



The science behind the report:

## Serve more online customers with new Dell EMC servers and Microsoft SQL Server 2017 software

This document describes what we tested, how we tested, and what we found. To learn how these facts translate into real-world benefits, read the report [Serve more online customers with new Dell EMC servers and Microsoft SQL Server 2017 software](#).

On April 17, 2018, we finalized the hardware and software configurations we tested. Updates for current and recently released hardware and software appear often, so unavoidably these configurations may not represent the latest versions available when this report appears. For older systems, we chose configurations representative of typical purchases of those systems. We concluded hands-on testing on April 20, 2018.

## Our results

The table below presents our findings in detail.

	OPM	Application latency (ms)	Data read latency (ms)	Data write latency (ms)
Dell EMC™ PowerEdge™ R740xd	197,635	6	0.22	0.65
Dell EMC PowerEdge R720xd	29,135	48	24.00	31.00
Improvement (percentage)	578%	88%	99%	98%

## System configuration information

The table below presents detailed information on the systems we tested.

Server configuration information	Dell EMC PowerEdge R740xd	Dell EMC PowerEdge R720xd
BIOS name and version	Dell 1.3.7	Dell 2.6.1
Non-default BIOS settings	None	Virtualization enabled
Operating system name and version/build number	Windows Server® 2016 Standard, Version 1607, Build 14393.2155	Windows Server 2012 R2 Datacenter, Version 6.3, Build 9600
Date of last OS updates/patches applied	03/19/18	03/21/18
Power management policy	Performance	Performance
Processor		
Number of processors	2	2
Vendor and model	Intel® Xeon® Gold 6130	Intel Xeon E5-2640
Core count (per processor)	16	6
Core frequency (GHz)	2.10	2.50
Stepping	H0	C2
Memory module(s)		
Total memory in system (GB)	192	192
Number of memory modules	12	12
Vendor and model	Hynix HMA82GR7AFR8N-VK	Hynix HMT42GR7MFR4C-PB
Size (GB)	16	16
Type	DDR4-2666	PC3-12800R
Speed (MHz)	2,666	1,333
Speed running in the server (MHz)	2,666	1,333
Storage controller		
Vendor and model	Dell PERC H730P Mini	Dell PERC H710P Mini
Cache size (GB)	1GB	1GB
Firmware version	25.5.4.0006	21.3.5-0002
Driver version	6.604.06.00	6.805.03.00
Local storage (type A)		
Number of drives	2	24
Drive vendor and model	Dell ST300MP0026	Dell ST9300653SS
Drive size (GB)	300	300
Drive information (speed, interface, type)	15K, 12Gbps, SAS, HDD	15K, 6Gbps, SAS, HDD

Server configuration information	Dell EMC PowerEdge R740xd	Dell EMC PowerEdge R720xd
Local storage (type B)		
Number of drives	12	N/A
Drive vendor and model	Dell THNSF8960CCSE	N/A
Drive size (GB)	960	N/A
Drive information (speed, interface, type)	6Gbps, SATA, SSD	N/A
Network adapter		
Vendor and model	QLogic BCM57800 10 GbE	Intel Gigabit 4P I350-t rNDC
Number and type of ports	2 x 1GbE, 2 x 10GbE	4 x 1GbE
Driver version	7.13.104.0	12.14.7.0
Cooling fans		
Vendor and model	Nidec UltraFlo 4VXP3-X30	San Ace 60 9GA0612P1J611
Number of cooling fans	6	6
Power supplies		
Vendor and model	Dell D1600E-S0	Dell E1100E-S0
Number of power supplies	2	2
Wattage of each (W)	1,600	1,100

## How we tested

We ran the DVD Store 2 test from a client server on a Dell EMC PowerEdge R720xd with 24 15K SAS HDDs. We first began by splitting up the disks into three RAID10 volumes. We used two disks for our OS volume, 16 disks for our Data volume, and six disks for our Log volume. We started testing with the R720xd, tuning the warm-up time, thread count, and think time until the benchmark ran at peak orders per minute (OPM).

We then ran the same test using the same method on a PowerEdge R740xd server configured with two 300GB 12Gbps 15K SAS HDDs and 12 960GB 6Gbps SATA SSDs. We used the two HDDs in a RAID1 configuration for our OS volume, 10 SSDs in RAID10 for our Data volume, and the remaining two SSDs in RAID1 for our Log volume.

## Installing Microsoft Windows Server 2012 R2 on the Dell EMC PowerEdge R720xd server

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. When prompted to boot from DVD, press any key.
6. When the installation screen appears, click My language is English (United States).
7. Leave the 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 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. Windows will begin and restart automatically.
14. At the Settings page, fill in the Password and Reenter Password fields with the same password.
15. Log in with the password you set up in the previous step.

## Configuring Windows Update on the Dell EMC PowerEdge R720xd server

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.

