



The science behind the report:

Achieve more analytics work, faster, with the Dell EMC PowerEdge R740xd

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 [Achieve more analytics work, faster, with the Dell EMC PowerEdge R740xd](#).

We concluded our hands-on testing on May 20, 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 May 5, 2019 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Results for the PowerEdge R720xd come from our earlier report, [Consolidate your data analytics servers with the Dell EMC PowerEdge R740xd](#). We used an identical testing methodology to conduct testing for this report.

Our results

	Dell EMC PowerEdge R720xd with HDDs	Dell EMC PowerEdge R730xd with SATA SSDs	Dell EMC PowerEdge R740xd with SATA SSDs	Dell EMC™ PowerEdge™ R740xd Intel DC P4610 Series NVMe SSDs
Per VM time to complete a query set (sec):	1	2	6	10
VM1 (sec)	4241	278	234	202
VM2 (sec)	N/A	265	237	202
VM3 (sec)	N/A	N/A	234	199
VM4 (sec)	N/A	N/A	239	200
VM5 (sec)	N/A	N/A	240	196
VM6 (sec)	N/A	N/A	238	202
VM7 (sec)	N/A	N/A	N/A	199

	Dell EMC PowerEdge R720xd with HDDs	Dell EMC PowerEdge R730xd with SATA SSDs	Dell EMC PowerEdge R740xd with SATA SSDs	Dell EMC™ PowerEdge™ R740xd Intel DC P4610 Series NVMe SSDs
VM8 (sec)	N/A	N/A	N/A	201
VM9 (sec)	N/A	N/A	N/A	199
VM10 (sec)	N/A	N/A	N/A	203
Average time (sec)	4241	271	237	200
Max time (min:sec)	70:41	4:38	4:00	3:22

System configuration information

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

Server configuration information	Dell EMC PowerEdge R720xd	Dell EMC PowerEdge R730xd	Dell EMC PowerEdge R740xd
BIOS name and version	Dell 2.5.4	Dell 2.9.1	Dell 2.1.6
Operating system name and version/build number	Windows Server 2012 R2	Microsoft Windows Server 2016 Datacenter	Microsoft Windows Server 2019 Datacenter
Date of last OS updates/patches applied	5/18/2017	5/9/2019	5/9/2019
Power management policy	Performance	High Performance	High Performance
Processor			
Number of processors	2	2	2
Vendor and model	Intel® Xeon® E5-2680 v2	Intel Xeon E5-2690 v3	Intel Xeon Gold 6230
Core count (per processor)	10	12	20
Core frequency (GHz)	2.80	2.6	2.10
Stepping	1	2	6
Memory module(s)			
Total memory in system (GB)	192	192	384
Number of memory modules	12	6	24
Vendor and model	Hynix® HMT42GR7MFR4C-PB	Samsung® M393A4K40BB1-CRC	Micron® 18ASF2G72PDZ-2G9E1
Size (GB)	16	32	16
Type	PC3-12800	PC4-2133	PC4-2666
Speed (MHz)	1,600	2,133	2,666
Speed running in the server (MHz)	1,600	2,133	2,666
Storage controller			
Vendor and model	Dell PERC H710P Mini	Dell PERC H730P Mini	Dell PERC H730P
Cache size	1,024 MB	2 GB	2 GB
Firmware version	21.3.4-0001	25.5.5.0005	25.5.5.0005
Driver version	6.805.3.0	6.603.7.0	6.604.6.0
Local storage A			
Number of drives	2	2	2
Drive vendor and model	Dell 0B24379	Intel SSDSC2BB80	Seagate® ST300MM0006
Drive size (GB)	146	800	300
Drive information (speed, interface, type)	6 Gb/s, SAS, HDD	SATA SSD	10k SAS HDD
Local storage B			
Number of drives	24	24	12
Drive vendor and model	Dell 0B24379	Seagate ST9300653SS	Intel D3-S4510

