



Boost SQL Server OLTP performance by choosing Dell EMC PowerEdge R6525 servers powered by 3rd Gen AMD EPYC 7543 processors

For the same hardware and support price, these servers achieved more orders per minute (OPM) than a cluster of identical servers with 2nd Gen AMD EPYC 7532 processors

In our data center, we ran an online transactional processing (OLTP) database workload on a Dell EMC™ PowerEdge™ R6525 server cluster in two configurations—one with 3rd Gen AMD EPYC™ 7543 processors and one with 2nd Gen AMD EPYC 7532 processors. Each cluster ran Microsoft Hyper-V and hosted Microsoft SQL Server 2019 virtual machines.

We found that the Dell EMC PowerEdge cluster with the 3rd Gen AMD EPYC processors achieved 15.6 percent more OPM than the cluster with the 2nd Gen AMD EPYC processors. When we compared the cost for hardware plus support for the two clusters, we found that they were the same price, meaning that your organization could get better performance without paying more for it.



Process 15.6% more orders per minute*



Better performance for the same price*†

*vs. the same server cluster with AMD EPYC 7532 processors †Based on the total hardware cost with 3 years of Basic Next Business Day support



How we approached testing

Our hands-on testing measured the virtualized OLTP performance of the following Hyper-V cluster configurations backed by Microsoft Storage Spaces Direct:

- Three Dell EMC PowerEdge R6525 servers, each powered by two 3rd Gen AMD EPYC 7543 processors. As of March 25, 2021, the list price for hardware plus Basic Next Business Day support (36 months) for one server was \$38,561.01, for a total of \$115,683.03 for the three-server cluster.¹
- Three Dell EMC PowerEdge R6525 servers, each powered by two 2nd Gen AMD EPYC 7532 processors. As of March 25, 2021, the list price for hardware plus Basic Next Business Day support (36 months) for one server was \$38,561.01, for a total of \$115,683.03 for the three-server cluster.²

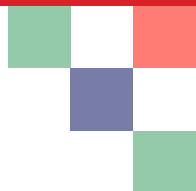
Both clusters ran Hyper-V with Failover Clustering and Storage Spaces Direct. Each cluster hosted 24 Microsoft SQL Server 2019 VMs (eight VMs per host), against which we ran the OLTP workload. We configured each cluster with 256 GB of RAM, two-port 25Gb NICs, and six NVMe™ SSDs. Details of the server configurations and our testing are available in the [science behind the report](#).

About 3rd Gen AMD EPYC 7543 processors

These 32-core processors use AMD Infinity Architecture and are part of the AMD EPYC 7003 Series. The latest offering from AMD, 3rd Gen EPYC processors offer increased I/O with up to 32MB L3 cache per core, 7nm x86 hybrid die core, and new security features such as Secure Encrypted Virtualization - Secure Nested Paging (SEV-SNP) and Encrypted State (SEV-ES).³ According to AMD, the EPYC 7543 model is well suited for workloads such as analytics, ERM/SCM/CRM apps, and apps requiring high VM density.⁴

Learn more at <https://www.amd.com/en/processors/epyc-7003-series>.





How each cluster performed

We used the DVD Store 3 (DS3) benchmarking tool to run an OLTP workload against each cluster. We summed the OPM that each of the 24 SQL Server VMs processed over the course of a 30-minute test run, and we show that per-cluster sum in Figure 1. The AMD EPYC 7543 processor-powered Dell EMC PowerEdge 6525 cluster came out on top with a rate of 264,551 OPM—an increase of 15.6 percent over the cluster with the 2nd Gen AMD EPYC 7532 processors, which performed at a rate of 228,678 OPM.

These results indicate that by investing in the 3rd Gen AMD EPYC 7543 processor-powered Dell EMC PowerEdge 6525 cluster rather than the cluster with the 2nd Gen AMD EPYC processors we tested, an organization could achieve better OLTP performance.

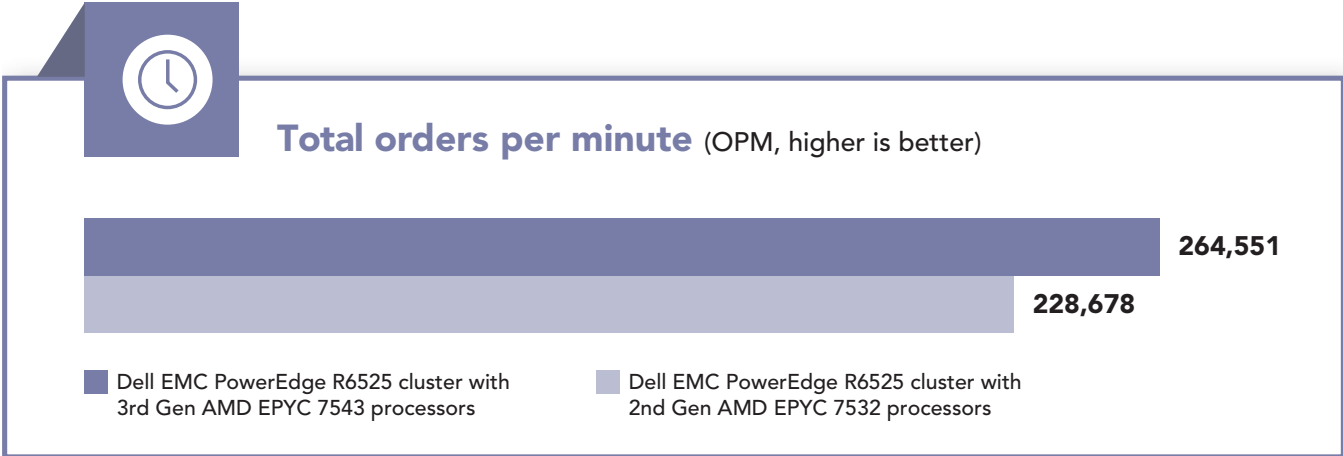


Figure 1: Total OPM each cluster achieved during testing. Higher is better. Source: Principled Technologies.

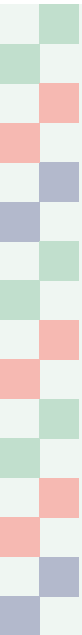


About Dell EMC PowerEdge R6525 rack servers

According to Dell Technologies, these servers have the following specifications:⁵

- Up to 128 high-performance AMD EPYC 3rd Gen cores in two sockets
- Up to 32 DDR4 RDIMM/LRDIMM slots
- Support for PCIe® Gen4 NVMe SSDs
- Integrated security features
- Embedded management tools

Learn more at <https://www.dell.com/en-us/work/shop/povw/poweredge-R6525>.





Real-world benefits for ecommerce

For large ecommerce organizations, small online retail stores, and businesses anywhere in between, the ability to support more customers could lead to more potential purchases and increased revenue. Hardware that can process more orders per minute, such as the Dell EMC PowerEdge R6525 server powered by 3rd Gen AMD EPYC 7543 processors, could help you support those additional customers, and therefore expand your business. In our tests, a cluster of three Dell EMC PowerEdge R6525 servers with the 3rd Gen processors achieved a rate of 264,551 OPM—a rate 15.6 percent higher than a cluster of the same servers with 2nd Gen AMD EPYC 7532 processors. If your small, medium, or large online business is looking at Dell EMC PowerEdge R6525 servers to process your orders, consider AMD EPYC 7543 processors to handle more transactions.

