



MIXED WORKLOADS ON PURE STORAGE

Microsoft SQL Server

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EXECUTIVE OVERVIEW

Data continues to be one of the most important assets for organizations. As technology evolves to produce decision-making opportunities from raw data, storage infrastructures need to be able to handle diverse workloads at any time. Often, database administrators no longer have the luxury of down time or maintenance windows for performing the essential maintenance operations necessary to maintain SQL Server database health.

Storage subsystems can become a bottleneck when mixed workloads are run concurrently, often resulting in high application latency and reduced productivity. The Pure Storage FlashArray//M offers flexibility – helping to reduce the impact on database performance when running a variety of concurrent workloads is necessary.

GOALS AND OBJECTIVES

Establish baseline performance for a given workload using Windows Perfmon tool for performance metrics collection. Compare baseline performance metrics while the following SQL Server maintenance tasks are running concurrently.

- Understand how the Pure Storage FlashArray//M product offering can reduce the complexity associated with managing storage in SQL Server environments.
- List performance metrics deviation when running baseline OLTP (Online Transaction Processing) concurrently with a DBCC (Database Console Command) CHECKDB consistency maintenance task.
- List performance metrics deviation when running baseline OLTP (Online Transaction Processing) concurrently with an Index Reorganize maintenance task.

AUDIENCE

This document is for database, system, and storage administrators responsible for maintaining SQL Server and storage environments.

PURE STORAGE INTRODUCTION

FlashArray//M makes server and workload investments more productive, while also lowering storage spend. With FlashArray//M, organizations can dramatically reduce the complexity of storage to make IT more agile and efficient, accelerating your journey to the cloud.

The performance of FlashArray//M can also make your business smarter by unleashing the power of real-time analytics, driving customer loyalty, and creating new, innovative customer experiences that simply weren't possible with disk. All this by transforming your storage with FlashArray//M.

SOLUTION SUMMARY

Problem

Database maintenance tasks are often performed concurrently with production workloads. This workload variety can strain infrastructures, increasing application response times.

Solution

The Pure Storage FlashArray architecture is flexible and efficient, utilizing flash-based storage for SQL Server environments.

Results

Deploying SQL Server on the Pure Storage FlashArray can optimize resources by removing storage bottlenecks when running diverse, concurrent workloads.

FlashArray//M R2 enables you to transform your data center, cloud, or entire business with an affordable all-flash array capable of consolidating and accelerating all your key applications.

MINI SIZE – Reduce power, space, and complexity by 90%

- 3U base chassis with 15 – 1500+ TBs usable
- ~1kW of power
- 6 cables

MIGHTY PERFORMANCE – Transform your datacenter, cloud, or entire business

- Up to 370,000 32K IOPS
- Up to 11.5 GB/s bandwidth
- <1ms average latency

MODULAR SCALE – Scale FlashArray//M R2 inside and outside of the chassis for generations

- Expandable to 1.5 PB usable via expansion shelves
- Upgrade controllers and drives to expand performance and/or capacity

MEANINGFUL SIMPLICITY – Appliance-like deployment with worry-free operations

- Plug-and-go deployment that takes minutes, not days
- Non-disruptive upgrades and hot-swap everything
- Fewer parts = more reliability

FlashArray//M R2 expands upon the FlashArray's modular, stateless architecture, designed to enable expandability and upgradability for generations. FlashArray leverages a chassis-based design with customizable modules, enabling both capacity and performance to be independently improved over time with advances in compute and flash, to meet your business' needs today and tomorrow.



THE PURE STORAGE FLASHARRAY IS IDEAL FOR:

Accelerating Databases and Applications – Speed transactions by 10x with consistent low latency, enable online data analytics across wide datasets, and mix production, analytics, dev/test, and backup workloads without fear.

Virtualizing and Consolidating Workloads – Easily accommodate the most IO-hungry Tier 1 workloads, increase consolidation rates (thereby reducing servers), simplify VDI administration, and accelerate common administrative tasks.

