



MICROSOFT SQL SERVER 2019 DATA WAREHOUSE PERFORMANCE WITH HPE MSA 2060/2062 FIBRE CHANNEL SFF STORAGE

Using HPE ProLiant DL380 Gen10 server



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EXECUTIVE SUMMARY

This technical white paper provides information for organizations interested in deploying a high-performing, cost-effective Data Warehouse/Business Intelligence (DW/BI) solution. It highlights the benefits of deploying the [HPE MSA 2060/2062 storage arrays](#) for a SQL Server 2019 Data Warehouse environment. Multiple hardware configurations were tested to demonstrate the different performance capabilities of the HPE MSA 2060/2062 storage arrays.

The term **Data Warehouse** (DW) is often used generically to refer to a repository of historical business data. Typical DW/BI activity consists of sequential I/O and is substantially more read intensive than write. High read loads usually occur during database queries, while heavy writes happen mainly during data loads. Although both read and write performance are important when designing a capable DW solution, higher priority is given to performance for query analysis than data loads (which can be done at off-peak times). The main design criteria for a DW deployment is sequential read performance—specifically the throughput that can be achieved through the storage subsystem, while also maintaining a balance with available compute and storage resources. Microsoft's Data Warehouse Fast Track (DWFT) tool provides a standard method to benchmark query workloads and determine storage performance.

Hewlett Packard Enterprise testing utilized the [HPE ProLiant DL380p Gen10 server](#) and HPE MSA 2060/2062 storage arrays, and was completed in September 2020,

Target audience

Readers should be familiar with Windows Server 2019, SQL Server 2019, and configuring HPE MSA storage.

The target audience for this solution include:

- Small and Medium Business (SMB) seeking a storage solution for their SQL Server DW workloads
- Existing or new SQL DW/BI customers who are migrating to SQL Server 2019
- Customers planning to upgrade their server and storage from previous generations of HPE hardware
- Data Warehouse architects
- Business intelligence users
- Database administrators
- IT planners

Document purpose

This document provides performance comparisons of SQL Data Warehouse testing between multiple HPE MSA 2060/2062 storage array configurations as well as performance increases over the previous generation HPE MSA hardware.



SOLUTION OVERVIEW

HPE MSA 2060/2062 configurations

The HPE MSA storage array was configured with an additional drive enclosure for testing with the HPE MSA 2060 utilizing HDDs and the HPE MSA 2062 utilizing SSDs. Drives in each enclosure were:

- Array enclosure – Twelve 1.92 TB Read Intensive SAS SSD
- Additional drive enclosure – Twenty 1.8 TB 10k RPM Enterprise-class SAS HDD

HPE MSA-DP+ has an enhanced feature set over traditional HPE MSA RAID levels, allowing for incremental capacity expansion, reduced reconstruct times, built-in spare capacity, and increased availability—using any number of drives between 12 and 128—and provides similar performance to RAID6. Tests were done using HPE MSA-DP+ when possible, and RAID6 when drive numbers were below HPE MSA-DP+ thresholds. HPE MSA-DP+ is recommended for HDD-only configurations.

The tested configurations were as follows:

- HDD-only, single storage pool (HPE MSA-DP+)
- HDD-only, dual storage pool (RAID6)
- HDD+Read Cache, single storage pool (HPE MSA-DP+, SSD Read Cache)
- HDD+Read Cache dual storage pool (RAID6, SSD for Read Cache)
- HDD+SSD single storage pool (RAID6)
- HDD+SSD dual storage pool (RAID6)
- SSD-only single storage pool (RAID6)
- SSD-only dual storage pool (RAID6)

HPE ProLiant DL380 Gen10 server configuration (Windows Server 2019 and SQL Server 2019)

The HPE ProLiant DL380 Gen10 server used for testing contained two CPUs (Intel® Xeon® Gold 6130), with 384 GB of RAM and a 400 GB SSD for the OS.

A new feature for the HPE ProLiant DL380 Gen10 server includes optimized power profiles in the BIOS for various types of server workloads. “Decision Support” was selected because this profile is optimized for Data Warehouse workloads. Access the settings from the Intelligent Provisioning Screen (F10) during POST, select **Perform Maintenance**, and then click the **BIOS/Platform Configuration** option, as shown in [FIGURE 1](#).