Server configuration information	Dell EMC PowerEdge R720xd	Dell EMC PowerEdge R730xd	Dell EMC PowerEdge R740xd
Drive size	146 GB	300 GB	1.92 TB
Drive information (speed, interface, type)	6 Gb/s, SAS, HDD	15k SAS HDD	SATA SSD
Local storage C			
Number of drives	N/A	N/A	12
Drive vendor and model	N/A	N/A	Intel P4610
Drive size (GB)	N/A	N/A	1.6 TB
Drive information (speed, interface, type)	N/A	N/A	PCIe NVMe SSD
Network adapter			
Vendor and model	Intel Gigabit 4P I350	Broadcom BCM5720	QLogic BCM57800
Number and type of ports	4 x 1Gb RJ45	4x 1Gb Ethernet	2x 1Gb Ethernet, 2x 10Gb Ethernet
Driver version	17.5.10	214.0.0.1	7.13.57.103
Cooling fans			
Number of cooling fans	6	6	6
Power supplies			
Vendor and model	Dell PWR SPLY 750WP	Dell 05RHVV	Dell 0Y26KX
Number of power supplies	2	2	2
Wattage of each (W)	750	750	1,100

How we tested

Microsoft SQL Server columnstore indexes

We took advantage of SQL Server's columnstore indexing technology to help improve query times for our testing. Because of the read-only limitation of columnstore indexes in SQL Server 2012, on the R720xd VM, we created non-clustered columnstore indexes for every table in the database except for the ORDERS and LINEITEMS tables after the initial database creation. SQL Server 2016 and SQL Server 2017 support both read and write operations for columnstore indexes, allowing us to create clustered columnstore indexes for each database table and take full advantage of this feature.

Detailed test methodology

We ran the TPC-H-like test from the HammerDB suite on a Dell EMC PowerEdge R720xd with 24 15K SAS HDDs. We first began by splitting up the disks into three RAID 10 volumes. We used four disks for our OS volume, 14 disks for our Data volume, and six disks for our Log volume. We then moved the TempDB and TempLog files to the Data and Log volumes, respectively. We started testing with a single VM and increased the VM count until the query completion time on the first VM increased. With this method, adding another VM increased the query completion time for both VMs, suggesting a storage bottleneck.

We then ran the same test using the same method on the PowerEdge R730xd server configured with 24 HDDs and the same RAID volumes. We scaled up to two VMs before reaching a storage bottleneck. For the PowerEdge R720xd test, we set the VM memory to 50GB, while on the R730xd each VM had 36 GB of memory. On the PowerEdge R740xd, we set the amount of memory inside each VM to 32 GB. Because of the storage I/O bottleneck in the PowerEdge R720xd configuration, we were able to utilize roughly 26 percent of the system's total RAM. With two VMs in the PowerEdge R730xd configuration, we utilized about 38 percent of the available RAM. With six VMs in the PowerEdge R740xd + SATA SSD configuration, we utilized about 50% of the RAM, and with ten VMs in the PowerEdge R740xd + NVMe SSD configuration, we utilized about 84 percent of the RAM.

Next, we switched to the PowerEdge R740xd with 12 SATA SSDs. We set up the 12 SSDs into three RAID volumes: six disks in a RAID 10 for data, four disks in a RAID 10 for logs, and two disks in a RAID 1 for the OS VHDs. We configured each VM with eight vCPUs and 32GB of memory for all R740xd testing.

We upgraded from the 12 SATA SSDs to 12 Dell EMC PowerEdge Express Flash NVMe P4610 SSDs. We used Windows Storage Spaces to create the same volume configuration as with our SATA SSDs. With the NVMe SSDs in place, we were able to scale up to 10 VMs. In this configuration, each VM outperformed our baseline.

Initial setup on the Dell EMC PowerEdge R720xd server

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

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When the option appears, press F11 to enter the Boot Manager.
3. Select BIOS Boot Menu.
4. Select SATA Optical Drive, and press Enter.
5. When prompted to boot from DVD, press any key.
6. When the installation screen appears, click My language is English (United States).
7. Leave the language, time/currency format, and input method as default, and click Next.
8. Click Install now.
9. When the installation prompts you, enter the product key.
10. Select Windows Server 2012 Datacenter (Server with a GUI), and click Next.
11. Check I accept the license terms, and click Next.
12. Click Custom: Install Windows only (advanced).
13. Select Drive 0 Unallocated Space, and click Next. Windows will begin and restart automatically.
14. At the Settings page, fill in the Password and Reenter Password fields with the same password.
15. Log in with the password you set up in the previous step.

Configuring Windows Update on the Dell EMC PowerEdge R720xd server

1. In the left pane of the Server Manager window, click Local Server.
2. In the main frame, next to Windows Update, click Not configured.
3. In the Windows Update window, in the main pane, click Let me choose my settings.
4. Under Important updates, select Never check for updates (not recommended), and click OK.
5. In the left pane, click Check for updates, and install all available updates.
6. Close the Windows Update window.

