Hewlett Packard Enterprise

Technical white paper

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HPE ALLETRA 9000 FOR MISSION-CRITICAL DATABASES

Comparing Microsoft SQL Server 2019 performance between HPE Alletra 9000 and HPE 3PAR 9450 storage

CONTENTS

Executive summary 3
Solution overview 3
Solution components 4
HPE storage 4
Testing and test results 5
OLTP DB workload information 6
OLTP testing with SQL Server 2019 6
Database build observations 6
Financial trading workload observations 8
Summary 12
Appendix A: HPE storage CLI performance commands 13
Appendix B: OLAP benefits 13

EXECUTIVE SUMMARY

All-NVMe storage systems bring new levels of IOPS and ultra-low latency especially suited for business and mission-critical applications and data. The HPE Alletra 9000 is the new all-NVMe storage array that delivers on this promise of increased performance, as well as new capabilities for cloud-native management. This paper details the lab-proven performance gains seen in running Microsoft SQL Server on the HPE Alletra 9000—almost 4X improvements—versus a previous-generation storage platform.

This technical paper is intended for the IT decision makers and hands-on database specialists who are running an on-premises version of SQL Server today along with the underlying infrastructure and need to architect what will be used to refresh the environment. The testing compares the state of the art in storage infrastructure: the HPE Alletra 9000 compared with a very typical previous generation system—HPE 3PAR 9000 storage. The test also used a brokerage account type workload derived from the popular TPC-E benchmark tool with representative data and focused on common metrics that will be valuable in system planning and sizing.

Highlights of the testing include database transactions that are double what was achievable on the previous system and read service times that are a fraction of what was possible on the older systems.

The new HPE Alletra All-NVMe storage systems deliver lab-proven enhanced performance as seen in this paper, plus availability guarantees, and can be purchased in an innovative as-a-service model. With HPE Alletra storage, you can run SQL Server or any important business application without compromise.

Target audience: This paper is intended for IT administrators, SQL Server administrators and architects, storage administrators, solution architects, and anyone interested in learning how HPE Alletra 9000 and HPE 3PAR 9000 storage handle SQL Server OLTP type workloads.

SOLUTION OVERVIEW

Figure 1 shows the test environment including the SQL Server client environment used to generate the SQL Server workload against the SQL Server database environments. The server with SQL Server installed has two instances: one instance that used the HPE Alletra 9080 storage, and the other instance that used the HPE 3PAR 9450 storage.

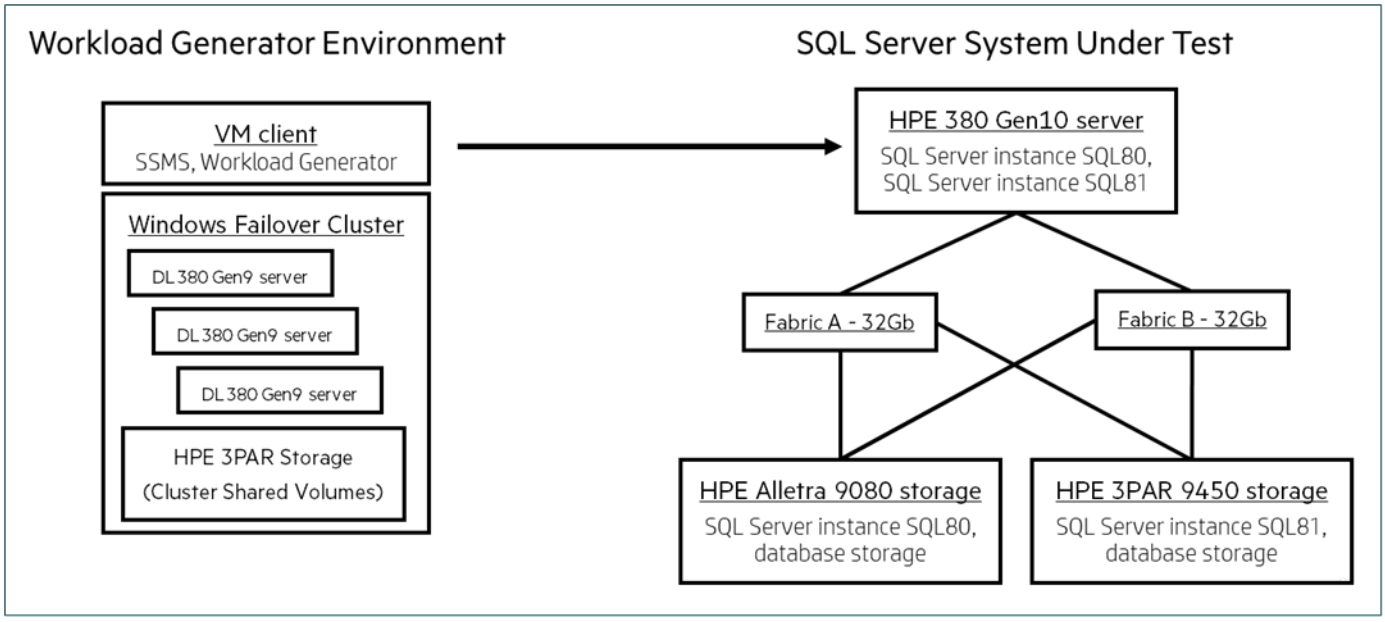

FIGURE 1. Test environment showing workload generator and the SQL Server solution

SOLUTION COMPONENTS

Important solution components are listed in Table 1 and are described in this section.