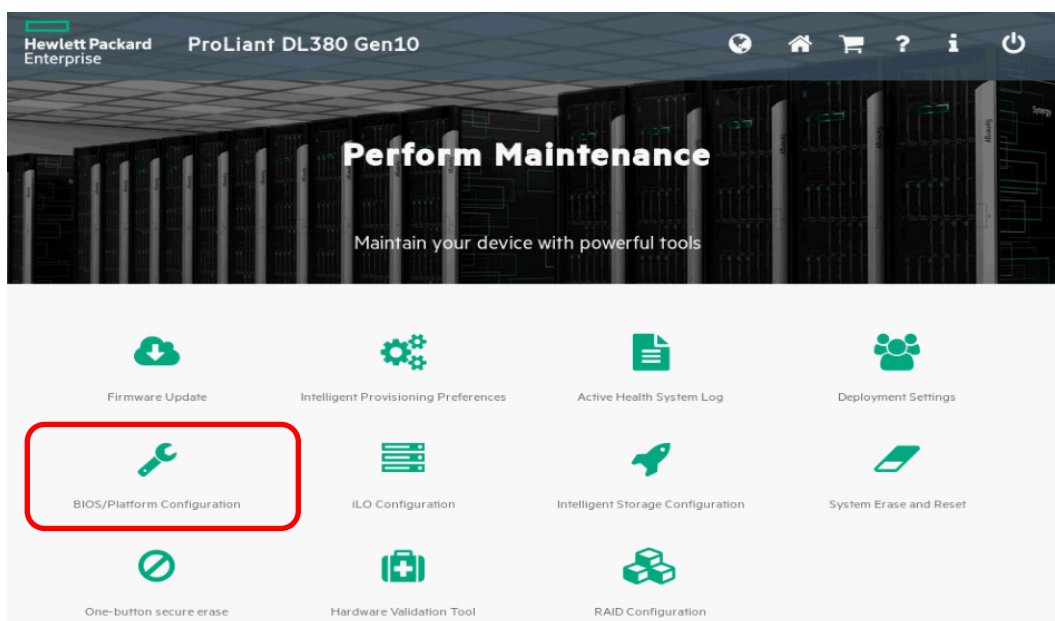


FIGURE 1. BIOS configuration



The **Workload Profile** has a drop-down list to choose from at the bottom of the screen that is not immediately apparent. Use this menu to select the proper server workload, as shown in [FIGURE 2](#). In this case, select the **Decision Support** profile from the drop-down menu and then click the **UPDATE** button.

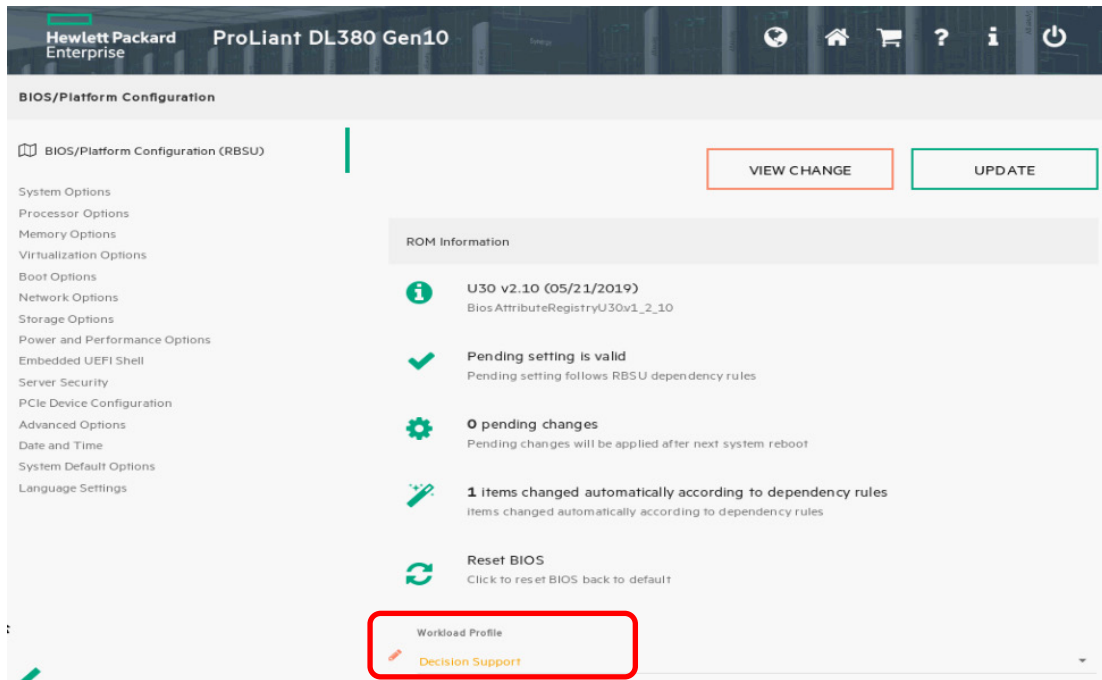


FIGURE 2. Selecting “Decision Support” option from the “Workload Profile”

A dual port Emulex SN1600 32 Gb FC card in the server was used to connect to the HPE MSA storage array via the FC switch.

Windows Server 2019 configuration

As there were multiple Fibre Channel paths between the server and storage (two 32 Gb FC ports on the server, and four 16 Gb ports on the HPE MSA storage), the MPIO server feature was installed. Without MPIO, Windows Server would see eight different devices (2 server ports x 4 storage ports) for a single volume presented from the HPE MSA storage, and not know they are the same device. Adding the MPIO server feature requires a reboot before proceeding to the next step.

