



The science behind the report:

Run more data analysis more quickly using Dell PowerEdge R760 servers

This document describes what we tested, how we tested, and what we found. To learn how these facts translate into real-world benefits, read the report [Run more data analysis more quickly using Dell PowerEdge R760 servers](#).

We concluded our hands-on testing on January 17, 2023. 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 December 23, 2022 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

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

Table 1: The time in seconds that each VM on each solution we tested needed to complete the data analytics workload. Lower numbers are better. Source: Principled Technologies.

	Dell™ PowerEdge™ R740xd	Dell PowerEdge R750	Dell PowerEdge R760
Number of VMs running data analytics workloads	10	16	20
VM1	202	166	120
VM2	202	164	120
VM3	199	165	117
VM4	200	166	115
VM5	196	166	117
VM6	202	165	116
VM7	199	166	117
VM8	201	163	115
VM9	199	166	117
VM10	203	165	115
VM11		165	117
VM12		165	115
VM13		166	117
VM14		165	114
VM15		165	117
VM16		161	117
VM17			116
VM18			115
VM19			120
VM20			120
Average time (sec)	200	165	116

System configuration information

Table 2: Detailed information on the system we tested.

System configuration information	Dell PowerEdge R760
BIOS name and version	Dell 1.0.0
Non-default BIOS settings	N/A
Operating system name and version/build number	Microsoft Windows Server 2022 Datacenter
Database version	Microsoft SQL Server 2022 (RTM) - 16.0.1000.6 (x64)
Date of last OS updates/patches applied	12/23/2022
Power management policy	Performance
Processor	
Number of processors	2
Vendor and model	Intel® Xeon® Platinum 8452Y
Core count (per processor)	36
Core frequency (GHz)	2.20
Stepping	Model 143 Stepping 6
Memory module(s)	
Total memory in system (GB)	2,048
Number of memory modules	16
Vendor and model	Dell AGZR W5WWM MOD
Size (GB)	64
Type	DDR5-4800
Speed (MHz)	4,800
Speed running in the server (MHz)	4,800
Storage controller	
Vendor and model	PERC H965i Front
Cache size (GB)	8.3
Firmware version	8.0.0.0.18-81
Driver version	8.01.18.00
Local storage (type A)	
Number of drives	2
Drive vendor and model	Dell EC NVMe ISE 7400 RI M.2 480GB
Drive size (GB)	480
Drive information (speed, interface, type)	NVMe, PCIe

System configuration information	Dell PowerEdge R760
Local storage (type B)	
Number of drives	16
Drive vendor and model	Dell Ent NVMe v2 AGN MU U.2
Drive size (GB)	1,600
Drive information (speed, interface, type)	NVMe, PCIe
Network adapter 1	
Vendor and model	Intel Ethernet 25G 2P E810-XXV OCP
Number and type of ports	2 x 25G
Driver version	21.5.9
Network adapter 2	
Vendor and model	2x Broadcom® BCM57508 2x100G QSFP PCIE
Number and type of ports	2x100G
Driver version	22.21.07.80
Power supplies	
Vendor and model	Dell 450-AJHG
Number of power supplies	2
Wattage of each (W)	1,400

How we tested

Performing initial setup of the Dell PowerEdge R760 server

Putting the server into Performance Mode in the BIOS

1. Enter LifeCycle Controller.
2. Select System Setup.
3. Select Advanced Hardware Configuration.
4. Select System BIOS.
5. Go to System Profile Settings.
6. Change System Profile to Performance.
7. Select Back.
8. Select Finish, and click Yes on the prompt to Save Changes.
9. Allow the server to reboot.

Configuring the RAID

1. Enter the Lifecycle Controller.
2. Go to System Setup.
3. Click Advanced Hardware Configuration.
4. Select Device Settings.
5. Select the appropriate RAID controller (in this case, SL 1: Dell PERC H965i Front Configuration first).
6. Select Main Menu.
7. Select Configuration Management.
8. Select Create Virtual Disk.
9. At Select RAID Level, select RAID 10.
10. Click Select Physical Disks.
11. Scroll down, and click Select All.
12. Once all physical disks have checkmarks, click Ok.
13. Once the operation is finished, select Ok.
14. Name the virtual disk (in this case, VM_VD_01).
15. On Disk Write Cache Policy, select Enable.
16. On Initialization, select Fast.
17. Select Create Virtual Disk.
18. Check the box for confirm, then click Yes.
19. Once the Operation is finished, select Ok.
20. Repeat steps 6 through 19 on the next PERC controller.

Installing Windows Server 2022 Datacenter Edition on the PowerEdge R760 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 2022 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 automatically begins and restarts.
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 R760

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 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 Dell PowerEdge R760

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. (We used 32,768.)
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. (We set the number of processors to eight.)
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, choose the Data volume for the location, and 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 2022 and any updates on the VM, following the same steps we outlined in previous sections.
22. Using Windows Disk Manager, add the three additional HDDs to the VM.