TABLE 1. List of major components

Qty	Item	Description
	Server	
1	HPE ProLiant DL380 Gen10	HPE ProLiant server, dual CPU with 384 GB RAM
2	HPE SN1600E 32Gb 2p FC HBA	Dual-ported Fibre Channel HBAs (four 32Gb Fibre Channel ports)
	HPE Alletra 9000 4-way NVMe Storage Base	
1	HPE Alletra 9080 storage (4-node)	All-NVMe cloud-native infrastructure storage
48	HPE Alletra 1.92 TB NVMe	RAID 6
4	HPE HPE32004-M 32 Gb Quad Port FC HBA (add-on card)	One HBA per controller (32 ports used)
4	HPE HPE41004 25 Gb Quad Port iSCSI card (add-on card)	Installed but not used in this solution
	HPE 3PAR 9450 storage	
1	HPE 3PAR 9450 storage (4-node)	HPE 3PAR storage enterprise-class flash array
48	HPE 3PAR 1.92 TB SSD	RAID 6
4	HPE 3PAR 16 Gb Quad Port FC HBA (add on card)	One HBA per controller (32 ports used)
0	HPE 3PAR 32Gb Quad Port FC HBA (add on card)	Optional (not available for this solution)
	Fabric	
2	HPE StoreFabric SN6600B 32 Gb FC Switch	Dual fabrics used for high availability
	Software	
1	Microsoft Windows Server 2019 Datacenter	Enterprise-class Microsoft Windows Server operating system
1	Microsoft SQL Server 2019	Microsoft relational database management system
	Microsoft SQL Server Management Studio	Used for management and monitoring of the SQL Server database and instances
1	HPE InfoSight	Used for system insight and reporting of HPE 3PAR and HPE Alletra storage
1	Data Services Cloud Console	Used for system management of HPE Alletra along with the CLI and user interface
1	HPE StoreServ Management Console (SSMC)	Used for system management of HPE 3PAR along with the CLI interface

HPE storage

HPE data storage solutions are fast, flexible, and efficient. The HPE storage portfolio covers the full spectrum of business requirements from small to very large enterprise environments. Included in the HPE storage portfolio is the HPE Alletra 9000 cloud-native storage, built on years of experience and incorporating leading-edge AI technology.

NOTE

HPE Alletra, HPE Primera, and HPE 3PAR storage perform wide striping of data across all back-end storage media for optimal performance.

Wide striping of data means the storage system automatically provides optimal performance all the time, whether there is one volume or many volumes. For SQL Server, it creates the volumes required for its performance without having to consider any back-end storage mapping limitations. An example of this is dealing with TempDB files; you do not need a separate HPE Primera volume for each TempDB file.

This testing used the all-NVMe HPE Alletra cloud-native storage and HPE 3PAR 9000 storage. These storage platforms use HPE InfoSight; HPE Alletra storage platforms also use the Data Services Cloud Console.

HPE Alletra 9000

HPE Alletra 9000 is ideally suited for mission-critical workloads with extreme latency sensitivity and availability requirements. It overcomes the agility versus reliability tradeoff between the public cloud and traditional enterprise storage by providing a modern, as-a-service experience through HPE GreenLake, combined with intelligence and automation that ensures applications are always-on and available. It features a unique, massively parallel, multi-node, and all-active platform with all volumes active on all media, controllers, and host ports at all times. The system lets you achieve unconstrained scalability for consolidating traditional and next-generation mission-critical applications

with predictable performance and ultra-low latency, backed by a 100% availability guarantee. It also eliminates the cost and complexity of business continuity and disaster recovery with fully active bidirectional replication.

Key features of the HPE Alletra 9000 include:

- 100% availability—Guaranteed as a standard benefit[1]
- Massive parallelization—All active and multi-node
- Most advanced disaster recovery / business continuity—Active/active stretch cluster
- HPE InfoSight integration
- Data Services Cloud Console integration

Learn more about HPE Alletra on the web and in the HPE Alletra 9000 data sheet.

HPE 3PAR 9000

The HPE 3PAR 9000 is an HPE enterprise-class flash array that helps to consolidate primary storage workloads for file, block, and object offering flexible I/O host connectivity without compromising performance, scalability, data services, or resiliency.

HPE 3PAR 9000 storage is available in a single all-flash model, the 9450, that offers rich Tier-1 data services, quad-node resiliency, fine-grained Quality of Service (QoS), seamless data mobility between systems, high availability through a complete set of persistent technologies, and simple and efficient data protection with a flat backup to HPE StoreOnce backup appliances.

HPE InfoSight

HPE InfoSight is the industry's most advanced AI for infrastructure[2]. HPE InfoSight gives users the power of AI to create an infrastructure that is autonomous. HPE InfoSight drives global intelligence and insights for infrastructure across servers, storage, and virtualized resources, with the power of cloud-based machine learning.

Learn more about HPE InfoSight.

Data Services Cloud Console

The Data Services Cloud Console provides the cloud experience wherever data lives.

Key features of the Data Services Cloud Console include:

- Deliver cloud operations—Automate infrastructure management
- Provide intent-based provisioning—Move from LUN-centric to intent-based AI-driven provisioning
- Manage from anywhere and on any device
- Manage infrastructure with fully programmable and unified API with user selectable orchestration tools

View the Data Services Cloud Console 5-minute Demo for a hands-on view of the console functionality.

TESTING AND TEST RESULTS

This section describes the testing with HPE Alletra 9000 storage, HPE 3PAR 9000 storage, and SQL Server.

