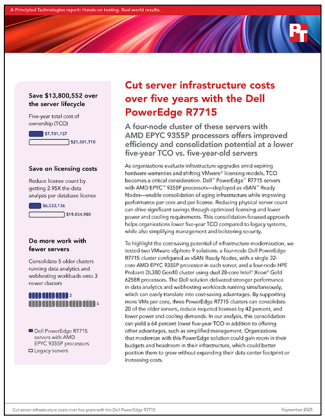

The science behind the report:

Cut server infrastructure costs over five years with the Dell PowerEdge R7715

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 Cut server infrastructure costs over five years with the Dell PowerEdge R7715.

We concluded our hands-on testing on August 7, 2025. 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 July 9, 2025 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: Results of our TCO and database performance comparison.

	Legacy HPE ProLiant DL380 Gen 10 servers with Intel® Xeon® Gold 6258R processors	Dell PowerEdge™ R7715 servers with AMD EPYC™ 9355P processors
5-year TCO for equivalent workloads		
Number of systems required for equivalent workloads	20	12
Purchase price	$0 (existing)	$335,037.00
Licensing	$21,337,760.00	$7,263,570.00
Power	$53,236.33	$36,122.44
Data center space	$9,523.81	$5,714.29
Maintenance	$101,190.00	$60,714.00
5-year TCO	$21,501,710.14	$7,701,157.73

	Legacy HPE ProLiant DL380 Gen 10 servers with Intel® Xeon® Gold 6258R processors	Dell PowerEdge™ R7715 servers with AMD EPYC™ 9355P processors
Analytical database performance (head-to-head four-node cluster comparison)		
Time to complete all workloads (lower is better) (sec)/number of VMs	206/20	203/12
Projected completed query sets per hour (higher is better)	209	354
WordPress performance		
Avg. transactions per second (TPS) (higher is better)	150	442
Number of servers required to do the same work		
Number of servers (lower is better)/ Number of four-node clusters	20/5	12/3
Power efficiency		
Completed query sets per hour per watt (higher is better)	0.67	0.38
Completed TPS per watt (higher is better)	1.04	0.27
Power consumption (single four-node cluster)		
Avg. watts (lower is better)	545.73	522.69

CPU utilization

Average CPU percentage during cluster median run for Dell PowerEdge R7715 solution with AMD EPYC 9355P processors

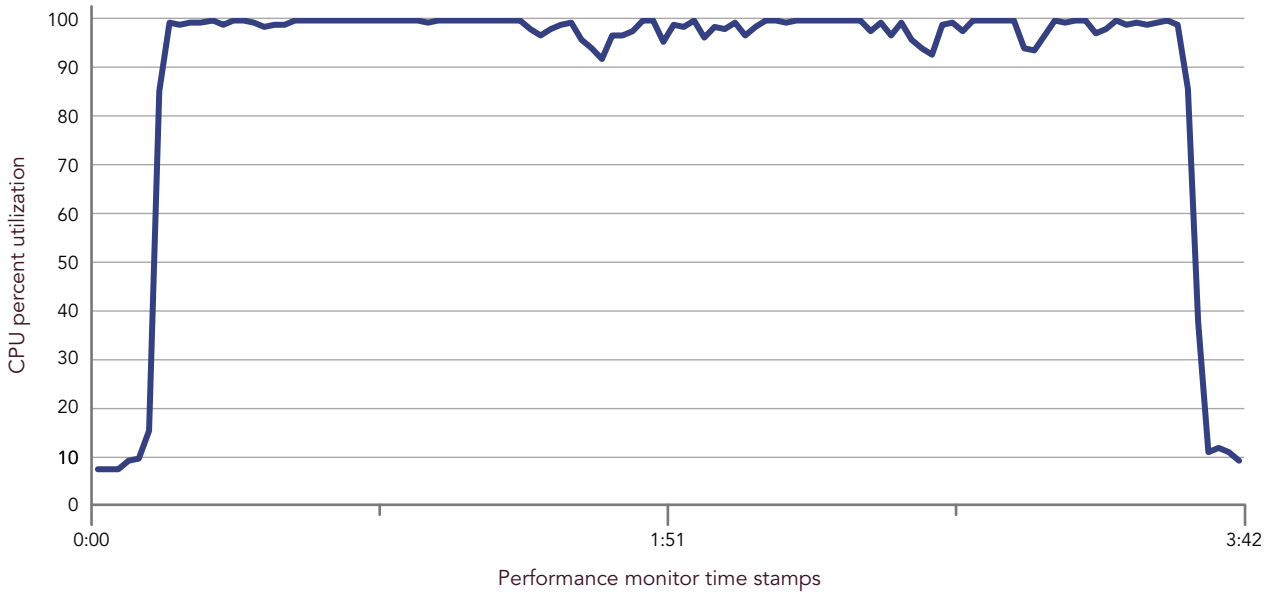

Figure 1: CPU utilization for the Dell PowerEdge R7715 cluster during testing. Source: PT.