Installing Windows Server 2022 Datacenter Edition on the Dell PowerEdge R760 server VM

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When prompted to boot from DVD, press any key.
3. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
4. Click Install now.
5. When the installation prompts you, enter the product key.
6. Select Windows Server 2022 Datacenter Edition (Desktop Experience), and click Next.
7. Check I accept the license terms, and click Next.
8. Click Custom: Install Windows only (advanced).
9. Select Drive 0 Unallocated Space, and click Next. Windows automatically begins and restarts.
10. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
11. Log in with the password you set up in the previous step.
12. Using Windows update, download and install all updates.
13. 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 Dell PowerEdge R760 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 2022 on the Dell PowerEdge R760 VM

1. Attach the installation media ISO for SQL Server 2022 to the VM.
2. Double-click the Setup application.
3. In the left pane, click Installation.
4. Click New SQL Server stand-alone installation or add features to an existing installation.
5. On the Edition Window, keep Specify a Free Edition checked, select Evaluation, and 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. On the Install Rules page, click Next.
9. On the Azure Extension for SQL Server, deselect Azure Extension for SQL Server, and click Next.
10. Check the boxes for the following features:
 - Database Engine Services
 - Full-Text and Semantic Extractions for Search
11. Click Next.
12. Leave the default instance, and click Next.
13. Leave the default Service Accounts, and click Next.
14. On the Server Configuration tab, choose Mixed Mode, and enter and confirm a Password for the SQL Server system administrator (sa) account.
15. Click Add Current User to Specify the SQL Server administrators.
16. On the Data Directories tab, change the Data root directory to the database volume.
17. Choose the log volume for the User database log directory.
18. If you plan to have a locally stored backup, change the Backup directory to point to that drive.
19. Click the TempDB tab.
20. Change the number of TempDB files to eight, and change its location to the Data volume.
21. Change the location of the TempLog file to the Log volume.
22. Click Next.
23. At the Error and usage reporting screen, click Next.
24. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
25. At the Ready to Install screen, click Install.
26. Close the installation window.
27. Download and install SQL Server Management Studio.

Expanding TempDB & TempLog files on the Dell PowerEdge R760 VM

1. Open SQL Server Management Studio.
2. Expand Database → System Databases.
3. Right-click tempdb, and choose Properties.
4. Click Files, and enter a new Initial Size (MB) for both files. The size you need depends on the scale of your TPC-H database. We set the eight tempdev files 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 Dell PowerEdge R760 VMs

1. Click Start, type `gpedit.msc` and click 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.

Configuring the VMs

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 SQL Server, then TPROC-H.
3. Expand SQL Server → TPROC-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. Check the box for clustered column store, and click OK.
7. Double-click Build. The build could take several hours.

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 set up, shut down the VM.
2. Create a copy of each VHD on the various volumes, with even VMs having Logs and OS on Disk 1, and Data and Backup on Disk 2. For odd VMs, reverse this so that Logs and OS are on Disk 2, and Data and Backup are on Disk 1.
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 as necessary.

Performing the test

1. Start HammerDB on each client.
2. Double-click SQL Server, then TPROC-H from the popup menu.
3. Expand TPROC-H options.
4. Expand Schema.
5. Double-click Options.
6. Change Authentication to SQL Server Authentication.

7. Leave SQL User ID as sa.
8. Change SQL Server User Password to the one set during SQL creation.
9. Set MAXDOP to 0.
10. Set Scale to 100.
11. Expand Driver Script, and click Load.
12. Expand to Virtual User, and open Options.
13. Ensure Virtual Users is set to 1.
14. Enable Log Output to Temp, Use Unique Log Name, and Log Timestamps, and click Ok.
15. Expand Mode, and double-click Options.
16. Select Primary Mode, and select Ok.
17. Make note of the Primary ID, and the hostname as the Primary ID will change between every restart and reconfiguration of HammerDB.
18. On each client, do the following:
 - Start HammerDB.
 - Double-click SQL Server, and select TPROC-H.
 - Expand TPROC-H, expand Mode, and open Options.
 - Select Replica Mode, enter the Primary ID and Hostname from the previous step, and click Ok.
 - When Prompted to switch from Local to Replica Mode, select Yes.
 - Expand Virtual User, and open Options.
 - Enable Log Output to Temp, User Unique Log Name, and Log Timestamps, then click Ok.
19. Expand the hamburger menu, and select Distribute to send the driver script to clients.
20. Double-click Create users.
21. Start Perfmon to capture CPU, RAM, and disk counters.
22. To begin the Power Test run, click Start.
23. When the run finishes, stop Perfmon.
24. Save the HammerDB results text file and Perfmon output.
25. Open SQL Manager, delete the TPCH database, and create a new one by restoring from the backup file.
26. Reboot the server.
27. Follow steps 1 through 26 twice more for a total of three runs.

Read the report at <https://facts.pt/mY8M2ci> ▶

This project was commissioned by Dell Technologies.



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