Testing was performed using two separate SQL Server instances installed on the same server using their own storage. This allowed testing of how SQL Server would be affected by an upgrade from an HPE 3PAR 9450 to an HPE Alletra 9080.

Tools used for data collection included SQL Server Management Studio (SSMS), Microsoft Perfmon and Logman, HPE SSMC, and the HPE storage CLI interface. Figure 2 shows the SSMS Activity Monitor output during testing.

[1] HPE Storage Satisfaction Guarantees: HPE Alletra, HPE Primera, and HPE Nimble Storage
[2] HPE InfoSight—the industry's most advanced artificial intelligence for infrastructure

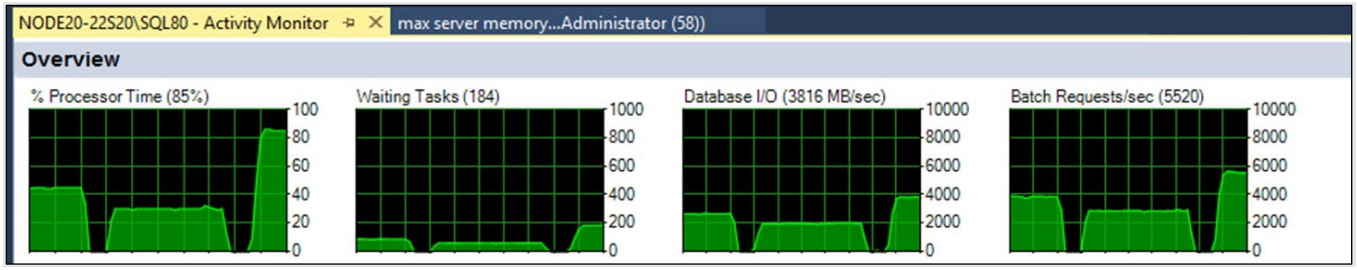

FIGURE 2. Typical SSMS Activity Monitor output during testing

OLTP DB workload information

For testing, the same SQL Server database configuration was used for the two arrays for the test comparison. The two storage systems are mounted to the same HPE ProLiant DL380 Gen 10 server and tested one at a time, each with its own SQL Server instance.

The database is 13 TB in size with 6 TB of used capacity (not including TempDB or TLogs) using the T-SQL `EXEC sp_spaceused` command. TempDB and transaction log files were located on the SAN storage system under test, not local server storage.

SQL Server 2019 was used with a financial brokerage account type of OLTP benchmarking tool with real data, not merely zeroes or random non-compressible unrealistic data. The benchmarking tool has complex automated scripts that perform tasks including create the SQL Server database, load the database with real data, create indexes, and confirm configurations.

OLTP workload

OLTP applications must be able to process transactions in a highly concurrent environment. Typically, OLTP activity consists of many small random I/Os and is substantially more read-intensive than write. Response time is extremely important for OLTP type workloads with the focus on read response times.

Random OLTP reads often come from back-end storage system media such as SSDs rather than faster cache, so back-end storage read response times are extremely important for OLTP transactions. The main design criteria for an OLTP deployment is fast concurrent random transactional performance—whether from server cache or back-end storage media. The focus is on the number of transactions rather than throughput. This paper focuses on the storage performance.

When I/O requests must be serviced from back-end storage, the physical interconnect type can have a significant impact on the I/O response times. If the storage media or slower internal architecture is part of the storage solution, then the interconnect type will not make much of a difference. However, with faster storage media and a performance architecture, the difference in performance between using either SAS interconnected or NVMe devices can have a dramatic benefit for OLTP type workloads as shown in this paper.

Storage performance information

Storage performance was observed using the SSMC, the storage CLI, Microsoft Windows Performance Monitor, and SQL Server Management Studio. The CLIs for HPE Alletra 9000 and HPE 3PAR storage use a similar command set. See Appendix A: HPE storage CLI performance commands for additional CLI information.

OLTP TESTING WITH SQL SERVER 2019

In an OLTP test, response time and the number of IOPs or transactions per second are the important metrics to evaluate.

For this test comparison, the number of transactions processed by the two arrays as well as the response times were very different, and as expected, server CPU utilization also varied as the amount of work being performed changed.

The test configuration was not a max storage configuration or max performance configuration test. This was a test of similarly configured storage systems to investigate the potential benefit of upgrading from an HPE 3PAR 9450 to a similarly configured HPE Alletra 9080.

The workload generator is described in the OLTP DB workload information section.

Database build observations

The HPE Alletra performance benefits were noticeable even during the database build process, which was not a planned test. The build process benefited in several ways including reduced service times, increased IOPS and throughput, and reduced build time.

Service time

The overall database build and population process showed an overall reduced read service time of 33% from the HPE Alletra 9080 and the whole process was reduced by about four hours. Figure 3 shows a comparison of the combined LUN read service times of the two storage systems during the database creation process. The two dashed trend lines were adding using the Logarithmic selection in the Microsoft Excel Trendline Options area for the graph.