After the server has rebooted, the MPIO feature should be available and ready for configuration. Adding the HPE MSA storage array to the MPIO settings does not require any special setup or DSM files; the array should automatically show up in the **Discover multi-paths** tab. To claim the device, simply click the **Add** button, illustrated in [FIGURE 3](#).



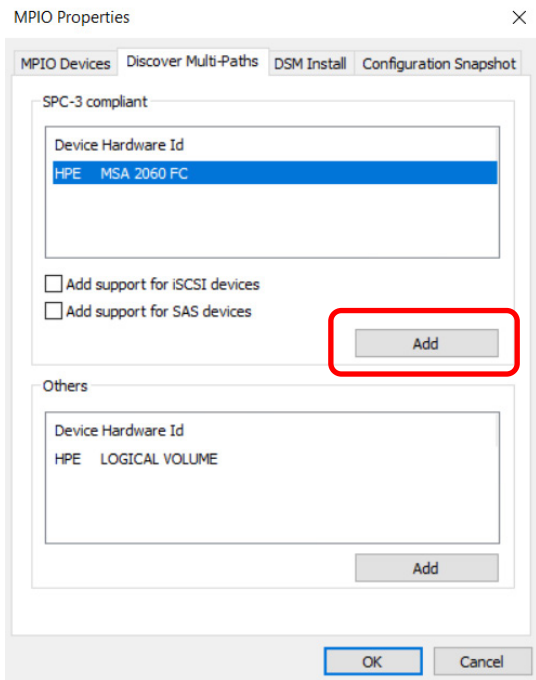


FIGURE 3. Windows Server 2019 “Discover Multi-Paths” showing the discovered HPE MSA storage array.

Additionally, if the array does not show up in the **Discover Multi-Paths** tab, it can be manually added by doing the following:

In the main **MPIO Devices** tab, click the **Add** button and enter one of the following according to the specific device:

- For Fibre Channel, use “HPE MSA 2060 FC”
- For iSCSI, use “HPE MSA 2060 ISCSI”

NOTE

Make sure to enter five spaces between “HPE” and “MSA” in either of the above entries.

The server will again require a reboot after the device has been added.

With MPIO properly set up, Disk Management will now show the correct number of volumes presented from the HPE MSA storage to the server. [FIGURE 4](#) is an example of the **MPIO Devices** list.



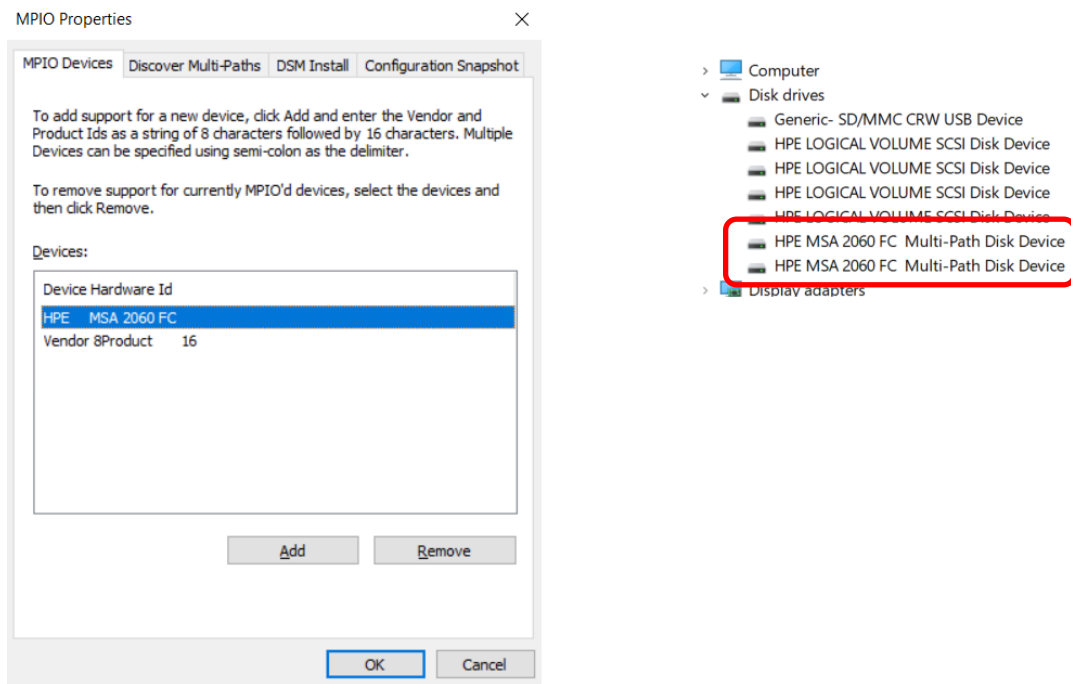


FIGURE 4. Windows Server 2019 “MPIO Devices” list showing HPE MSA storage array added, and the added devices in Device Manager

Windows Server power options were set to high performance, as displayed in FIGURE 5.

