



The science behind the report:

# Support more VMs with large databases and memory footprints by adding Intel Optane DC persistent memory to your Dell EMC PowerEdge R940 server

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 [Support more VMs with large databases and memory footprints by adding Intel Optane DC persistent memory to your Dell EMC PowerEdge R940 server](#).

We concluded our hands-on testing on November 15, 2019. 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 October, 20, 2019 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

## Our results

The table below shows the number of VMs each configuration supported on three separate test runs. The Dell EMC™ PowerEdge™ R940 server with Intel Optane DC persistent memory supported 16 VMs consistently, while the configuration without Intel® Optane™ varied from supporting one to six VMs.

	Dell EMC PowerEdge R940 with Intel Optane DC persistent memory	Dell EMC PowerEdge R940 without Intel Optane
Run 1	16	6
Run 2	16	1
Run 3	16	3

## System configuration information

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

Server configuration information	Dell EMC PowerEdge R940
BIOS name and version	2.3.10
Non-default BIOS settings	None
Operating system name and version/build number	VMware® vSphere® 6.7.0 14320388
Date of last OS updates/patches applied	10/30/2019
Power management policy	Performance
<b>Processor</b>	
Number of processors	4
Vendor and model	Intel® Xeon® Platinum 8280M
Core count (per processor)	28
Core frequency (GHz)	2.70
Stepping	2
<b>DDR Memory module(s)</b>	
Total memory in system (GB)	1,536
Number of memory modules	24
Vendor and model	Samsung® M393A8G40MB2-CVF
Size (GB)	64
Type	PC4-2933
Speed (MHz)	2,933
Speed running in the server (MHz)	2,666
<b>DCPMM Memory module(s)</b>	
Total memory in system (GB)	6,144
Number of memory modules	24
Vendor and model	Intel Optane™ NMA1XBD256GQS
Size (GB)	256
Type	DCPMM
Speed (MHz)	2,666
Speed running in the server (MHz)	2,666
<b>Storage controller</b>	
Vendor and model	PERC H740P
Cache size (GB)	8GB
Firmware version	50.5.0-2819
Driver version	7.708.07.00

Server configuration information		Dell EMC PowerEdge R940
HDD storage		
Number of drives		24
Drive vendor and model		Dell C6K76
Drive size (GB)		1.92
Drive information (speed, interface, type)		SATA SSD
Network adapter		
Vendor and model		Broadcom® NetXtreme
Number and type of ports		2x 1GbE, 2x 10GbE
Driver version		Bnxtnet 214.0.222.0
Cooling fans		
Vendor and model		Tecra S9421
Number of cooling fans		8
Power supplies		
Vendor and model		Dell 095HR5A04
Number of power supplies		2
Wattage of each (W)		1,600

## How we tested

We set BIOS settings to defaults except for the System Profile, which we changed to Performance. We created a single RAID1 pair using two of the capacity drives to host the hypervisor. We placed the remaining capacity drives in a single RAID10 group for VM data. We used the 10Gb integrated NIC for client traffic.

### Installing VMware ESXi™ 6.7

1. Attach the installation media.
2. Boot the server.
3. At the VMware Installer screen, press Enter.
4. At the EULA screen, to Accept and Continue, press F11.
5. Under Storage Devices, select the appropriate virtual disk, and press Enter.
6. As the keyboard layout, select US, and press Enter.
7. Enter the root password twice, and press Enter.
8. To start installation, press F11.
9. After the server reboots, press F2, and enter root credentials
10. Select Configure Management Network, and press Enter.
11. Select the appropriate network adapter, and select OK.
12. Select IPv4 settings, and enter the desired IP address, subnet mask, and gateway for the server.
13. Select OK, and restart the management network.