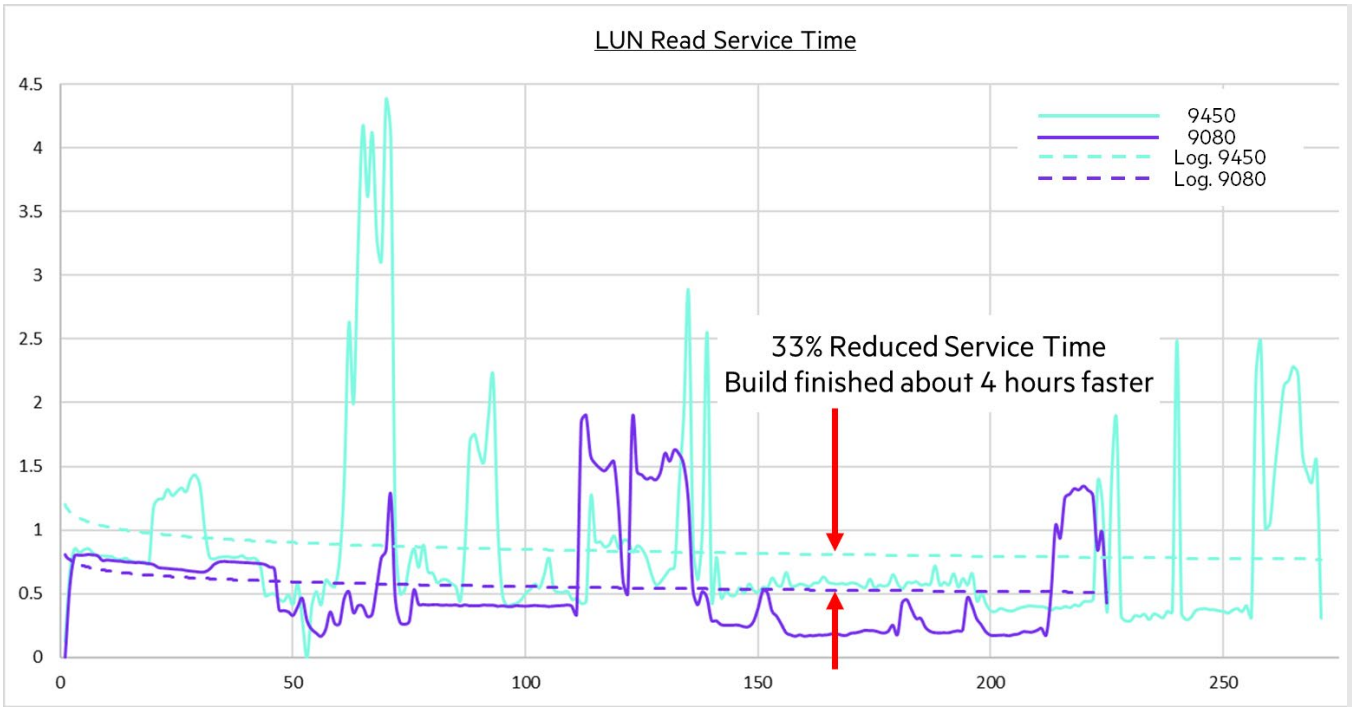

FIGURE 3. Comparison of the combined LUN read service times of the two storage systems during the database creation process

Focusing in on the time-correlated portion of the intensive index creation phase that lasted over two hours, Figure 4 shows that the service time for the HPE Alletra was 73% better than the HPE 3PAR array.

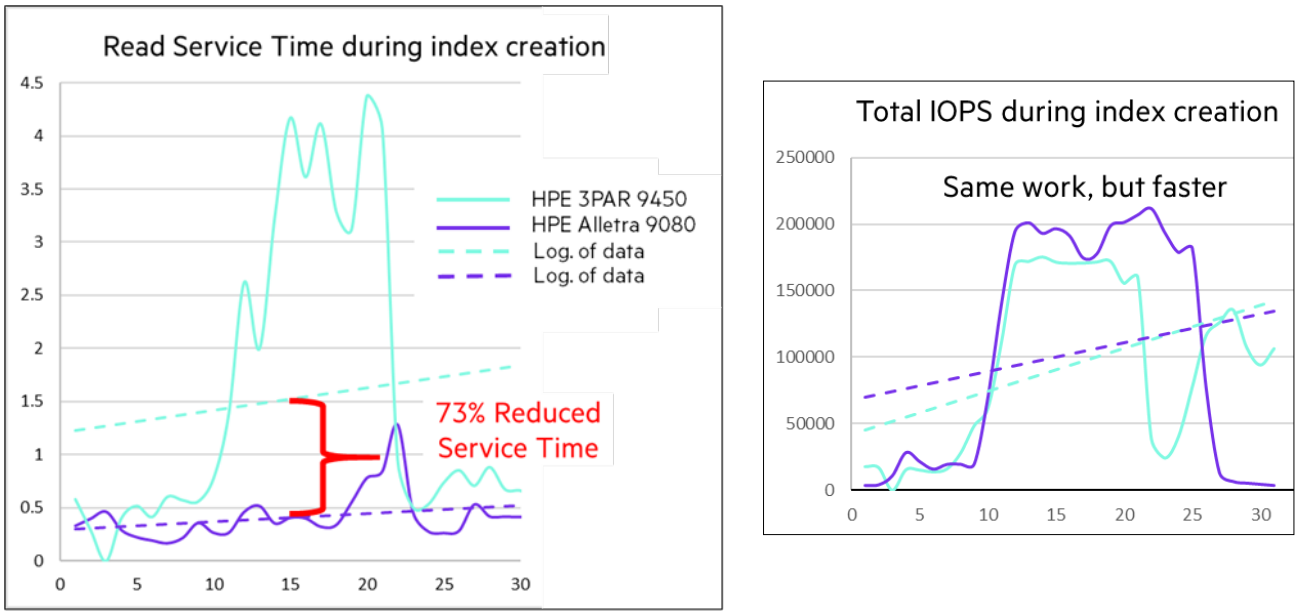

FIGURE 4. Graphs showing read service time and total IOPs during index creation

Takeaways:

- The HPE Alletra 9080 responded 73% faster during the more than two-hour index creation time (more than 3x faster response time).
- The HPE Alletra 9080 responded 33% faster (or in 2/3rds the time) on average during the more than 18-hour automated database creation.
- The HPE Alletra 9080 saved almost four hours in a 22+ hour automated database build process.