Delivering the Ultimate Virtual Desktop Experience – Support demanding users with better performance than physical desktops, scale without disruption from pilot to >1000s of users, and experience all-flash performance for under \$100/desktop.

Protecting and Recovering Vital Data Assets – Provide always-on protection for business-critical data, maintain performance even under failure conditions, and recover instantly with FlashRecover.

PURE STORAGE FLASHARRAY SETS THE BENCHMARK FOR ALL-FLASH ENTERPRISE STORAGE ARRAYS. IT DELIVERS:

Consistent Performance – FlashArray//M delivers consistent <1ms average latency. Performance is optimized for real-world application workloads that are dominated by I/O sizes of 32K or larger vs. 4K/8K hero performance benchmarks. Full performance is maintained even under upgrades and failures.

Lower Cost than Disk – Inline de-duplication and compression deliver 5 – 10x space savings across a broad set of I/O workloads including databases, virtual machines and virtual desktop infrastructure.

Mission-Critical Resiliency – FlashArray//M has proven >99.9999% delivered availability, as measured across the Pure Storage installed base, inclusive of non-disruptive everything and without performance impact.

Disaster Recovery Built-In – FlashArray//M offers native, fully-integrated, data reduction-optimized backup and disaster recovery at no additional cost. Setup disaster recovery with policy-based automation within minutes. And recover instantly from local, space-efficient snapshots or remote replicas.

Simplicity Built-In – FlashArray//M offers game-changing management simplicity that makes storage installation, configuration, provisioning, and migration a snap. No more managing performance, RAID, tiers, or caching. Achieve optimal application performance without any tuning at any layer. Manage the FlashArray the way you like it: web-based GUI, CLI, VMware® vCenter, Rest API, or OpenStack.

Cisco and Pure Compatibility with FlashStack – Flashstack™ is a converged infrastructure solution that brings the benefits of an all-flash storage platform to your converged infrastructure deployments. Built on best-of-breed components from Cisco and Pure Storage, FlashStack provides a converged infrastructure solution that is simple, flexible, efficient, and costs less than legacy converged infrastructure solutions based on traditional disk.

FLASHARRAY//M R2 TECHNICAL SPECIFICATIONS



	//M10*	//M20*	//M50*	//M70*
Capacity	Up to 25TBs effective capacity* 5 – 10TBs raw capacity	Up to 250+TBs effective capacity* 5 – 80TBs raw capacity	Up to 500+TBs effective capacity* 20 – 176TBs raw capacity	Up to 1.5PBs effective capacity* 42 – 512TBs raw capacity
All-Inclusive Performance**	Up to 100,000 32K IOPS† <1ms average latency Up to 3 GB/s bandwidth††	Up to 200,000 32K IOPS† <1ms average latency Up to 6 GB/s bandwidth††	Up to 270,000 32K IOPS† <1ms average latency Up to 9 GB/s bandwidth††	Up to 370,000 32K IOPS† <1ms average latency Up to 11.5 GB/s bandwidth††
Connectivity	16 Gb/s Fibre Channel 10 Gb/s Ethernet iSCSI 1 Gb/s Management & Replication ports	16 Gb/s Fibre Channel 10 Gb/s Ethernet iSCSI 10 Gb/s Replication ports 1 Gb/s Management ports	16 Gb/s Fibre Channel 10 Gb/s Ethernet iSCSI 10 Gb/s Replication ports 1 Gb/s Management ports	16 Gb/s Fibre Channel 10 Gb/s Ethernet iSCSI 10 Gb/s Replication ports 1 Gb/s Management ports
Physical	3U 575 – 625 Watts (nominal – peak) 95 lbs (43.1 kg) 5.12" x 18.94" x 29.72" chassis	3U – 5U 600 – 950 Watts (nominal – peak) 95 lbs (43.1 kg) fully loaded 5.12" x 18.94" x 29.72" chassis	3U – 5U 650 – 1280 Watts (nominal – peak) 95 lbs (43.1 kg) fully loaded + 44 lbs per expansion shelf 5.12" x 18.94" x 29.72" chassis	5U – 7U 1230 – 1760 Watts (nominal – peak) 97 lbs (44.0 kg) fully loaded + 44 lbs per expansion shelf 5.12" x 18.94" x 29.72" chassis

* Stated specifications are applicable to //M R2 versions.