## Disabling the Windows Update Service on the Dell EMC PowerEdge R720xd server

1. After you have installed all updates, press the Start Menu button and type Services.
2. Scroll down, and right-click on the Windows Update service.
3. Click Properties.
4. Choose Disabled as the startup type.
5. Stop the service if it is running.
6. Click Apply.
7. Click OK to close the window.

## Formatting a Windows NTFS volume for SQL Server® on the Dell EMC PowerEdge R720xd server

1. Right-click the start icon, and click Disk Management.
2. Right-click the disk, and click Online.
3. Right-click the disk again, and click Initialize.
4. Right-click an unallocated area, and select New Simple Volume.
5. Click Next.
6. Click Next.
7. Assign a letter path, and click Next.
8. Set the Allocation Unit Size to 64K, and name the volume label.
9. Click Next.
10. Click Finish.
11. Repeat steps 1-10 on all data and log volumes.

## Installing SQL Server 2008 R2 Standard on the PowerEdge R720xd server

1. Mount the installation DVD for SQL Server 2008 R2 Standard.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, double-click on SQL Server 2008 R2 Standard DVD.
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, enter the product key, and click Next.
6. Click the check-box 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 appear, click Next. (If a failure does appear, resolve the issue and start the installation again.)
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 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.
15. Change the Startup Type to Automatic, and click Next.
16. At the Database Engine Configuration screen, select the authentication method you prefer. In our tests, we selected Mixed Mode.
17. Enter and confirm a password for the system administrator account.
18. Click Add Current user. This may take several seconds.
19. Click Next.
20. At the Error and usage reporting screen, click Next.
21. At the Installation Configuration Rules screen, check to that ensure no failures or relevant warnings appear, and click Next.
22. At the Ready to Install screen, click Install.
23. After installation completes, click Close.
24. Close the installation window.

## Installing Windows Server 2016 Standard on the PowerEdge R740xd server

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 UEFI Boot Menu.
4. Select the boot media, and press Enter.
5. When prompted to boot from DVD, press any key.
6. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
7. Click Install now.
8. When the installation prompts you, enter the product key.
9. Select Windows Server 2016 Standard Edition (Server with a GUI), and click Next.
10. Check I accept the license terms, and click Next.
11. Click Custom: Install Windows only (advanced).
12. Select Drive 0 Unallocated Space, and click Next. Windows will begin and restart automatically.
13. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
14. Log in with the password you set up in the previous step.

## Formatting a Windows NTFS volume for SQL Server on the PowerEdge R740xd server

1. Right-click the start icon, and click Disk Management.
2. Right-click the disk, and click Online.
3. Right-click the disk again, and click Initialize.
4. Right-click an unallocated area, and select New Simple Volume.
5. Click Next.
6. Click Next.
7. Assign a letter path, and click Next.
8. Set the Allocation Unit Size to 64K, and name the Volume Label.
9. Click Next.
10. Click Finish.
11. Repeat steps 1-10 on all Data and Log volumes.

## Installing SQL Server 2017 Standard on the PowerEdge R740xd server

1. Attach the installation media ISO for SQL Server 2017 Standard to the host.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2017 Standard 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. Enter the SQL Standard license key, and click Next.
6. Click the check-box to accept the license terms, and click Next.
7. Click Use Microsoft Update to check for updates, and click Next.
8. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, and Client Tools Backwards Compatibility.
9. Click Next.
10. At the Instance configuration screen, leave the default selection of default instance, and click Next.
11. At the Server Configuration screen, click Next.
12. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
13. Enter and confirm a password for the system administrator account.
14. Click Add Current user. This may take several seconds.
15. Click Next.
16. At the Ready to Install screen, click Install.
17. Close the installation window.
18. Download and Install SQL Server Management Studio.

## Installing and configuring the database clients

For the DS2 scripts, we used a single client to simulate a user putting a load on the server. For our client, we copied the DS2 driver files from <https://github.com/dvdstore/ds21>. We installed the .NET 3.5 framework on each client, as the DS2 test executable requires at least .NET2.0. We followed this process for the installation:

1. Install Microsoft Windows Server 2016 Standard on the client server.
2. Enter a password for the administrator login.
3. Select Eastern Time Zone.
4. Use typical settings for the Network installation.
5. Type Workgroup for the workgroup.
6. Install Windows Updates and .NET 3.5 framework, and copy the DVD Store client executable into the C:\ClientShare folder.
  - Note: We customized the DS2 driver adding options to specify the SQL database name, log performance output to a CSV file, and adjust OPM report rate frequency. Additionally, we added the output of Orders Per Second (OPS) for more detailed reporting during tuning.
7. Assign a valid IP address and subnet mask to the client's NIC.