About Microsoft SQL Server 2019

According to Microsoft, the latest version of Microsoft SQL Server “builds on previous releases to grow SQL Server as a platform that gives you choices of development languages, data types, on-premises or cloud environments, and operating systems.”⁶ It includes features in the following areas: data virtualization and SQL Server 2019 Big Data Clusters, Intelligent Query Processing, In-Memory Database technologies, monitoring, developer experience, security, high availability, platform choice, and more.

Learn more about Microsoft SQL Server 2019 at <https://www.microsoft.com/en-us/sql-server/sql-server-2019>.



Conclusion

In hands-on testing, we found that a cluster of three dual-socket Dell EMC PowerEdge R6525 rack servers, each powered by 3rd Gen AMD EPYC 7543 processors, achieved 15.6 percent more transactional database OPM than a cluster of three of the same Dell EMC PowerEdge servers powered by 2nd Gen AMD EPYC 7532 processors. This performance indicates that organizations using the solution with the newer processors could support more transactions without higher hardware costs, potentially growing their business or meeting increased demands.

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- 1 "PowerEdge R6525 Rack Server," accessed March 25, 2021, https://www.dell.com/en-us/work/shop/cty/pdp/spd/poweredge-r6525/pe_r6525_13783_vi_vp.
 - 2 "PowerEdge R6525 Rack Server."
 - 3 "AMD EPYC 7003 Series Processors," accessed March 18, 2021, <https://www.amd.com/en/processors/epyc-7003-series>.
 - 4 "AMD EPYC 7543," accessed March 18, 2021, <https://www.amd.com/en/products/cpu/amd-epyc-7543>.
 - 5 "PowerEdge R6525," accessed March 25, 2021, https://i.dell.com/sites/csdocuments/Product_Docs/en/poweredge-r6525-spec-sheet.pdf.
 - 6 "What's new in SQL Server 2019 (15.x)," accessed March 24, 2021, <https://docs.microsoft.com/en-us/sql/sql-server/what-s-new-in-sql-server-ver15?view=sql-server-ver15>.

Read the science behind this report at <http://facts.pt/bXW5sRs> ►



Facts matter.®

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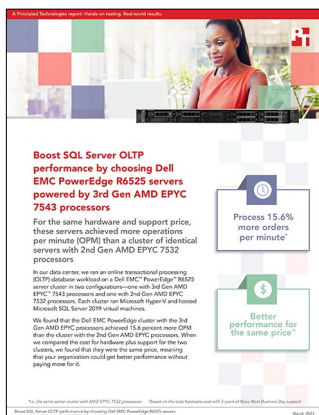
This project was commissioned by Dell Technologies.

Disclaimer:

The content on the following pages includes appendices and methodologies from our hands-on work.

We will publish this content as a separate document linked to the report.

We must receive your approval on both the report and this document before taking them public simultaneously.



The science behind the report:

Boost SQL Server OLTP performance by choosing Dell EMC PowerEdge R6525 servers powered by 3rd Gen AMD EPYC 7543 processors

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 [Boost SQL Server performance by choosing Dell EMC PowerEdge R6525 servers powered by 3rd Gen AMD EPYC 7543 processors](#).

We concluded our hands-on testing on March 12, 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 10, 2021 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

Table 1: Results of our testing

	Dell EMC™ PowerEdge™ R6525 cluster with AMD EPYC™ 7532 processors	Dell EMC PowerEdge R6525 cluster with AMD EPYC 7543 processors
Operations per minute (OPM)	228,678	264,551
Percentage OPM increase	-	15.69%
Average node core utilization	57.33%	53.45%

CPU results charts

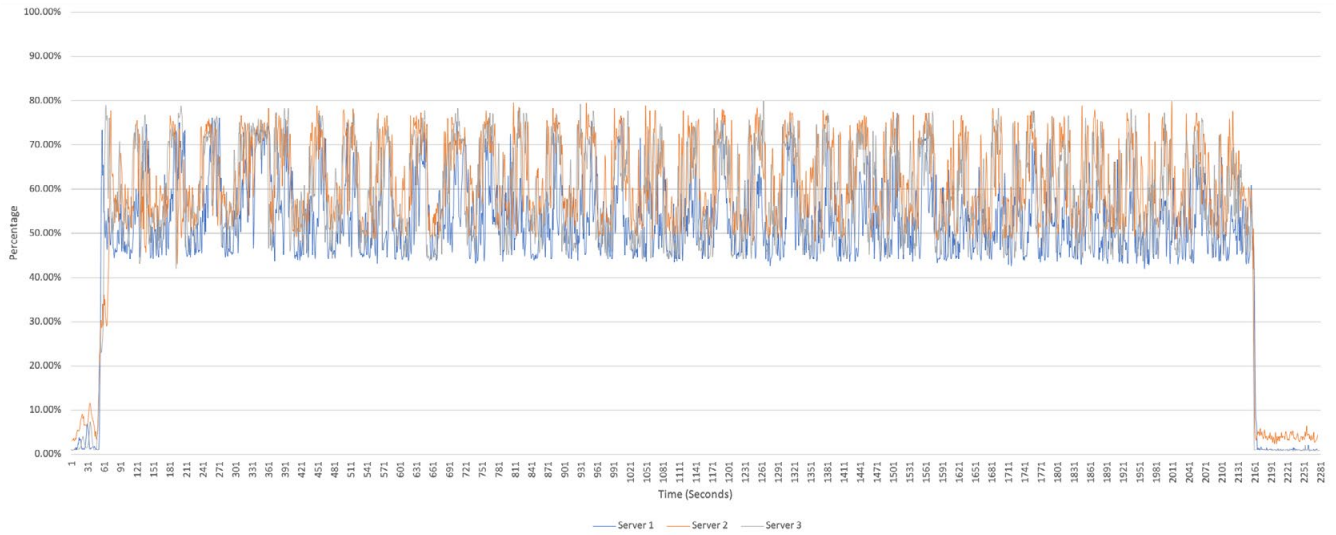


Figure 1: Average server CPU usage for individual Dell EMC PowerEdge R6525 servers with AMD EPYC 7543 processors. Source: Principled Technologies.