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

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

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

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

Installing the Hyper-V role on the Dell EMC PowerEdge R720xd server

1. Open the Server Manager.
2. Click Manage→Add Roles and Features.
3. At the Before You Begin screen, click Next.
4. Choose Role-based or feature-based installation, and click Next.
5. Choose the local server, and click Next.
6. Choose Hyper-V, and click Add Features when prompted. Click Next.
7. At the Things to note screen, click.
8. Choose a port for the virtual switch, and click Next.
9. Choose whether to add live migration capabilities, and click Next.
10. Set your default storage, and click Next.
11. Check the box for automatic restart, and click Install.

Creating and configuring the VMs on the Dell EMC PowerEdge R720xd server

1. Open the Hyper-V manager.
2. Right-click the host server, and choose New→Virtual Machine.
3. At the Before You Begin screen, click Next.
4. Name the VM, and choose the storage option. Click Next.
5. Choose Generation 2, and click Next.
6. Enter 51200 MB for the startup memory, and click Next.
7. Choose the network connection, and click Next.
8. Choose 40 GB for the disk size, and click Next.

9. Choose Install an operating system later, and click Next.
10. Click Finish.
11. When the system finishes creating the VM, right-click the VM, and choose Settings....
12. Change the number of processors to four, and click Apply.
13. Click the SCSI Controller, highlight Hard Drive, and click Add.
14. Choose Virtual hard disk, and click New.
15. At the Before You Begin screen, click Next.
16. Choose Fixed size, and click Next.
17. Name the HDD, and choose the Data volume as the location. Click Next.
18. Set the size to 275 GB, and click Next.
19. Click Finish.
20. Repeat steps 13 through 19 twice more to create a 115GB Log VHD and a 201GB backup VHD, storing the Log VHD on the Log volume, and the backup VHD on the Backup volume.
21. Install Windows Server 2012 R2 and any updates on the VM, following the same steps outlined in previous sections.
22. Using Windows Disk Manager, add the three additional HDDs to the VM.

Installing SQL Server 2012 on the PowerEdge R720xd VM

1. Mount the installation DVD for SQL Server 2012.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2012 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. Select the Enter the product key radio button, and enter the product key. Click Next.
6. Click the checkbox to accept the license terms, and click Next.
7. Click Use Microsoft Update to check for updates, and click Next.
8. Click Install to install the setup support files.
9. If no failures appear, click Next.
10. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
11. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools—Basic, and Management Tools—Complete. Click Next.
12. At the Installation Rules screen, after the check completes, click Next.
13. At the Instance configuration screen, leave the default selection of default instance, and click Next.
14. At the Server Configuration screen, choose NT Service\SQLSERVERAGENT for SQL Server Agent, and choose NT Service\MSSQLSERVER for SQL Server Database Engine. Change the Startup Type to Automatic. Click Next.
15. At the Database Engine Configuration screen, select the authentication method you prefer. In our tests, we selected Mixed Mode.
16. Enter and confirm a password for the system administrator account.
17. Click Add Current user. This may take several seconds.
18. Click Next.
19. At the Error and usage reporting screen, click Next.
20. At the Installation Configuration Rules screen, check to ensure there are no failures or relevant warnings, and click Next.
21. At the Ready to Install screen, click Install.
22. After installation completes, click Close.
23. Close the installation window.
24. Open SQL Server 2012 Configuration Manager, and expand Protocols for MSSQLSERVER.
25. Right-click Named Pipes, and choose Enabled.
26. Click OK, and restart the SQL service.

Moving and expanding tempdb on the PowerEdge R720xd VM

1. Open SQL Management Studio.
2. Run the following query with the appropriate destinations:

```
SELECT name, physical_name AS CurrentLocation
FROM sys.master_files
WHERE database_id = DB_ID(N'tempdb');
GO
```

```
USE master;
GO
ALTER DATABASE tempdb
MODIFY FILE (NAME = tempdev, FILENAME = 'E:\Data\tempdb.mdf');
GO
ALTER DATABASE tempdb
MODIFY FILE (NAME = templog, FILENAME = 'F:\Logs\templog.ldf');
GO
```

3. Stop and restart the SQL server instance.
4. Verify that the files are in the new destinations.
5. Run the following query to verify that SQL recognizes the new destination:

```
SELECT name, physical_name AS CurrentLocation, state_desc
FROM sys.master_files
WHERE database_id = DB_ID(N'tempdb');
```
6. Delete the original tempdb files.
7. Expand Databases→System Databases
8. Right-click tempdb, and choose Properties.
9. Click Files, and enter a new Initial Size (MB) for both files. The size required will depend on the scale of your TPC-H database. We set tempdev to 50GB and templog to 10GB to ensure more than enough space.
10. When the files are finished expanding, click OK.

