

# Accelerate Performance of Microsoft SQL Server 2019 Containers

on Dell PowerFlex with KIOXIA SAS SSDs



# The Trend Towards Microsoft SQL Server Containerization

**In recent years, organizations have considered the cost of storing data, processing data, business agility, time-to-market, high availability, management overheads and emerging technology adoption as critical factors to success.** This has led to a rise of cloud computing, most notably server and storage infrastructure—as enterprises explore and enjoy the potential cost and agility benefits that come with using virtual infrastructure on demand.

Cloud Services provided alternatives to on-premises infrastructure to store (storage) and process data (compute) which lowers the barriers of adoption and reduces the cost and time to maintain the resources. One such service which was extensively adopted was Database-as-a-Service (DBaaS). DBaaS offers multiple potential benefits, including lower database licensing and infrastructure costs, reduced administration overhead, and faster time to application development.

Many IT organizations focus on their ability to provide an agile infrastructure in support of complex business demands. They are adapting modern technologies including continuous software delivery through agile methodology, scaling private clouds, and adopting commercially available technology solutions for both operational and mission-critical needs. Containerization and associated microservices help to provide the flexibility, agility and scalability that is needed for such organizations to adapt quickly to rapidly changing events.

## OVERVIEW

# Key Considerations Regarding Containerization

The purpose of containerization is to ensure that resources can be quickly provisioned for application development, testing, and production empowering development teams. As such, there is an ever-increasing need for organizations to bring their database services, such as Microsoft SQL Server, closer to their containerized applications and integrate the database within the microservices architecture for the following reasons.

- 1 Cost Model** Increasingly, organizations are opting for container-based enterprise database models to save time, resources, and money. They are adapting a model where on-premises licensing costs are replaced with subscription-based pricing.
- 2 Efficient Data Management** Data is more important today than ever before. MS SQL Server enables effective and efficient data collection and analysis. This allows organizations to direct resources where needed and increase customer loyalty.

## Additional Containerization Use Cases

Considerable savings can be achieved by running a database service in the cloud. There are also a number of use cases that can effectively leverage DBaaS to simplify day-to-day activities that DBAs and developers are tasked with, from disaster recovery and application development to real-time reporting. These tasks include:

- 1 Disaster Recovery**
- 2 Application development enabling CI/CD or DevOps**
- 3 Patching and upgrading without impacting production environment**
- 4 Feature testing**
- 5 Realtime reporting**

Dell Technologies has been integral in the transformation to container-based database applications by publishing [reference architectures](#) that detail best practice deployment of databases, such as Microsoft SQL Server 2019.

## SPECIFICATIONS

# KIOXIA Enterprise SAS SSDs – PM6 Series

Components that get less attention in many reference architectures are the storage devices, despite the fact that storage is a critical part of any SQL Server deployment. In fact, the storage layer is as critical as any other component of the infrastructure stack needed for a database to operate.

Dell PowerFlex software-defined infrastructure incorporates the KIOXIA PM6 Series dual-port 24G SAS SSDs. These enterprise solid state devices (SSDs) are suitable for high-performance Tier 0 computing, server and storage systems that require high levels of performance and reliability.

The PM6 Series is a 24G Enterprise SAS SSD and are optimized for read intensive applications, including web services, transactional databases, data warehousing, streaming media and video on demand. The series provides high levels of performance, reliability, and endurance and is designed to minimize total cost of ownership (TCO).

For more information and specifications regarding KIOXIA PM6 series SAS SSDs please refer to the link below.

[KIOXIA Enterprise SAS SSDs – PM6 Series](#)



KIOXIA (formerly Toshiba Memory) is the first storage vendor to introduce SSDs based on the 24G SAS (SAS-4) interface with its PM6 Series. These new enterprise SAS SSDs deliver the fastest SAS SSD performance as each 24G SAS lane supports a line rate of 22.5 gigabits per second (Gb/s), effectively doubling the bandwidth from the previous SAS-3 (12 Gb/s) generation. PM6 Series SSDs leverage industry-leading BiCS FLASH™ 3D flash memory technology and feature a full line-up of supported capacities (up to 30.72 terabytes (TB)), endurances and security options to meet the demanding application and workload requirements of server and storage OEMs. The PM6 Series is KIOXIA's sixth SAS SSD generation that builds on the company's successes as a leading SAS SSD vendor.