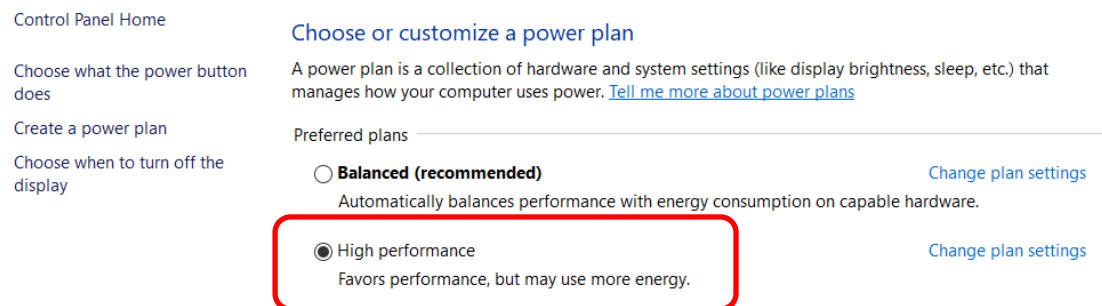


FIGURE 5. Windows Server 2019 power options

When formatting a partition or volume that will be used for SQL Server data files, a 64 KB allocation unit size for data, logs, and tempdb is suggested. Note that using allocation unit sizes greater than 4 KB does not allow the use of NTFS compression on the volume. Although not recommended, SQL Server does support read-only data on compressed volumes.

The HPE MSA volumes were formatted as ReFS and added as drive letters in Windows Server. The controller A storage pool volume was assigned to S:\, and controller B was assigned to T:\. For the single storage pool test, all database files were located on the S:\ drive. In the dual storage pool tests, database files were evenly split between S:\ and T:\.

Each HPE MSA controller (A and B) presented a 3 TB volume to the server for the Data Warehouse SQL database.

SQL Server setup

The SQL Server 2019 installation options only included the database engine and client connectivity tools. A logical SSD volume (E:\) on the local server was used for the SQL tempdb files (nine tempdb files, one tempdb log).

As the client tools are no longer included with the server installation, [SQL Server Management Studio](#) was downloaded and installed separately.



Following DWFT test documentation ([Data Warehouse Fast Track Reference Guide for SQL Server - PDF download](#)), SQL **Resource Governor** was enabled (using the default setting of 25%), as shown in [FIGURE 6](#).

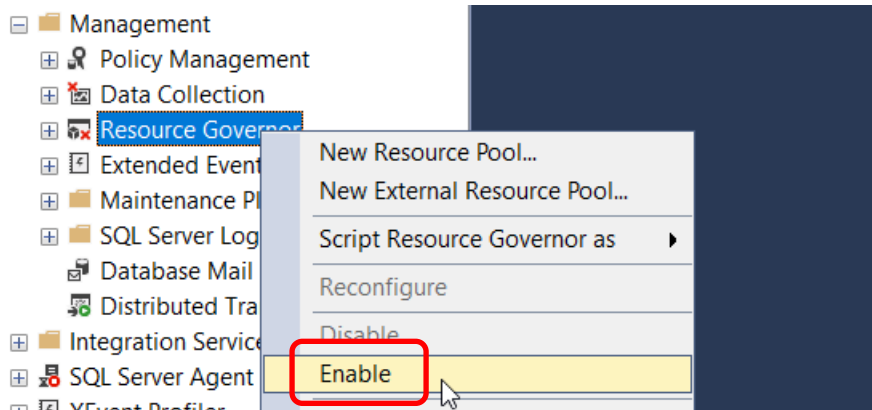


FIGURE 6. Enabling “Resource Governor”

SQL memory was set to 118 GB (out of 384 GB total system RAM), as illustrated in [FIGURE 7](#), following the DWFT testing guidelines for two physical processors.

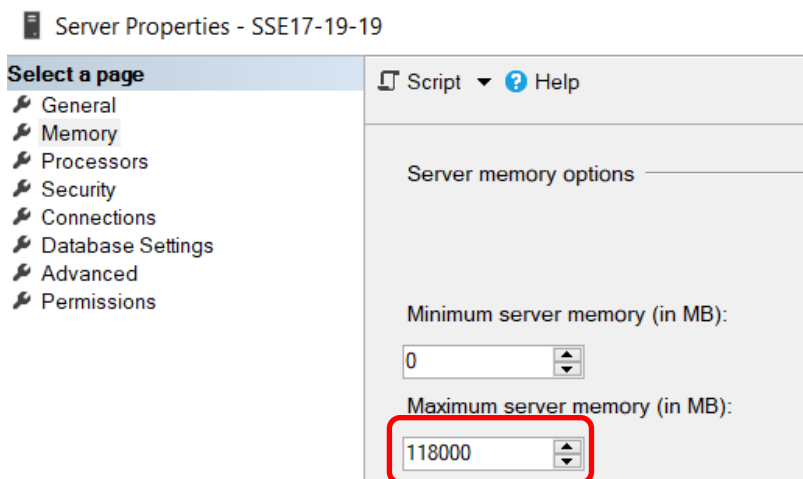


FIGURE 7. SQL memory configuration

SQL volumes were initially tested with one SQL database file per volume, then later with all SQL database files on one volume. No notable difference in performance was seen between the two database layouts. For ease of volume management, a single volume was used for testing.

