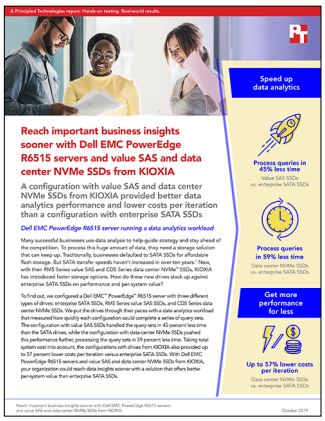

The science behind the report:

Reach important business insights sooner with Dell EMC PowerEdge R6515 servers and value SAS and data center NVMe SSDs from KIOXIA

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 Reach important business insights sooner with value SAS and data center NVMe SSDs from KIOXIA.

We concluded our hands-on testing on August 12, 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 August 2, 2019 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

The table below presents our findings in detail.

Configuration type	Configuration with enterprise SATA SSDs	Configuration with value SAS SSDs from KIOXIA	Configuration with data center NVMe™ SSDs from KIOXIA
Query time (mm:ss)	42:54	23:33	17:37
Percentage win over SATA SSDs		45%	59%
Max throughput (GB/s)	1.7	3.2	5.5
Percentage win over SATA SSDs		88%	224%
Average throughput (GB/s)	1.3	2.5	3.4
Percentage win over SATA SSDs		92%	162%
Average latency (ms)	250	146	56
Percentage win over SATA SSDs		42%	78%

Cost analysis results

We used list pricing information obtained from Dell EMC on September 26, 2019 to arrive at our system costs. These numbers, while recent at the time of testing, are subject to change. To calculate the cost-per-iteration metric, we took the cost of each configuration and divided it by the number of times our sample dataset of 22 queries could run in an hour. We used normalization to show the performance results and pricing in relative terms compared to the baseline set by the SATA SSDs. As the below table shows, the configuration with data center NVMe SSDs cost slightly more and the configuration with value SAS SSDs cost slightly less than the configuration with SATA SSDs, but in both cases the improved data analytics performance lowered iteration costs.

	Configuration with enterprise SATA SSDs	Configuration with value SAS SSDs from KIOXIA	Configuration with data center NVMe SSDs from KIOXIA
Total time to complete a 22-query set (mm:ss)	42:54	23:33	17:37
System price	$33,418.00	$33,018.00	$34,618.00
Cost per iteration (USD)	$11.06	$6.00	$4.71

In any given production environment, a database admin may have a limited amount of time to run this type of resource-intensive analytic reporting, generally doing so during planned maintenance windows or periods of low user traffic. We wanted to provide some examples of how an organization might benefit from lower costs per iteration while running data analytics workloads for varying amounts of time. We calculated these costs over a three-year server lifecycle (the point at which Forrester recommends organizations refresh their servers[1]) at workload frequencies ranging from one hour to 20 hours per week. As the below table demonstrates, the drives from KIOXIA delivered consistently higher overall system value.

	1 hour	1 hour/week	5 hours/week	10 hours/week	15 hours/week	20 hours/week
Configuration with enterprise SATA SSDs	$23,893.87	$153.17	$51.06	$15.32	$10.21	$7.66
Configuration with value SAS SSDs from KIOXIA	$12,959.57	$83.07	$27.69	$8.31	$5.54	$4.15
Configuration with data center NVMe SSDs from KIOXIA	$10,164.23	$65.16	$21.72	$6.52	$4.34	$3.26
Percentage win (configuration with value SAS SSDs)	46%	46%	46%	46%	46%	46%
Percentage win (configuration with data center NVMe SSDs)	57%	57%	57%	57%	57%	57%

1 Forrester, "Why Faster Refresh Cycles And Modern Infrastructure Management Are Critical To Business Success," accessed October 7, 2019, https://www.dellemc.com/resources/en-us/asset/analyst-reports/solutions/forrester-why-faster-refresh-cycles-and-modern-infrastructure-management-are-critical-to-business-success.pdf.

System configuration information

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

Server configuration information	Dell EMC™ PowerEdge™ R6515
BIOS name and version	Dell 0.4.4
Non-default BIOS settings	Processor→Number of Cores per CCD→FOUR(2+2)
Operating system name and version	Microsoft Windows Server 2019 (Datacenter Edition)
Date of last OS updates/patches applied	08/02/2019
Power management policy	Performance
Processor	
Number of processors	1
Vendor and model	AMD EPYC™ 7702P
Core count (per processor)	64
Core frequency (GHz)	2.00
Stepping	SSP-B0
Memory module(s)	
Total memory in system (GB)	256
Number of memory modules	16
Vendor and model	Hynix® HMA82GR7CJR8N-XN
Size (GB)	16
Type	PC4-3200AA
Speed (MHz)	3,200
Speed running in the server (MHz)	2,933
Storage controller	
Vendor and model	Dell PERC H730P Mini Controller
Cache size (GB)	2
Firmware version	25.5.5.0005
Driver version	6.604.6.0
Local storage #1	
Number of drives	2
Drive vendor and model	Intel® SSDSCKKB240G8R
Drive size (GB)	240
Drive information (speed, interface, type)	SATA M.2 SSD