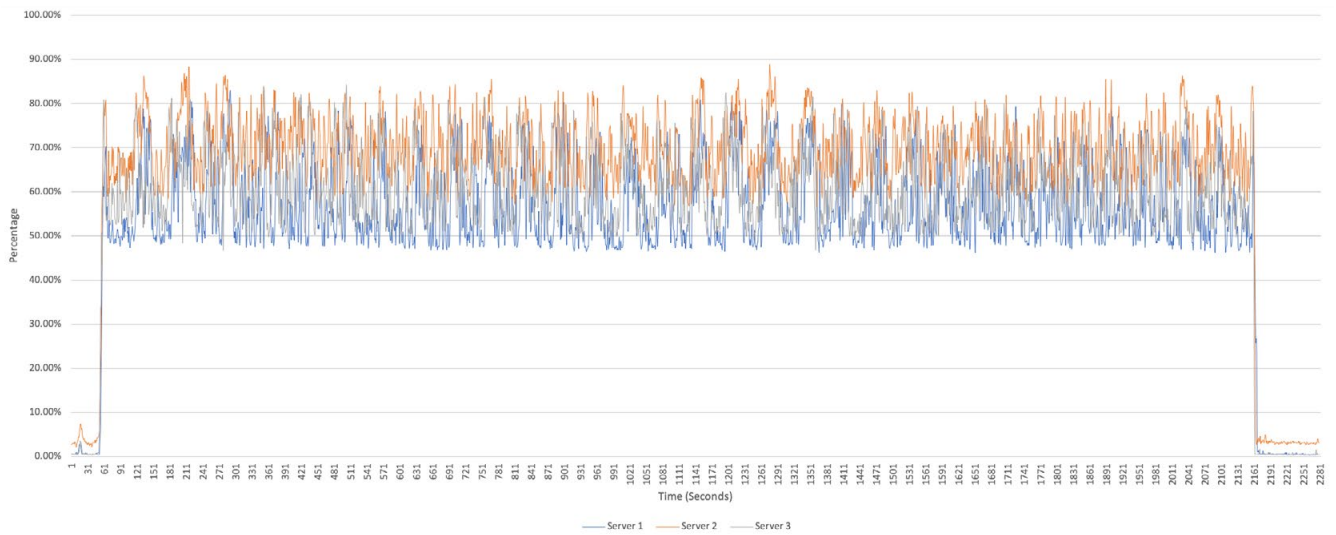


Figure 2: Average server CPU usage for individual Dell EMC PowerEdge R6525 servers with AMD EPYC 7532 processors. Source: Principled Technologies.

System configuration information

Table 2: Detailed information on the systems we tested.

Server configuration information	3 x Dell EMC PowerEdge R6525	
BIOS name and version	Dell 2.0.3	
Operating system name and version/build number	Windows Server 2019 version 1809 build 17763.1757	
Date of last OS updates/patches applied	2/01/21	
Power management policy	Performance	
Processor	3rd Gen	2nd Gen
Number of processors	2	2
Vendor and model	AMD EPYC 7543	AMD EPYC 7532
Core count (per processor)	32	32
Core frequency (GHz)	2.8	2.4
Stepping	1	0
Memory module(s)		
Total memory in system (GB)	256	
Number of memory modules	8	
Vendor and model	Hynix® HMA82GR7CJR8N-XN	
Size (GB)	32	
Type	PC4-3200AA	
Speed (MHz)	3,200	
Speed running in the server (MHz)	3,200	
Storage controller 1		
Vendor and model	Dell PERC H345	
Cache size (GB)	2	
Firmware version	51.13.0-3485	
Driver version	7.705.08.00	
Storage controller 2		
Vendor and model	Dell BOSS-S1	
Cache size (GB)	0	
Firmware version	2.5.13.3024	
Local storage (OS)		
Number of drives	1	
Drive vendor and model	Intel® Intel-SSDSCCKB240G8R	
Drive size (GB)	240	
Drive information (speed, interface, type)	M.2 SATA SSD	

Server configuration information		3 x Dell EMC PowerEdge R6525
Local storage (capacity)		
Number of drives	4	
Drive vendor and model	Samsung® MZ-WLJ1T90	
Drive size (GB)	1920	
Drive information (speed, interface, type)	PCIe 4.0 NVMe SSD	
Local storage (cache)		
Number of drives	2	
Drive vendor and model	Samsung MZ-WLJ1T60	
Drive size (GB)	1600	
Drive information (speed, interface, type)	PCIe 4.0 NVMe SSD	
Network adapter 1		
Vendor and model	Broadcom® Gigabit Ethernet BCM5720	
Number and type of ports	2 x 1GbE	
Driver version	21.60.16	
Network adapter 2		
Vendor and model	Broadcom Adv. Dual 25Gb Ethernet	
Number and type of ports	2 x 25GbE	
Firmware version	21.65.33.33	
Cooling fans		
Vendor and model	Dell VF60381B1	
Number of cooling fans	6	
Power supplies		
Vendor and model	Dell 01CW9GA03	
Number of power supplies	2	
Wattage of each (W)	1400	

How we tested

We installed Windows Server 2019 with Hyper-V and Failover Clustering on each Dell EMC PowerEdge R6525 server and used Storage Spaces Direct to pool a set of PCIe 4.0 NVMe SSDs: two mixed-use 1.6TB SSDs for caching and four read-intensive 1.92TB SSDs for capacity. Each server in the cluster hosted eight Microsoft SQL Server 2019 VMs against which we ran an OLTP workload. We measured the performance of the cluster using Microsoft SQL Server 2019 and the DVD Store 3 (DS3) benchmark, which targets a transactional database and produces a metric of orders per minute.

We used a single Dell EMC Networking S5048-ON switch and created management, VM private traffic, and Storage Spaces traffic VLANs across all 48 ports using two 25GbE network connections per host.

Each SQL test VM had a 28GB RAM, 16 vCPU, 100GB operating system drive, 85GB database drive, and 30GB log drive. Each VM supported a 40GB DS3 database.

We hosted 24 client DS3 VMs on a Dell EMC PowerEdge R630 server to drive the workload. Each client had a 4GB RAM, one vCPU and 137GB operating system drive. Each client VM targeted a single SQL test VM. For the DS3 test parameters, we used 32 threads, 0 think time, 30-minute run time, and 5-minute warmup.

Below are the steps we took to configure our test environment and conduct our testing.

Preparing each node for Storage Spaces

Setting up the Dell EMC PowerEdge R6525 cluster node BIOS

1. During post, press F2 for System Setup.
2. In the System Setup Main Menu (SSMM), click System BIOS.
3. In System BIOS Settings, click Default.
4. When asked if you want to load the default settings, click Yes.
5. At the Success window, click Ok.
6. Click Finish.
7. At the Warning "Settings have changed. Do you want to save the changes?" click Yes.
8. At the Success window, click Ok to return to the System Setup Main Menu.
9. Click Device Settings.
10. Click NIC in Mezzanine 1 Port 2: Broadcom Adv Dual 25Gb Ethernet.
11. Click Device Level Configuration.
12. For Link FEC, click the down arrow to the right, and click Both CL74 and CL91.
13. Click Back.
14. At the NIC in Mezzanine 1 Port 1: Broadcom Adv. Dual 25Gb Ethernet screen > Main Configuration Page, click Finish.
15. At the warning "Settings have changed. Do you want to save the changes?" click Yes.
16. Click Ok.
17. At the System Setup > Device Settings page, click NIC in Mezzanine 1 Port 1: Broadcom Adv Dual 25Gb Ethernet.
18. Repeat steps 11 through 16 to set up the other NIC port.
19. At the System Setup > Device Settings page, click Finish.
20. At the System Setup > System Setup Main Menu, click System BIOS.
21. Click System Profile Settings.
22. For System Profile, click the down arrow to the right, and click Performance.
23. Click Back.
24. Click Finish.
25. At the warning "Settings have changed. Do you want to save the changes?" click Yes.
26. At the Success window, click Ok.
27. Click Finish.
28. At the warning "Are you sure you want to exit and reboot?" click Yes.