	<b>PM6-M Series</b>	<b>PM6-V Series</b>	<b>PM6-R Series</b>
<b>Application</b>	Enterprise Write-Intensive SSD	Enterprise Mixed-Use SSD	Enterprise Read-Intensive SSD
<b>DWPD</b>	10	3	1
<b>Interface</b>	SAS, 22.5 Gbit/s		
<b>Flash Memory</b>	BiCS FLASH™ 3D TLC		
<b>Storage Capacity (GB)</b>	400–3,200	800–12,800	960–30,720
<b>Encryption Feature</b>	SIE, SED, SED FIPS		

# BENCHMARKING THE SQL SERVER CONTAINER PERFORMANCE

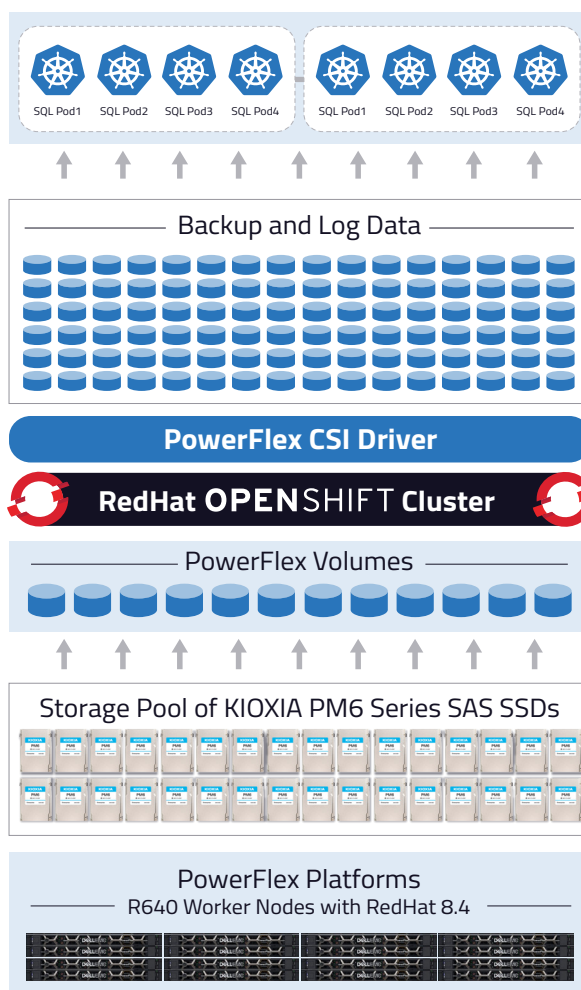
## Dell PowerFlex Software-Defined Infrastructure with KIOXIA Enterprise SAS SSDs

PowerFlex empowers organizations to move faster and respond effectively to rapidly changing business needs. It provides unprecedented freedom to deploy and scale the critical workloads that drive your business, while ensuring exceptional simplicity and manageability. The document [Architecting Microsoft SQL Server 2019 Containers on Dell EMC PowerFlex](#) was created by Dell Technologies as a reference architecture illustrating the steps required to create a best-practice container architecture for Microsoft SQL Server 2019.

The architecture for this environment uses Red Hat OpenShift, a leading enterprise Kubernetes platform that enables a cloud-like experience everywhere it's deployed. Whether it's in the cloud, on-premise, or at the edge, Red Hat OpenShift gives you the ability to choose where you build, deploy, and run applications through a consistent experience. Red Hat OpenShift's full-stack automated operations and self-service provisioning for developers lets teams work together more efficiently to move ideas from development to production.