Server configuration information	Dell EMC™ PowerEdge™ R6515
Local storage #2	
Number of drives	2
Drive vendor and model	Dell EMC MZ-WLL1T6C
Drive size (TB)	1.6
Drive information (speed, interface, type)	NVMe 2.5" SSD
SATA SSD	
Number of drives	4
Drive vendor and model	Intel SSDSC2KB960G8R
Drive size (GB)	960
Drive information (speed, interface, type)	SATA 6Gbps SSD
SAS SSD	
Number of drives	4
Drive vendor and model	KIOXIA KRM5XRUG960G
Drive size (GB)	960
Drive information (speed, interface, type)	SAS 12Gbps SSD
NVMe SSD	
Number of drives	4
Drive vendor and model	KIOXIA KCD5XLUG960G
Drive size (GB)	960
Drive information (speed, interface, type)	NVMe PCIe Gen3
Network adapter	
Vendor and model	Broadcom® 57414 Dual Port 25Gb
Number and type of ports	2 x 25GbE
Firmware	21.40.17
Cooling fans	
Vendor and model	Sunon® PG40561BX-Q130-S9H
Number of cooling fans	6
Power supplies	
Vendor and model	Dell D550E-S1
Number of power supplies	2
Wattage of each (W)	550

How we tested

BIOS configuration

For a TPC-H-type workload with single threaded processing, reducing the core count can help boost performance and disk throughput. In this study, we set the BIOS settings to default, set the system profile to Performance, and then configured the processor settings to reduce the number of cores. We changed the "Number of Cores per CCD" to "FOUR (2+2)." This reduced the core count from 64 to 32.

RAID configuration

For the SAS and SATA drive sets (four SATA, four SAS), we used two sets of four SSD RAID10 volumes for data. For the NVMe drive set, we configured a Storage Spaces Direct virtual drive in a mirrored configuration using all four NVMe SSDs for data. For all three drive configurations, we used two 1.6TB NVMe drives in a Dell PERC RAID1 configuration for SQL database logging. We installed the OS on an internal BOSS card with two 240GB M.2 SSDs in a RAID1 configuration.

Installing Microsoft Windows Server 2019

1. Insert the Microsoft Windows Server 2019 installation DVD into the optical drive.
2. Power on the server, and boot into the Windows installer.
3. Once the installation files have copied into memory, select the appropriate language, time and currency format, and keyboard layout, and click Next.
4. Click Install Now.
5. Enter the product key, and click Next.
6. Choose Windows Server 2019 Datacenter (Server with a GUI), and click Next.
7. Check the I accept the license terms box, and click Next.
8. Choose Custom: Install Windows only (advanced).
9. Select the OS hard drive from the list, and click Next. This will begin the installation.

Configuring Windows Update

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.

Installing SQL Server 2017

1. Attach the installation media ISO for SQL Server 2017 to the VM.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2017 DVD, and double-click it.
3. In the left pane, click Installation.
4. Click New SQL Server stand-alone installation or add features to an existing installation.
5. To accept the license terms, click the checkbox, and click Next.
6. To check for updates, click Use Microsoft Update, and click Next.
7. To install the setup support files, click Install.
8. If the system displays no failures, 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, and Client Tools Backwards Compatibility.
11. Click Next.
12. At the Instance Configuration screen, leave the instance default selection, 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 Data Directories tab.
17. Change the database directory, the database log directory, and the backup directory storage locations to the data, log, and backup volumes.

18. Click the TempDB tab.
19. Change the number of files to 8.
20. Change the initial file size to 1,024 MB.
21. Change the Data Directory to the data volume.
22. Change the initial size of the log to 1,024 MB.
23. Change the Log Directory to the log volume.
24. Click Next.
25. At the Error and usage reporting screen, click Next.
26. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
27. At the Ready to Install screen, click Install.
28. When the install has finished, go to the Installation tab in the Installation Center, and click Install SQL Server Management Tools.
29. In the browser that pops up, click Download SQL Server Management Studio 18.X.
30. To open the installer, click on the download.
31. Click Run.
32. Click Install.
33. When the installation has completed, close the installation window.

Creating a database

1. Open SQL Server Management Studio.
2. Right-click Databases→New Database.
3. Name the database. We named ours `tpch`
4. To add seven more database files (for a total of eight), click Add.
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 300 scale and 32 virtual users.
6. Check the Clustered Columnstore box.
7. Click OK.
8. Double-click Build. This 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.

Performing the test on Windows

1. Start HammerDB.
2. Set the database server to SQL Server and the workload to TPC-H.
3. Open the Options panel for the Schema Build: SQL Server→TPC-H→Schema Build→Options.
4. Change the ODBC Driver to "ODBC Driver 13 for SQL Server."
5. Change the MAXDOP to 64.
6. For Scale Factor, select 300.
7. Click OK.
8. Open the Options panel for the Virtual Users: SQL Server→TPC-H→Virtual User→Options.
9. Select 1 Virtual Users.
10. Select the following: "Show Output," "Log Output to Temp," and "Use Unique Log Name."
11. Click OK.
12. Open the Options panel for the Driver: SQL Server→TPC-H→Driver Script→Options.
13. Set Total Query Sets per User to 1.
14. Click OK.
15. Load the Driver Script: SQL Server→TPC-H→Driver Script→Load.
16. To capture CPU, RAM, and disk performance counters, start a custom Perfmon data collector set.
17. Click the green arrow in the HammerDB UI.
18. To start the run, note the name of the log file, and click OK.
19. When the run finishes, stop Perfmon.
20. Save the HammerDB results text file and Perfmon output.
21. Reboot the server.

Read the report at http://facts.pt/pmw9od7 ▶

This project was commissioned by KIOXIA.

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