Initial setup on the Dell EMC PowerEdge R730xd server

Installing Windows Server 2016 Datacenter Edition on the PowerEdge R730xd server

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When the option appears, press F11 to enter the Boot Manager.
3. Select UEFI Boot Menu.
4. Select the boot media, and press Enter.
5. When prompted to boot from DVD, press any key.
6. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
7. Click Install now.
8. When the installation prompts you, enter the product key.
9. Select Windows Server 2016 Datacenter Edition (Server with a GUI), and click Next.
10. Check I accept the license terms, and click Next.
11. Click Custom: Install Windows only (advanced).
12. Select Drive 0 Unallocated Space, and click Next. Windows will begin and restart automatically.
13. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
14. Log in with the password you set up in the previous step.
15. Using Windows update, download and install all updates.
16. Once all updates are installed, disable the Windows Update service to ensure no new updates are applied during testing.

Installing the Hyper-V role on the PowerEdge R730xd

1. Open the Server Manager.
2. Click Manage→Add Roles and Features.
3. At the Before You Begin screen, click Next.
4. Choose Role-based or feature-based installation, and click Next.
5. Choose the local server, and click Next.
6. Choose Hyper-V, and click Add Features when prompted. Click Next.
7. At the Hyper-V Things to note screen, click Next.
8. Choose a port for the virtual switch, and click Next.
9. Choose whether or not you want to add live migration capabilities, and click Next.
10. Set your default storage, and click Next.
11. Check the box for automatic restart, and click Install.

Creating and configuring the VMs on the PowerEdge R730xd

1. Open the Hyper-V manager.
2. Right-click the host server, and choose New→Virtual Machine
3. At the Before You Begin screen, click Next.
4. Name the VM, and choose the storage option. Click Next.
5. Choose Generation 2, and click Next.
6. Enter the desired amount of memory for the startup memory, and click Next. In our testing we used 36864.
7. Choose the network connection, and click Next.
8. Choose 30 GB for the disk size, and click Next.
9. Choose Install an operating system later, and click Next.
10. Click Finish.
11. After VM creation, right-click the VM and choose Settings...
12. Change the number of processors, and click Apply. For our tests, we set the number of processors to 12.
13. Click on the SCSI Controller, highlight Hard Drive, and click Add.
14. Choose Virtual hard disk, and click New.
15. At the Before You Begin screen, click Next.
16. Choose Fixed size, and click Next.
17. Name the HDD, and choose the Data volume for the location. Click Next.
18. Set the size to 350 GB, and click Next.
19. Click Finish.
20. Repeat steps 13 through 19 twice more to create a 115GB Log VHD and a 100GB backup VHD, storing the Log VHD on the Log volume, and the backup VHD on the OS volume.
21. Install Windows Server 2016 and any updates on the VM, following the same steps outlined in previous sections.
22. Using Windows Disk Manager, add the three additional HDDs to the VM.

Installing Windows Server 2016 DataCenter Edition on the PowerEdge R730xd server VM

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When the option appears, press F11 to enter the Boot Manager.
3. Select UEFI Boot Menu.
4. Select the boot media, and press Enter.
5. When prompted to boot from DVD, press any key.
6. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
7. Click Install now.
8. When the installation prompts you, enter the product key.
9. Select Windows Server 2016 Datacenter Edition (Server with a GUI), and click Next.
10. Check I accept the license terms, and click Next.
11. Click Custom: Install Windows only (advanced).
12. Select Drive 0 Unallocated Space, and click Next. Windows will begin and restart automatically.
13. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
14. Log in with the password you set up in the previous step.
15. Using Windows update, download and install all updates.
16. Once all updates are installed, disable the Windows Update service to ensure no new updates are applied during testing.