### Test Environment Configuration

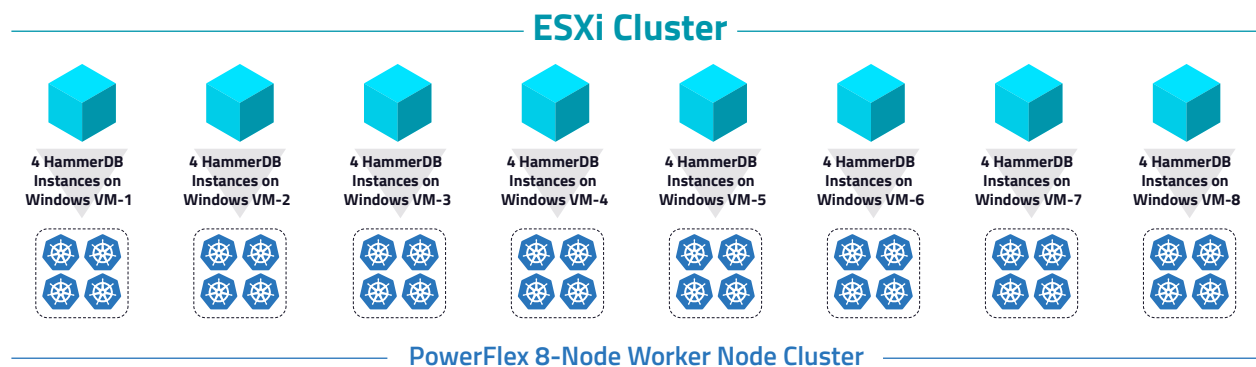
Dell PowerFlex running the previously mentioned reference architecture is the infrastructure which achieved maximum performance from SQL Server based on the tests conducted to compare the performance of SQL Server 2019 for configuration with varying vCPU count, number of pods, and memory allocated for each pod. These tests were conducted using the HammerDB benchmark tool. HammerDB is a leading benchmarking tool and load testing software for the most popular databases. It focuses on schema creation, data loading, and simulating transactional and analytic workloads.



**Test Environment Configuration.** The benchmark configuration was a three-node ESXi cluster hosting eight Windows Server 2019 Virtual Machines (8vCPU and 8GB RAM). HammerDB 4.2 was installed on the VMs in order to generate OLTP type TPC-C workloads. Each of the HammerDB VMs initiated up to four database instances, pointing to Microsoft SQL Server 2019 pods running on OpenShift cluster to generate workloads.

Exploring the reference architecture further, the SQL Server 2019 container pods were deployed on eight-node clusters containing PowerFlex Software-defined infrastructure with 80 KIOXIA PM6 Series SAS SSDs. In the reference architecture, the PowerFlex cluster is built from eight baremetal nodes that are configured in a hyperconverged deployment model. Each node is populated with ten KIOXIA 960GB PM6-R SAS SSD drives. Thus, a total of 80 SSDs from eight nodes are aggregated to make one resilient storage pool, with SSDs optimized for rebuild, rebalance, and I/O parallelism. Each SQL Server 2019 pod was configured with 300GB for data, 100GB for logs, 350 GB for both temp DB and backup. The SQL Server was then loaded with 1000 Data Warehouses that comprised approximately 100GB of the server's storage capacity. SQL Server Max Memory was set to 31GB to simulate a real-world database configuration and to ensure that no more than one-third of the 100GB database could be cached at one time.

In this test configuration scenario, four Microsoft SQL Server pods were deployed on each node, 32 pods in total. Each SQL Server pod was configured with 16vCPU and 32GB RAM. Workload tests were initiated by four HammerDB instances from each of eight Windows Server 2019 VMs (total of 32 HammerDB instances) created on a separate ESXi environment. Each HammerDB instance was configured to connect to one of the SQL Server pods running on eight worker nodes to generate an OLTP type of workload.



## Performance Benchmark Results

The results of performance benchmarking executed on SQL Server Pods on PowerFlex powered by Kioxia SAS SSDs proved exceptional. We observed 8.2 million TPM with submillisecond latency using this PowerFlex infrastructure.\* The charts on the following page depict results of a variety of read, write and mixed read-and-write workloads.

*\* Internal testing.*

Virtual users (VU) counts were varied to identify “sweet spots” achieving maximum Transactions/Minute. PowerFlex software-defined infrastructure demonstrated high performance, resilience and scalability well beyond the expectations of traditional architectures.

- ✓ Achieved a maximum of **8.2 million TPM** from eight nodes with 32 pods
- ✓ Achieved a maximum of **547K IOPS** with sub-millisecond latency
- ✓ Read latency: **0.25 milliseconds**
- ✓ Write Latency: **0.24 milliseconds**

