



The science behind the report:

# A single-socket Dell EMC PowerEdge R7515 solution delivered better value on a transactional database use case than a dual-socket HPE ProLiant DL380 Gen10 solution

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 [A single-socket Dell EMC PowerEdge R7515 solution yielded greater transactional database performance per dollar than a dual-socket HPE ProLiant DL380 Gen10 solution](#).

We concluded our hands-on testing on September 9, 2019. The results in this report reflect configurations that we finalized on August 29, 2019. Unavoidably, these configurations may not represent the latest versions available when this report appears. Our pricing analysis focuses on only the Dell EMC PowerEdge R7515 and HPE ProLiant DL380 Gen10 vSAN™ clusters. We did not include the pricing for shared infrastructure server or network switch.

## Our results

The tables below present our findings in detail.

### Performance results

	Single-socket Dell EMC™ PowerEdge R7515 cluster	Dual-socket HPE ProLiant DL380 Gen10 cluster	Dual-socket HPE ProLiant DL380 Gen9 legacy cluster
Total orders per minute (OPM)	138,128	147,873	86,026
Percentage OPM increase over HPE ProLiant DL380 Gen9 cluster	60.57%	71.89%	
Dell EMC PowerEdge R7515 cluster OPM as percentage of HPE ProLiant DL380 Gen10 cluster OPM	93.41%		
Average node core utilization	90.1%	94.2%	99.3%

### Hardware and summary software pricing

	Single-socket Dell EMC PowerEdge R7515 cluster	Dual-socket HPE ProLiant DL380 Gen10 cluster	Difference (raw)	Difference (percentage)
Hardware (list price for three servers) <sup>1</sup>	\$98,923.29	\$138,159.00	\$39,235.71	28.40%
Four-year software licensing and support (see table below for details)	\$1,449,234.00	\$1,678,956.00	\$229,722.00	13.68%
Total hardware and software costs	\$1,548,157.29	\$1,817,115.00	\$268,957.71	14.80%

## Detailed software pricing

	Single-socket Dell EMC PowerEdge R7515 cluster	Dual-socket HPE ProLiant DL380 Gen10 cluster	Notes
Microsoft Windows Server® 2019 Datacenter	\$73,920.00	\$83,160.00	Four-year cost for two-core package (license and support): \$1,540.00 <sup>2</sup> Dell EMC cluster requires 48; HPE cluster requires 54
Microsoft SQL Server® 2017 Enterprise	\$1,319,808.00	\$1,484,784.00	Four-year cost for two-core package (license and support): \$27,496.00 <sup>3</sup> Dell EMC cluster requires 48; HPE cluster requires 54
VMware vSphere® 6.7 U3 Enterprise Plus with production support	\$21,573.00	\$43,146.00	Four-year cost for single-socket license and support: \$7,191.00 <sup>4</sup> Dell EMC cluster requires 3; HPE cluster requires 6
VMware vSAN Enterprise with production support	\$33,933.00	\$67,866.00	Four-year cost for single-socket license and support: \$11,311.00 <sup>5</sup> Dell EMC cluster requires 3; HPE cluster requires 6
Total software costs	<b>\$1,449,234.00</b>	<b>\$1,678,956.00</b>	

## Price/performance and performance/price results

	Single-socket Dell EMC PowerEdge R7515 cluster	Dual-socket HPE ProLiant DL380 Gen10 cluster	Difference (raw)	Difference (percentage)
Orders per minute (OPM)	138,128	147,873	9,745	6.59%
Cluster hardware and software costs	\$1,548,157.29	\$1,817,115.00	\$268,957.71	14.80%
Dollars per OPM	\$11.21	\$12.29	\$1.08	8.79%
OPM per dollar	0.0892	0.0814	0.0078	9.64%

- 1 Pricing for the Dell EMC PowerEdge R7515 came in an August 30, 2019 quote we received from Dell EMC. Pricing for HPE ProLiant DL380 Gen10 came in a July 16, 2019 quote we received from PCM.com.
- 2 Pricing for Microsoft Windows Server 2019 Datacenter came from the [Microsoft](#) website on September 4, 2019.
- 3 Pricing for Microsoft SQL Server 2017 Enterprise came from the [Microsoft](#) website on September 4, 2019.
- 4 Pricing for VMware vSphere 6.7U3 Enterprise Plus with production support came from the [VMware](#) website on September 4, 2019.
- 5 Pricing for VMware vSAN Enterprise with production support came in a September 3, 2019 quote we received from the third-party firm BlueAlly.