## Setting up DVD Store

### Data generation overview

We built the database schema using the scripts in the DS2 distribution package. First, we extracted the DS2 folder on a Linux server. Prior to running the data generation script, we recompiled each generation script to upgrade them to 64-bit to avoid integer limits for larger datasets. You can find these files at ds2/data\_files in three different folders: orders, cust, and prod. Run the following from the orders folder:

```
gcc -o ds2_create_orders ds2_create_orders.c -lm
gcc -o ds2_create_inv ds2_create_inv.c -lm
```

Run the following from the cust folder:

```
gcc -o ds2_create_cust ds2_create_cust.c -lm
```

Run the following from the prod folder:

```
gcc -o ds2_create_prod ds2_create_prod.c -lm
```

We used the Install\_DVDstore.pl script to generate 400 GB of data and the SQL Server database creation scripts. We then copied the data files and scripts to the R720xd and the R740xd servers. We ran the database creation scripts on each server to create the 400GB database for SQL Server 2008 R2 Standard and SQL Server 2017 Standard, making changes to file locations, expanding to four files per file group, and increasing the initial datafile sizes. For SQL Server 2017 Standard, we ran the DS2 database in SQL 2014 compatibility mode due to some issues with DS2 and newer SQL database versions. We then created a full backup of each database for restoring in between test runs. We stored the backup file on a PCIe drive for the Dell EMC PowerEdge R720xd for quick access. On the PowerEdge R740xd, we stored the backup file on the Data volume.

### Performing the test

Using the legacy server as our base system, we ran the DS2 test while monitoring disk utilization at different think times and thread counts, as well as the time to fully cache the memory. We determined that a warm-up time of 45 minutes enabled SQL Server to fully utilize RAM on the legacy PowerEdge R720xd system. The PowerEdge R740xd server took less time to fill the RAM, so we used only a 30-minute warm-up time. Once we determined that a run time of 30 minutes with 0 think time and 24 threads provided peak OPM performance for the R720xd server, we used these same parameters on the PowerEdge R740xd server. On each server under test, we created a user-defined data collector set in Perfmon to capture CPU, RAM, and disk performance counters.

1. Start the custom Perfmon data collector set on the target host to capture CPU, RAM, and disk counters.

2. Run DS2 driver command on client:

```
ds2sqlserverdriver.exe -target=SQLServer_IP --ramp_rate=10 --run_time=30 --n_threads=24 --db_size=400GB --think_time=0 --detailed_view=Y --warmup_time=30 --report_rate=1 --csv_output=C:\ds2_output\filename.csv
```

3. When the run finishes, stop Perfmon.

4. Save the DS2 results text file and Perfmon output.

5. Restore the database backup using the script on page 8.

6. Reboot the server.

7. Repeat steps 2-6 two times to account for variance.

## DS2 database restore script

We used the following SQL script to restore the DS2 database backup in between test runs. We used the same script for both solutions, changing the backup and datafile locations accordingly.

```
USE [master]
GO

IF EXISTS (SELECT * FROM sys.server_principals WHERE name = N'ds2user')
DROP LOGIN [ds2user]
GO

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

USE [master]
GO
IF EXISTS (SELECT name FROM sys.databases WHERE name = N'DS2')
DROP DATABASE [DS2]
GO

RESTORE DATABASE [DS2]
FROM DISK = N'E:\Backup\400GB-SQL2017.bak'
WITH FILE = 1,
MOVE N'primary' TO N'E:\Data\ds.mdf',
MOVE N'ds_misc' TO N'E:\Data\ds_misc.ndf',
MOVE N'cust1' TO N'E:\Data\cust1.ndf',
MOVE N'cust2' TO N'E:\Data\cust2.ndf',
MOVE N'cust3' TO N'E:\Data\cust3.ndf',
MOVE N'cust4' TO N'E:\Data\cust4.ndf',
MOVE N'orders1' TO N'E:\Data\orders1.ndf',
MOVE N'orders2' TO N'E:\Data\orders2.ndf',
MOVE N'orders3' TO N'E:\Data\orders3.ndf',
MOVE N'orders4' TO N'E:\Data\orders4.ndf',
MOVE N'ind1' TO N'E:\Data\ind1.ndf',
MOVE N'ind2' TO N'E:\Data\ind2.ndf',
MOVE N'ind3' TO N'E:\Data\ind3.ndf',
MOVE N'ind4' TO N'E:\Data\ind4.ndf',
MOVE N'ds_log' TO N'H:\Log\ds_log.ldf',
NOUNLOAD, STATS = 10
GO

USE [DS2]
GO

IF EXISTS (SELECT * FROM sys.database_principals WHERE name = N'ds2user')
DROP USER [ds2user]
GO

USE [DS2]
GO
CREATE USER [ds2user] FOR LOGIN [ds2user]
GO
USE [DS2]
GO
EXEC sp_addrolemember N'db_owner', N'ds2user'
GO

*****JUST FOR SQL SERVER 2017*****

ALTER DATABASE [DS2]
SET COMPATIBILITY_LEVEL = 120
GO
```

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