SQL databases were restored to the appropriate SSD or HDD volumes for each type of test.

To save time, separate row and column store databases were used. This avoided the conversion steps between row and columns stores if just a single database was used.

After the Data Warehouse tests following Microsoft’s guidelines (Resource Governor at 25%, memory at 118 GB) were complete, extra testing was performed with the Resource Governor disabled and all system RAM made available to SQL Server. These tests demonstrated the performance gain that could be expected for a SQL Server installation where Resource Governor is not enabled by default.



SOLUTION COMPONENTS

Hardware

HPE MSA 2060/2062 storage arrays were used for testing. Configuration for the 2060 included all HDD (with the option of two SSDs for read cache), and the 2062 was configured with all-flash pools.

HPE MSA storage – What's new

- New 6th Gen HPE MSA storage architecture that provides a modernized platform with more resources for features such as automated tiering, a new RAID protection scheme (MSA-DP+), a new task-optimized web interface, and highly optimized data management through a new RESTful interface.
- Improved array performance that provides more IOPS, bandwidth, and back-end connectivity; up to 45% increase in IOPS and up to 70% improvement on sequential throughput vs. HPE MSA Gen 5 (depending on protocol).
- The new disk group type (MSA-DP+) increases availability, dramatically decreases the time to recover from mechanical drive failure, improves performance, simplifies setup (eliminates Power of 2 requirements, automatically handles spares), and provides more granular expansion of disk pools.

Leverage Data Protection features to keep your business running in the event of a disaster

- HPE MSA storage delivers virtualized snapshot technology for data protection and instant recovery.
- Remote replication via Fibre Channel (FC) or iSCSI facilitates an affordable disaster recovery solution.
- Encrypted SSDs and HDDs with local key management can be deployed to deliver a secure, encrypted storage solution with no loss of performance.

HPE MSA 2060 storage array specific features

The HPE MSA 2060 storage array is easy to install, easy to use, and easy to maintain—even for an IT generalist. Administrators will find the new HPE MSA 2060 Storage Management Utility intuitive and easy to navigate.

The HPE MSA storage automated tiering engine dynamically responds to workload changes so you do not have to—ensuring the hottest data will be moved to the fastest media automatically and in real-time.

Flexible, modular architecture that facilitates growth into the future

- HPE MSA 2060 storage supports a mixture of 3.5 inch LFF and 2.5 inch SFF expansion enclosures for a maximum of 9 (10 including base system) enclosures.
- Start small and scale as needed with any combination of SSDs, Enterprise SAS, or MidLine SAS HDDs.

HPE MSA 2062 storage array specific features

HPE MSA 2062 storage array is designed for affordable application acceleration for small and remote office deployments.

HPE MSA 2062 storage gives you the combination of simplicity, flexibility, and advanced features not usually found in an entry-priced storage array.

Capable of delivering in excess of 325,000 IOPS, HPE MSA 2062 storage saves you up to 32% with an all-inclusive software suite and 3.84 TB of flash capacity included. It is seriously simple and affordable flash storage to help you achieve high performance yet meet challenging budgets.

NOTE

HPE MSA 2060/2062 storage arrays no longer have converged FC/iSCSI controllers as with previous generations. Be sure that the correct protocol controller is selected for your use case.



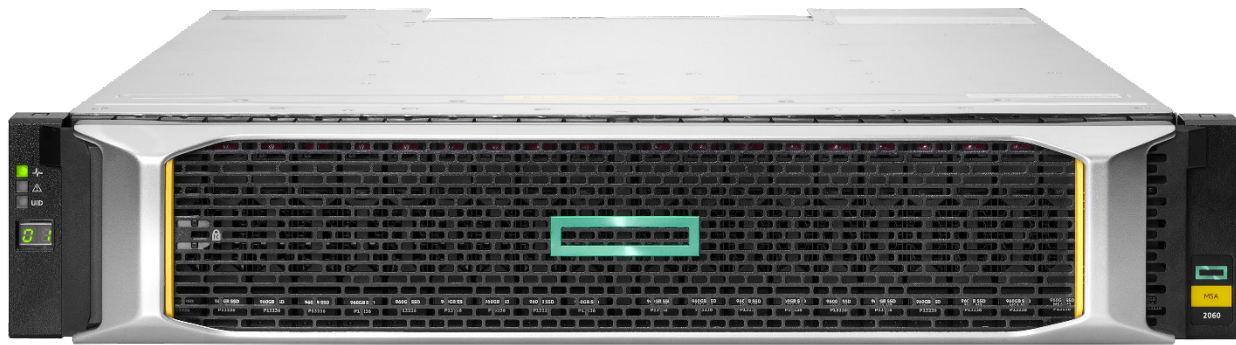


FIGURE 8. HPE MSA 2060/2062 Storage Array (front facing, bezel, SFF drives)



