The science behind the report:

Reap better SQL Server OLTP performance with new-generation Dell EMC PowerEdge MX servers

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 Reap better SQL Server OLTP performance with new-generation Dell EMC PowerEdge MX servers.

We concluded our hands-on testing on March 8, 2021. During testing, we determined the appropriate hardware and software configurations and applied updates as they became available. The results in this report reflect configurations that we finalized on March 7, 2021 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

To learn more about how we have calculated the wins in this report, go to http://facts.pt/calculating-and-highlighting-wins. Unless we state otherwise, we have followed the rules and principles we outline in that document.

Table 1: Results of our DVD Store 3 testing. These scores are the median of three runs.

	Dell EMC™ PowerEdge™ MX740c vSAN cluster	Dell EMC PowerEdge MX750c vSAN cluster	Dell EMC PowerEdge MX750c vSAN cluster
Number of VMs	**12**	**12**	**15**
Total orders per minute	**151,923**	**180,462**	**206,864**
Average application response time (ms)	**109.8**	**89.6**	**100.4**
Average orders per minute per VM	**12,660**	**15,038**	**13,790**
Client 1	12,438	15,391	14,018
Client 2	13,170	15,141	14,010
Client 3	13,166	15,585	13,487
Client 4	12,385	15,199	13,831
Client 5	12,459	15,088	13,350
Client 6	13,094	14,805	15,277
Client 7	11,771	14,749	13,228

	Dell EMC™ PowerEdge™ MX740c vSAN cluster	Dell EMC PowerEdge MX750c vSAN cluster	Dell EMC PowerEdge MX750c vSAN cluster
Client 8	12,652	14,772	13,054
Client 9	12,593	14,497	15,205
Client 10	12,767	15,076	12,744
Client 11	12,732	14,997	13,413
Client 12	12,696	15,162	13,404
Client 13	NA	NA	14,014
Client 14	NA	NA	14,247
Client 15	NA	NA	13,582

System configuration information

Table 2: Detailed configuration information on the servers we tested.

System configuration information	3 x Dell EMC PowerEdge MX740c	3 x Dell EMC PowerEdge MX750c
BIOS name and version	Dell 2.9.4	Dell 0.4.2
Non-default BIOS settings	Virtualization performance mode	Virtualization performance mode
Operating system name and version/build number	VMware® ESXi 7.0.1 17551050 U1 P30	VMware ESXi 7.0.1 17551050 U1 P30
Date of last OS updates/patches applied	03/07/21	03/07/21
Power management policy	Performance	Performance
Processor		
Number of processors	2	2
Vendor and model	Intel® Xeon® Gold 6230	Intel Xeon Gold 6330
Core count (per processor)	20	28
Core frequency (GHz)	2.10	2.00
Stepping	7	6
Memory module(s)		
Total memory in system (GB)	192	512
Number of memory modules	12	16
Vendor and model	Hynix HMA82GR7AFR8N-VK	Hynix HMAA4GR7AJR8N-XN
Size (GB)	16	32
Type	PC4-21300	PC4-23400
Speed (MHz)	2,666	2,933
Speed running in the server (MHz)	2,666	2,933
Storage controller		
Vendor and model	VMware NVMe™ PCIe®	VMware NVMe PCIe
Driver version	1.2.3.9-2vmw.701.0.0.16850804	1.2.3.9-2vmw.701.0.0.16850804
Local storage (type A)		
Number of drives	4	4
Drive vendor and model	Dell Ent NVMe AGN MU U.2 1.6TB	Dell Ent NVMe AGN MU U.2 3.2TB
Drive size (GB)	1,600	3,200
Drive information (speed, interface, type)	U.2 NVMe, 8GT/s	U.2 NVMe, 16GT/s
Network adapter		
Vendor and model	Intel Ethernet 25G 2P XXV710 Mezz	Broadcom Adv Quad 25Gb Ethernet
Number and type of ports	2 x 25GbE	4 x 25GbE
Driver version	1.8.1.123-1vmw.701.0.0.16850804	216.0.50.0-16vmw.701.0.0.16850804

Table 3: Configuration information for the server enclosure we tested.

System configuration information	Dell EMC PowerEdge MX7000 Modular Chassis
Number of management modules	2
Management module firmware revision	1.30.00
I/O modules	
Vendor and model number	Dell EMC Networking MX9116N Fabric Switching Engine
I/O module firmware revision	10.5.1.7.273
Number of modules	2
Occupied bay(s)	A1, A2
Power supplies	
Vendor and model number	Dell 0H7TFGA02
Number of power supplies	6
Wattage of each (W)	3,000
Cooling fans	
Vendor and model number	Dell 0FHH0KA00
Number of fans	9

Table 4: Configuration information for the network switches we tested.

System configuration information	2 x Dell EMC Networking S4048-ON
Firmware revision	10.5.1.4.249
Number and type of ports	48 x SFP+ 10GbE, 6 x QSFP+ 40GbE
Number and type of ports used in test	12 x SFP+ 10GbE, 8 x QSFP+ 40GbE

How we tested

Using two existing VMware Cloud Foundation™-based vSAN™ workload clusters on Dell PowerEdge R740c and R750c compute sleds in a parallel study, we created a test environment consisting of Microsoft SQL Server 2019 servers running on Windows Server 2019. The previous-generation cluster and the new cluster both used four PCIe 4.0-capable NVMe drives; however, the older architecture supports PCIe 3.0 speeds, while the newer architecture supports PCIe 4.0. The vSAN configuration parameters were identical, as were the individual VM configurations. We first tested the previous-generation cluster to find its peak performance configuration in DVD Store 3, and then replicated that on the new-generation cluster. Finding additional compute headroom on the newer-generation cluster, we added one more VM to each host in the cluster and retested with the same parameters to fully saturate the processors' capacity.