Installing Windows Server 2019 on the cluster nodes

1. Boot the server to the Windows Server 2019 installation media.
2. At the prompt to boot from the CD/DVD location, press any key.
3. Click Next.
4. Click Install Now.
5. Click Windows Server 2019 Datacenter Edition (Desktop Experience), and click Next.
6. Click the checkbox beside I accept the license terms, and click Next.
7. Click the OS drive, and click Next.
8. After installation, enter a password for the Administrator, and click Finish.

Configuring and updating firmware, driver, and OS on cluster nodes

1. Boot to Windows, and log in.
2. If Server Manager is not open, press the Windows key, and, in the Menu that appears, click Server Manager.
3. In Server Manager, click Local Server.
4. Look to the right of IE Enhanced Security Configuration.
 - If it says On, perform these steps:
 - i. Click On.
 - ii. For both Administrator and Users, click the radio buttons for Off.
 - iii. Click Ok.
5. Look to the right of Remote Desktop.
 - If it says Disabled, perform these steps:
 - i. Click Disabled.
 - ii. Click the radio button beside Allow remote connections to this computer.
 - iii. Click Ok.
6. Go to the appropriate websites and download the latest drivers and firmware:
 - a. Download the drivers from www.broadcom.com/products/ethernet-connectivity/network-adapters/25gb-nic-ocp#downloads.
 - b. From device manager, click Other Devices to find the Ethernet controller.
 - c. Update the driver for each Ethernet controller, being sure to click "Browse my computer for driver software," and browse to the folder where you saved the downloaded driver.
 - d. Click Next.
 - e. Once the driver is installed, click Ok.
7. Install and/or update all remaining drivers and firmware.
8. In Server Manager, beside Time zone, click Pacific Time.
9. In the Date and Time Window, click Change time zone...
10. Click Ok.
11. In Server Manager, locate Windows Update, and click the text to the right.
12. Click Install now.
13. Once Windows Update completes, reboot.
14. Repeat steps 11 through 13 until you have installed all Windows updates.
15. In the Windows Update window, click Update Notifications.
16. Click Advanced Options.
17. Under Pause Updates, move the slider to the right so that the text beside the slider says, "On."
18. Click the X to close the Windows Update window.
19. Click the Windows button.
20. Type PowerShell
21. Click the menu item for Windows PowerShell™ ISE.
22. In the PowerShell window, change the host name by running the following command, replacing "S2D-Node01" with the appropriate name for your node:

```
Rename-Computer -NewName S2D-Node01 -Restart
```
23. After restart, join the active directory domain as the domain administrator:
 - a. Repeat steps 19 through 21 to open a PowerShell window.
 - b. Run the following command, replacing "test.local" with the appropriate name for your domain:

```
$credential = Get-Credential  
Add-Computer -DomainName test.local -Credential $credential -Restart
```

24. After reboot, log into the new account:
 - a. Press Control+Alt+Delete.
 - b. Click Other.
 - c. Beside User Name, click the textbox, and type TEST\Administrator or whatever domain\username you plan on using.
 - d. Beside Password, click the textbox, and enter the password.
25. In Server Manager, click Local Server.
26. Locate Windows Defender Firewall, and click the text to the right.
27. Click Domain network.
28. To turn the firewall off, under Windows Defender Firewall, click the slider beside "On."
29. Click Firewall & network protection.
30. Click Private network.
31. Repeat steps 28 and 29.
32. Click Public Network.
33. Repeat steps 28 and 29.
34. At the top right of the window, click the X to close Windows Defender Firewall. (For simplicity, in a non-production environment, we turned firewall off. For production environments, this is not recommended.)
35. Configure the adapter settings on both RoCE adapters by doing the following:
 - a. In Server Manager, for the adapter you want to configure, click IPv4 address assigned by DHCP, IPv6 enabled.
 - b. Right-click Properties.
 - c. Click Configure.
 - d. Click the Advanced tab.
 - e. Leave all settings as default except for the following (Note: Not all NICs will have all settings):
 - ◆ DCBX mode: Firmware in charge
 - ◆ Flow control: Disabled
 - ◆ Forward Error Correction: Auto Negotiate
 - ◆ Ignore FCS errors: Enabled
 - ◆ Network Direct Functionality: Enabled
 - ◆ Network Direct Technology: RoCEv2
 - ◆ Packet Direct: Enabled
 - ◆ Receive Segment Coalescing (IPv4): Enabled
 - ◆ Receive Segment Coalescing (IPv6): Enabled
 - ◆ SR-IOV: Disabled
 - ◆ VMLAN Filtering: Disabled
 - f. Click Ok.
36. Assign a static IP address for both the SAN adapters:
 - a. Right-click, and select Properties.
 - b. Select Internet Protocol Version 4 (TCP/IPv4).
 - c. Click Properties.
 - d. Beside "Use the following IP address," click the radio button and enter the appropriate IP address. There should be two storage subnets for Storage Spaces Direct. Each cluster node should have a storage adapter on each subnet.
 - e. The radio button for "Use the following DNS server addresses" should be pre-selected. Enter the IP address of your ADDS server.
 - f. Click Ok.
 - g. Click Close.
37. If a dialogue box appears asking if you want to allow your PC to be discoverable by other PCs and devices on the network, click No.

Configuring the OS9 Dell Network Switch for Data Center Bridging (DCB) and RDMA Over Converged Ethernet (RoCE)

1. Enter the following commands on your SAN network switch:

```
#enable
#config
#dcb-enable
#dcb enable pfc-queues
#copy running-config startup-config
#reload
#dcb-map RoCE priority-group 2 bandwidth 4 pfc off
#priority-group 0 bandwidth 1 pfc off
#priority-group 1 bandwidth 95 pfc on
#priority-pgid 00000102
#exit
#interface vlan 110
#description Storage Spaces Network 1
#tagged TenGigabitEthernet 1/2-1/48
#no shutdown
#exit
#interface vlan 111
#description Storage Spaces Network 2
#tagged TenGigabitEthernet 1/2-1/48
#no shutdown
#exit
```

2. Enter the following command:

```
#show interfaces | grep Flowcontrol
```

3. If Flowcontrol is enabled, you must disable it so you can use PFC instead. If necessary, disable Flowcontrol by entering the following commands for each network port used for the SAN:

```
#interface twentyFiveGigabitEthernet 1/<port number>
#flowcontrol rx off tx off
#exit
```

4. Enter the following commands for each network port used for the SAN:

```
#interface twentyFiveGigabitEthernet 1/<port number>
#dcb-map RoCE
#mtu 9216
#portmode hybrid
#switchport
#no shutdown
#spanning-tree rstp edge-port
#exit
```