Average CPU percentage during cluster median run for legacy HPE ProLiant DL380 Gen10 solution with Intel Xeon Gold 6258R processors

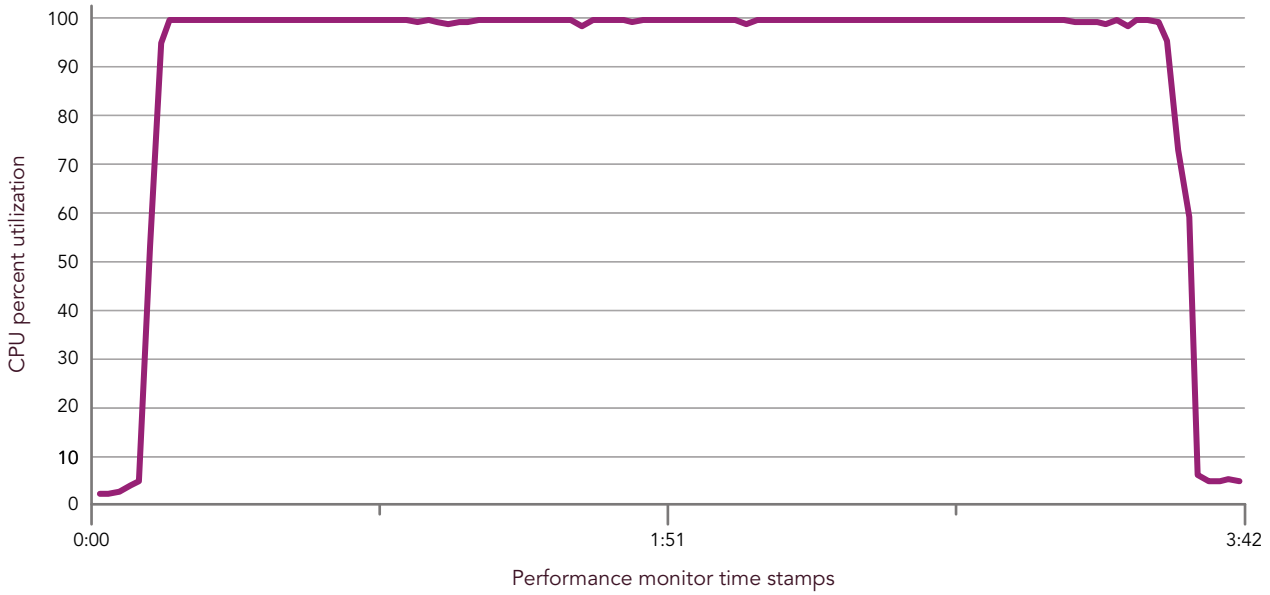

Figure 2: CPU utilization for the HPE ProLiant DL380 Gen10 cluster during testing. Source: PT.

TCO summary

Table 2: Analytics performance comparison and the total number of systems required for equivalent workload support for the two solutions.

	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
Servers			
Number of servers per cluster	4	4	
Number of VMs per server	3	5	
Number of VMs per cluster	12	20	
Number of systems required to perform equivalent workload using 60 VMs	20	12	
Number of four-node clusters required for 60 VMs	5	3	

Table 3: Licensing cost comparison for the two solutions.

Licensing costs	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
Licensing costs - SQL Server 2022 Enterprise			
Total physical cores per system requiring licenses	56	32	
Number of two-core license packs required for system physical cores	28	16	
Annual cost per two-core license pack	$15,123.00	$15,123.00	Source (MS pricing page from Aug 2025): https://www.microsoft.com/en-us/sql-server/sql-server-2022-pricing
Annual cost for Software Assurance (SA) per license pack	$3,780.75	$3,780.75	SA costs an additional 25% of annual licensing cost.
Total annual cost for SQL 2022 Enterprise licenses	$423,444.00	$241,968.00	
Total annual cost for SA	$105,861.00	$60,492.00	
First year cost for 1 system (core licenses + SA)	$529,305.00	$302,460.00	
Total cost for 4 additional years of SA	$423,444.00	$241,968.00	
Total 5y cost for 1 system	$952,749.00	$544,428.00	
Total 5y cost for all required systems	$19,054,980.00	$6,533,136.00	

Licensing costs	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
Licensing costs - Windows Server 2025 Datacenter			
Total cores per system requiring licenses	56	32	
Number of16-core license packs required for system physical cores	4	2	We rounded up for the HPE solution to cover all cores.
Annual cost per 16-core license pack	$6,771.00	$6,771.00	Source (MS pricing page from Aug 2025): https://www.microsoft.com/en-us/windows-server/pricing
Annual cost for Software Assurance (SA) per license pack	$1,692.75	$1,692.75	SA costs an additional 25% of annual licensing cost.
Total annual cost for WS2025 Datacenter licenses	$27,084.00	$13,542.00	
Total annual cost for SA	$6,771.00	$3,385.50	
First year cost for 1 system (core licenses + SA)	$33,855.00	$16,927.50	
Total cost for 4 additional years of SA	$27,084.00	$13,542.00	
Total 5y cost for 1 system	$60,939.00	$30,469.50	
Total 5y cost for all required systems	$1,218,780.00	$365,634.00	
Licensing costs - VMware® vSphere® Foundation 9			
Total cores per system requiring licenses	56	32	
vSphere Foundation subscription annual cost per core	$190.00	$190.00	Source (from Aug 2025): https://wintelguy.com/vmware-licensing-calc.pl
Total annual cost for system physical cores	$10,640.00	$6,080.00	vSphere Foundation license (includes vSAN license) costs for one year
Total 5y cost for 1 system	$53,200.00	$30,400.00	
Total 5y cost for all required systems	$1,064,000.00	$364,800.00	

Table 4: Power and cooling cost comparison for the two solutions.