Financial trading workload observations

The brokerage account type of workload as described in OLTP DB workload information was used for this testing.

Batch Requests

An important SQL Server metric to monitor is Batch Requests/sec. This metric is an indicator of how busy SQL Server is and the transaction handling ability of the hardware. Transactions/sec is another useful metric, but it only shows activity in a transaction and not all activity. Therefore, Batch Requests/sec provides a better indicator of system performance.

Figure 5 shows the relative increase in performance of the HPE Alletra 9080 over the HPE 3PAR 9450 for several different workload settings. At the lower settings, the difference between the two arrays is not as large, but as the workload is increased, the HPE Alletra provides more than 2x the batch request performance of the older array model.

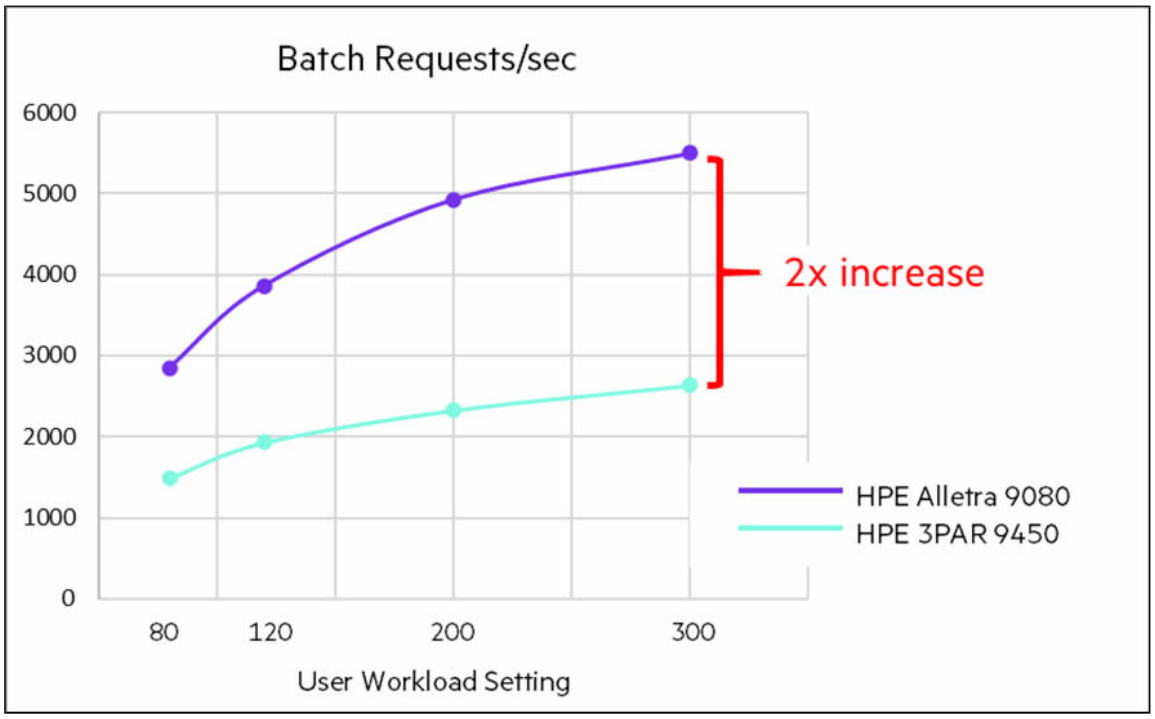

FIGURE 5. Batch Request/sec comparison for different workload settings

The bar chart in Figure 6 shows the relative differences between the two storage systems at each workload setting. The larger the difference the better. A larger number means more SQL Server requests were completed per second because the hardware is faster. Note that the only hardware difference is the newer HPE Alletra 9080.