5. Enter the final command:

```
#copy-running-config startup-config
```

Preparing each node for Storage Spaces and RDMA over converged ethernet

Installing the required roles and features for Storage Spaces Direct

1. As the domain administrator, on each cluster node, open a PowerShell window. (Note: Instructions for opening a PowerShell window are in steps 19 through 21 of the section Configuring and updating firmware, driver, and OS on cluster nodes.)
2. Run the following command:

```
Install-WindowsFeature -Name "Data-Center-Bridging","Failover-Clustering","Hyper-V","RSAT-Clustering-PowerShell","Hyper-V-Powershell","File-Services" -IncludeManagementTools
```

Configuring the cluster nodes for RoCE

1. As the domain administrator, on each cluster node, open a PowerShell ISE window as Administrator. (Note: Instructions for opening a PowerShell window are in steps 19 through 21 of the section Configuring and updating firmware, driver, and OS on cluster nodes.)
2. Beside Script, click the down arrowhead to expand the script pane.
3. Paste in the following script:

```
Remove-NetQosPolicy -Confirm:$False
New-NetQosPolicy "Cluster" -Cluster -PriorityValue8021Action 7
New-NetQosTrafficClass "Cluster" -Priority 7 -BandwidthPercentage 1 -Algorithm ETS
Set-NetQosDcbxSetting -InterfaceAlias "Ethernet" -Willing $false
Set-NetQosDcbxSetting -InterfaceAlias "Ethernet 2" -Willing $false
New-NetQosPolicy "SMB" -NetDirectPortMatchCondition 445 -PriorityValue8021Action 5
Enable-NetQosFlowControl -Priority 5
New-NetQosTrafficClass "SMB" -priority 5 -bandwidthpercentage 95 -algorithm ETS
Enable-NetAdapterQos -InterfaceAlias "Ethernet"
Enable-NetAdapterQos -InterfaceAlias "Ethernet 2"
New-NetQosPolicy "DEFAULT" -Default -PriorityValue8021Action 0
Disable-NetQosFlowControl 0,1,2,3,4,6,7
```

4. In the blue PowerShell pane, type the following command to find the system name for your RoCE adapters:

```
get-NetAdapter
```

5. Edit the script in step 3 to make the following replacements:
 - a. Replace "Ethernet" with the adapter name for port 1 of your RoCE Network adapter.
 - b. Replace "Ethernet 2" with the adapter name for port 2 of your RoCE Network adapter.
6. To run the script, click the green play button.
7. At the Confirmation window, click Yes. The script will configure DCB to match the DCB configuration on your switch.
8. After any reboot, always re-run this script to make sure the adapters are set up for properly for RoCE.

Configuring the VM switch and adapters

1. As the domain administrator, on each cluster node, open a PowerShell ISE window as Administrator. (Note: Instructions for opening a PowerShell window are in steps 19 through 21 of the section Configuring and updating firmware, driver, and OS on cluster nodes.)
2. Beside Script, click the down arrowhead to expand the script pane.
3. Paste in the following script:

```
Set-NetAdapterAdvancedProperty -Name "Ethernet" -RegistryKeyword VlanID -RegistryValue "0"
Set-NetAdapterAdvancedProperty -Name "Ethernet 2" -RegistryKeyword VlanID -RegistryValue "0"
New-VMSwitch -Name SetSwitch -NetAdapterName "Ethernet" -AllowManagementOS $true
-EnableEmbeddedTeaming $true
Rename-VMNetworkAdapter -ManagementOS -NewName Mgmt
Add-VMNetworkAdapter -ManagementOS -VMNetworkAdapterName SMB_1
remove-netipaddress -InterfaceAlias "vEthernet (Mgmt)" -IPAddress 192.168.110.27 -PrefixLength 24
New-NetIPAddress -InterfaceAlias "vEthernet (Mgmt)" -IPAddress 192.168.110.28 -PrefixLength 24
New-NetIPAddress -InterfaceAlias "vEthernet (SMB_1)" -IPAddress 192.168.110.27 -PrefixLength 24
set-vmnetworkadaptervlan -ManagementOS -Access -VlanID 110 -VMNetworkAdapterName SMB_1
set-vmNetworkAdapter -ManagementOS -Name "SMB_1" -IeeePriorityTag on
Get-NetAdapterRdma "vEthernet (SMB_1)"
Enable-NetAdapterRdma "vEthernet (SMB_1)"
Add-VMSwitchTeamMember -VMSwitchName "SETSwitch" -NetAdapterName "Ethernet 2"
Add-VMNetworkAdapter -ManagementOS -Name SMB_2
New-NetIPAddress -InterfaceAlias "vEthernet (SMB_2)" -IPAddress 192.168.111.27 -PrefixLength 24
Set-VMNetworkAdapterVlan -VMNetworkAdapterName "SMB_2" -VlanID "111" -Access -ManagementOS
Set-VMNetworkAdapter -ManagementOS -Name SMB_2 -IeeePriorityTag on
```

```
Enable-NetAdapterRdma "vEthernet (SMB_2)"
Set-VMNetworkAdapterTeamMapping -ManagementOS -VMNetworkAdapterName SMB_1 -PhysicalNetAdapterName
"Ethernet"
Set-VMNetworkAdapterTeamMapping -ManagementOS -VMNetworkAdapterName SMB_2 -PhysicalNetAdapterName
"Ethernet 2"
```

- In the blue PowerShell pane, type the following command to find the system name for your RoCE adapters:

```
get-NetAdapter
```

- Edit the script in step 3 to make the following replacements:
 - Replace "Ethernet" with the adapter name for port 1 of your RoCE Network adapter.
 - Replace "Ethernet 2" with the adapter name for port 2 of your RoCE Network adapter.
 - Replace the IP addresses with the appropriate IP addresses for your system.
- To run the script, click the green play button.
- At the Confirmation window, click Yes. The script will configure the SET switch for use by Storage Spaces Direct.
- Set up a third vSwitch to use your non-RoCE adapter that has access to the main network:
 - Configure the adapter for DHCP on VLAN 0.
 - In the blue PowerShell pane, type the following command, replacing NIC1 with the name of your network connected NIC:

```
New-VMSwitch -Name Internet -NetAdapterName NIC1 -AllowManagementOS $true
```

Using one node to create the Storage Spaces Direct cluster storage

- Choose one node on each cluster and run the cluster validation tool on it:
 - As the domain administrator, open a PowerShell window. (Note: Instructions for opening a PowerShell window are in steps 19 through 21 of the section Configuring and updating firmware, driver, and OS on cluster nodes.)
 - Run the following command:

```
Test-Cluster -Node S2D-Node01, S2D-Node02, S2D-Node03 -Include 'Storage Spaces Direct',
'Inventory', 'Network', System Configuration'
```