Power and cooling costs	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
Cost per kWh	0.1747	0.1747	Avg price of electricity Aug 2025 https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_es1a
Hours in year	8,760	8,760	
Percentage time under load/ active (remainder idle)	0.50	0.50	Assume 50% active (12 hours per day)
Power usage per server (watts-active)	546	523	
Power usage per server (watts-idle)	150	264	
Typical watts	347.865	393.395	Calculation: (% time active * Watts-active) + (% time idle * Watts-idle)
Annual kWh per server	3,047.30	3,446.14	
Total annual energy cost per server	$532.36	$602.04	
Total 5y energy cost per server	$2,661.82	$3,010.20	
Total 5y cost for all required systems	$53,236.33	$36,122.44	

Table 5: Data center space cost comparison for the two solutions.

Data center space costs	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
Rack units per server (U)	2	2	
Annual data center costs per rack (42U)	$2,000.00	$2,000.00	Estimate assuming $2,000, but could be anywhere from $1,000-$3,000+ depending on location, bandwidth, infrastructure, and other factors. See https://cyfuture.cloud/kb/colocation/how-much-does-renting-rack-space-cost-key-factors-to-consider

Data center space costs	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
Annual data center costs per rack unit (1U)	$47.62	$47.62	
Rack units (U) required for all systems	40	24	
Annual cost for all required systems	$1,904.76	$1,142.86	
Total 5y cost for all required systems	$9,523.81	$5,714.29	

Table 6: Maintenance and administration cost comparison for the two solutions.

Maintenance/ administration costs	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
Number of servers per IT admin	100	100	PT estimate. Can vary based on management/infrastructure factors.
Number admins needed for all required systems	0.2	0.12	Total required systems divided by number of servers per IT admin.
Average salary of an administrator	$101,190.00	$101,190.00	Average for network and computer systems administrator, BLS May 2024 https://www.bls.gov/oes/current/oes_nat.htm
Annual administration cost	$20,238.00	$12,142.80	
Total 5y administration cost	$101,190.00	$60,714.00	

Table 7: CAPEX costs comparison for the two solutions.

Total hardware costs	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
New cost of systems required	$0	$27,919.75	No purchase required for legacy systems. Dell PowerEdge R7715 server cost estimate from Dell sales via Dell marketing August 14, 2025. Price subject to change.

Table 8: Five-year TCO comparison for the two solutions.

Total five-year TCO	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
Number of systems required	20	12	
Total hardware cost	$0	$335,037.00	

Total five-year TCO	Legacy HPE ProLiant DL380 Gen 10 solution with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 solution with AMD EPYC 9355P processors	Notes
Total 5y licensing cost	$21,337,760.00	$7,263,570.00	SQL + WS + vSphere
Total 5y power cost	$53,236.33	$36,122.44	
Total 5y data center space cost	$9,523.81	$5,714.29	
Total 5y maintenance cost	$101,190.00	$60,714.00	
Total 5y costs	$21,501,710.14	$7,701,157.73	

System configuration information

Table 9: Detailed information on the systems we tested.

System configuration information	HPE ProLiant DL380 Gen 10	Dell PowerEdge R7715
BIOS name and version	U30 v3.50	Dell 1.2.4
Non-default BIOS settings	N/A	N/A
Operating system name and version/build number	VMware® ESXi™ 9.0.0 Build-24755229	Dell-VMWare ESXi 9.0 GA Build-24755229 (A00)
Date of last OS updates/patches applied	07/14/2025	07/14/2025
Power management policy	Dynamic Power Savings Mode	Performance Per Watt (OS)
Processor		
Number of processors	2	1
Vendor and model	Intel Xeon Gold 6258R	AMD EPYC 9355P
Core count (per processor)	28	32
Core frequency (GHz)	2.7	3.55
Stepping	1	Model 2 Stepping 1
Memory module(s)		
Total memory in system (GB)	256	768
Number of memory modules	4	12
Vendor and model	Micron® 72ASS8G72LZ-2G3A1	Samsung® M321R8GA0EB2-CCPKF
Size (GB)	64	64
Type	DDR4	DDR5
Speed (MHz)	2,400	6,400
Speed running in the server (MHz)	2,400	5,200
Storage controller		
Vendor and model	HPE Smart Array P408i-a SR Gen10	BOSS-N1 DC-MHS
Cache size (GB)	2	0
Firmware version	7.43	2.2.13.2033
Driver version	90.4800.0.5000-2vmw.900.0.24755229	n/a
Local storage (type A)		
Number of drives	2	2
Drive vendor and model	INTEL SSDSC2BB960G7	Dell EC NVMe ISE 7450 RI
Drive size (GB)	960	480
Drive information (speed, interface, type)	6G SATA SSD	M.2 80
Local storage (type B)		
Number of drives	2	1
Drive vendor and model	Toshiba® PX05SMB320Y	Dell DC NVMe CD8P E3.S