FIGURE 9. HPE MSA 2060/2062 Storage Array (rear facing, dual Fibre Channel controllers)

HPE ProLiant DL380 Gen10 server

The [HPE ProLiant DL380 Gen10 server](#) delivers the latest in security, performance, and expandability, backed by a comprehensive warranty. The HPE ProLiant DL380 Gen10 server is securely designed to reduce costs and complexity, featuring the First- and Second-Generation Intel® Xeon® Processor Scalable Family with up to a 60% performance gain and a 27% increase in cores, plus the HPE 2933 MT/s DDR4 SmartMemory supporting 3.0 TB. It supports 12 Gb/s SAS, and up to 20 NVMe drives plus a broad range of compute options. HPE Persistent Memory offers unprecedented levels of performance for databases and analytic workloads. Run everything from the most basic to mission-critical applications and deploy with confidence.



FIGURE 10. HPE ProLiant DL380 Gen10 server (Front, SFF)



Software

The following Microsoft software components were used in testing:

- Windows Server 2019
- SQL Server 2019 Developers Edition
- SQL Server Management Studio 18.6

TESTING

The following results are for different tested configurations, as well as comparisons among them. The HPE MSA 2062 (SSD-only) using dual storage pools (with DWFT testing limits in place) was used as a performance baseline. Because these tests do not generate exact equivalent numbers in each run, variances of a few percentage points are expected between similar tests.

HPE MSA 2060/2062 performance comparisons

The dual storage pool HPE MSA 2060 (HDD-only configuration) was compared to the dual storage pool SSD-only HPE MSA 2062, as illustrated in [TABLE 1](#). Performance increased by an average of 104.22% across all categories.

TABLE 1. HPE MSA 2060 HDD-only vs HPE MSA 2060 SSD-only – dual storage pools

	Row Relative Throughput	Column Relative Throughput	Row Measured Throughput (Queries/hr/TB)	Column Measured Throughput (Queries/hr/TB)	Row Scan Rate Physical (MB/sec)	Columns Scan Rate Physical (MB/sec)
2060 HDD dual	75	150	116	2469	1714	1858
2062 SSD dual	189	254	377	2516	4734	1875
Percent increase	152	69.3	225	1.9	176.2	0.9

As shown in [TABLE 2](#), read-cache-enabled (RC) HPE MSA 2060 was compared to the HPE MSA 2060 HDD-only, both with dual storage pools. Performance increased by an average of 30.17% across all categories.

TABLE 2. HPE MSA 2060 HDD vs HPE MSA 2060 HDD+RC – dual storage pools

	Row Relative Throughput	Column Relative Throughput	Row Measured Throughput (Queries/hr/TB)	Column Measured Throughput (Queries/hr/TB)	Row Scan Rate Physical (MB/sec)	Columns Scan Rate Physical (MB/sec)
2060 HDD dual	75	150	116	2469	1714	1858
2060 HDD+RC dual	113	226	171	2291	2623	1606
Percent increase	50.7	50.7	47.4	-7.2	53	-13.6

With the newer hardware, a single storage pool HPE MSA 2062 SSD achieved better performance than a dual storage pool HPE MSA 2052 SSD, as displayed in [TABLE 3](#). Performance increased by an average of 16.2% across all categories.

TABLE 3. HPE MSA 2052 SSD dual storage pools vs HPE MSA 2062 SSD single storage pool

	Row Relative Throughput	Column Relative Throughput	Row Measured Throughput (Queries/hr/TB)	Column Measured Throughput (Queries/hr/TB)	Row Scan Rate Physical (MB/sec)	Columns Scan Rate Physical (MB/sec)
2052 SSD dual	124	249	157	2006	3150	1850
2062 SSD single	128	256	189	2490	4437	1957
Percent increase	3.2	2.8	20.4	24.1	40.9	5.8



TABLE 4 illustrates a direct comparison of the dual storage pool HPE MSA 2052 (SSD) vs the dual storage pool HPE MSA 2062 (SSD). Column Relative Throughput and Column Scan Rate Physical are roughly the same with the DWFT testing limits in place, however Row performance has significantly increased. Performance increased by an average of 45.27% across all categories.