Formatting a Windows NTFS volume for SQL on the PowerEdge R730xd VM

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

Installing SQL Server 2016 on the PowerEdge R730xd VM

1. Attach the installation media ISO for SQL Server 2016 to the VM.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2016 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. Click the checkbox to accept the license terms, and click Next.
6. Click Use Microsoft Update to check for updates, and click Next.
7. To install the setup support files, click Install.
8. If no failures appear, click Next.
9. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
10. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility.
11. Click Next.
12. At the Instance configuration screen, leave the default selection of default instance, and click Next.
13. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
14. Enter and confirm a password for the system administrator account.
15. Click Add Current user. This may take several seconds.
16. Click the TempDB tab.
17. Change the number of TempDB files to eight, and change its location to the Data volume.
18. Change the location of the TempLog file to the Log volume.
19. Click Next.
20. At the Error and usage reporting screen, click Next.
21. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
22. At the Ready to Install screen, click Install.
23. Close the installation window.
24. Download and Install SQL Server Management Studio.

Expanding TempDB & TempLog files on the PowerEdge R730xd VM

1. Open SQL Server Management Studio.
2. Expand Databases→System Databases
3. Right-click tempdb, and choose Properties.
4. Click Files, and enter a new Initial Size (MB) for both files. The size required will depend on the scale of your TPC-H database. We set tempdev to 50 GB and templog to 10 GB to ensure more than enough space.
5. When the files are finished expanding, click OK.

Enabling Lock Pages in Memory on the PowerEdge R730xd VM

1. Click Start, and type `gpedit.msc`, and press Enter.
2. In the Local Group Policy Editor, expand Computer Configuration→Windows Settings→Security Settings→Local Policies
3. Select User Rights Assignment, and scroll down to Lock pages in memory in the right pane.
4. Right-click Lock pages in memory, and click Properties.
5. Click Add User or Group, and add your SQL user account (NT SERVICE\MSSQLSERVER).
6. Click OK.

Initial setup of the Dell EMC PowerEdge R740xd server

Installing Windows Server 2019 DataCenter Edition on the PowerEdge R740xd server

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When the option appears, press F11 to enter the Boot Manager.
3. Select UEFI Boot Menu.
4. Select the boot media, and press Enter.
5. When prompted to boot from DVD, press any key.
6. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
7. Click Install now.
8. When the installation prompts you, enter the product key.
9. Select Windows Server 2019 Datacenter Edition (Server with a GUI), and click Next.
10. Check I accept the license terms, and click Next.
11. Click Custom: Install Windows only (advanced).
12. Select Drive 0 Unallocated Space, and click Next. Windows will begin and restart automatically.
13. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
14. Log in with the password you set up in the previous step.
15. Using Windows update, download and install all updates.
16. Once all updates are installed, disable the Windows Update service to ensure no new updates are applied during testing.
17. Securely erasing and seasoning the SATA SSDs and NVMe SSDs.
18. Ensure that the disks are set to Non-RAID mode in the BIOS or through the RAID controller.
19. Create a bootable USB drive with the PartedMagic ISO.
20. Insert the bootable USB into the PowerEdge R740xd.
21. Press F11 to select a boot device.
22. Select the bootable USB.
23. Select the time zone, and click OK.
24. Double-click the Secure Erase icon on the desktop.
25. From within the Internal tab, select either SATA SSD or NVMe SSD Secure Erase.
26. Check each disk you wish to securely erase, and click Next.
27. Click the check box to confirm you'd like to securely erase the SSDs, and click OK.
28. When the process is over, confirm that each SSD completed erasure successfully, and click OK.
29. Double-click the quit icon, and select Reboot.
30. After Windows reboots, open Iometer.
31. In the Disk Target tab, assign one worker to each raw disk.
32. Set the number of outstanding I/O to 256, and the Write IO data pattern to Pseudo random.
33. Click the Access Specification tab.
34. Create a new Access Specification with the following parameters:
 - Transfer Request Size – 128K
 - Percent of Access Specification – 100
 - Percent Read/Write Distribution – 100% Write
 - Percent Random/Sequential Distribution – 100% Sequential
35. Assign the newly created Access Specification to each worker.
36. Click the Test Setup tab.
37. Set the Ramp Up time to 60 seconds.
38. Set the Run Time to the appropriate amount of time it takes to fill up twice the capacity of the drives.
39. Click the green flag icon to start the seasoning.
40. When the seasoning has finished, create the volumes as described at the top of this section.