System configuration information	HPE ProLiant DL380 Gen 10	Dell PowerEdge R7715
Drive size (GB)	3,200	3,840
Drive information (speed, interface, type)	12G SAS SSD	NVMe 2.0 32 GT/s
Local storage (type C)		
Number of drives	2	1
Drive vendor and model	Samsung MZ7LH1T9HALT0D3	Dell NVMe PM1743 RI E3.S
Drive size (GB)	1,920	7,680
Drive information (speed, interface, type)	6G SATA SSD	NVMe® 1.4 32 GT/s
Network adapter (type A)		
Vendor and model	HPE Ethernet 1Gb 4-port 331i	Broadcom® BCM57412
Number and type of ports	4x 1GbE	4x 10GbE
Driver version	ntg3 4.1.15.0	bnxtnet 232.0.154.0
Network adapter (type B)		
Vendor and model	Intel Eth E810-XXVDA2	Broadcom BCM57508
Number and type of ports	2x 10GbE	2x 100GbE
Driver version	icen 1.15.2.0	bnxtnet 232.0.154.0
Cooling fans		
Vendor and model	HPE 875075-001	Dell Platinum
Number of cooling fans	6	12
Power supplies		
Vendor and model	HPE 865414-B21	Dell 0P41HJA01
Number of power supplies	2	2
Wattage of each (W)	800	3,200

How we tested

Installing and configuring ESXi on the hosts

We checked for firmware updates and ensured we had the most recent BIOS version on each host before we installed VMware ESXi. We used an HPE ESXi 9.0 image for the HPE cluster, and a Dell ESXi 9.0 image for the Dell cluster.

Installing ESXi

1. Load the ESXi 9.0 image onto the system using the iLO/iDRAC console.
2. To start the installation process, turn on the server, or reboot the server and boot into the ISO.
3. On the welcome screen, press Enter.
4. To accept the EULA, press Enter.
5. Select the disk to which you wish to install the OS, and press Enter.
6. If prompted, confirm your disk selection, and approve a data wipe of those disks.
7. Choose the keyboard type, and press Enter.
8. Enter your password, and press Enter.
9. To initiate the installation, press F11.
10. After the installation completes, press Enter to reboot the host.
11. Complete steps 1 through 10 on all eight hosts, using the appropriate vendor version of the ESXi 9.0 ISO.

Setting a static IP on the host

1. Once the system finishes booting into the new OS, press F2 to open the configuration menu.
2. Enter the password, and press Enter.
3. Navigate to Configure Management Network, and press Enter.
4. Navigate to IPv4 Configuration, and press Enter.
5. Choose Set static IPv4 address and network configuration.
6. Enter the static IP, subnet mask, and default gateway.
7. To save the changes, press Enter.
8. Press Escape, and save the changes when prompted.
9. In a browser, log into the local ESXi host console with the new IP to confirm all is working.
10. Complete steps 1 through 9 on all eight hosts.

Deploying vCenter Server 9.0

We deployed a white box infrastructure server with ESXi for each test bed to host the vCenter Server VM and other VMs, such as the Siege benchmark client for the WordPress tests.

1. Download the VMware VCSA installer to a Windows system on the same network as the ESXi hosts.
2. Mount the ISO to the DVD Drive, and navigate to the vcsa-ui-installer folder.
3. Open the win32 folder, and double-click the installer.exe file.
4. To install a new vCenter server, click Install.
5. On the Introduction screen, click Next.
6. Accept the EULA, and click Next.
7. Enter the IP address, username, and password of the infrastructure host. Click Next.
8. On the Certificate Viewer popup, click Accept.
9. Enter a name and password for the vCenter Server VM, and click Next.
10. Choose the Small deployment size from the dropdown menu, and leave the storage size set to Default. Click Next.
11. Choose the datastore to host the vCenter VM, and select Enable Thin Disk Mode. Click Next.
12. Enter the static IP address, subnet mas, default gateway, and DNS servers for your vCenter Server, and click Next.
13. On the Ready to complete stage 1 screen, review your selections, and click Finish.
14. Once the Stage 1 deployment completes, press Continue.
15. Ensure Stage 2 is selected, and click Next.
16. On the configuration screen, choose Synchronize time with the NTP servers, and enter the IP or URL of an NTP server (we used `pool.ntp.org`).
17. Also on the configuration screen, set SSH access to Activated. Click Next.
18. On the single sign-on (SSO) configuration screen, set the SSO domain name (we kept `vsphere.local`), username, and password. Click Next.

19. Deselect the Join the Customer Experience Improvement Program (CEIP), and click Next.
20. Review your settings, and click Finish.
21. When the installation completes, click Close.
22. In a browser, navigate to the IP of the vCenter Server, and log in with your username@domain and password.

Creating and configuring the vSAN clusters

We created two clusters, one with the HPE DL380 Gen 10 servers and one with the Dell PowerEdge R7715 servers. Each cluster had a management network, a testing network, and a vSAN distributed switch. The testing and vSAN networks used the higher-bandwidth NICs on the servers (10GbE on the HPE cluster, and 100GbE on the Dell cluster).

Adding hosts to the vSphere Client

1. In the vSphere Client console, right-click the vCenter IP in the left pane, and click New Datacenter….
2. Enter a name for the data center, and click OK.
3. In the left pane, right-click the newly created datacenter, and click Add Host….
4. Enter the IP address of the first host in the cluster, and click Next.
5. Enter the host's username and password, and click Next.
6. Review the summary, and click Next.
7. Choose Extract the image on the host, and click Next.
8. On the Security Alert popup, click Yes.
9. Once the image loads, click Next
10. Choose a license, and click Next.
11. Leave the default (Disabled) on the Lockdown mode screen, and click Next.
12. Select the data center you created, and click Next.
13. Review your configuration, and click Finish.
14. Complete steps 1 through 13 with each of the four hosts.

