Hyper-V as the hypervisor, and had virtual machines running Windows Server 2012 R2 with a single instance of SQL Server 2014 and a 40GB database. Each virtual machine was configured with eight vCPUs, 8 GB of memory, and three volumes: a 40GB volume for operating system, a 50GB volume for database logs, and a 100GB volume for database files.

We configured the eight-disk bay Dell PowerEdge R820 with 192 GB of memory, and installed seven 300GB 10K SAS disks and one 400GB SAS SSD. We configured three of the 300GB 10K SAS disks on a RAID5 configuration to install the hypervisor, and to host virtual machine files and database logs. We chose RAID5 since drive bays were limited on the PowerEdge R820, and we needed to increase capacity to reach at least four VMs. The other four 300GB 10K SAS disks were set up on a RAID10 configuration and used it to host database files exclusively. Lastly, we set up the 400GB SSD disk on a RAID0 configuration to be used as a CacheCade caching device.

We configured the Dell PowerEdge FX2 with one FC830 server, 192 GB of memory and installed eight 300GB 10K SAS disks on that server. Two of those disks we set up on a RAID1 configuration to install the hypervisor while the remaining six disks we set up on a RAID5 configuration to host virtual machine files. This FX2 also had two FD332 storage blocks, and outfitted each block with ten 300GB 10K SAS disks, which we set up on a RAID10 configuration to host database and logs files, and six 200GB SAS SSD disks, which we set up on a RAID10 configuration to be used as a SanDisk DAS Cache caching device. Our final configuration had two large volumes for database files and logs and two SSD-based SanDisk caching devices.

Our infrastructure and servers under test were connected using a Dell Networking 6224 switch over 1Gb network connections. We used an eight-port 1Gb pass-through module to connect the FX2 solution to the test network, and used the onboard 1Gb connections on the back of the Dell PowerEdge R820 to connect to the test network.

We used DVD Store 2.1 scripts to generate a 40GB database and to execute the test workload using 32 threads per client and a 50-millisecond think-time.

Creating OS, logs, and database and SanDisk DAS Cache volumes on Dell PowerEdge FC830

1. Power on the server and press CTL-R to enter the RAID controller configuration.
2. Select the local PERC H730 Mini controller.
3. Press F2 to create a new virtual disk and select (2) 300GB disks:
 - RAID-1
 - VD name: OS volume
4. Click Advanced, and select Initialize.
5. Click OK.
6. Press F2 to create a new virtual disk and select (6) 300GB disks:
 - RAID-5
 - VD name: VMs volume
7. Click Advanced, and select Initialize.
8. Click OK.

9. Hit ESC and select the controller on the first FD332 storage block.
10. Press F2 to create a new virtual disk and select (10) 300GB disks:
 - RAID-10
 - VD name: Database and Logs Volume
11. Click Advanced, and select Initialize.
12. Click OK.
13. Press F2 to create a new virtual disk and select (6) 200GB SSD disks:
 - RAID-10
 - VD name: SanDisk DAS Cache
14. Click Advanced, and under Read Policy, select No Read Ahead.
15. Under Write Policy, select Write Through, and select Initialize.
16. Click OK.
17. Hit ESC, and select OK to exit.
18. Repeat steps 9 – 17 on second storage block.
19. Reboot the server.

Creating OS, logs, and database and CacheCade volumes on Dell PowerEdge R820

1. Power on the server and press CTL-R to enter the RAID controller configuration.
2. Press F2 to create a new virtual disk and select (3) 300GB disks:
 - RAID-5
 - VD name: OS+Logs volume
3. Click Advanced, and select Initialize.
4. Click OK.
5. Press F2 to create a new virtual disk and select (4) 300GB disks:
 - RAID-10
 - VD name: Database volume
6. Click Advanced, and select Initialize.
7. Click OK.
8. Press F2 and select Create CacheCade Virtual Disk
9. Select the 400GB disk and click OK.
10. Hit ESC and select OK to exit.
11. Reboot the server.

Installing Microsoft Windows Server 2012 R2 Datacenter Edition

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When the option appears, press F11 to enter the Boot Manager.
3. Select BIOS Boot Menu.
4. Select SATA Optical Drive, and press Enter.
5. Press any key when prompted to boot from DVD.
6. When the installation screen appears, click My language is English (United States).