- The PowerShell window will display the location of the generated cluster validation report. Open the cluster validation report, and ensure no failures have taken place. Verify that any warnings in the report are negligible or correct the warnings before deployment.
- Deploy the Failover cluster by typing the following command in the PowerShell window, replacing the IP address, cluster name, and node names with the appropriate values for your network:

```
New-Cluster -Name "S2DCluster" -Node "S2D-Node1","S2D-Node2","S2D-Node3" -NoStorage -StaticAddress
10.214.200.240
```

- Enable Storage Spaces Direct on the failover cluster by typing the command listed below for your cluster hardware in the PowerShell window:

```
New-Volume -StoragePoolFriendlyName "S2D on S2DCluster" -FriendlyName Volume1 -Size 2250GB
New-Volume -StoragePoolFriendlyName "S2D on S2DCluster" -FriendlyName Volume2 -Size 2250GB
New-Volume -StoragePoolFriendlyName "S2D on S2DCluster" -FriendlyName Volume3 -Size 2250GB
```


Preparing the master VM

Creating the SQL Server master VM

1. Choose one node from each cluster. As the domain administrator, open a PowerShell ISE window as Administrator. (Note: Instructions for opening a PowerShell window are in steps 19 through 21 of the section Configuring and updating firmware, driver, and OS on cluster nodes.)
2. Beside Script, click the down arrowhead to expand the script pane.
3. Paste in the following script, and insert the appropriate paths to OS, SQL Server, and DB2 backup files:

```
# =====
# Options toggles
# =====
# -----
# -- Toggle script sections --
# -----
# Create a 1-disk or 3-disk VM (for SQL DB/log files)
$3DiskVM = $true
# Validate DVD Store DB and Log folders are in place
$ConfigureForDVDStore = $true
# Install SQL Server
$InstallSQL = $true
# Path
$VMpath = "C:\GoldenVM"
# -----
# -- VM guest configuration --
# -----
# Hyper-V hardware version. Generation 1 or 2.
$Generation = '2'
# Set disk size and type. Must be greater than 25GB for the OS.
$DiskOSSize = 100*1000000000
$DiskDBSize = 85*1000000000
$DiskLogSize = 30*1000000000
# Destination disk format
$OSDiskFormat = "EagerZeroedThick" # EagerZeroedThick, Thick, Thin
$DBDiskFormat = "EagerZeroedThick" # EagerZeroedThick, Thick, Thin
$LogDiskFormat = "EagerZeroedThick" # EagerZeroedThick, Thick, Thin
# vSwitch - Please configure your vSwitch before running this script.
$VirtualSwitch = "SETSwitch"
$VirtualSwitch2 = "Internet"
# Target VM name
$VMName = 'AMD-SQL-GOLD'
# VM CPU allocation
$VMCPU = 16
# VM RAM allocation 28GB
$VMMemory = 1024*1024*1024*16
# Path to ISO files - please copy to local directory before running script.
$WindowsDisc = <path to Windows Server 2019 ISO>
$SQLDisc = <path to SQL Server 2019 RC ISP>
# DS2 SQL backup file location - please copy to local directory before running script.
#Local file copied from "\\pt-data01.ptnet.principledtech.com\pt\Everyone\Chris B\memoria\DS3-40GB.bak"
#DS2Backup is local hypervisor location of backup file
#DS2BackupPath is VM location to copy backup file to.
$CopyDS2Backup = $true
$DS2Backup = <Local directory with a copy of DS3-40GB.bak (This file should be generated using the benchmarking directions at the end of the methodology)>'
$DS2BackupPath = <VM directory where DS3040GB.bak will be stored>
$SQLInstallCommandLine = ` /qs /ACTION=Install /FEATURES=SQLEngine,Replication,FullText /
INSTANCENAME=MSSQLSERVER /SECURITYMODE=SQL /SAPWD=Password1 /SQLSVCACCOUNT="NT AUTHORITY\SYSTEM" /
SQLSYSADMINACCOUNTS="Administrators" /AGTSVCACCOUNT="NT AUTHORITY\Network Service" /TCPENABLED=1 /
IACCEPTSQLSERVERLICENSETERMS /UpdateEnabled=True /UpdateSource=MU'
# Wait for VM to first boot. If script errors because of slow VM load, increase this value. (Default 60)
$BootTime = 120
```

```

# -----
# -- Windows guest variables --
# -----
# -
# Initialization security definitions
# -
# Local admin
$Username = 'Administrator'
$Password = 'Password1'
$SecPass = ConvertTo-SecureString -AsPlainText $Password -Force
$SecCred = New-Object System.Management.Automation.PSCredential -ArgumentList $Username, $SecPass
# Create destination VM folder
$FolderCheck = Test-Path $VMpath -PathType Container
if ($FolderCheck -eq $false)
{
try {
Write-Host -ForegroundColor Green " - Creating destination VM folder $VMpath on localhost"
New-Item -Path $VMpath -ItemType Directory -ErrorAction Stop | Out-Null #-Force
}
catch {
Write-Host -ForegroundColor Red "Unable to create destination VM directory '$VMpath'. Error was: $_"
-ErrorAction Stop
}}
else
{
Write-Host "$VMpath folder exists" -ForegroundColor DarkGreen
}
# =====
# Create VM
# =====
# Create VM
Write-Host -ForegroundColor Green "1. Creating OS VHDx."
if ($OSDiskFormat -eq "EagerZeroedThick" -OR $OSDiskFormat -eq "Thick") {
#Thick provisioned
$OSVHDParam = @{
Path = "$VMpath\OS.vhdx"
Fixed = $True
SizeBytes = $DiskOSSize
}
} Else {
#Thin provisioned
$OSVHDParam = @{
Path = "$VMpath\OS.vhdx"
Dynamic = $True
SizeBytes = $DiskOSSize
}}
New-VHD @OSVHDParam
function Eagerzero
{
param(
[string]$vhdxpath
)
Mount-VHD -Path $vhdxpath -passthru -Confirm:$false| Initialize-Disk -Passthru -PartitionStyle GPT
-Confirm:$false| New-Partition -DriveLetter Z -UseMaximumSize | Format-Volume -Confirm:$false -Force
$tozero = (fsutil volume diskfree Z:).split(" ")[13]
fsutil file createnew Z:\clear $tozero
fsutil file setvaliddata Z:\clear $tozero
fsutil file setzerodata offset=0 length=$tozero Z:\Clear
del Z:\Clear
Remove-Partition -DriveLetter Z -confirm:$False
Dismount-VHD -Path $vhdxpath
}
if ($OSDiskFormat -eq "EagerZeroedThick") {
Eagerzero "$VMpath\OS.vhdx"
}
}

