PRESERVE DATABASE PERFORMANCE WHEN RUNNING MIXED WORKLOADS

Testing shows that a Pure Storage® FlashArray//m storage array used for Microsoft® SQL Server® 2016 helps eliminate latency and preserve productivity.

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WHY ELIMINATING LATENCY AND PRESERVING PRODUCTIVITY MATTERS

Data drives today's organizations. And data runs on database solutions that require storage. Storage, though, can create latency that leads to bottlenecks. Latency can prevent applications from being responsive and the users who depend on those applications from being productive, particularly when a database is running mixed workloads, such as IT performing maintenance while production workloads are running.

Any database solution, for example the popular Microsoft SQL Server 2016 — a scalable, hybrid database platform for everything from in-memory performance to advanced security to in-database analytics — is best run on an underlying storage solution that helps eliminate latency and therefore preserves productivity. An ideal storage solution is Pure Storage FlashArray//m.

To demonstrate how using the Pure Storage FlashArray//m solution as the underlying storage solution for SQL Server 2016 removes typical storage bottlenecks, significantly reduces latency, and preserves database performance when running concurrent workloads with SQL Server 2016, Pure Storage performed testing.

Test Objectives

The objective of Pure Storage's testing was to demonstrate how the Pure Storage FlashArray//m product reduces the complexity associated with managing storage in SQL Server environments.

That complexity is compounded because SQL Server requires that a variety of maintenance tasks be run in order to maintain operational health. Today's database administrators can't afford the luxury of downtime or maintenance windows to perform those maintenance operations, and so administrators usually run maintenance tasks concurrently with typical database workloads.

Test Workloads and Maintenance Tasks

To get a broad view of the advantages of using a FlashArray//m storage array, Pure Storage tested intensive and non-intensive tasks alongside online transaction processing (OLTP) workloads. Pure Storage chose two areas that require monitoring and service: index management and data consistency and integrity. Pure Storage captured baseline metrics for OLTP-only workloads and then captured the deviation in performance when running baseline OLTP workloads concurrently with a Database Console Command (DBCC) CHECKDB maintenance task and again with a Reorganize Index task.

DBCC CHECKDB

The DBCC CHECKDB task checks both logical and physical database objects for consistency errors by scanning each database one page at a time. When run on large databases, DBCC CHECKDB can be resource intensive, require long intervals to complete, and can slow system performance for both users and other processes.

SOLUTION SUMMARY

Problem

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

Solution

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

Result

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

Reorganize Index

Database indexes are data structures used to search on specific rows in a data table. Over time, database modifications can cause the information in the index to become fragmented. Indexes can require significant maintenance because heavily fragmented indexes can slow down query performance and application response times. In SQL Server 2016, running the Reorganize Index task requires only minimal system resources.

TEST ENVIRONMENT CONFIGURATION

To perform our testing, Pure Storage set up a SQL Server environment with a Cisco® server powered by two processors from the Intel® Xeon® processor E5-2670 v3 product family with a FlashArray//m20 storage array with capacity of 11.71 TB used for storage. The testing database was a 1.4-TB database in SQL Server Enterprise. See Table 1 for full configuration details.

Performance Metrics

To establish baseline performance for a given workload, Pure Storage used the Windows® Perfmon tool to collect performance metrics. Pure Storage ran an OLTP-type workload to capture the following baseline metrics in Perfmon after a 30-minute ramp-up time:

- Average disk seconds/read (response time)
- SQL Server database transactions/second (unit of work)
- Percent processor time (processor utilization)
- SQL Server lazy writes/second (background thread to swap pages in and out of the buffer pool; can be used to identify memory pressure)

To compare baseline performance metrics against metrics gathered for the same activities while SQL Server maintenance tasks ran concurrently, Pure Storage ran the following workloads on the same SQL Server instance:

- **An OLTP-type workload** to capture relevant metrics for the baseline
- **The same OLTP-type workload concurrent with Reorganize Index** on the same database to capture relevant metrics and compare with the baseline
- **The same OLTP-type workload on the baseline database concurrent with DBCC CHECKDB** running on a database clone from a Pure Storage Flash Recover snapshot volume to capture relevant metrics and compare with the baseline

Rather than focus on a high single performance-metric score, Pure Storage strives for optimization of resources. FlashArray//m storage arrays achieve this by helping eliminate storage as a bottleneck.