Installing the Hyper-V role on the PowerEdge R740xd

1. Open the Server Manager.
2. Click Manage→Add Roles and Features.
3. At the Before You Begin screen, click Next.
4. Choose Role-based or feature-based installation, and click Next.
5. Choose the local server, and click Next.

6. Choose Hyper-V, and click Add Features when prompted. Click Next.
7. At the Hyper-V Things to note screen, click Next.
8. Choose a port for the virtual switch, and click Next.
9. Choose whether or not you want to add live migration capabilities, and click Next.
10. Set your default storage, and click Next.
11. Check the box for automatic restart, and click Install.

Creating and configuring the VMs on the PowerEdge R740xd

1. Open the Hyper-V manager.
2. Right-click the host server, and choose New→Virtual Machine
3. At the Before You Begin screen, click Next.
4. Name the VM, and choose the storage option. Click Next.
5. Choose Generation 2, and click Next.
6. Enter the desired amount of memory for the startup memory, and click Next. In our testing we used 32768.
7. Choose the network connection, and click Next.
8. Choose 40 GB for the disk size, and click Next.
9. Choose Install an operating system later, and click Next.
10. Click Finish.
11. After VM creation, right click the VM and choose Settings...
12. Change the number of processors, and click Apply. For our tests, we set the number of processors to eight.
13. Click on the SCSI Controller, highlight Hard Drive, and click Add.
14. Choose Virtual hard disk, and click New.
15. At the Before You Begin screen, click Next.
16. Choose Fixed size, and click Next.
17. Name the HDD, and choose the Data volume for the location. Click Next.
18. Set the size to 175 GB, and click Next.
19. Click Finish.
20. Repeat steps 13 through 19 twice more to create a 50GB Log VHD and a 100GB backup VHD, storing the Log VHD on the Log volume, and the backup VHD on the OS volume.
21. Install Windows Server 2016 and any updates on the VM, following the same steps outlined in previous sections.
22. Using Windows Disk Manager, add the three additional HDDs to the VM.

Installing Windows Server 2019 DataCenter Edition on the PowerEdge R740xd server VM

Insert the installation media into the CD/DVD drive, and restart the server.

1. When prompted to boot from DVD, press any key.
2. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
3. Click Install now.
4. When the installation prompts you, enter the product key.
5. Select Windows Server 2019 Datacenter Edition (Desktop Experience), and click Next.
6. Check I accept the license terms, and click Next.
7. Click Custom: Install Windows only (advanced).
8. Select Drive 0 Unallocated Space, and click Next. Windows will begin and restart automatically.
9. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
10. Log in with the password you set up in the previous step.
11. Using Windows update, download and install all updates.
12. Once all updates are installed, disable the Windows Update service to ensure no new updates are applied during testing.

Formatting a Windows NTFS volume for SQL on the PowerEdge R740xd VM

1. Right-click the start icon, and click Disk Management.
2. Right-click the disk, and click Online.
3. Right-click the disk again, and click Initialize.
4. Right click an unallocated area, and select New Simple Volume.
5. Click Next.

6. Click Next.
7. Assign a letter path, and click Next.
8. Set the Allocation Unit Size to 64K, and name the Volume Label.
9. Click Next.
10. Click Finish.
11. Repeat steps 1 through 10 on all data and log volumes.

Installing SQL Server 2017 on the PowerEdge R740xd VM

1. Attach the installation media ISO for SQL Server 2016 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. Click the checkbox to accept the license terms, and click Next.
6. Click Use Microsoft Update to check for updates, and click Next.
7. To install the setup support files, click Install.
8. If no failures appear, click Next.
9. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
10. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility.
11. Click Next.
12. At the Instance configuration screen, leave the default selection of default instance, and click Next.
13. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
14. Enter and confirm a password for the system administrator account.
15. Click Add Current user. This may take several seconds.
16. Click the TempDB tab.
17. Change the number of TempDB files to eight, and change its location to the Data volume.
18. Change the location of the TempLog file to the Log volume.
19. Click Next.
20. At the Error and usage reporting screen, click Next.
21. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
22. At the Ready to Install screen, click Install.
23. Close the installation window.
24. Download and Install SQL Server Management Studio.