```

```

Write-Host -ForegroundColor Green "2. Creating VM."
$NewVMPParam = @{
Name = $VMName
MemoryStartupBytes = $VMMemory
SwitchName = $VirtualSwitch2
VHDPath = "$VMpath\OS.vhdx"
Path = $VMpath
Generation = $Generation
}
$VM = New-VM @NewVMPParam
$VM = Set-VM -VMName $VMName -ProcessorCount $VMCPU
$VM = Get-VM -Name $VMName
# Mount install ISO
$VMDVDParam = @{
VMName = $VMName
Path = $WindowsDisc
Confirm = $False
}
Add-VMDvdDrive @VMDVDParam
# Start VM
Start-VM $VMName
Start-Sleep $BootTime
Write-Host -ForegroundColor Green "3. Open Hyper-V and connect to the new VM. Run the Windows
install process."
Write-Host -ForegroundColor Green "4. Once the install is complete, log in with the default user and
password."
Write-Host -ForegroundColor Green "5. You may be prompted to select if the server is discoverable on
the network. Select the appropriate choice for your environment. "
Write-Host -ForegroundColor Cyan " ** If you are not using DHCP for the VM, you must statically
assign an IP at this point. **"
# Wait for VM to reboot and installation to complete
Pause
Stop-VM -Name $VMName -Confirm:$false
do {} until ((Get-VM $VMName).State -eq "Off")
# Dismount OS install ISO
Write-Host -ForegroundColor Green "6. Dismounting and removing virtual CD-ROMs."
$DVD = Get-VMDvdDrive -VMName $VMName
Remove-VMDvdDrive -VMDvdDrive $DVD -Confirm:$False
Start-Sleep -s 5
# Power on VM
Write-Host -ForegroundColor Green "7. Starting VM."
Start-VM $VMName
Start-Sleep $BootTime
# Windows Updates
Write-Host -ForegroundColor Green "8. Log in, run "-NoNewline
Write-Host -ForegroundColor Yellow "sconfig.cmd"-NoNewline
Write-Host -ForegroundColor Green ", and change Windows Update Settings to " -NoNewline
Write-Host -ForegroundColor Yellow "Manual (Option 5)" -NoNewline
Write-Host -ForegroundColor Green ", and then run "
Write-Host -ForegroundColor Yellow "Download and Install Updates (Option 6) " -NoNewline
Write-Host -ForegroundColor Green ", and install all updates."
Write-Host -ForegroundColor Yellow "Once Complete, Enable Remote, change DNS to your DNS server,
change the name, and add the machine to your domain"
Write-Host -ForegroundColor Green "9. When all updates are complete, continue this script."
Write-Host -ForegroundColor Yellow "Note that if Windows says no updates are available, the VM may
not have an IP address."
# Wait for user to run Windows Updates
Pause
if ($3DiskVM -ne $true)
{
# Reboot VM
Write-Host -ForegroundColor Green "Rebooting VM"
ReStart-VM -VMname $VMName -RunAsync -Confirm:$false
Start-Sleep $BootTime
}

```

```

# =====
# Configure DB and Log disks
# =====
# Create DB and Log VHDx
# If 3-disk is true, create VHDx
if($3DiskVM) {
# Shutdown VM
Write-Host -ForegroundColor Green "10. Shutting down VM."
Stop-VM -Name $VMName -Confirm:$false
do {} until ((Get-VM $VMName).State -eq "Off")
Start-Sleep 15
# Create DB and Log disks
Write-Host -ForegroundColor Green "11. Creating additional DB/Log disks and attaching."
if ($DBDiskFormat -eq "EagerZeroedThick" -OR $DBDiskFormat -eq "Thick") {
#Thick provisioned
$DBVHDParam = @{
Path = "$VMpath\DB.vhdx"
Fixed = $True
SizeBytes = $DiskDBSize
}
} Else {
#Thin provisioned
$DBVHDParam = @{
Path = "$VMpath\DB.vhdx"
Dynamic = $True
SizeBytes = $DiskDBSize
}}
if ($LogDiskFormat -eq "EagerZeroedThick" -OR $LogDiskFormat -eq "Thick") {
#Thick provisioned
$LogVHDParam = @{
Path = "$VMpath\Log.vhdx"
Fixed = $True
SizeBytes = $DiskLogSize
}
} Else {
#Thin provisioned
$LogVHDParam = @{
Path = "$VMpath\Log.vhdx"
Dynamic = $True
SizeBytes = $DiskLogSize
}}
New-VHD @DBVHDParam
New-VHD @LogVHDParam
if ($DBDiskFormat -eq "EagerZeroedThick") {
Eagerzero -vhdxpath "$VMpath\DB.vhdx"
}
if ($LogDiskFormat -eq "EagerZeroedThick") {
Eagerzero -vhdxpath "$VMpath\Log.vhdx"
}
$AddDBVHDParam = @{
Path = "$VMpath\DB.vhdx"
ControllerType = `SCSI'
ControllerLocation = 1
VM = $VM
}
Add-VMHardDiskDrive @AddDBVHDParam
$AddLogVHDParam = @{
Path= "$VMpath\Log.vhdx"
ControllerType = `SCSI'
ControllerLocation = 2
VM = $VM
}
Add-VMHardDiskDrive @AddLogVHDParam
# Power on VM
Write-Host -ForegroundColor Green "12. Starting VM."

```

```

Start-VM $VMName
Start-Sleep $BootTime
# Bring VHDx online
Start-Sleep 30
Write-Host -ForegroundColor Green "13. Setting disks Online."
$s = New-PSSession -ComputerName $VMName -Credential $SecCred
Invoke-Command -Session $s -ScriptBlock { Get-Disk | Where-Object IsOffline -Eq $True | Set-Disk
-IsOffline $False }
# Initialize DB and log drives
Write-Host -ForegroundColor Green "14. Initializing disks."
Invoke-Command -Session $s -ScriptBlock {set-disk -Number 1 -IsOffline $false}
Invoke-Command -Session $s -ScriptBlock {set-disk -Number 2 -IsOffline $false}
Invoke-Command -Session $s -ScriptBlock {set-disk -Number 1 -IsReadOnly $false}
Invoke-Command -Session $s -ScriptBlock {set-disk -Number 2 -IsReadOnly $false}
Invoke-Command -Session $s -ScriptBlock {clear-disk -Number 1 -Confirm:$false}
Invoke-Command -Session $s -ScriptBlock {clear-disk -Number 2 -Confirm:$false}
Invoke-Command -Session $s -ScriptBlock {Initialize-Disk 1 -PartitionStyle GPT}
Invoke-Command -Session $s -ScriptBlock {Initialize-Disk 2 -PartitionStyle GPT}
# Set drive letters. G: database, H: transaction logs.
Write-Host -ForegroundColor Green "15. Setting drive letters to G and H"
Invoke-Command -Session $s -ScriptBlock {New-Partition -DiskNumber 1 -UseMaximumSize
-AssignDriveLetter}
Invoke-Command -Session $s -ScriptBlock {New-Partition -DiskNumber 2 -UseMaximumSize
-AssignDriveLetter}
Invoke-Command -Session $s -ScriptBlock {Set-Partition -DiskNumber 1 -PartitionNumber 2
-NewDriveLetter G}
Invoke-Command -Session $s -ScriptBlock {Set-Partition -DiskNumber 2 -PartitionNumber 2
-NewDriveLetter H}
# Format DB and log drives
Write-Host -ForegroundColor Green "16. Quick-formatting drives."
Invoke-Command -Session $s -ScriptBlock {Format-Volume -DriveLetter G}
Invoke-Command -Session $s -ScriptBlock {Format-Volume -DriveLetter H}
}
# =====
# Configure VM for DVDStore
# =====
if ($ConfigureForDVDStore)
{
Write-Host -ForegroundColor Green "17. Configuring DVDStore paths."
Invoke-Command -Session $s -ScriptBlock {New-Item G:\db -type directory}
Invoke-Command -Session $s -ScriptBlock {New-Item H:\log -type directory}
# Copy DVDStore restore file to the C:\ drive
if ($CopyDS2Backup)
{
Write-Host -ForegroundColor Green "18. Copying DVDStore SQL backup manually."
Write-Host -ForegroundColor Yellow "Copy-Item $DS2Backup -Destination $DS2BackupPath"
pause
}
}
# =====
# Install SQL Server 2019 RC
# =====
# Install SQL Server
if ($InstallSQL)
{
Write-Host -ForegroundColor Green "19. Installing SQL Server."
Write-Host -ForegroundColor Green " - Attaching DVD."
Stop-VM -Name $VMName -Confirm:$false
do {} until ((Get-VM $VMName).State -eq "Off")
# Mount ISO
$VMDVDPParam = @{
VMName = $VMName
Path = $SQLDisc
Confirm = $False
}
}