TABLE 4. HPE MSA 2052 SSD vs HPE MSA 2062 SSD – dual storage pools

	Row Relative Throughput	Column Relative Throughput	Row Measured Throughput (Queries/hr/TB)	Column Measured Throughput (Queries/hr/TB)	Row Scan Rate Physical (MB/sec)	Columns Scan Rate Physical (MB/sec)
2052 SSD dual	124	249	157	2006	3150	1850
2062 SSD dual	189	254	377	2516	4734	1875
Percent increase	52.4	2.0	140.1	25.4	50.3	1.4

TABLE 5 contains performance comparisons of all HPE MSA 2060/2062 single and dual pool configurations, as well as HPE MSA 2052 dual pool performance that was taken in a previous HPE MSA 2052 DWFT certification.

TABLE 5. HPE MSA 2060/2062/2052 comparisons from DWFT test

	Row Relative Throughput	Column Relative Throughput	Row Measured Throughput (Queries/hr/TB)	Column Measured Throughput (Queries/hr/TB)	Row Scan Rate Physical (MB/sec)	Columns Scan Rate Physical (MB/sec)
2060 HDD single	27	55	42	2186	640	1500
2060 HDD dual	75	150	116	2469	1714	1858
2060 HDD+RC single	36	72	58	1820	882	1338
2060 HDD+RC dual	113	226	171	2291	2623	1606
2062 SSD single	128	256	189	2490	4437	1957
2062 SSD dual	189	254	377	2516	4734	1875
2052 SSD dual	124	249	157	2006	3150	1850
2060 HDD dual, no RG	97	194	170	3283	*	*
2060 HDD+RC dual, no RG	119	237	195	3229	*	*
2062 SSD dual, no RG	222	445	258	3207	*	*

* Unable to get results due to test incompatibility with removing Resource Governor and memory limits in SQL Server.



FIGURE 11 is the same information in bar graph form for easy viewing.

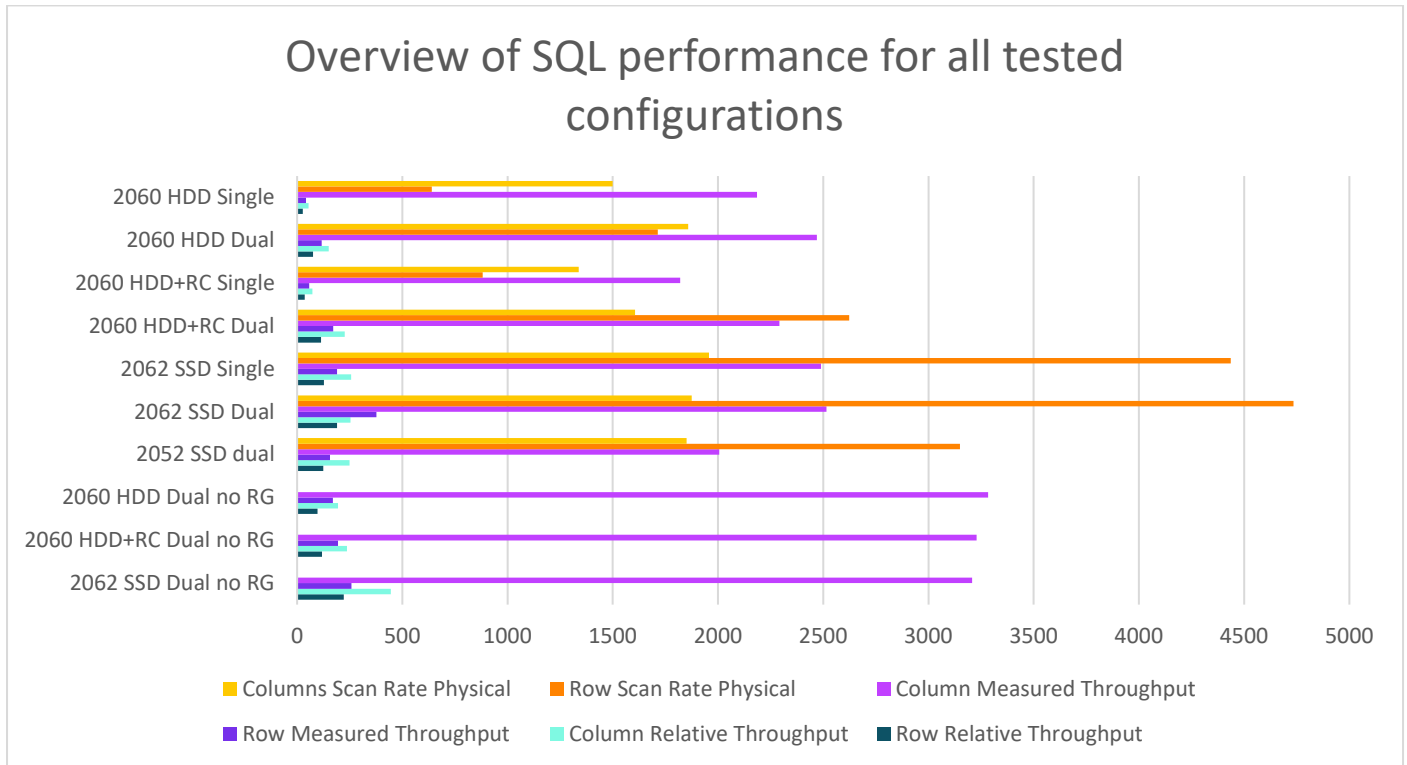


FIGURE 11. All tested HPE MSA storage configurations

TABLE 6 shows the performance increases with the Resource Governor and SQL memory limits removed. The Row and Column physical scan rate results were eliminated because the calculations became inaccurate when removing the SQL limits for the test. Unless there is a specific reason to limit SQL (for example, multiple databases contending for server resources), enabling the Resource Governor or memory limits is not recommended.