### Deploying the VMware vCenter® Server 6.7

1. On a Windows server or VM, locate the VMware-VCSA installer image.
2. Mount the image, navigate to the vcsa-ui-installer folder, and double-click win32.
3. Double-click installer.exe.
4. Click Install.
5. Click Next.
6. Accept the terms of the license agreement, and click Next.
7. Leave the default “vCenter Server with an Embedded Platform Services Controller” selected and click Next.
8. Enter the FQDN or IP address of the host onto which the vCenter Server Appliance will be deployed.
9. Provide the server’s username and password, and click Next.
10. Accept the certificate of the host you chose to connect to by clicking Yes.
11. Provide a name and password for the vCenter Appliance, and click Next.
12. Set an appropriate Appliance Size, and click Next.
13. Select the appropriate datastore, and click Next.
14. 1At the Configure Network Settings page, configure the network settings as appropriate for your environment, and click Next.
15. Review your settings, and click Finish.
16. When the deployment completes, click on Next.
17. At the Introduction page, click on Next
18. At the Appliance configuration page, select the time synchronization mode and SSH access settings, click on Next
19. Select Create a new SSO domain.
20. Provide a password, and confirm it.
21. Provide an SSO Domain name and SSO Site name, and click on Next.
22. At the CEIP page click Next
23. At the Ready to complete page click on Finish.
24. When installation completes, click Close.
25. Using the vSphere web client, log into the vCenter server using the credentials previously provided.

### 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 RAID10 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 16.
  - b. Set the Memory to 96GB when testing on DRAM, and 256GB when testing on Optane.
  - c. Add 1x 340GB VMDK for OS, 1x 500GB VMDK for database files and 1x 100GB VMDK for database logs.
  - d. Create two additional VMware Paravirtual SCSI controllers, and assign the data and log VMDKs to the new controllers.
  - e. Attach the Windows Server 2019 ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.

## Installing Windows Server 2019

We used the following steps to install and configure SQL Server VMs:

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

## Installing SQL Server 2017

1. Attach the installation media ISO for SQL Server 2017 to the VM.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2017 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.

## Installing and running the compute workload

1. Download the Prime95 ZIP file for Windows and extract the contents.
2. Run prime95.exe and select Torture Test.
3. Enter 65536 for the minimum and maximum FFT sizes.
4. Enter 86400 for the maximum memory allocation.
5. Set the number of workers to 1.
6. When ready to test, click OK.

## Configuring and running the DVD Store 2 benchmark

### Data generation overview

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 300GB 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 2017. We built the 300GB 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 to 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 DS2 download. Make size modifications specific to our 300GB database, and make the appropriate changes to drive letters.
2. Transfer the files from our 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. Set the database recovery model to bulk-logged to prevent excess logging.
5. Load the data we 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
```

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.

## Cloning additional SQL Server VMs

Once the DB has been generated, the ds2user login has been created and the backup has been stored on the Master SQL VM, we can clone the rest of our VMs from the Master. For our testing, we created 16 SQL VMs.

1. From a web browser, log into vCenter.
2. Right-click the Master SQL VM and select Clone -> Clone to Virtual Machine
3. Select a name for the VM and a datastore location to store it, and click Next.
4. Select the compute resource which the VM will reside on, and click Next.
5. Set "Select virtual disk format" to "Same format as source".
6. Set "VM Storage Policy" to "Keep existing VM storage policies".
7. Select the appropriate datastore and click Next.
8. Deselect all clone options and click Next.
9. Review your settings, and click Next.

## 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 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 host and VMs.
5. Wait for a ping response from the target VMs and the client system.
6. Let the test server idle for 10 minutes.
7. Start the DVD Store driver on the clients.

We used parameters appropriate to the performance ceilings of each server. The command used to run the benchmark is below:

```
ds2sqlserverdriver.exe --target=<target _ IP> --ramp_rate=10 --run_time=60 --n_threads=24 --db_size=300GB --think_time=600 --detailed_view=Y --warmup_time=15 --report_rate=1 --pct_newcustomers=20 --csv_output=<drivepath>
```

Read the report at <http://facts.pt/q662z7t> ▶

This project was commissioned by Dell Technologies.



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