## System configuration information

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

Server configuration information	Dell EMC PowerEdge R7515	HPE ProLiant DL380 Gen10	HPE ProLiant DL380 Gen9
BIOS name and version	Dell 1.0.1	U30 v2.10	P89 v2.72
Operating system name and version/build number	ESXi™ 6.7.0U3 14320388	ESXi 6.7.0U3 14320388	ESXi 6.7.0U3 14320388
Date of last OS updates/patches applied	08/16/19	08/16/19	08/16/19
Power management policy	Performance	Virtualization – Max Performance	Virtualization – Max Performance
Processor			
Number of processors	1	2	2
Vendor and model	AMD EPYC™ 7502P	Intel® Xeon® Gold 6240	Intel Xeon E5-2680 v3
Core count (per processor)	32	18	12
Core frequency (GHz)	2.50	2.6	2.5
Stepping	0	6	M1
Memory module(s)			
Total memory in system (GB)	256	256	256
Number of memory modules	16	8	16
Vendor and model	Hynix® HMA82GR7CJR8N-XN	Hynix HMA84GR7CJR4N-WM	Samsung® M386A2G40DB0
Size (GB)	16	32	16
Type	PC4-3200AA	PC4-2933Y	PC4-2133P
Speed (MHz)	3,200	2,933	2,133
Speed running in the server (MHz)	2,933	2,933	2,133
Storage controller			
Vendor and model	N/A	N/A	HPE H240ar SBA
Cache size (GB)	N/A	N/A	N/A
Firmware version	N/A	N/A	6.88
Driver version	N/A	N/A	2.0.22-3vmw.670.1.28.10302608
OS drive			
Number of drives	1	1	1
Drive vendor and model	Dell EMC SSDSCKKB240G8R	HPE 8GB Dual microSD Flash USB Drive	HPE 8GB microSDHC
Drive size (GB)	240	16 (2 x 8)	8
Drive information (speed, interface, type)	6Gbps, M.2 SATA, SSD	Dual microSD USB	MicroSD card

Server configuration information	Dell EMC PowerEdge R7515	HPE ProLiant DL380 Gen10	HPE ProLiant DL380 Gen9
Local storage (capacity)			
Number of drives	6	6	6
Drive vendor and model	KIOXIA KCD5XLUG960G	KIOXIA KCM5XRUG960G	Intel S3610
Drive size (GB)	960	960	800
Drive information (speed, interface, type)	NVMe, SSD	NVMe, SSD	6Gbps, SATA, SSD
Local storage (cache)			
Number of drives	2	2	2
Drive vendor and model	Samsung PM1725b	Samsung PM1725b	Intel S3710
Drive size (GB)	1,600	1,600	800
Drive information (speed, interface, type)	NVMe, SSD	NVMe, SSD	6Gbps, SATA, SSD
Network adapter 1			
Vendor and model	Broadcom Adv. Dual 25Gb Ethernet	HPE 640FLR-SFP28	Emulex OCE14102-UM
Number and type of ports	2x 25GbE SFP	2x 10/25GbE SFP	2x 10GbE SFP
Driver version	21.40.20.70	14.23.8052	10.2.370.19
Network adapter 2			
Vendor and model	Broadcom Gigabit Ethernet	HPE 331i	HPE 331i
Number and type of ports	2x 1GbE	4x 1GbE	4x 1GbE
Driver version	21.40.17	20.14.54	20.14.54
Cooling fans			
Vendor and model	Dell VF60381B1	HPE V60E12BS1M3	HPE V60E12BS2CB5
Number of cooling fans	6	6	6
Power supplies			
Vendor and model	Dell D1600E-S0	HPE HSTNS-PC41-1	HPE HSTNS-PL41
Number of power supplies	2	2	2
Wattage of each (W)	1,600	800	800

## How we tested

We installed and configured the latest available version of VMware vSphere 6.7 on the Dell EMC PowerEdge R7515 servers, HPE ProLiant DL380 Gen10 servers, and HPE ProLiant DL380 Gen9 servers. We did the same on a separate two-socket server we used to host infrastructure and benchmark client VMs. For the Dell EMC servers, we installed the OS on internal M.2 SATA drives. For the HPE servers, we installed the OS on HPE Enterprise SD cards and USB drives. For the Dell EMC solution and HPE Gen10 solution, we configured the drives in HBA mode and created all-flash VMware Virtual SAN (vSAN) clusters using three servers per solution. We built two vSAN local disk groups per server, and each disk group consisted of one mixed-use 1,600GB PCIe SSD as a caching device and three read-intensive 960GB PCIe SSDs as capacity drives. We used the default vSAN storage policy, which uses the following settings:

- Number of failures to tolerate = 1
- Number of disk stripes per object = 1
- Object space reservation = 0%
- Flash read cache reservation = 0%
- Force provisioning = NO

We also created an all-flash VMware vSAN cluster using three HPE ProLiant DL380 Gen9 servers with drives in HBA mode and two vSAN local disk groups per server. Each disk group consisted of one mixed-use 800GB SATA SSD as a caching device and three read-intensive 800GB SATA SSDs as capacity drives. We also used the default vSAN storage policy.