** Effective capacity assumes HA, RAID, and metadata overhead, GB-to-GiB conversion, and includes the benefit of data reduction with always-on inline deduplication, compression, and pattern removal. Average data reduction is calculated at 5-to-1.

*** Includes always-on RAID-3D, deduplication, compression, and encryption.

† Why does Pure Storage quote 32K, not 4K IOPS? The industry commonly markets 4K IOPS benchmarks to inflate performance numbers, but multiple real world workloads consolidating on a single array average closer to 32K. FlashArray adapts automatically to 512B – 32KB IO for superior performance, scalability, and data reduction. IOPS are based on 100% 32KiB reads.

†† Data throughput is based on 100% 32KiB reads.

PURITY OPERATING ENVIRONMENT

Purity implements advanced data reduction, storage management, and flash management features. All features of Purity are included in the base cost of the FlashArray//M.

Storage Software Built for Flash – FlashCare technology virtualizes the entire pool of flash within the FlashArray, and allows Purity to both extend the life and ensure the maximum performance of consumer-grade MLC flash.

Granular and Adaptive – Purity Core is based upon a 512-byte variable block size metadata layer. This fine-grain metadata enables all of Purity’s data and flash management services to operate at the highest efficiency.

Best Data Reduction Available – FlashReduce implements five forms of inline and post-process data reduction to offer the most complete data reduction in the industry. Data reduction operates at a 512-byte aligned variable block size, to enable effective reduction across a wide range of mixed workloads without tuning.

Highly Available and Resilient – FlashProtect implements high availability, dual-parity RAID-3D, non-disruptive upgrades, and encryption, all of which are designed to deliver full performance to the FlashArray during any failure or maintenance event.

Backup and Disaster Recovery Built-In – FlashRecover combines space-saving snapshots, replication, and protection policies into an end-to-end data protection and recovery solution that protects data against loss locally and globally. All FlashProtect services are fully integrated in the FlashArray and leverage native data reduction capabilities.



The Pure1® cloud-based management platform provides the following features:

Pure1 Manage – By combining local web-based management with cloud-based monitoring, Pure1 Manage allows you to manage your FlashArray wherever you are – with just a web browser.

Pure1 Connect – A rich set of APIs, plug-ins, application connectors, and automation toolkits enable you to connect FlashArray to all your data center and cloud monitoring, management, and orchestration tools.

Pure1 Support – FlashArray is constantly cloud-connected, enabling Pure Storage to deliver the most proactive support experience possible. Highly trained staff combined with big data analytics help resolve problems before they start.

Pure1 Collaborate – Extend your development and support experience online, leveraging the Pure1 Collaborate community to get peer-based support and to share tips, tricks, and scripts.

EXPERIENCE EVERGREEN™ STORAGE

Get storage that behaves like SaaS and the cloud. Deploy it once and keep expanding and improving performance, capacity, density, and/or features for 10 years or more – without downtime, performance impact, or data migrations. Our “Right Size” capacity guarantee ensures you get started knowing you’ll have the effective capacity you need. And our Capacity Consolidation program keeps your storage modern and dense as you expand. With Evergreen Storage, you’ll never re-buy a TB you already own.

SQL SERVER MAINTENANCE

SQL Server requires running a variety of maintenance tasks to maintain operational health. Two common areas that require monitoring and service are index management for performance and consistency for data integrity.

INDEX REORGANIZE

- Database indexes are data structures used to search on a specific row in a table. Over time however they can become fragmented due to the insertion and deletion of data. Depending on the fragmentation level, they can be reorganized to improve their efficiency.
- Reorganizing an index can be time consuming – depending on the amount of data, and how much fragmentation is present. As the data has changed the index needs to be maintained for efficiency during query processing.

DBCC CHECKDB

- CHECKDB scans database objects both logical and physical for consistency errors. Checking for consistency is a read-only workload that can also be time consuming depending on the amount and type of objects the database contains.