Creating a host cluster

1. In the vSphere Client console, right-click the Datacenter in the left pane, and choose New Cluster….
2. On the Basics screen, name the cluster and enable vSAN. Uncheck Enable vSAN ESA.
3. Also on the Basics screen, select Extract an image from a host in this vCenter instance, and click Next.
4. Choose one of the four hosts in your vCenter instance, and click Extract Image.
5. Once the image extracts, click Next.
6. Review your settings, and click Finish.
7. Complete steps 1 through 6 for all four hosts.

Configuring vSAN

1. In the left pane in the vSphere Client console, click on the cluster you created, and navigate to the Configure tab.
2. Under Configuration, click Quickstart.
3. The Cluster basics step should already show vSAN enabled with a green checkbox showing that the step is complete.
4. On step 2 Add hosts, click Add.
5. Enter the IP addresses, usernames, and passwords of all four hosts. Click Next.
6. On the Host summary screen, review and resolve any issues, and click Next.
7. On the Import Image screen, choose Don't import an image, and click Next.
8. Review, and click Finish.
9. On step 3 in the Quickstart page, click Configure.
10. On the Distributed switches screen, choose 1 distributed switch, name it, and accept the default port groups. Add the physical adapter that aligns with the NIC you want to use for the vSAN network. Click Next.
11. On the Storage traffic screen, enter IP addresses for each host, and click Next.
12. On the Advanced options screen, leave defaults, and click Next.
13. On the Claim disks screen, expand each host, and choose the disks for vSAN to claim.

14. When all disks are claimed, click Next.
15. On the Proxy settings screen, leave defaults, and click Next.
16. Review your settings, and click Finish.
17. If there are any warnings or errors, resolve them, and click re-validate until your cluster is ready.

Creating and configuring the Microsoft SQL VMs

Before starting the following steps, upload the Windows Server 2025 and SQL Server 2022 ISOs to the local vSphere datastore. We performed the steps below on the HPE DL 380 Gen 10 cluster. Complete the same steps on the Dell PowerEdge R7715 cluster, configuring the VMs according to Table 13 and cloning a total of 20 VMs with five VMs on each host.

Table 10: The settings we used for each cluster VM.

	Legacy HPE ProLiant DL380 Gen 10 servers with Intel Xeon Gold 6258R processors	Dell PowerEdge R7715 servers with AMD EPYC 9355P processors	All WordPress VMs
Number of vCPUs	32	12	8
Memory (GB)	56	112	4
OS disk size (GB)	50	50	60
Data disk size (GB)	140	140	N/A
Log disk size (GB)	80	80	N/A

Creating a gold VM

1. Sign into the vSphere Client, and right-click one of the hosts in your vSAN cluster.
2. Choose New Virtual Machine….
3. On the Select a creation type screen, choose Create a new virtual machine, and click Next.
4. On the Select a name and folder screen, enter a name for your base SQL Server VM, and choose your data center. Click Next.
5. On the Select a compute resource screen, choose the host to which you wish to add your VM, and click Next.
6. On the Select storage screen, choose the vSAN datastore, and click Next.
7. On the Select compatibility screen, ensure the ESXi 9.0 or later option is selected, and click Next.
8. On the Select a guest OS screen, choose Windows as the Guest OS Family and Microsoft Windows Server 2025 (64-bit) as the Guest OS Version. Click Next.
9. On the Customize hardware screen, set the following, and click Next:
   - Set the CPU, Memory, and Hard disk 1 size according to Table 13.
   - Choose Add New Device, and add two additional hard disks for data and logs matching the sizes in Table 13.
   - Choose Datastore ISO File from the New CD/DVD Drive dropdown menu, and add the Windows Server 2025 ISO stored on the local datastore. Check Connect At Power On.
10. Review your settings, and click Finish.

Installing WS2025 on the gold VM

1. In vSphere Client, click the gold VM you created in the previous section, and power it on.
2. To open the VM console, click Launch Web Console.
3. When prompted, press any key to boot into the Windows Server 2025 ISO.
4. On the Select Language settings screen, leave defaults, and click Next.
5. On the Select keyboard settings screen, leave defaults, and click Next.
6. On the Select setup option screen, choose Install Windows Server, check the box to agree to deleting everything, and click Next.
7. On the Select Image screen, choose Windows Server 2025 Standard Evaluation (Desktop Experience), and click Next.
8. On the Select location to install Windows Server screen, choose the OS disk (likely Disk 0), and click Next.
9. On the Ready to install screen, click Install.
10. After the install finishes and the VM reboots, on the Customize settings screen, enter an administrator password into the Password and Reenter Password fields. Click Finish.

Configuring WS2025 on the gold VM

Disabling Windows Firewall

1. Log into Windows, and select to share only required data to Microsoft.
2. In the Windows Search bar, type `Firewall`.
3. Click Windows Defender Firewall with Advanced Security.
4. Under the Public Profile section, click Windows Defender Firewall Properties.
5. On the Domain profile page, under Firewall State, click the drop-down menu, and select Off.
6. Click Private profile, and under Firewall State, click the drop-down menu, and select Off.
7. Click Public profile, and under Firewall State, click the drop-down menu, and select Off.
8. Click OK.
9. Right-click the gold VM, and select Manage → Install VMware Tools.
10. In the VM, open Windows Explorer, and run the VMware Tools executable.
11. Choose to install VMware Tools with defaults.