Expanding TempDB & TempLog files on the PowerEdge R740xd VM

1. Open SQL Server Management Studio.
2. Expand Databases→System Databases
3. Right-click tempdb, and choose Properties.
4. Click Files, and enter a new Initial Size (MB) for both files. The size required will depend on the scale of your TPC-H database. We set tempdev to 50 GB and templog to 10 GB to ensure more than enough space.
5. When the files are finished expanding, click OK.

Enabling Lock Pages in Memory on the PowerEdge R740xd VMs

1. Click Start, and type gpedit.msc, and hit Enter.
2. In the Local Group Policy Editor, expand Computer Configuration→Windows Settings→Security Settings→Local Policies
3. Select User Rights Assignment, and scroll down to Lock pages in memory in the right pane.
4. Right-click Lock pages in memory, and click Properties.
5. Click Add User or Group, and add your SQL user account (NT SERVICE\MSSQLSERVER).
6. Click OK.
7. Configure the VMs on all servers

Creating a Database

1. Open SQL Server Management Studio.
2. Right-click Databases→New Database.
3. Name the database. We named ours tpch.
4. Click Add to add seven more database files for a total of eight.
5. Name the database files, and click OK.

Installing HammerDB

1. Download the latest version of HammerDB from www.hammerdb.com/download.html
2. Double-click the exe file, choose English, and click OK.
3. Click Yes.
4. Click Next.
5. Choose a destination location, and click Next.
6. Click Next.
7. Click Finish.

Populating the database

1. Open HammerDB, and click Options→Benchmark.
2. Choose MSSQL Server and TPC-H.
3. Expand SQL Server→TPC-H→Schema Build.
4. Double-click Options.
5. Choose 100 scale, and the number of virtual users corresponding to the number of CPU cores.
6. On the R720xd, click OK, and move to step 8.
7. On the R730xd and R740xd, check the box for clustered column store, and click OK.
8. Double-click Build. This build could take several hours.

Creating non-clustered Columnstore indexes for the PowerEdge R720xd VM

1. Open SQL Server Management Studio.
2. Expand Databases→tpch→Tables→dbo.customer.
3. Right-click Indexes→New Index→Non-Clustered Columnstore Index.
4. Click ADD and add all of the columns to the columnstore.
5. Click OK.
6. Repeat steps 1 through 5 for all tables except Orders and Lineltem.

Backing up the database

1. Open SQL Server Management Studio.
2. Right-click the TPCH database, and click Tasks→Back up...
3. Choose a location to store the backup, and click OK.

Cloning the VMs

1. Once the initial VM is completely setup, shut down the VM.
2. Create a copy of each VHD on the various volumes.
3. Create a new VM with the desired amount of RAM and vCPUs, and with no VHDs.
4. Add the copied VHDs to the VM: OS, Data, Log, and Backup.
5. Repeat steps 1 through 4 for as many VMs that are required.

Performing the test

1. Using the legacy server and one VM as our base system, we ran the TPC-H test while increasing the DOP on each run by one until the time to finish increased. We determined that a DOP of six was the ideal performance point on the legacy system, and kept the DOP consistent across all VMs and tests.
2. Select Options→Benchmark.
3. Choose MSSQL Server and TPC-H.
4. Expand SQL Server→TPC-H→Schema Build.
5. Double-click Options, and set the scale to 100. Click OK.
6. Expand Driver Script, and double-click Options.
7. Set MAXDOP to 6, and check the box for Refresh Function.
8. Click OK.
9. Double-click Load.
10. Expand Virtual User, and double-click Options.
11. Choose 1 Virtual User, and check the boxes for Show Output, Log Output to Temp, and Use Unique Log Name.
12. Click OK.
13. Double-click Create users.

14. Start Perfmon to capture CPU, RAM, and disk counters.
15. Click Start to begin the Power Test run.
16. When the run finishes, stop Perfmon.
17. Save the HammerDB results text file and Perfmon output.
18. Open SQL Manager, delete the TPCB database, and create a new one by restoring from the backup file.
19. Reboot the server.
20. Follow steps 1 through 20 again, to get three runs.
21. Complete these runs on the following systems/configurations:
 - With one VM on the PowerEdge R720xd
 - With two VMs simultaneously on the PowerEdge R730xd
 - With six VMs simultaneously on the PowerEdge R740xd with the database data and log files on the SATA SSDs, and
 - With ten VMs simultaneously on the PowerEdge R740xd, with the database data and log files on the NVMe SSDs.

Read the report at <http://facts.pt/6yh586b> ►

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