We used a single Dell EMC Networking S5048-ON switch and created management, VM private traffic, and vSAN traffic VLANs across all 48 ports. For management, private VM, and vSAN traffic, the Dell EMC PowerEdge R7515 and HPE ProLiant DL380 Gen10 servers used two bonded 25GbE connections, while the HPE ProLiant DL380 Gen9 servers used two bonded 10GbE connections. We enabled jumbo frames end to end.

We ran the complete test three times on each cluster and report the results from the run with the median OPM result.

## 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. For the keyboard layout, select US, and press Enter.
7. Enter the root password twice, and press Enter.
8. To start the 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.
14. Repeat steps 1 through 13 on the rest of the servers.

## 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 you will deploy the vCenter Server Appliance.
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. At the Configure Network Settings screen, 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 Next.
17. At the Introduction screen, click Next
18. At the Appliance configuration screen, select the time synchronization mode and SSH access settings, click 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 Next.
22. At the CEIP screen, click Next.
23. At the Ready to complete screen, click Finish.
24. When installation completes, click Close.
25. Using the vSphere web client, log into the vCenter server using the credentials previously provided.

## Creating a cluster and adding the hosts to VMware vCenter

1. Log into the vCenter, and navigate to Hosts and Clusters.
2. Select the primary site management vCenter.
3. Right-click the vCenter object, and select New Datacenter...
4. Enter a name for the new datacenter, and click OK.
5. Right-click the new datacenter, and click New Cluster...
6. As the name for the new cluster, enter vSAN
7. Click OK.

## Configuring the Virtual SAN on the cluster using Quickstart

1. In the Hosts and Clusters pane, select the newly created vSAN cluster.
2. Click the Configure tab, and under Configuration, select Quickstart.
3. Under Cluster basics, click Edit.
4. Enable vSAN, and click OK.
5. Under Add Hosts, click Add.
6. Enter the IP and credentials for each of the hosts you wish to add to the cluster, and click Next.
7. Under Configure hosts, click Configure.
8. Under Physical adapters, click the drop-down next to the adapters you wish to use for vSAN traffic, and select DSwitch. Leave the Distributed switches and Port groups options as default. Click Next.
9. Enter the value of the VLAN you wish to use for vSAN.
10. If you wish, change IP type to static and type in IP addresses for the hosts. Otherwise, leave the IP type as DHCP. Click Next.
11. On the Advanced options screen, click Next.
12. On the Claim disks screen, select the disks you wish to use for capacity and cache, and click Next.
13. Click Next, and click Finish.

## 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:
  - Set the vCPU count to 16.
  - Set the Memory to 16GB.
  - Add 1x 100GB VMDK for OS / Backup, 1x 100GB VMDK for database files, and 1x 50GB VMDK for database logs. Set OS VMDK to thin provisioning, and set all other VMDKs to thick provision eager zeroed.
  - Create two additional VMware Paravirtual SCSI controllers, and assign the data and log VMDKs to the new controllers.
  - Attach the OS ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.

## Installing Windows Server 2019

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 screen 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 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 version 3 benchmark

## Data generation overview

We generated the data using the Install.pl script included with DVD Store version 3 (DS3), providing the parameters for our 40GB 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 2014. We built the 40GB 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 modifications we made to the schema creation scripts were the specified file sizes for our database. We deliberately 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 DS3 download. Make size modifications specific to our 40GB 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. To prevent excess logging, set the database recovery model to bulk-logged.
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

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. Using SQL Server Management Studio, create the necessary full text index.
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 you have generated the database, created the ds2user login, and stored the backup on the Master SQL VM, you can clone the rest of our VMs from the Master. For our testing, we created 18 SQL VMs per vSAN cluster.

1. From a web browser, log into vCenter.
2. Right-click the Master SQL VM, select Clone, and select 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 on which the VM will reside, 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 (OPM) 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 the following 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 30 minutes.
7. Start the DVD Store driver on the clients.

We used the following DVD Store 3 parameters for testing:

```
ds3sqlserverdriver.exe --target=<target _ IP> --ramp_rate=10 --run_time=30 --n_threads=32 --db_size=40GB --think_time=0.00 --detailed_view=Y --warmup_time=15 --report_rate=1 --pct_newcustomers=20 --csv_output=<drivepath>
```

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