Enabling Remote Desktop on WS2025

1. In Server Manager, click Local Server.
2. On the Local Server properties page, next to Remote Desktop, click Disabled to open the System Properties window.
3. In the System Properties menu, select Allow remote connections to this computer.
4. On the warning that appears, click OK.
5. To exit, click OK.

Enabling Remote SSH Access

1. From Server Manager, click Local Server.
2. On the Local Server properties page, scroll down, and next to Remote SSH Access, select Disabled to open a PowerShell prompt.
3. When prompted, type `Yes`, and press Enter.

Setting a static IP address

1. In the Windows Search bar, type `Control Panel`.
2. Right-click the Ethernet port, and click Properties.
3. Double-click Internet Protocol Version 4 (TCP/IPv4).
4. Click Use the following IP address, and enter a static IP address for your network.
5. Click Use the following DNS server addresses, enter a static DNS address for your network, and click OK.
6. To close the Ethernet Properties window, click OK.

Running Windows Update

1. In the Windows Search bar, type `Update`, and click Check for updates.
2. Click Check for Updates.
3. Click Install All.
4. If prompted, restart Windows.
5. Once all updates are complete, choose to suspend updates for 5 weeks in the Windows Update window.

Installing and configuring SQL Server 2022 on the gold 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. Select Evaluation, and click Next.
6. Click the check box 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. Check the boxes for the following features, and click Next:
   - Database Engine Services
   - Full-Text and Semantic Extractions for Search
10. Leave the Default instance, and click Next.

11. Leave the default Service Accounts, and click Next.
12. On the Server Configuration tab, choose Mixed Mode, and enter and confirm a password for the SQL Server system administrator account.
13. Click Add Current User to Specify the SQL Server administrators.
14. On the Data Directories tab, change the data root directory to the database volume.
15. Choose the log volume for the User database log directory.
16. If you plan to have a locally stored backup, change the Backup directory to point to it.
17. Click Next.
18. At the Error and usage reporting screen, click Next.
19. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
20. At the Ready to Install screen, click Install.
21. Close the installation window.
22. Download and install SQL Server Management Studio.

Enabling Lock pages in memory on the gold VM

1. In the Start menu, click Run. In the Open box, type `gpedit.msc`.
2. On the Local Group Policy Editor console, expand Computer Configuration, and expand Windows Settings.
3. Expand Security Settings, and expand Local Policies.
4. Select the User Rights Assignment folder.
5. In the details pane, double-click Lock pages in memory.
6. In the dialog box for Local Security Setting - Lock pages in memory, click Add User or Group.
7. In the dialog box for Select Users, Service Accounts, or Groups, select the SQL Server Service account (NT SERVICE\MSSQLSERVER).
8. For this setting to take effect, restart the SQL Server Service.

Installing Microsoft ODBC Driver 18 for SQL Server

1. Download the latest ODBC Driver for SQL Server from https://learn.microsoft.com/en-us/sql/connect/odbc/download-odbc-driver-for-sql-server.
2. Double-click the .exe file, and click Next.
3. Check the box to accept the terms, and click Next.
4. Click Next.
5. Click Install.
6. Click Finish.

Configuring the test database

Creating the database

1. Open SQL Server Management Studio.
2. Right-click the TempDB database, and select Properties.
3. Navigate to the Files tab, expand each TempDB file to 1132 MB, and the log to 72 MB.
4. Right-click Databases → New Database.
5. Name the database. We named ours `tpch`.
6. Navigate to the Filegroups tab, and create a new primary filegroup.
7. Navigate to the Files tab, and to add a data file, click Add.
8. Repeat step 7 until you have eight total data files.
9. Pregrow the database files to 12,500 MB each.
10. Pregrow the log file to 16,584 MB.
11. Rename the database files, change their locations to the appropriate path (`E:\data` for database files and `F:\log` for log files), and click OK.

Installing HammerDB on the VM

1. Download the latest version of HammerDB from www.hammerdb.com/download.html. We used 5.0.
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 TPROC-H.
3. Expand SQL Server → TPROC-H → Schema Build.
4. Double-click Options.
5. Choose 100 scale, and set the number of virtual users corresponding to the number of vCPUs.
6. Change to user authentication instead of Windows authentication, and enter your sa username and password.
7. Check the box for clustered column store, uncheck the box for BCP, and click OK.
8. Double-click Build. This build could take a few hours.

Backing up the database

1. Open SQL Server Management Studio.
2. Right-click the tpch database, and click Tasks → Back up….
3. In compression, make sure Compress the backup file is selected.
4. Choose a location to store the backup, and click OK.

Creating and configuring the WordPress VMs

Before you start, copy the Ubuntu 24.04.2 ISO to the local vSphere datastore. We performed the steps below on the PowerEdge R740xd cluster. Complete the same steps on the PowerEdge R7715 cluster, being sure to configure the VMs according to Table 13 and cloning a total of four VMs with one VM on each host.

