

Behind the Report—Testing Addendum:

Life After SATA: KIOXIA Value SAS vs. 6 Gbps SATA Application Benefits Test

This document provides the system configuration details and step-by-step procedures that Prowess Consulting used to perform benchmark testing to evaluate the performance differences between KIOXIA Serial-Attached SCSI (SAS) drives and Samsung® Serial ATA (SATA) drives on typical database workloads in a modern data center.

Prowess Consulting engineers used Microsoft® SQL Server® 2022 running on Windows Server® 2022 and ran HammerDB benchmarks to evaluate both online transaction processing (OLTP) workloads (with the TPROC-C benchmark) and analytic workloads (with the TPROC-H benchmark).

Prowess Consulting conducted the testing on two identical Dell™ PowerEdge™ R650 systems, differing only in that one server had all-SAS RAID and one server had all-SATA RAID. The hypothesis was that using the SAS drives would provide better performance than using the SATA drives.

For the full analysis, read the report at www.prowesscorp.com/project/kioxia-sas-value-ssd-outperforms-sata.

Testing was concluded on January 19, 2023.

Server Configurations

Configuration	KIOXIA SAS RAID 10	Samsung® SATA RAID 10
Model Name	Dell™ PowerEdge™ R650	Dell™ PowerEdge™ R650
CPU	Intel® Xeon® Silver 4314	Intel® Xeon® Silver 4314
Number of CPUs	2	2
Cores/Threads Per CPU	16/32	16/32
Cores/Threads Total	32/64	32/64
Frequency (Base/SCT/MCT)	2.4 GHz	2.4 GHz
Storage Controller 1	Broadcom®/LSI Dell™ PowerEdge RAID Controller 11 (PERC 11) H755 Front	Broadcom®/LSI Dell™ PowerEdge RAID Controller 11 (PERC 11) H755 Front
Storage Technology	SAS	SATA
Disk	3.84 TB KIOXIA RM6 Series KRM6VRUG3T84	3.84 TB Samsung® PM 883 MZ7LH3T8MLT0D3
Number of Disks	4	4

Storage Controller 2	Marvell Technology Group Ltd. Dell™ Boot Optimized Server Storage (BOSS)-S1	Marvell Technology Group Ltd. Dell™ Boot Optimized Server Storage (BOSS)-S1
Disk	2 x 480 GB Micron® MTFDDAV480TDS	2 x 480 GB Micron® MTFDDAV480TDS
Number of Disks	2	2
Installed Memory	256 GB error correction code (ECC) DDR4	256 GB error correction code (ECC) DDR4
Memory DIMM	32 GB Hynix® HMAA4GR7CJR8N-XN	32 GB Hynix® HMAA4GR7CJR8N-XN
Memory Speed	2,666 megatransfers per second (MT/s) (maximum 3,200 MT/s)	2,666 megatransfers per second (MT/s) (maximum 3,200 MT/s)
Number of Memory DIMMs	8	8
Operating System (OS)	Windows Server® 2022	Windows Server® 2022
OS Version	Version 21H2	Version 21H2
OS Kernel	OS build 20348.1194	OS build 20348.1194
Microsoft® SQL Server® Version	Microsoft® SQL Server® 2022 Developer Edition build 20348	Microsoft® SQL Server® 2022 Developer Edition build 20348
BIOS Version	1.7.5	1.7.5
HammerDB	4.5	4.5

Testing Procedures

For testing, the Prowess Consulting engineers used a server with Windows Server 2022 preinstalled, with SAS RAID 10 and SATA RAID 10 volumes pre-created. The following sections describe how to replicate the testing by installing and configuring Microsoft SQL Server and running TPROC-C tests and TPROC-H tests in HammerDB.

Installing and Configuring the Microsoft® SQL Server® 2022 Environment

1. Download SQL Server 2022 from the Microsoft website at www.microsoft.com/en-us/evalcenter/download-sql-server-2022.
 - a. Under **EXE Download**, select **64-bit edition**.
 - b. In the **Downloads** folder, double-click **SQL2022-SSEI-Eval.exe**.
2. In the SQL Server Installation wizard, select the **Basic** installation type.
 - a. In the **Microsoft SQL Server License Terms** window, click **Accept** to agree to the license terms.
 - b. In the **Specify SQL Server install location** window, click **Install**.
 - c. In the **Installation has completed successfully** window, click **Install SSMS**.
 - i. Under the **Download SMSS** heading, click the linked web page, and then click the **Free Download for SQL Server Management Studio (SSMS)** link.
 - ii. Double-click to launch **SSMS-Setup-ENU.exe**.
 1. In the SSMS Install wizard, click **Install**.
 2. Once setup is complete, click **Close**.
3. Open SQL Server Management Studio:
 - a. On the **Connect to Server** screen, click **Connect**.
 - b. In the explorer, right-click the server name:
 - i. Select **Server Properties**.
 - ii. On the **Database Settings** page, enter the path name of the SAS RAID 10 volume in the **Data, Log**, and **Backup** fields, and then click **OK**.
 - c. In the explorer, right-click **Security**.
 - i. Click **New**.
 - ii. Click **Login**.
 - d. In the New Login wizard, in the **Login Name** box, enter **loaduser**.
 - i. Select **SQL Server Authentication**.
 1. In both the **Password** and **Confirm Password** fields, enter **<password>**.
 - ii. Clear the **Enforce Password Policy** checkbox.