```

```

Add-VMDvdDrive @VMDVDParam
Write-Host -ForegroundColor Green " - Starting VM."
Start-VM -VMname $VMName
Start-Sleep $BootTime
Write-Host -ForegroundColor Green " - Start Installation Manually."
Write-Host -ForegroundColor Yellow "D:\Setup.exe $SQLInstallCommandLine"
Write-Host -ForegroundColor Green "20. Continue when installation is complete."
Pause
# Remove install disc
Write-Host -ForegroundColor Green "21. Dismounting and removing virtual CD-ROMs."
Start-Sleep 15
Write-Host -ForegroundColor Green " - Shutting down VM."
Stop-VM -Name $VMName -Confirm:$false
do {} until ((Get-VM $VMName).State -eq "Off")
# Dismount SQL install ISO
Write-Host -ForegroundColor Green " - Dismounting disc."
Set-VMDvdDrive -VMName $VMName -Path $null -Confirm:$false
Start-Sleep -s 5
Write-Host -ForegroundColor Green " - Starting VM."
Start-VM -VMname $VMName
Start-Sleep $BootTime
}
# =====
# End of script
# =====
Write-Host -ForegroundColor Cyan "You may wish to run Windows Update at this time if you installed
SQL Server."
pause
#Copy Sysprep files to local hypervisor install directory before beginning script
Write-Host -ForegroundColor Green "27. Manually copy Sysprep files to VM"
Write-Host -ForegroundColor Yellow "Copy-Item \\S2DLEGINTEL01\install\Sysprep_Files\* -Destination
C:\\"
pause
Write-Host -ForegroundColor Green "28. Manually disable remote, remove from domain, and remove DNS."
pause
Write-Host -ForegroundColor Green "29. Manually Run this file in C:\ as Administrator:" -NoNewline
Write-Host -ForegroundColor Yellow "RunMeAsAdministrator.bat"
pause
Write-Host -ForegroundColor Green "30. In Hyper-V change the settings for the VM."
Write-Host -ForegroundColor Yellow "Change automatic stop action to Shut down."
Write-Host -ForegroundColor Red "======"
Write-Host -ForegroundColor Red "SCRIPT COMPLETE"
Write-Host -ForegroundColor Red "======"
pause
EXIT

```

Cloning the master VM

1. Use the same cluster node that generated the master VM image on each cluster. As the domain administrator, open a PowerShell ISE window as Administrator.
2. Beside Script, click the down arrowhead to expand the script pane.
3. Paste in the following script, inserting the appropriate location for the ExportDirectory to store a copy of the Master VM.

```
$VMName = 'GOLDENVM'
$ExportDirectory='<Insert appropriate directory here.>'
#Make Export
$FolderCheck = Test-Path $ExportDirectory -PathType Container
if ($FolderCheck -eq $false)
{
  try {
    Write-Host -ForegroundColor Green " - Creating destination Export folder $ExportDirectory on localhost"
    New-Item -Path $ExportDirectory -ItemType Directory -ErrorAction Stop | Out-Null #-Force
    Write-Host -ForegroundColor Yellow "Make sure you have done sysprep before we export."
    pause
    Export-VM -Name $VMName -Path $ExportDirectory
  }
  catch {
    Write-Host -ForegroundColor Red "Unable to create destination Export folder '$VMpath'. Error was: $_" -ErrorAction Stop
  }
}
else
{
  Write-Host -ForegroundColor Yellow "$ExportDirectory folder exists, assuming VM is already exported."
}
Write-Host -ForegroundColor Green "Export Complete"
#Make copies and import
$Volumes = Get-VirtualDisk | where-object {$_.FriendlyName -Match "^Volume?"}
$startno = 1
$Endno = 8
foreach ($volume in $Volumes) {
  $name = $volume.FriendlyName
  for ($VMno=$startno; $VMno -le $Endno; $VMno++) {
    $destination = "C:\ClusterStorage\$name\Copy$VMno"
    mkdir $destination
    $MyVM = Import-VM -Path (ls "$ExportDirectory\$VMName\Virtual Machines\*.vmcx").tostring() -Copy
    -GenerateNewID -VhdDestinationPath $destination -VirtualMachinePath $destination
    Rename-VM -VM $MyVM -NewName "VM$VMno"
  }
  $startno=$Endno+1
  $Endno=$Endno+8
}
```

Configuring and running the DVD Store 3 benchmark

Generating data

We generated the data using the Install.pl script included with 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 2019. 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 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 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. 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 ds3user SQL Server login using the following Transact SQL (TSQL) script:

```
USE [master]
GO
CREATE LOGIN [ds3user] WITH PASSWORD=N'',
DEFAULT_DATABASE=[master],
DEFAULT_LANGUAGE=[us_english],
CHECK_EXPIRATION=OFF,
CHECK_POLICY=OFF
GO
EXEC master..sp_addsrvrolemember @loginame = N'ds3user',
@rolename = N'sysadmin'
USE [DS3]
CREATE USER [ds3DS3user] FOR LOGIN [ds3user]
EXEC sp_addrolemember N'db_owner', N'ds3DS3user'
USE [master]
CREATE USER [ds3masteruser] FOR LOGIN [ds3user]
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 report, we report the last OPM that each target reported.

Each complete test cycle consisted of these 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:

```
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=5 --report_rate=1 --pct_newcustomers=20 --csv_output=<drivepath>
```

Preparing Failover Cluster Manager

Setting up the VMs on Failover Cluster Manager

1. Open Failover Cluster Manager on node 2.
2. Click the S2DCluster.
3. Select Configure Role.
4. Select Virtual Machine.
5. Click Next.
6. Check all the test virtual machines.
7. Click Next.
8. Verify the settings for high availability.
9. Click Next.
10. Click Finish.

Read the report at <http://facts.pt/QbC85Z3> ►

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