Creating the base WordPress VM

1. Sign into the vSphere Client, and right-click one of the hosts in your vSAN cluster.
2. Choose New Virtual Machine….
3. On the Select a creation type screen, choose Create a new virtual machine, and click Next.
4. On the Select a name and folder screen, enter a name for your base WordPress VM, and choose your data center. Click Next.
5. On the Select a compute resource screen, choose the host to which you wish to add your VM, and click Next.
6. On the Select storage screen, choose the vSAN datastore, and click Next.
7. On the Select compatibility screen, ensure the ESXi 9.0 or later option is selected, and click Next.
8. On the Select a guest OS screen, choose Linux as the Guest OS Family and Ubuntu Linux (64-bit) as the Guest OS Version. Click Next.
9. On the Customize hardware screen, set the following, and click Next:
   - Set the CPU, Memory, and Hard disk 1 size according to Table 13.
   - Choose Datastore ISO File from the New CD/DVD Drive dropdown menu, and add Ubuntu 24.04.2 ISO stored on the local datastore. Check Connect At Power On.
10. Review your settings, and click Finish.

Installing Ubuntu 24.04.2 LTS

1. In the vCenter interface, click the gold VM you created, and power it on.
2. Open the VM console.
3. In the Select Language settings, leave defaults, and press Enter.
4. On the Keyboard configuration screen, leave defaults, and press Enter.
5. In Choose your install, select Install Ubuntu (minimal configuration), and press Enter.
6. In Network connections, change to a static network configuration, set your IP, highlight Done, and press Enter.
7. In Proxy setup, accept defaults, and press Enter.
8. In Filesystem setup, accept defaults, and press Enter.
9. When prompted to select a disk, choose the only disk available, and press Enter.
10. In the Filesystem summary, make any changes you want (we used defaults), highlight Done, and press Enter.
11. Ensure Skip Ubuntu Pro setup for now is selected, and press Enter.
12. In the confirmation window that appears, highlight Continue, and press Enter.
13. In the feature selection screen, select Install OpenSSH server, and press Enter.
14. In the Profile setup, enter whatever information you need for your Ubuntu user, highlight Done, and press Enter.
15. When Ubuntu is installed, highlight Reboot Now, and press Enter.

Updating Ubuntu and installing WordPress

1. Run any system updates necessary:

```
sudo apt-get update
sudo apt-get upgrade
```

2. Install utilities you will use later in the installation:

```
sudo apt-get install wget tar vim apache2 ghostscript libapache2-mod-php mysql-server php php-bcmath
php-curl php-imagick php-intl php-json php-mbstring php-mysql php-xml php-zip unzip -y
```

3. Download WordPress, and move it into its installation directory:

```
sudo mkdir -p /srv/www
wget https://wordpress.org/latest.tar.gz
sudo tar -xzvf latest.tar.gz -C /srv/www
```

4. Create a WordPress site in Apache by creating a file at /etc/apache2/sites-available/wordpress.conf and putting the following configuration into it:

```
<VirtualHost *:80>
    DocumentRoot /srv/www/wordpress
    <Directory /srv/www/wordpress>
        Options FollowSymLinks
        AllowOverride Limit Options FileInfo
        DirectoryIndex index.php
        Require all granted
    </Directory>
    <Directory /srv/www/wordpress/wp-content>
        Options FollowSymLinks
        Require all granted
    </Directory>
</VirtualHost>
```

5. Modify the base Apache installation to enable WordPress as the base site:

```
sudo a2ensite wordpress
sudo a2enmod rewrite
sudo a2dissite 000-default
sudo service apache2 reload
```

6. Enter the MySQL console:

```
sudo mysql -u root
```

7. Configure MySQL to work with WordPress:

```
CREATE DATABASE wordpress;
CREATE USER wordpress@localhost IDENTIFIED BY ‘Password1’;
GRANT SELECT,INSERT,UPDATE,DELETE,CREATE,DROP,ALTER
    -> ON wordpress.*
    -> TO wordpress@localhost;
FLUSH PRIVILEGES;
quit
```

8. Turn MySQL on:

```
sudo service mysql start
```

9. Configure WordPress to connect to MySQL:

```
sudo chown -R www-data:www-data /srv/www
sudo -u www-data cp /srv/www/wordpress/wp-config-sample.php /srv/www/wordpress/wp-config.php
sudo -u www-data sed -i 's/database_name_here/wordpress/' /srv/www/wordpress/wp-config.php
sudo -u www-data sed -i 's/username_here/wordpress/' /srv/www/wordpress/wp-config.php
sudo -u www-data sed -i 's/password_here/Password1/' /srv/www/wordpress/wp-config.php
```

10. Edit the `/srv/www/wordpress/wp-config.php` file and replace the security key lines (starting with `AUTH_KEY` and ending with `NONCE_ SALT)` with the lines generated at https://api.wordpress.org/secret-key/1.1/salt/. Save the file.
11. Restart Apache to allow WordPress to correctly start:

```
sudo systemctl restart apache2
```

Configuring WordPress

1. On a separate machine, navigate to the IP address of your new WordPress VM, and to finalize the WordPress deployment, fill out the site survey.
2. On the WordPress VM, download and install the WordPress content dummy generator plug-in:

```
cd /srv/www/wordpress/wp-content/plugins
sudo wget https://downloads.wordpress.org/plugin/wp-dummy-content-generator.zip
sudo wget https://downloads.wordpress.org/plugin/woocommerce.9.5.1.zip
sudo unzip wp-dummy-content-generator.zip
sudo unzip woocommerce.9.5.1.zip
```