Creating the SQL Server Master VM

1. In VMware vCenter®, navigate to Virtual Machines.
2. To create a new VM, click the icon.
3. Leave Create a new virtual machine selected, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Place the VM on the desired host with available CPUs, and click Next.
6. Select the appropriate datastore to host the VM, and click Next.
7. Select the appropriate guest OS, and click Next.
8. In the Customize Hardware section, use the following settings:
    a. Set the vCPU count to 12.
    b. Set the Memory to 38GB.
    c. Add 1 x 90GB VMDK for OS / Backup, 1 x 250GB VMDK for database files, and 1 x100GB VMDK for database logs. Set OS VMDK to thin provisioning, and set all other VMDKs to thick provision eager zeroed.
    d. Create two additional VMware Paravirtual SCSI controllers, and assign the data and log VMDKs to the new controllers.
    e. Attach the OS ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.

Installing Windows Server 2019

1. We used the following steps to install and configure SQL Server VMs.
2. Attach the Windows Server 2019 ISO to the virtual machine.
3. Open the VM console, and start the VM.
4. When the system prompts you to boot from DVD, press any key.
5. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
6. Click Install now.
7. When the installation prompts you, enter the product key.
8. Select Windows Server 2019 Datacenter Edition (Server with a GUI), and click Next.
9. Check I accept the license terms, and click Next.
10. Click Custom: Install Windows only (advanced).
11. Select Drive 0 Unallocated Space, and click Next. This starts Windows automatically, and Windows will restart automatically after completing.
12. When the Settings page appears, fill in the Password and Reenter Password fields with the same password. Log in with the password you set up previously.
13. Install VMware Tools in the VMs hosted on the ESXi servers.
14. From Server Manager, disable Windows Firewall.
15. Run Windows Updates.

Installing SQL Server 2019

1. Attach the installation media ISO for SQL Server 2019 to the VM.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2019 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. Specify Evaluation as the edition you are installing, and click Next.
6. To accept the license terms, click the checkbox, 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, accept defaults, and 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. In the SQL Server Installation Center, click on Install SQL Server Management Tools.
19. Click Download SQL Server Management Studio.
20. Click Run.
21. When the Microsoft SQL Server Management Studio screen appears, click Install.
22. When the installation completes, click Close.

Configuring and running the DVD Store 3 benchmark

Generating data

We generated the data using the Install.pl script included with DVD Store 3 (DS3), providing the parameters for our 100GB database size and the database platform we used. We ran the Install.pl script on a utility system running Linux® to generate 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 2019. We built the 100GB database in SQL Server, then performed a full backup, storing the backup file remotely for quick access.

We used that backup file to restore the database when necessary.

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 with the DVD Store documentation. Specifically, we followed these steps:

1. Generate the data, and create the database and file structure using database creation scripts in the DS3 download. Make size modifications specific to the 100GB database, and make the appropriate changes to drive letters.
2. Transfer the files from the Linux data generation system to a Windows system running SQL Server.
3. Create database tables, stored procedures, and objects using the provided DVD Store scripts.
4. To prevent excess logging, set the database recovery model to bulk-logged.
5. Load the data you generated into the database. For data loading, use the import wizard in SQL Server Management Studio. Where necessary, retain options from the original scripts, such as Enable Identity Insert.
6. Create indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. Update statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, create 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
EXEC master..sp_addsrvrolemember @loginame = N'ds2user',
```

```
    @rolename = N'sysadmin'
USE [DS3]
    CREATE USER [ds3DS3user] FOR LOGIN [ds2user]
    EXEC sp_addrolemember N'db_owner', N'ds3DS3user'
    USE [master]
    CREATE USER [ds3masteruser] FOR LOGIN [ds2user]
    EXEC sp_addrolemember N'db_owner', N'ds3masteruser'
```

9. Set the database recovery model back to full.
10. Create the necessary full text index using SQL Server Management Studio.
11. Create a database user, and map this user to the SQL Server login.
12. Perform a full backup of the database. This backup allows you to restore the databases to a pristine state.

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 study, we report the last OPM that each target reported.

Each complete test cycle consisted of general steps:

1. Clean up prior outputs from the target system.
2. Drop the database from the target.
3. Restore the database on the target.
4. Reboot the target.
5. Wait for a ping response from the server under test and the client system.
6. Let the test server idle for 10 minutes.
7. Start the DVD Store driver on the clients.

We used the following DVD Store 3 parameters for testing:

```
ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=60 --n_threads=16 --db_
    size=100GB --think_time=0.001 --detailed_view=Y --warmup_time=5 --report_rate=1 --pct_
    newcustomers=20 --pct_newmember=1 --pct_newreviews=5 --pct_newhelpfulness=10 --csv_
    output=<drivepath>
```


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