7. Leave language, time/currency format and input method as default, and click Next.
8. Click Install now.
9. When the installation prompts you, enter the product key.
10. Select Windows Server 2012 R2 Datacenter (Server with a GUI), and click Next.
11. Check I accept the license terms, and click Next.
12. Click Custom: Install Windows only (advanced).
13. Select Drive 0 Unallocated Space, and click Next, at which point Windows begins automatically, and restarts automatically after completing.
14. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
15. Log in with the password you set up previously.

Creating new disks in Windows Server 2012 R2 Datacenter Edition

1. In the Server Manager window, click Tools, and click Computer Management.
2. In the left pane, click Disk Management.
3. Right-click the shaded area, and click New Simple Volume.
4. On the New Simple Volume Wizard that pops up, click Next.
5. Select a size (maximum, for all volumes), and click Next.
6. Assign a drive letter, and click Next.
7. For the log and database volume select Format this volume with the following settings, and leave the default settings. Click Next.
8. For the SAS SSD DAS Cache volumes, select Do not format this volume to make it a RAW device.
9. Click Finish.

Configuring Windows Update

1. In the left pane of the Server Manager window, click Local Server.
2. In the main frame, next to Windows Update, click Not configured.
3. In the Windows Update window, in the main pane, click Let me choose my settings.
4. Under Important updates, select Never check for updates (not recommended), and click OK.
5. In the left pane, click Check for updates, and install all available updates.
6. Close the Windows Update window.

Installing and configuring SanDisk DAS Cache on Dell PowerEdge FC830

1. Double-click the .msi file to start installation.
2. Select the Caching Engine and GUI Management components, and click Next.
3. Click Install to initiate the installation process.
4. Upon completion, click Finish and Reboot the server.
5. Start SanDisk DAS Cache by double-clicking on the desktop shortcut.
6. Select Configure this Machine.
7. Under Cache is Not Configured, select Configure.
8. Select Write-back as the cache mode.
9. Select the SSD volume you want SanDisk DAS Cache to use for caching.

10. Select the database volume to accelerate, and click Next.
11. Enter a unique Cache Name, and click Next.
12. At the summary screen, click Finish.
13. Confirm volume acceleration by clicking on the Volumes tab.
14. Repeat steps 9 to 13 to configure the second caching device.

Installing Hyper-V and creating virtual machines.

1. Log in into the Windows Server 2012 R2 server.
2. Open Server Management and click on Manage.
3. Click on Add roles and Features.
4. Under Installation type select Role-based and click Next.
5. Select the local system and click Next.
6. Select the Hyper-V roles and click Next.
7. Select Add features and click Next.
8. Choose a port for the virtual switch and click Next.
9. Choose whether or not you want to add live migration capabilities, and click Next.
10. Set the default storage, and click Next.
11. Check the box for automatic restart, and click Install.

Creating a new Virtual machine

1. Open the Hyper-V manager.
2. Right-click the host server, and choose New→Virtual Machine
3. Click Next on the Before You Begin screen.
4. Name the VM, and choose the storage option. Click Next.
5. Choose Generation 2, and click Next.
6. Enter 8192 MB for the startup memory, and click Next.
7. Choose the network connection, and click Next.
8. Choose 40GB for the disk size, and click Next.
9. Choose Install an operating system later, and click Next.
10. Click Finish.
11. When the VM has been created, right click the VM and choose Settings...
12. Change the number of processors to 8, and click Apply.
13. Click on the SCSI Controller, highlight Hard Drive, and click Add.
14. Choose Virtual hard disk, and click New.
15. Click Next on the Before You Begin screen.
16. Choose Fixed size, and click Next.
17. Name the HDD Database, and choose a volume for the location. Click Next.
18. Set the size to 100 GB, and click Next.
19. Click Finish.

20. Repeat steps 13 through 19 two more times to create a 50GB Log VHD.
21. Install Windows Server 2012 R2 and updates on the VM following the same steps outlined in previous sections.
22. Add the three additional HDDs to the VM using Windows Disk Manager.