- e. On the **Server Roles** page, select the following roles:
 - i. **dbcreator**
 - ii. **public**
 - iii. **sysadmin**
 - f. On the **Status** page:
 - i. Under **Permission to connect to database engine**, select **Grant**.
 - ii. Under **Login**, select **Enabled**.
4. From the **Start** menu, search for and launch **SQL Server Configuration Wizard**.
- a. Expand the menu under **SQL Server Network Configuration**.
 - b. Select **Protocols for MSSQLSERVER**.
 - c. Double-click **TCP/IP**.
 - i. In the TCP/IP Properties wizard, select **Yes** from the drop-down menu to the right of **Enabled**.
 - ii. Click the **IP Addresses** tab.
 - iii. Under the **IPAll** header, set **TCP Port** to **1433**.
 - iv. Click **OK**.
 - d. Click **SQL Server Services** from the explorer menu on the left side.
 - i. Right-click **SQL Server (MSSQLSERVER)**, and then click **Restart**.
 - e. Once the progress pop-up closes, close the SQL Server Configuration wizard.
5. Download the HammerDB 64-bit client from <https://github.com/TPC-Council/HammerDB/releases>.
- a. Scroll down to **Version 4.5**.
 - b. In the **Downloads** folder, double-click **HammerDB-4.5-Win-x64-Setup.exe**.
 - c. Under the **User Account Control** pop-up, click **Yes**.
 - d. In the **Setup** window, click **Next**.
 - e. In the **License Agreement** window, select **I Accept the Agreement**.
 - f. In the **Installation Directory** window, click **Next**.
 - g. In the **Ready to Install** window, click **Next**.
 - h. In the **Completing the HammerDB Setup Wizard** window, clear the checkboxes for **View Readme File** and **Run HammerDB**, and then click **Finish**.

Running TPROC-C Tests in HammerDB

Prowess Consulting engineers created the TPROC-C test database and conducted the HammerDB TPROC-C testing process using the following steps:

1. Navigate to **C:\Program Files\HammerDB-4.5**, and then double-click the batch file labeled **hammerdb.bat**.
2. From the **Options** drop-down menu, select **Benchmark**.
3. In the **Benchmark Options** pop-up, select **SQL Server** and **TPROC-C**.
4. In the **Benchmark** view, navigate to **SQL Server > TPROC-C > Schema Build**.
5. Select **Options**, and then enter the following values:
 - **SQL Server: (local)\MSSQLServer**
 - **SQL Server ODBC Driver: ODBC Driver 17 for SQL Server**
 - **Authentication: SQL Server Authentication**
 - **SQL Server User ID: loaduser**
 - **SQL Server User Password: <password>**
 - **TPROC-C SQL Server Database: tpcc**
 - **Number of Warehouses: 640**
 - **Virtual Users to Build Schema: 45**
6. Close the **Options** menu by clicking **OK**, and then click **Build**.
7. From the **Start** menu, search for and launch **SQL Server Management Studio (SSMS)**.
8. Connect to SQL Server.
9. Expand **Databases**.
10. Right-click the **tpcc** database.
11. Click **Backup**.

12. In the **Benchmark** view, navigate to **SQL Server > TPROC-C > Driver Script**.
13. Double-click **Options**, and then enter the following values:
 - **SQL Server: (local)\MSSQLServer**
 - **SQL Server ODBC Driver: ODBC Driver 17 for SQL Server**
 - **Authentication: SQL Server Authentication**
 - **SQL Server User ID: loaduser**
 - **SQL Server User Password: <password>**
 - **TPROC-C SQL Server Database: tpcc**
 - **TPROC-C Driver Script: Timed Driver Script**
 - **Total Transactions Per User: 10000000**
 - **Minutes of Rampup Time: 7**
 - **Minutes for Test Duration: 20**
 - **Use All Warehouses: Checked**
14. Close the **Options** page by clicking **OK**, and then double-click **Load**.
15. In the **Benchmark** view, navigate to **SQL Server > TPROC-C > Virtual User**.
16. Double-click **Options**, and then enter the following values:
 - **Virtual Users: 16**
 - **User Delay (ms): 500**
 - **Repeat Delay (ms): 500**
 - **Iterations: 1**
 - **Show Output: Selected**
 - **Log Output to Temp: Selected**
 - **Use Unique Log Name: Selected**
 - **No Log Buffer: Unselected**
 - **Log Timestamps: Selected**
17. Close the **Options** page by clicking **OK**, and then double-click **Run**.
18. The Virtual User Output tab will display test progress. Record the new orders per minute (NOPM) and transactions per minute (TPM) values from the **Virtual User 1** display at the top left.
19. From the **Start** menu, launch **SQL Server Management Studio**.
 - a. In the **Explorer** panel, right-click the SQL Server name.
 - b. From the drop-down menu, click **Restart**.
 - c. In the **Windows User Account Control** pop-up, click **Yes**.
 - d. In the **SQL Server Management Studio** pop-up, click **Yes**.
20. Repeat steps 15–19, adjusting the number of virtual users between each run according to this scale:
 - 16
 - 32
 - 64
 - 96
 - 112
21. Open **SQL Server Management Studio**.
 - In the explorer, right-click the **Server Name**.
 - i. Select **Server Properties**.
 - ii. On the **Database Settings** page, enter the path name of the SATA RAID 10 volume in the **Data, Log, and Backup** fields, and then click **OK**.
22. Right-click **Databases**, and then click **Restore Database**.
23. Select **Device**, click the ellipses, and then search for and select the **tpcc** database backup.
24. Repeat steps 15–20 to complete testing on the SATA RAID 10 volume.