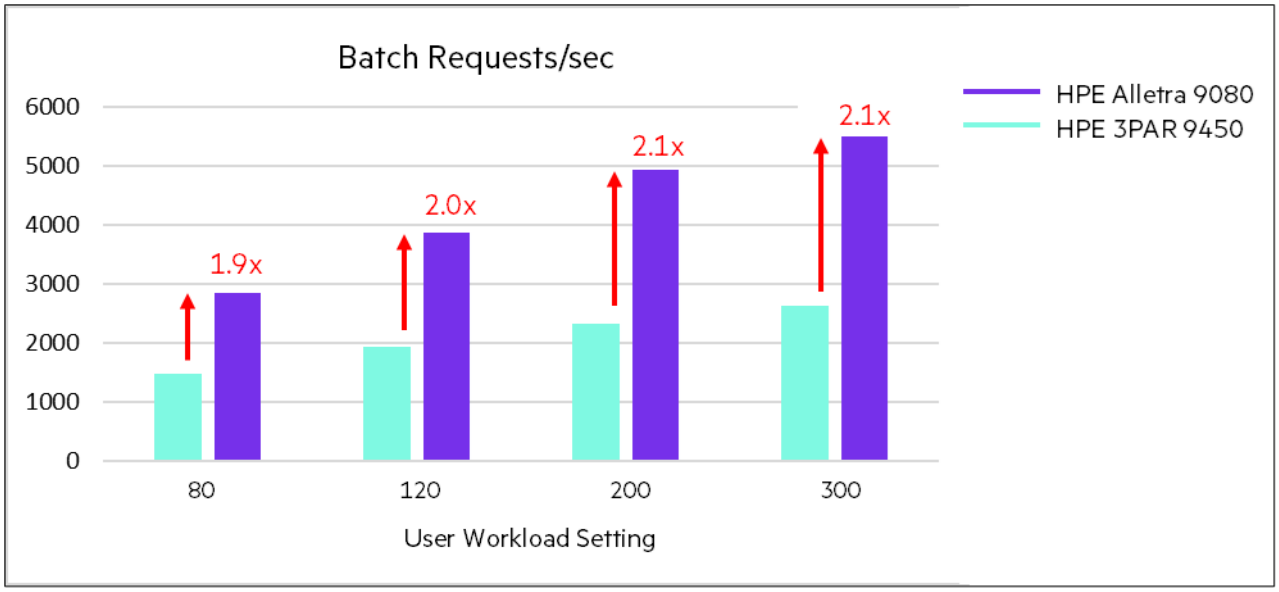

FIGURE 6. Chart showing the relative performance differences at specific workload settings

Takeaways:

- The HPE Alletra 9080 starts with about 2x the transactions requests per second.
- The HPE Alletra 9080 maintains a 2x better SQL Server Batch Requests/sec rate throughout the test.
- The HPE Alletra 9080 provides a great upgrade path for aging storage.

Response times

Another important metric for a well-running SQL Server OLTP environment is response time, as shown in Figure 7. When storage is pushed towards its limits, transactional storage I/O will tend to have a sluggish response. This translates to inefficient server CPU utilization. Storage should be sized for the workload.

The lower line in this graph shows that with the increasing workload, the HPE Alletra 9080 response time is relatively unchanged. The upper line shows the HPE 3PAR array is having difficulty keeping up with the newer array for the same workload. The rightmost portion of the graph shows the older array is gracefully handling the increased workload; however, the increased response time of more than 1ms for an OLTP small block type of workload on an all-flash array is an indicator that the all-flash array is being pushed harder than it should.

In contrast, the newer array is running at a much lower response time while servicing 2x the workload as shown in the Batch Requests section of this paper. The results here are for the same test events shown earlier.

Note that lower numbers are better because they indicate a faster response time, which means the storage is responding faster with SQL Server data.

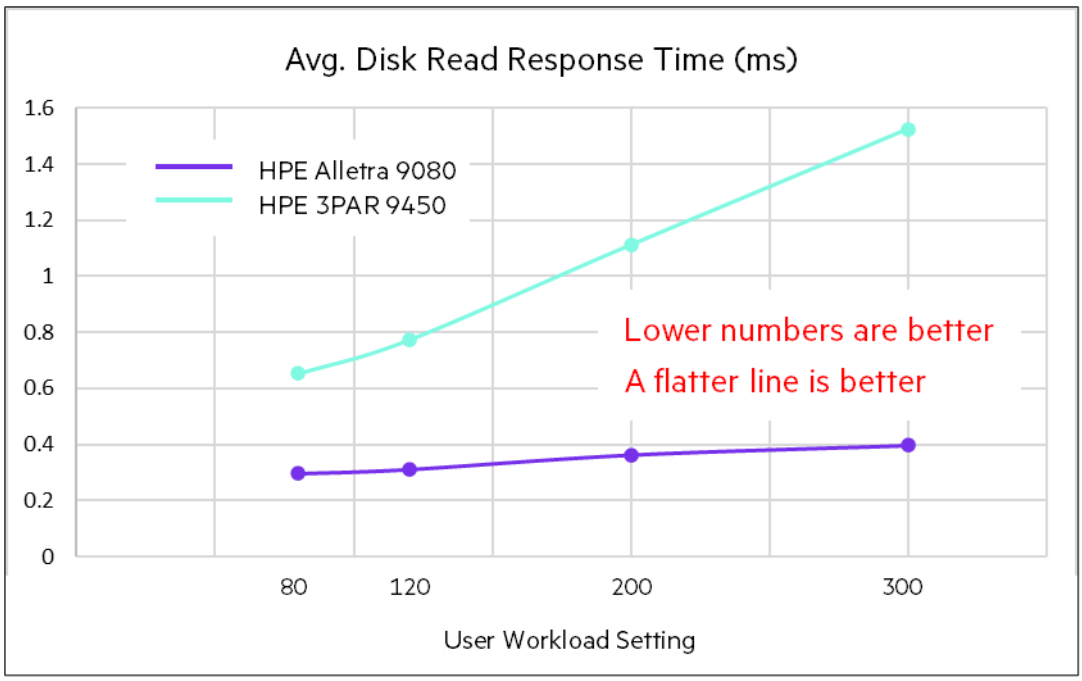

FIGURE 7. Average disk read response times

The bar chart in Figure 8 shows the response time differences at each workload setting. The lower the bar the better. A smaller number means SQL Server requests were responded to faster. The differences start with the HPE Alletra having a 2.2x lower response time and end with almost 4x lower response time.