TABLE 1. System-configuration details for the Pure Storage testing

Compute	Information/Parameter
Vendor	Cisco
Model	Cisco UCS® B200 M4
Processor	Two Intel Xeon processor E5-2670 v3 (12 cores)
DRAM	112 GB
HBA	Two Cisco Virtual Interface Cards (VIC) with Fibre Channel (FC)
Storage	
Model	FlashArray//m20
Operating Environment	Purity 4.7.3
Capacity	11.71 TB
OLTP Type Workload	Read/write ratio: 80/20
Average Read Input/Output (I/O) Size	8 KB
Average Write I/O Size	10 KB
Users	300
Microsoft SQL Server Enterprise	2016 13.0.1708.0 (x64)
Database Size	1.4 TB
Data Size (Table Data)	814 GB
Trace Flags	None
Min/Max Memory	102,400 MB/110,592 MB
Operating System	
Windows Server® 2012 R2 with 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

TEST RESULTS

Our testing demonstrated that using the Pure Storage FlashArray//m storage array as the storage subsystem for SQL Server 2016:

- Ensured higher processor utilization
- Preserved performance when OLTP was run concurrently with the DBCC CHECKDB task
- Preserved performance when OLTP was run concurrently with the Reorganize Index task

A summary of results follows.

Mixed Maintenance Workload Results

Looking at vital resources, such as processor, memory, and storage backed by FlashArray//m storage arrays, our testing showed that processor resources were not waiting for work (not underutilized); instead, they maintained a high average utilization rate during concurrent workloads relative to the baseline. Processor utilization was nearly identical to the baseline when running concurrent workloads.

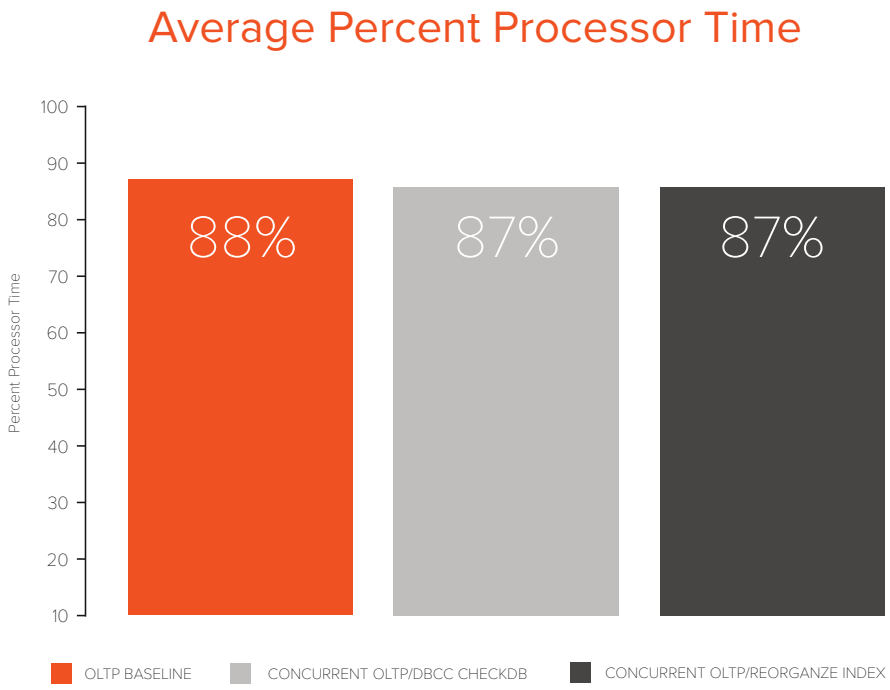

FIGURE 1. Average percent of processor time used for the three tests run with the same Microsoft SQL Server instance on a Pure Storage FlashArray//m storage array.

LAZY WRITES AND WORKLOAD PERFORMANCE

When SQL Server can't fit the entire working dataset into its buffer-pool memory space (a place in system memory that is used to cache table and index data pages as they are modified or read from the disk), SQL Server is considered to be under memory pressure and will rely on a background thread called a "lazy writer." The lazy writer increases the rate at which pages are retrieved and evicted from the buffer-pool space beyond the internal least recently used (LRU) algorithm. Extensive lazy-write activity can create bottlenecks, as it affects other resources by causing additional physical disk I/O activity and using more CPU resources.

On average, SQL Server experiences higher lazy-write occurrences — greater than 100 — resulting in some memory pressure when it is running OLTP and maintenance workloads concurrently as compared to only running an OLTP workload:

- 288 lazy writes per second for OLTP workload (baseline)
- 560 lazy writes per second for concurrent OLTP and DBCC CHECKDB workloads
- 461 lazy writes per second for concurrent OLTP and Reorganize Index workloads

Pure Storage Preserves Performance Even with Lazy Writes

In testing, using Pure Storage FlashArray//m storage arrays for the SQL Server database files showed an average response time of less than one millisecond (ms). This response time was maintained for the concurrent workloads in our testing even as memory pressure occurred and lazy writes increased.