As illustrated in TABLE 6, HPE MSA 2060 HDD results increased by roughly a third when compared to the DWFT testing numbers with the memory limits and Resource Governor in place. Performance increased by an average of 34.55% across all categories.

TABLE 6. HPE MSA 2060 HDD vs HPE MSA 2060 HDD with no Resource Governor – dual storage pools

	Row Relative Throughput	Column Relative Throughput	Row Measured Throughput (Queries/hr/TB)	Column Measured Throughput (Queries/hr/TB)
2060 HDD dual	75	150	116	2469
2060 HDD dual no Resource Governor	97	194	170	3283
Percent change	29.3	29.3	46.6	33

Non-Resource Governed HPE MSA 2062 SSD performance increases were not as large as the HPE MSA 2060 HDD test above, with moderate performance increases in Row and Column Relative Throughput, and a significant increase in Column Measured Throughput, as displayed in TABLE 7. Performance increased by an average of 16.15% across all categories.

TABLE 7. HPE MSA 2062 SSD vs HPE MSA 2062 SSD with no Resource Governor – dual storage pools

	Row Relative Throughput	Column Relative Throughput	Row Measured Throughput (Queries/hr/TB)	Column Measured Throughput (Queries/hr/TB)
2062 SSD dual	189	377	254	2516
2062 SSD dual no Resource Governor	222	445	258	3207
Percent change	17.5	18	1.6	27.5



SUMMARY

This white paper highlights performance expectations for multiple configurations of the HPE MSA 2060/2062 storage arrays using Microsoft's Data Warehouse testing suite. Hewlett Packard Enterprise can deliver a Data Warehouse solution for Microsoft SQL Server 2019 that enables customers to deploy a reliable, tested, and validated configuration. It combines the industry-leading HPE ProLiant server (DL380 Gen10) with HPE MSA 2060/2062 storage arrays to provide a Microsoft SQL Server 2019 Data Warehouse solution.

As expected, corresponding performance increases follow higher performing HPE MSA storage hardware—ranked from lowest to highest:

- 2060 HDD single storage pool
- 2060 HDD dual storage pool
- 2060 HDD+Read Cache single storage pool
- 2060 HDD+Read Cache dual storage pool
- 2062 SSD single storage pool
- 2062 SSD dual storage pool

These tests also highlight the performance increases that can be expected over previous generation HPE server and HPE MSA storage hardware.

LIST OF ACRONYMS

DW/BI – Data warehouse/Business Intelligence

IOPS – Input/Output Operations Per Second

FC – Fibre channel

DWFT – Data Warehouse Fast Track

HDD – Hard disk drive

SSD – Solid state drive

SAS – Serial attached SCSI

LFF – Large form factor

SFF – Small form factor



RESOURCES AND ADDITIONAL LINKS

HPE Links:

- HPE MSA Storage
hpe.com/us/en/storage/msa-shared-storage.html
- HPE MSA 2060 Storage Array QuickSpecs
h20195.www2.hpe.com/v2/GetDocument.aspx?docname=a00094629enw
- HPE MSA 2062 Storage Array QuickSpecs
h20195.www2.hpe.com/v2/getpdf.aspx/a00094630enw
- HPE MSA Firmware Updates
h41111.www4.hpe.com/storage/msafirmware.html
- HPE MSA Gen6 Virtual Storage Technical Reference Guide
h20195.www2.hpe.com/v2/Getdocument.aspx?docname=a00103247enw
- HPE MSA Best Practices
h20195.www2.hpe.com/v2/GetDocument.aspx?docname=a00105260enw&doctype=Technical%20white%20paper&doclang=EN_US&searchquery=&cc=it&lc=it
- HPE ProLiant DL380 Gen10 server
hpe.com/us/en/product-catalog/servers/proliant-servers/pip,hpe-proliant-dl380-gen10-server.1010026818.html#10
- HPE Reference Architectures
hpe.com/info/ra
- HPE Servers and Systems
hpe.com/servers

Microsoft links:

- Microsoft SQL Server
microsoft.com/en-us/sql-server/default.aspx
- Microsoft Data Warehouse Fast Track Reference Guide for SQL Server (PDF download)
download.microsoft.com/download/F/8/6/F8654654-6784-48F5-83C0-2D46186EEC66/Data_Warehouse_Fast_Track_Reference_Guide_for_SQL_Server_2016_EN_US.pdf

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