Running TPROC-H Tests in HammerDB

Prowess Consulting engineers created the TPROC-H test database and conducted the HammerDB TPROC-H testing process using the following steps:

1. In HammerDB, select the **Options** drop-down menu, and then select **Benchmark**.
2. In the **Benchmark** pop-up, select **SQL Server**.
 - a. In the **SQL Server** menu, select **TPROC-H**, and then click **OK**.
3. Under the **Benchmark** menu in the side panel, expand the **TPROC-H** menu.
 - a. Expand the **Schema Build** menu, and then click **Options** and provide the following values:
 - i. **SQL Server: (local)\SQL**
 - ii. **SQL Server ODBC Driver: ODBC Driver 17 for SQL Server**
 - iii. **Authentication: SQL Server Authentication**
 - iv. **SQL Server User ID: loaduser**
 - v. **SQL Server User Password: <password>**
 - vi. **TPROC-H SQL Server Database: tpch**
 - vii. **MAXDOP: 2**
 - viii. **Scale Factor: 30**
 - ix. **Virtual Users to Build Schema: 1**
 - b. Click **OK** to close, and then double-click **Build**.
4. From the **Start** menu, search for and launch **SQL Server Management Studio (SSMS)**.
5. Connect to SQL Server.
6. Expand **Databases**.
7. Right-click the **tpch** database.
8. Click **Backup**.
9. Navigate to **Driver Script**, and then click **Options** and provide the following values:
 - a. **SQL Server: (local)\SQL**
 - b. **SQL Server ODBC Driver: ODBC Driver 17 for SQL Server**
 - c. **Authentication: SQL Server authentication**
 - d. **SQL Server User ID: loaduser**
 - e. **SQL Server User Password: <password>**
 - f. **TPROC-H SQL Server Database: tpch**
 - g. **MAXDOP: 2**
 - h. **Total Query Sets/User: 1**
10. Click **OK** to close, and then double-click **Load**.
11. Navigate to **Virtual User**, click **Options**, and then provide the following values:
 - a. **Virtual Users: 1**
 - b. **User Delay (ms): 500**
 - c. **Repeat Delay (ms): 500**
 - d. **Iterations: 1**
 - e. **Show Output: Selected**
 - f. **Log Output to Temp: Selected**
 - g. **Use Unique Log Name: Selected**
 - h. **No Log Buffer: Unselected**
 - i. **Log Timestamps: Selected**
12. Close the **Options** page by clicking **OK**, and then double-click **Run**.
 - a. The Virtual User Output tab will display test progress. Record the total transaction values from the **Virtual User 1** display in the top left.
13. Open **SQL Server Management Studio**.
 - a. In the **Explorer** panel at the left, right-click the SQL Server name.
 - i. Select **Restart** from the drop-down menu.
 - ii. In the **Windows User Account Control** pop-up, click **Yes**.
 - iii. In the **SQL Server Management Studio** pop-up, click **Yes**.

14. Repeat steps 11–13, adjusting the number of virtual users each time:
 - a. 1
 - b. 5
 - c. 10
15. Open **SQL Server Management Studio**.
16. In the explorer, right-click the **Server Name**.
 - a. Select **Server Properties**.
 - b. On the **Database Settings** page, enter the path name of the SATA RAID 10 volume in the **Data, Log,** and **Backup** fields.
 - c. Click **OK**.
17. Repeat steps 11–13 to test the SATA RAID 10 volume.

Measuring Power Consumption

1. Follow steps 1–12 of the **Running TPROC-C Tests in HammerDB** process.
 - a. In step 13, set **Minutes of Ramp Up Time** to **5**.
 - b. Set **Minutes of Test Duration** to **10**.
 - c. Continue following the steps in the **Running TPROC-C Tests in HammerDB** process until step 17.
2. Use Secure Shell (SSH) to sign in to the system under test's (SUT's) **iDRAC Address** to access the racadm prompt.
3. Continue by following the **Running TPROC-C Tests in HammerDB** testing steps 17–20.
 - a. 10 minutes into each test, run the following command in the racadm prompt:

```
get system.Power.Realtime.Power
```
 - b. Record the listed wattage in the command's output.