Average Response Time

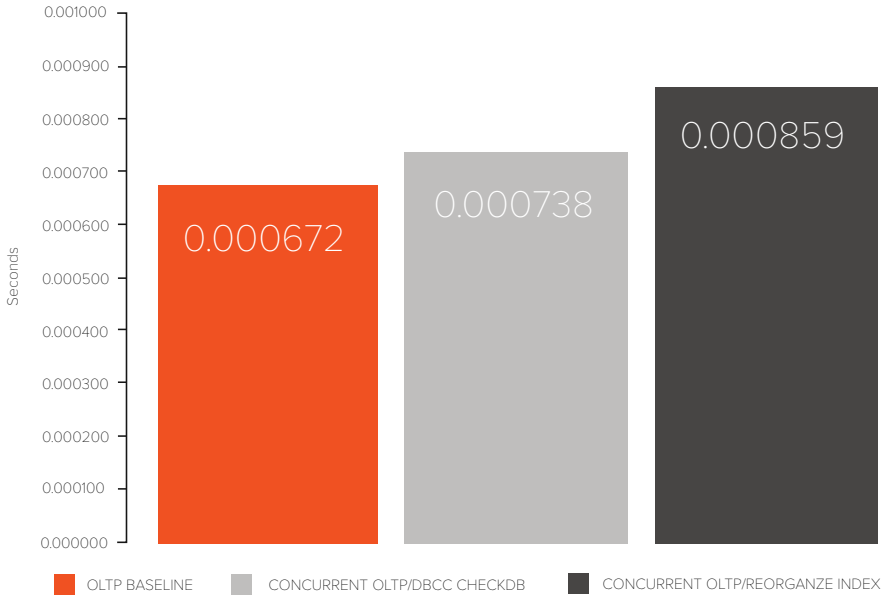

FIGURE 2. When using Pure Storage FlashArray//m storage arrays as the storage for Microsoft SQL Server database files, an average response time of less than one millisecond is maintained for concurrent workloads while memory pressure occurs.

Under a variety of workloads, transactions per second and standard-deviation values per workload for SQL Server were consistent, with only minimal impact on overall performance.

Average SQL Server Transactions/Second

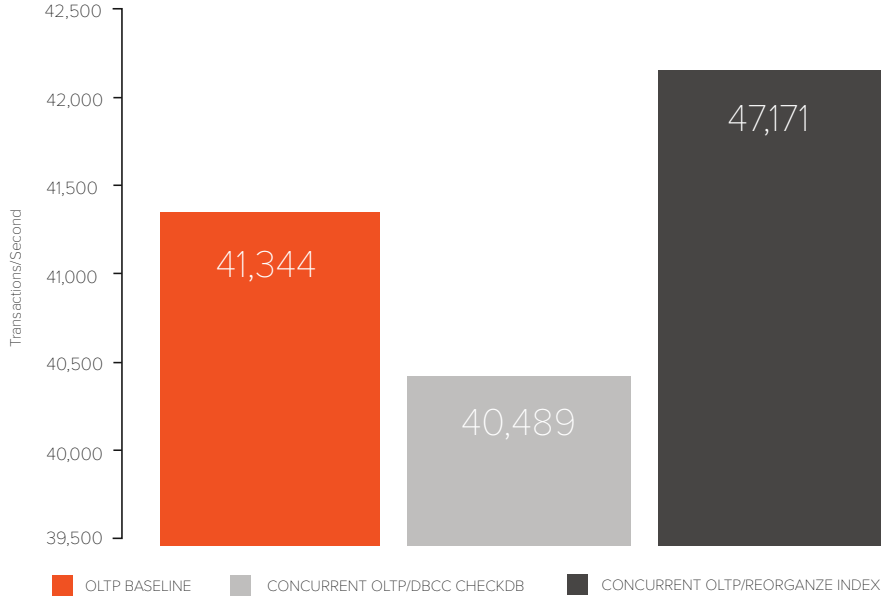

FIGURE 3. Using Pure Storage FlashArray//m storage arrays as the storage for Microsoft SQL Server database files, standard-deviation values per workload for SQL Server transactions per second remained consistent with little impact on overall performance.

Standard-Deviation Values

- 4,847 transactions per second for the baseline OLTP workload
- 4,056 transactions per second for concurrent OLTP and DBCC CHECKDB workloads
- 5,072 transactions per second for concurrent OLTP and Reorganize Index workloads

It was the Pure Storage FlashArray//m solution that enabled these results due to the ability of Flash Storage to eliminate the latency of disk.

PURE STORAGE FLASHARRAY//M STORAGE ARRAYS

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

The performance of FlashArray//m storage arrays can allow businesses to unleash the power of real-time analytics, drive customer loyalty, and create new, innovative customer experiences that simply aren't possible with disk storage — all by transforming storage with FlashArray//m.