**TEST CONFIGURATION**

Each pod:  
**16CPU & 32 GB RAM**

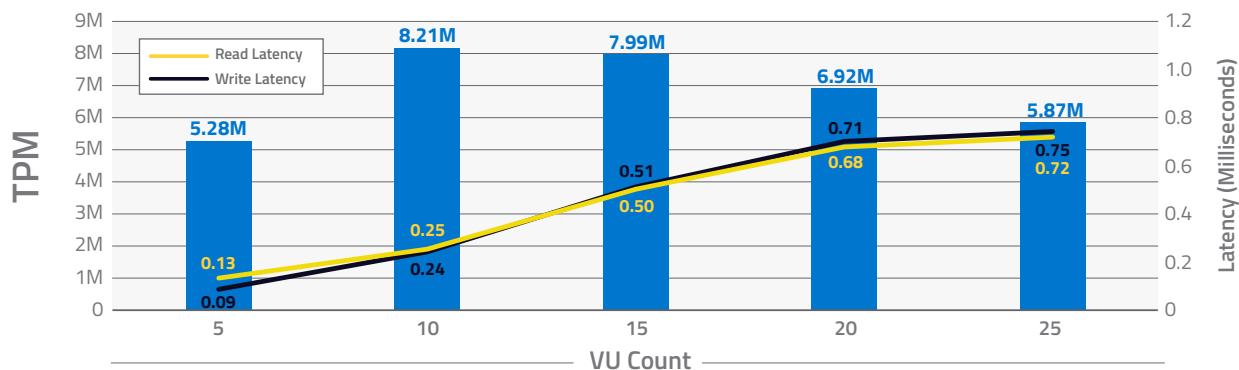
SQL Server 2019 Max Memory: **32 GB**

Each SQL Server: **300GB** for data, **100 GB** for logs and **300 GB** backup and TempDB

Database size on each SQLSERVER pod:  
**100 GB** (i.e. 1000 Warehouses)

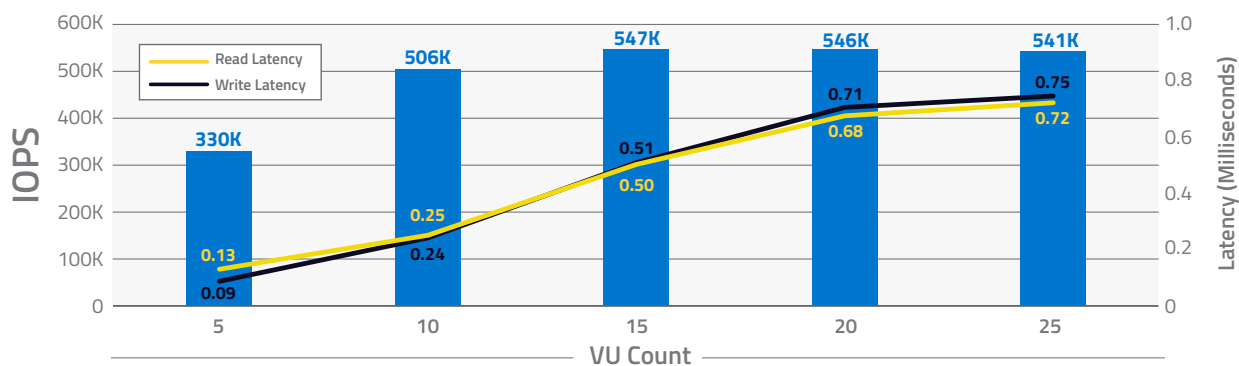
**32 total pods** (4 per node)

### Throughput Performance with Increasing Virtual User Count



**Graph 1: 32 Pods Deployed on 8 Nodes.** The above graph demonstrates the performance of SQL Server Pods (Transactions/Minute and Latency) achieved for varying Virtual User count. For TPM, higher is better. For latency, lower is better.

### IOPS and Latency with Increasing Virtual User Count



**Graph 2: 32 MSSQL Pods Deployed on 8 Worker Nodes.** The above graph demonstrates the performance of SQL Server Pods (IOPS and latency) achieved for varying Virtual User count.

## SUMMARY

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# Dell PowerFlex Software-Defined Infrastructure with KIOXIA PM6 Series SAS SSDs is Optimized to Achieve Superior SQL Server 2019 Pod Performance

The performance of SQL Server 2019 container pods is enhanced with KIOXIA PM6 Series SAS SSDs in the PowerFlex software-defined platform. With RedHat OpenShift in the solution mix, it enabled end-to-end visibility and management while simplifying container provisioning.

This solution demonstrated how KIOXIA Enterprise PM6 series SAS SSDs empowered PowerFlex platform to achieve exceptional database performance in a containerized configuration. The superior performance of KIOXIA PM6 Series SAS SSDs enhanced database transaction processing by completing more database transactions per minute while sustaining sub millisecond latencies which is validated by HammerDB tests.

## REFERENCES

[Introduction to the Dell Technologies PowerFlex Family](#)

[Microsoft SQL Server 2019 Reference Architecture](#)

[KIOXIA PM6 Series SAS SSDs](#)

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