Installing SQL Server 2014 on virtual machines

1. Insert the installation DVD for SQL Server 2012 into the DVD drive.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2014 DVD, and double-click it.
3. In the left pane, click Installation.
4. Click New SQL Server stand-alone installation or add features to an existing installation.
5. Select the Enter the product key radio button, and enter the product key. Click Next.
6. Click the checkbox to accept the license terms, and click Next.
7. Click Use Microsoft Update to check for updates, and click Next.
8. Click Install to install the setup support files.
9. If no failures are displayed, click Next.
10. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
11. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools –Basic, and Management Tools – Complete. Click Next.
12. At the Installation Rules screen, after the check completes, click Next.
13. At the Instance configuration screen, leave the default selection of default instance, and click Next.
14. At the Server Configuration screen, choose NT Service\SQLSERVERAGENT for SQL Server Agent, and choose NT Service\MSSQLSERVER for SQL Server Database Engine. Change the Startup Type to Automatic. Click Next.
15. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
16. Enter and confirm a password for the system administrator account.
17. Click Add Current user. This may take several seconds.
18. Click Next.
19. At the Error and usage reporting screen, click Next.
20. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
21. At the Ready to Install screen, click Install.
22. After installation completes, click Close.
23. Close the installation window.
24. Navigate to the SQL Server 2014 DVD, and double-click it.
25. In the left pane, click Installation.
26. Click New SQL Server stand-alone installation or add features to an existing installation.

27. At the Installation Type screen, select Perform a new Installation of SQL Server 2014. Click Next.
28. Select the Enter the product key radio button, and enter the product key. Click Next.
29. Click the checkbox to accept the license terms, and click Next.
30. At the Setup Role screen, select SQL Feature Installation. Click Next.
31. At the Feature Selection screen, select Database Engine Services and Full-Text and Semantic Extractions for Search. Click Next.
32. At the Instance Configuration screen, select named instance, and enter a name. Click Next.
33. At the Server Configuration screen, choose NT Service\SQLSERVERAGENT for SQL Server Agent, and choose NT Service\MSSQLSERVER for SQL Server Database Engine. Change the Startup Type to Automatic. Click Next.
34. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
35. Enter and confirm a password for the system administrator account.
36. Click Add Current user.
37. Click Next.
38. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
39. At the Ready to Install screen, click Install.
40. After installation completes, click Close.
41. Reboot the virtual machine.

Configuring the database

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 40GB database size and the database platform on which we ran, Microsoft SQL Server. We ran the Install.pl script on a utility system running Linux. The Install.pl script generated the database schema.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server. We built the 40GB database in SQL Server, and then performed a full backup, storing the backup file remotely for quick access. We used that backup file to restore the server between test runs.

The only modification we made to the schema creation scripts were the specified file sizes for our database. We explicitly set the file sizes higher than necessary to ensure that no file-growth activity would affect the outputs of the test. Other than this file size modification, we created and loaded the database in accordance to the DVD Store documentation. Specifically, we followed these steps:

1. We generated the data, and created the database and file structure using database creation scripts in the DS2 download. We made size modifications specific to our 40GB database, and made the appropriate changes to drive letters.
2. We transferred the files from our Linux data generation system to a Windows system running SQL Server.
3. We created database tables, stored procedures, and objects using the provided DVD Store scripts.
4. We set the database recovery model to bulk-logged to prevent excess logging.

5. We loaded the data we generated into the database. For data loading, we used the import wizard in SQL Server Management Studio. Where necessary, we retained options from the original scripts, such as Enable Identity Insert.
6. We created indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. We updated statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, we created a ds2user SQL Server login using the following Transact SQL (TSQL) script:

```
USE [master]
GO
CREATE LOGIN [ds2user] WITH PASSWORD=N'',
    DEFAULT_DATABASE=[master],
    DEFAULT_LANGUAGE=[us_english],
    CHECK_EXPIRATION=OFF,
    CHECK_POLICY=OFF
GO
```

9. We set the database recovery model back to full.
10. We created the necessary full text index using SQL Server Management Studio.
11. We created a database user, and mapped this user to the SQL Server login.
12. We then performed a full backup of the database. This backup allowed us to restore the databases to a pristine state relatively quickly between tests.

Running the DVD Store tests

We created a series of batch files, SQL scripts, and shell scripts to automate the complete test cycle. DVD Store outputs an orders-per-minute metric, which is a running average calculated through the test. In this report, we report the last OPM reported by each client/target pair.

Each complete test cycle consisted of the following general steps:

1. Clean up prior outputs from the target system and the client driver system.
2. Drop the database from the target.
3. Restore the database on the target.
4. Shut down the target.
5. Reboot the host and client system.
6. Wait for a ping response from the server under test (the hypervisor system), the client system, and the target.
7. Let the test server idle for 20 minutes.
8. Start the DVD Store driver on the client.

We used the following DVD Store parameters for testing:

```
ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=60 --
n_threads=32 --db_size=40GB --think_time=0.05 --detailed_view=Y --
warmup_time=5 --csv_output=<drive path>
```

ABOUT PRINCIPLED TECHNOLOGIES



Principled Technologies, Inc.
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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.

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