The FlashArray//m storage array expands upon the modular, stateless architecture of the Pure Storage FlashArray. FlashArray//m storage arrays use a chassis-based design with customizable modules that enable expanding and increasing capacity and performance independently over time as needs increase and compute and flash technologies improve.

The benefits of the Pure Storage FlashArray//m storage array include:

- Scalable and predictable performance regardless of the application or process it is used for, which can reduce the complexity associated with managing storage in SQL Server environments
- Easy consolidation of various workloads and applications onto the same platform
- Faster transactions — up to 10x faster, with typically less than one millisecond latency
- Support for running online data analytics across wide datasets and with mixed production, analytics, dev/test, and backup workloads
- Easy accommodation of the most I/O-hungry tier-1 workloads, increased consolidation rates (thereby reducing the number of servers required), simplified virtual-infrastructure (VI) administration, and accelerated common administrative tasks

Find complete FlashArray//m storage array specifications at www.purestorage.com/products/flash-array-m/hardware-tech-spec-flash-array.html.

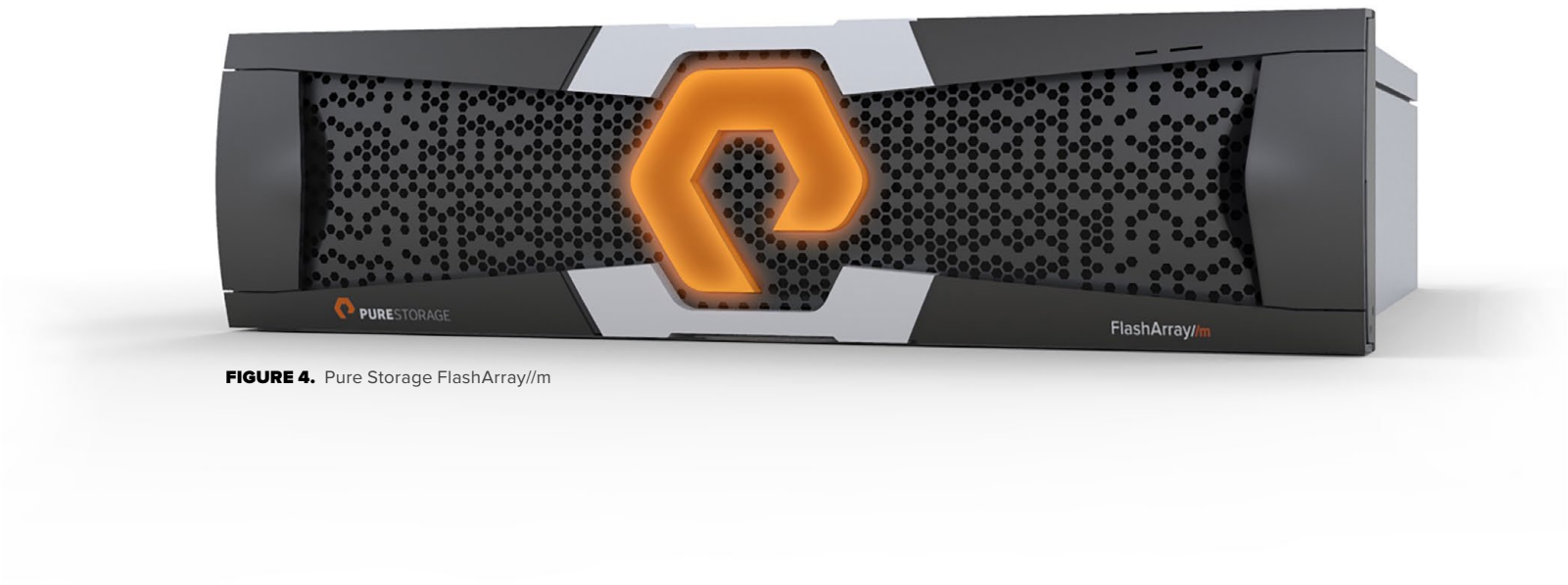

FIGURE 4. Pure Storage FlashArray//m

MAXIMIZE YOUR SQL SERVER ENVIRONMENT WITH PURE STORAGE

SQL Server is the mission-critical platform of choice for many organizations. To ensure it delivers optimal performance, run it on the storage solution that can help eliminate typical storage bottlenecks and optimize performance and productivity, including for mixed workloads.

Testing shows that the FlashArray//m storage array is the ideal storage solution for SQL Server 2016 environments and can provide consistent performance and maximum processor utilization across mixed workload environments.

For configuration details and full test results, download the report, "**Mixed Workloads on Pure Storage: Microsoft SQL Server**," or contact your Pure Storage representative.

When running concurrent mixed workloads, the performance impact to productions systems can vary. Environment resources and the types of workloads are variables to consider. Pure Storage recommends running your specific workloads in a test environment first, before implementing to a production environment, in order to evaluate their behavior.

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