3. In a web browser, log into your WordPress VM.
4. At the top of the web page, click Plugins.
5. Click the Dummy Content Generator plugin.
6. In the WP Dummy Content Generator plugin page, click Generate Users.
7. In Choose User Role, choose Administrator, and in Number of Users, select 5. Click Generate users.
8. Once the administrators are generated, in User Role, choose Editor, and in Number of Users, select 5. Click Generate Users.
9. Once the editors are generated, in User Role, choose Author, and in Number of Users, select 20. Click Generate Users.
10. Once the authors are generated, in User Role, choose Subscriber, and in Number of Users, enter 200. Click Generate Users.
11. On the left of the web page, Generate Posts.
12. In Posts date range, choose 01/01/2020–02/01/2025, make sure 10 posts will be generated, and click Generate Posts.
13. On the left of the web page, click Generate Products.
14. In the Generate Products page, in the number of products, select 300, and select Featured Image/Thumbnail. Click Generate Products.
15. Once you have finished generating content, shut down the WordPress server.

Creating the WordPress Siege client

To create the Siege client, we followed the Creating the Base WordPress VM and Installing Ubuntu sections and then performed the following steps.

1. Run any system updates necessary:

```
sudo apt-get update
sudo apt-get upgrade
```

2. Install utilities you will use later in the installation:

```
sudo apt-get install vim openssl openssl-devel zlib gzip gcc inetutils-ping -y
```

3. Download and extract Siege:

```
wget http://download.joedog.org/siege/siege-latest.tar.gz
tar -xzvf siege-latest.tar.gz
```

4. Navigate to the newly extracted directory, and build Siege:

```
cd siege-4.1.7/
./configure
make
sudo make install
```

Cloning the test VMs

1. In vSphere, right-click the gold VM, and choose Clone → Clone to Virtual Machine....
2. Name the VM, and click Next.
3. Select the first host, and click Next.
4. Select the vSAN datastore, and click Next.
5. On the Select clone options screen, leave everything unchecked, and click Next.
6. On the Ready to complete screen, review your settings, and click Finish.
7. Complete steps 1 through 6, placing the VMs on the four HPE DL380 Gen 10 hosts in a round-robin fashion so you end up with one VM on each host for a total of four VMs.

Changing the IPs and configuring WordPress

After cloning the VMs, we performed the following steps to give each VM a unique IP. We then had to edit the WordPress installation to ensure the WordPress URL used the new IP.

1. Power on one WordPress VM, and SSH to it.
2. Disable Cloud-init configuration by first creating the following config file:

```
sudo nano /etc/cloud/cloud.cfg.d/99-disable-cloud-init.cfg
```

3. Edit the new config file by typing `network: {config: disabled}`
4. Save and close the config file.
5. Set a manual IP by editing the `cloud-init .yaml` file.

```
sudo nano /etc/netplan/50-cloud-init.yaml
```

6. In the .yaml file, do the following:
   - Change dhcp4: true to dhcp4: no
   - Add or edit the addresses, gateway4, and name servers as follows:

```
            addresses:
              - 172.16.42.202/16
            gateway4: 172.16.0.1
            nameservers:
              addresses: [172.16.0.1]
```

7. Apply the changes to the system:

```
sudo netplan apply
```

8. Once the new IP is applied, the system will disconnect your SSH session. Reconnect using the new IP.
9. Connect to the MySQL install:

```
sudo mysql
```

10. Connect to the WordPress database:

```
connect wordpress
```

11. Run the following commands replacing <new-IP> with the IP you just set in the previous steps:

```
update wp_options set option_value='http://<new-IP>' where option_name = 'siteurl';
update wp_options set option_value='http://<new-IP>' where option_name = 'home';
```

12. Exit MySQL:

```
exit
```

13. Restart the Apache service:

```
sudo systemctl restart apache2
```

14. On a separate system, you can double-check your changes by navigating to the new IP address URL.
15. Follow steps 1 through 14 for each WordPress VM until all four have unique IPs.

Running the tests

We simultaneously started all Microsoft SQL Server VMs and WordPress VMs. We stopped the WordPress VMs when the last TPROC-H VM output its results. We ran the HammerDB test once without recording the output to cache as much of the database into memory as possible. We then ran the test again and recorded the results. This approach represents more realistic results on database servers that are under heavy use. We completed these steps three times to get three sets of results and report the median run.

Starting the HammerDB tests

1. In each SQL VM, open HammerDB.
2. In the popup menu, double-click SQL Server, and double-click TPROC-H.
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 you set during SQL creation.
9. Set MAXDOP to 0.
10. Set Scale to 100.
11. Expand Driver Script, and click Load.
12. Expand Virtual User, and open Options.
13. Set Virtual Users to 5.
14. Enable Log Output to Temp, Use Unique Log Name, and Log Timestamps, and click OK.
15. Double-click Create users.
16. When ready, click Start.

Starting the WordPress tests

1. Open PowerShell, and SSH to your Siege client.
2. To start the test, run the following command against each WordPress client:

```
sudo siege http://<wordpress IP> -c 1 -q -l
```

Read the report ▶

This project was commissioned by Dell Technologies.

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