TEST CONFIGURATION

Note: To ensure optimal configuration, please reference and apply the following Pure Storage Best Practice Guides to ensure performance and compatibility:

- *Microsoft Windows Server Best Practices Guide*
- *SQL Server Best Practices Guide*

Compute	Information/Parameter
Vendor	Cisco
Model	UCSB-B200-M4
Processor	Qty.(2) Intel E5-2670 v3 12 Core
DRAM	112 GB
HBA	Qty. (2) Cisco VIC FC

Storage	Information/Parameter
Model	FA-m20
Operating Environment	Purity 4.7.3
Capacity	11.71 TB

Workload	Information/Parameter
OLTP	Type Workload Read/Write Ratio 80/20
Average Read IO Size	8K
Average Write IO Size	10K
Users	300

Storage	Information/Parameter
Microsoft SQL Server Enterprise	2016 13.0.1708.0 (X64)
Database Size	1.4TB
Data Size (Table Data)	814GB
Trace Flags	None
Min/Max Memory	102400(MB)/110592(MB)

Operating System	Information/Parameter
Windows Server 2012 R2 w/Updates	Build 6.3.9600
Power Management	High Performance Enabled
Local Security Policy	Lock Pages in Memory Enabled
Perform Volume Maintenance Tasks	Instant File Initialization Enabled

SQL SERVER FILE/VOLUME CONFIGURATION

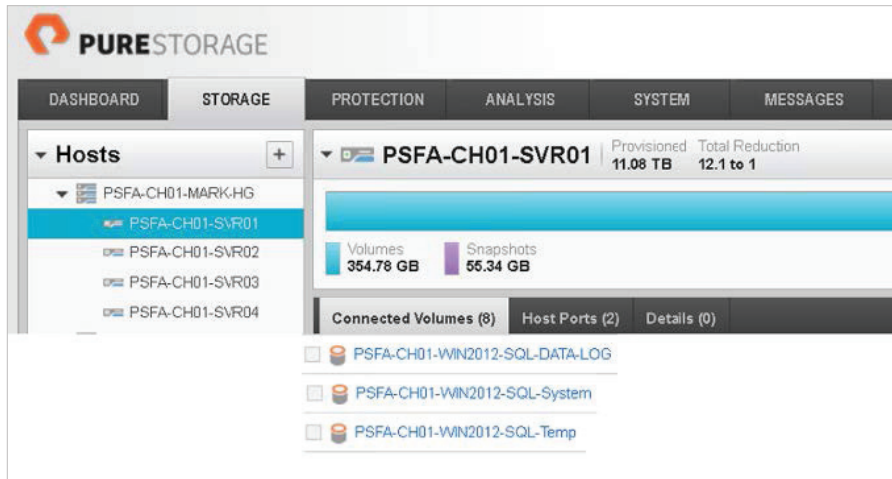


Figure 1

WINDOWS VOLUMES



Figure 2

TEST ENVIRONMENT PERFORMANCE ANALYSIS

The Windows Perfmon tool was used to collect performance metrics. An OLTP type workload was run to capture the following baseline perfmon metrics after a 30-minute ramp time:

INDEX REORGANIZE

- Avg. Disk sec/Read (Response Time)
- SQL Server database transactions/sec (Unit of Work)
- % Processor Time (Processor Utilization)
- SQL Server Lazy Writes/second (Background thread to swap pages in/out of the buffer pool, can be used to identify memory pressure.)

The following tests were run for this evaluation on the same SQL Server instance:

- Run an OLTP-type workload.
 - Capture relevant metrics for baseline.
- Run the same OLTP-type workload concurrently with Index Reorganize on the same database.
 - Capture relevant metrics and compare with baseline.
- Run the same OLTP-type workload on baseline database concurrently while DBCC CHECKDB () is run on a database clone from a Pure Storage Flash Recover snapshot volume.
 - Capture relevant metrics and compare with baseline.

Rather than focus on a high single performance metric score Pure Storage strives for optimization of resources. FlashArray//M achieves this by helping remove storage as the bottleneck.