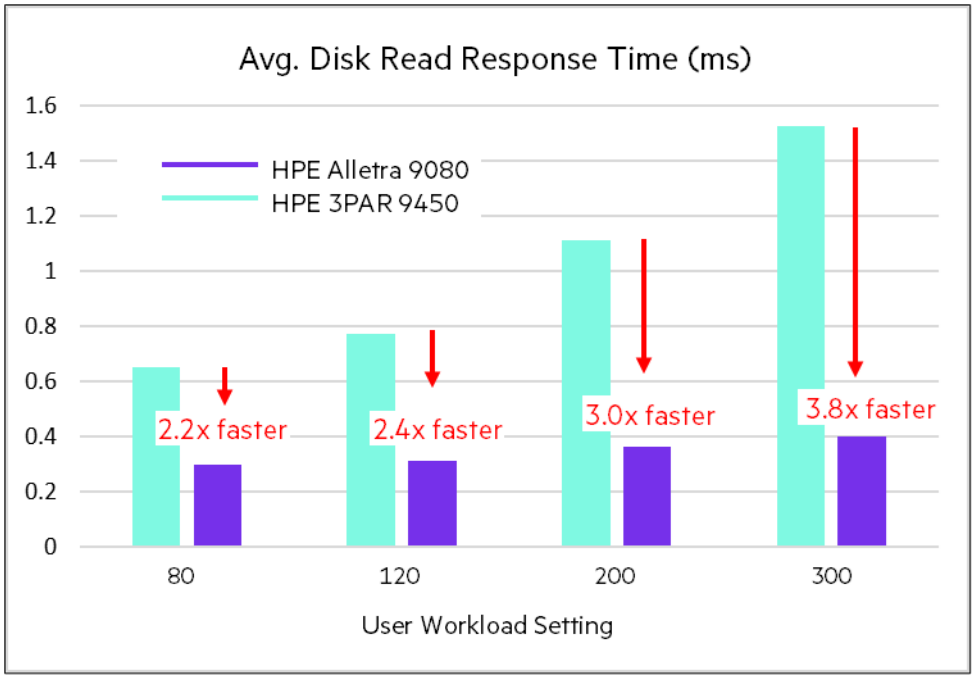

FIGURE 8. Relative response time differences

Takeaways:

- The HPE Alletra 9080 starts out with a 2x better response time.
- The HPE Alletra 9080 has a 3x better response time at the higher workload.
- The HPE Alletra 9080 maintains a significantly flatter and lower response time overall.
- The HPE Alletra 9080 provides a great upgrade path for storage

Server CPU utilization

Server CPU utilization is an important consideration, too, when considering differences in storage hardware and the impact it may have in a SQL Server environment.

Here the faster HPE Alletra 9080 allowed SQL Server to handle more work and perform it more quickly. This positive impact caused the server CPU to be a concern as the Perfmon % Processer Time counter exceeded 80%. This counter is an indicator of the time the processor spends executing the non-idle thread—in other words, doing real work.

Figure 9 shows that as the transactions increased with the HPE Alletra array, the CPU utilization exceeded 90% utilization or almost 3x the utilization being achieved by the other array. This startling effect goes to show how during any upgrade, the total solution must be considered when planning an upgrade to an HPE Alletra 9080. Do not make the mistake of underestimating the positive impact the HPE Alletra could have on your environment.

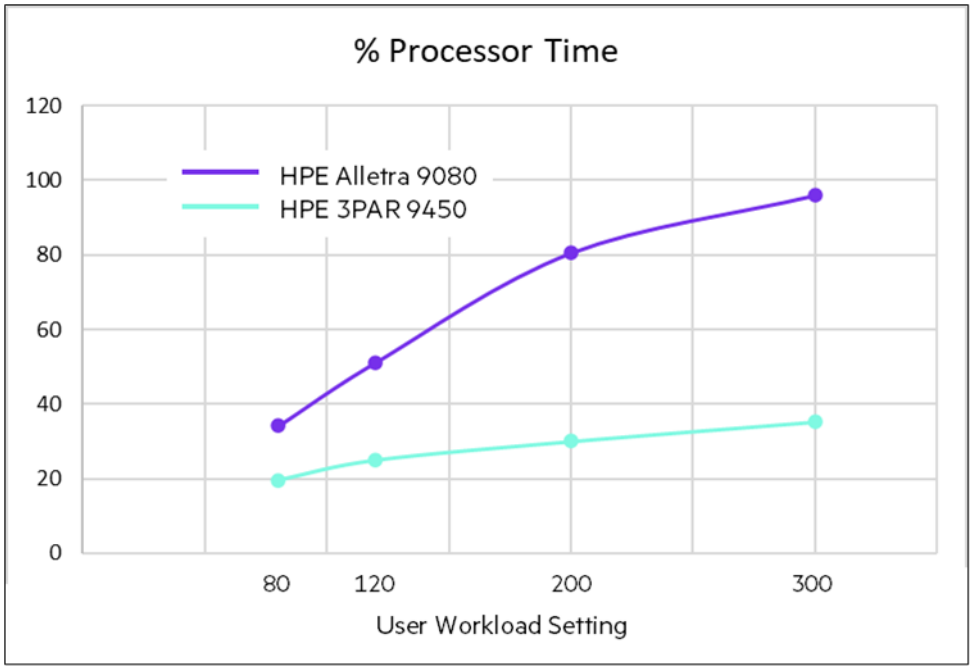

FIGURE 9. Perfmon % Processer Time graph

As the HPE Alletra services more transactions, the server CPU utilization increases to almost 100% utilization, showing the server might need an upgrade, too.