RESOURCE UTILIZATION DATABASE ENVIRONMENTS

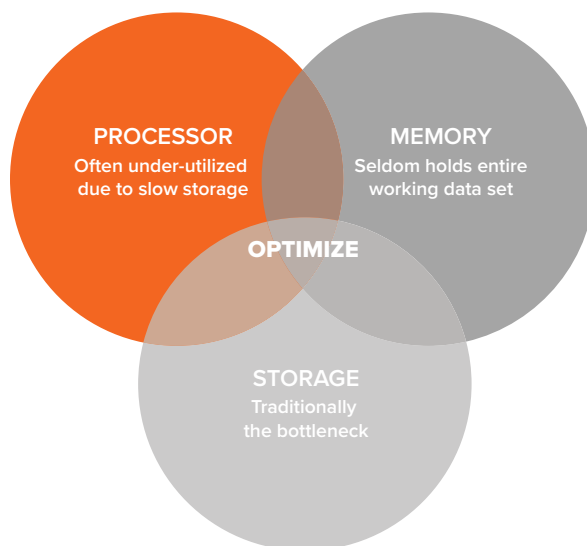


Figure 3

MIXED MAINTENANCE WORKLOAD RESULTS

Looking at vital resources such as processor, memory, and storage backed by FlashArray//M, we see processor resources are not waiting for work; instead, they are maintaining a high average utilization rate during concurrent workloads relative to the baseline.

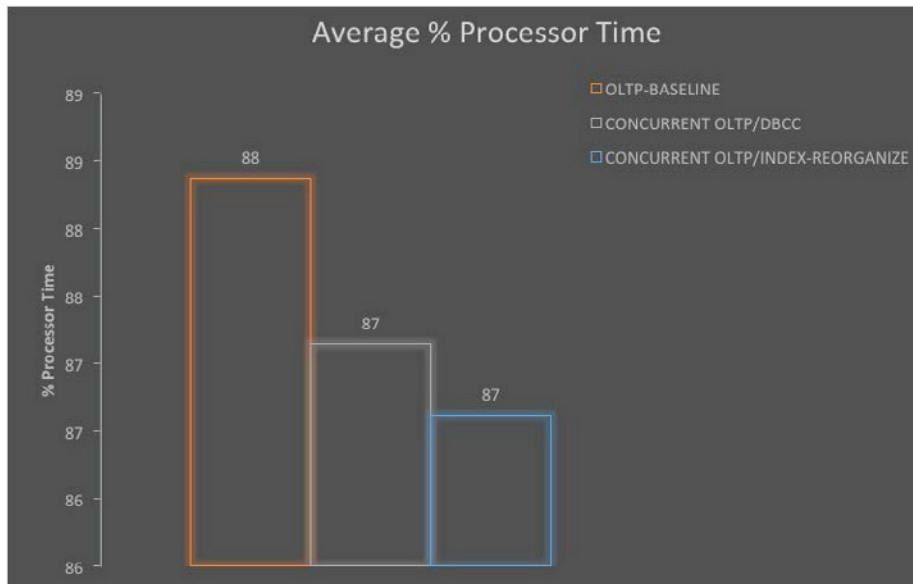


Figure 3

When SQL Server cannot fit the entire working data set into its buffer pool memory space, it will rely on a background thread called a Lazy Writer. The Lazy Writer's task is to increase the rate at which pages are retrieved and evicted from the buffer pool space beyond the internal LRU (least recently used) algorithm. Both the workload and amount of host DRAM available to the buffer pool contribute to how often the Lazy Writer is used by the buffer manager.

We can see that SQL Server is experiencing higher Lazy Write occurrences (greater than 100), resulting in some memory pressure with concurrent maintenance workloads.