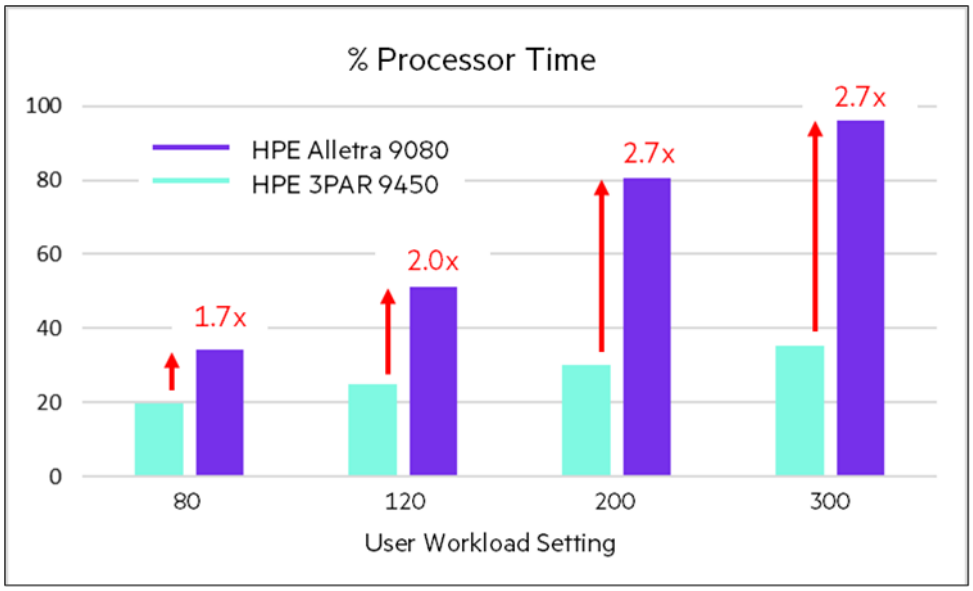

FIGURE 10. Perfmon % Processer Time chart

Takeaways:

- The HPE Alletra 9080 can help breathe new life into a sluggish SQL Server environment.
- The HPE Alletra 9080 can keep the server CPU busy by servicing data requests faster.
- Remember to size the whole solution when considering a server or storage upgrade.

SUMMARY

As detailed in this paper, the HPE Alletra 9000 is the new all-NVMe storage array that delivers on the promise of increased performance as well as new capabilities for cloud-native management. The system was shown to bring important and lab-validated performance benefits for SQL Server, as much as almost 4X versus the previous-generation storage platform.

In a SQL Server OLTP type environment where the HPE Alletra and HPE 3PAR arrays were tested, the following was observed:

- The HPE Alletra 9080 has much higher throughput.
- The HPE Alletra 9080 is much faster.
- The HPE Alletra 9080 is an excellent choice for upgrading older hardware with new all-flash NVMe storage.

IT decision makers, architects, and database specialists can use this data to help with system planning and sizing. This information is especially useful when considering the refresh of business and mission-critical database environments.

The HPE Alletra 9080 array provides a perfect upgrade path from the earlier star performer HPE 3PAR 9450 array. Along with the detailed performance gains, the system includes 100% data availability guaranteed, and can now be purchased in an innovative as-a-service model through HPE GreenLake.

APPENDIX A: HPE STORAGE CLI PERFORMANCE COMMANDS

The HPE Alletra 9000, HPE Primera, and HPE 3PAR product families share a common CLI performance command set.

There are many useful commands available to report storage performance, including options to examine volume, port, and logical unit number (LUN) performance.

- For the HPE storage CLI reference documentation, consult HPE Support Center.
- For the SSMC graphs, navigate from the SSMC Main Menu drop-down list and select **Show all → Reports**. The SSMC also has preconfigured reports and the ability to create custom reports in the SSMC Reports area.

There are two basic types of performance reports: current and historical. Real-time reports use stat commands, and historical commands use System Reporter (sr) commands, both of which can be found in the CLI reference documents. Both the stat commands and the sr commands were used during testing for this paper.

APPENDIX B: OLAP BENEFITS

Although this paper is based on an OLTP workload, SQL Server and HPE Alletra are designed for On-line Analytical Processing (OLAP) workloads, too. Findings in this paper can be translated to an OLAP workload.

OLTP workloads are more focused on the speed of transaction processing and require fast response times. Typically, array write cache ensures server writes are fast and the HPE Alletra storage does this with duplexed (for redundancy) write cache. Reads are more difficult because when the data is not in cache (it usually is not), it must be read from back-end storage media. As shown in this paper, the HPE Alletra 9080 is an excellent upgrade for an older storage system as well as a greenfield OLTP installation with its blazing fast response times and excellent throughput capability.

OLAP workloads are focused more on throughput for data analysis; however, OLAP workloads are still on-line workloads and benefit from fast storage response times. Processing of SQL Server data can take a long time and anything that can be done to speed things along is a welcomed benefit. During testing, results confirmed that the HPE Alletra 9080 delivers the throughput and the response times that can increase OLAP data analysis effectiveness.

NOTE

Best practice: Whether upgrading sluggish storage with an HPE Alletra or just planning a greenfield installation, it is a best practice to consult with HPE to confirm that both server and storage are well matched for the task. Do not assume your past OLTP or OLAP servers have adequate CPU headroom to process your data when adding the HPE Alletra into the mix.

Resources and additional links

HPE Alletra Storage
https://www.hpe.com/us/en/storage/alletra.html

HPE Primera Storage
hpe.com/us/en/storage/hpe-primera.html

Microsoft SQL Server
microsoft.com/en-us/sql-server/default.aspx

HPE and Microsoft Alliance website
https://www.hpe.com/us/en/alliance/microsoft.html

HPE Storage
www.hpe.com/storage

HPE Storage Solutions for Microsoft
https://www.hpe.com/us/en/storage/microsoft.html

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