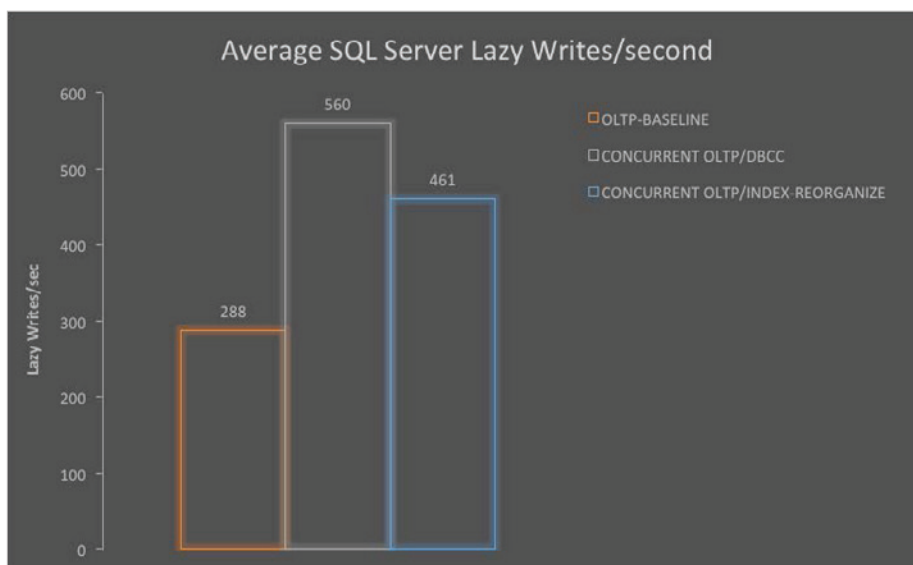


Figure 4

Using Pure Storage FlashArray//M-backed storage for the SQL Server database files, the average response time of less than 1ms is maintained for concurrent workloads while memory pressure is occurring.

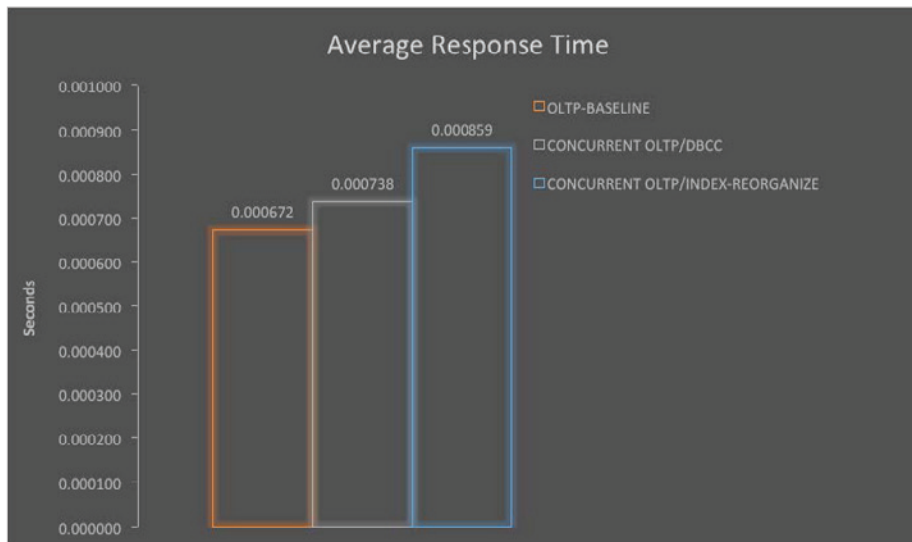


Figure 5

With a variety of workloads, the transaction pattern and standard deviation values per workload for SQL Server Transactions/second are consistent with little impact:

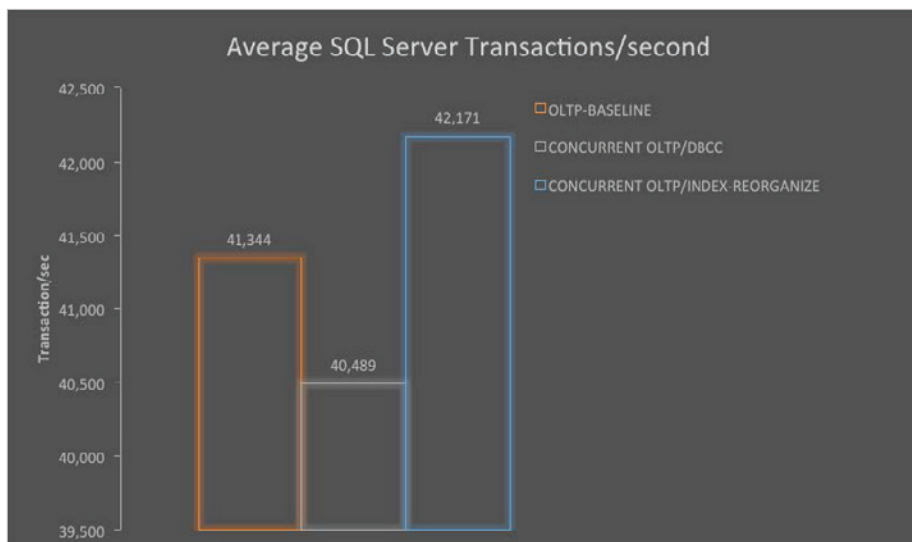


Figure 6

STANDARD DEVIATION VALUES

- 4,847 (Baseline)
- 4,056 (Concurrent OLTP/DBCC)
- 5,072 (Concurrent OLTP/Index-Reorganize)

STANDARD DEVIATION VALUES

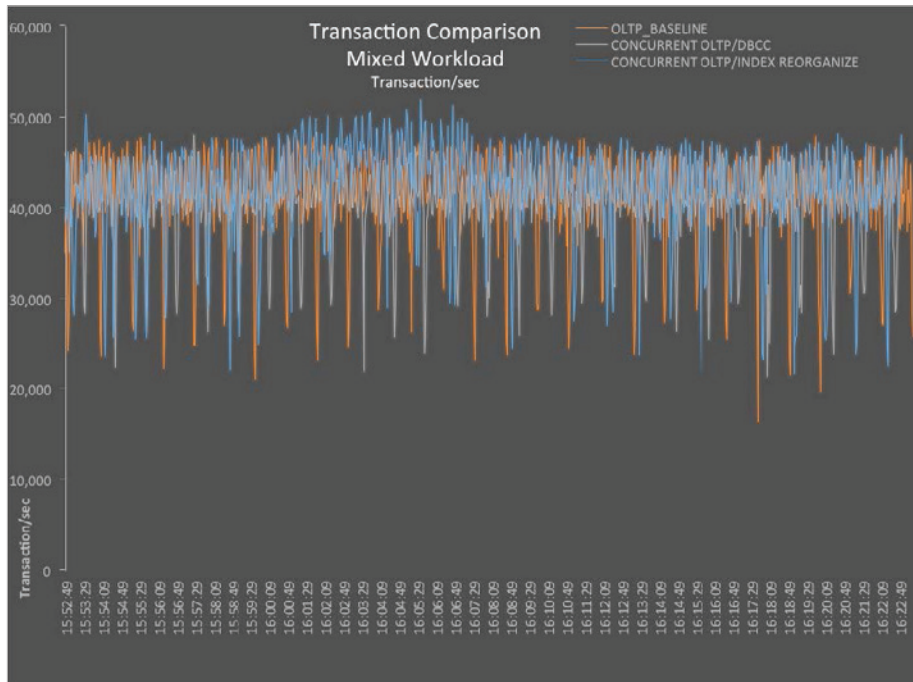


Figure 7

Note: When running concurrent mixed workloads, the performance impact to production systems can vary. Environment resources and the types of workloads are variables to consider. We recommend running your specific workloads in a test environment first – before implementing to a production environment – to evaluate their behavior.

SUMMARY

SQL Server has evolved and become the mission-critical platform of choice for many organizations. As your data platform evolves, so should your storage, backed by the FlashArray//M product offering. Utilizing all-flash technology and our Purity Operating Environment can help meet the demands of running a variety of workloads associated with SQL Server maintenance tasks to optimize environment resources. Pure Storage reduces the complexity of dealing with mixed workloads by providing consistent performance across mixed workload environments.

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