LSI® Nytro™ XD Caching Solution Evaluation

Evaluation report prepared under contract with LSI Corporation

Introduction

IT professionals who oversee the performance of mission-critical applications are looking for ways to increase performance and decrease latency for these applications. While these IT professionals want to improve the performance of these applications, they do not have unlimited resources and must achieve these improvements frequently with limited budgets.

Enterprise-level flash technology is transforming the computing environment and is bringing high performance storage to the datacenter environment. Flash-based caching is an excellent way to bring the high performance and low latency of flash technology at a minimal cost and without requiring application changes or back-end storage changes.

LSI commissioned Demartek to evaluate its Nytro™ XD Application Acceleration Solution, a product that caches storage area network (SAN) or direct attached storage (DAS) storage on server-side Nytro WarpDrive™ PCI-Express®-connected flash card. This evaluation was conducted in the Demartek lab in Arvada, Colorado and its purpose was to measure performance and latency improvements using two database workloads on an enterprise database software platform.

Evaluation Summary

The LSI Nytro XD solution performed in an outstanding manner, increasing database application performance by at least 500% and as much as 800%, depending on the specific workload. Nytro XD also reduced latency by at least 67% in one set of tests. All of these gains were obtained without changing the application or the back-end storage system.

We believe that the LSI Nytro XD approach is an excellent caching product for accelerating database performance with a server-side PCIe flash.

Caching on Flash Technology

Caching on flash is garnering much attention for the promise of substantial performance increases and latency reductions for enterprise applications, especially database workloads. Caching on flash, regardless of where it is implemented in the I/O path, places a copy of "hot" data into its cache so that I/O activity can be accelerated. This caching technique benefits any application whose data is considered "hot" and is within the scope of management and visibility of the cache.

Flash-based caches improve performance over time as the cache fills up with hot data. This is known as "cache warm-up" or "cache ramp up" and can happen within minutes or hours, depending of the size of the cache and the I/O rate and access patterns.

Server-Side Caching

While there are several possible ways to implement caching on flash, one excellent way is with the LSI Nytro XD solution composed of caching software and the Nytro WarpDrive™ PCIe flash-based card. The LSI Nytro XD solution fits into the category of "server-side caching." This type of flash-based caching accelerates I/O activity without requiring changes to the applications running in the host server. It also accelerates existing storage area network (SAN) storage without requiring any changes to SAN storage.

One of the primary benefits of server-side caching on flash is that as the cache inside the server warms, increasing numbers of I/O requests are satisfied without having to access the external storage network. This improves overall storage performance and drives down I/O response time, or latency. This is especially advantageous for financial and database applications that will benefit from lower latency.

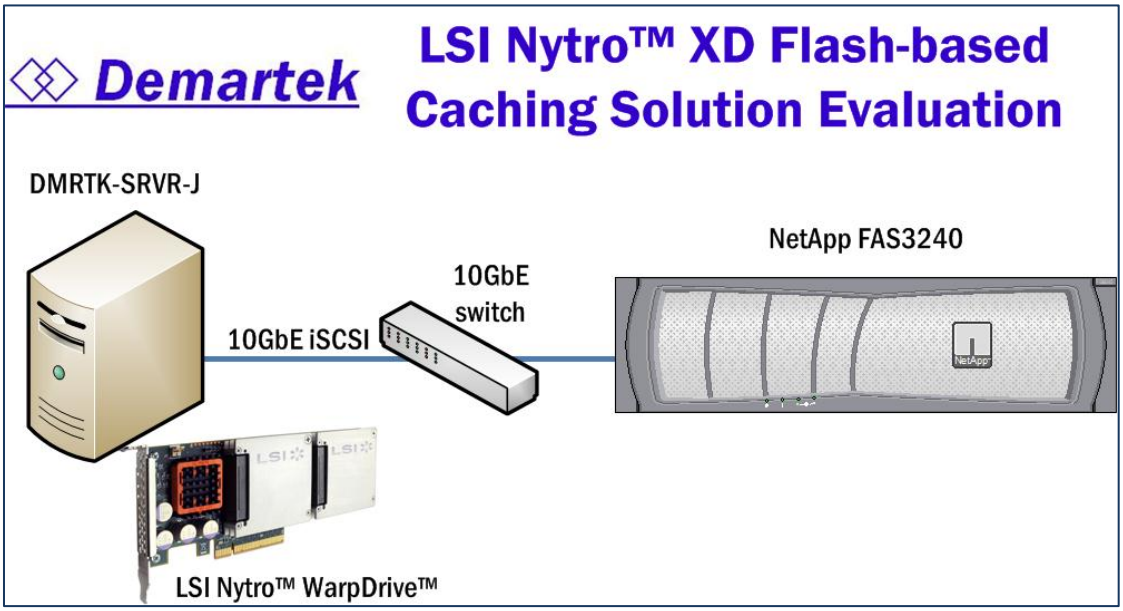
Performance Test Results

We ran two database workloads, an OLTP transaction-oriented workload and a read-intensive decision support workload with the goal of measuring the increased performance offered by the LSI Nytro XD caching solution. We were especially interested in the amount of performance increase as the amount of data in the cache increased.

The database workloads were run with the Nytro XD caching solution disabled, then repeated with the Nytro XD solution enabled.

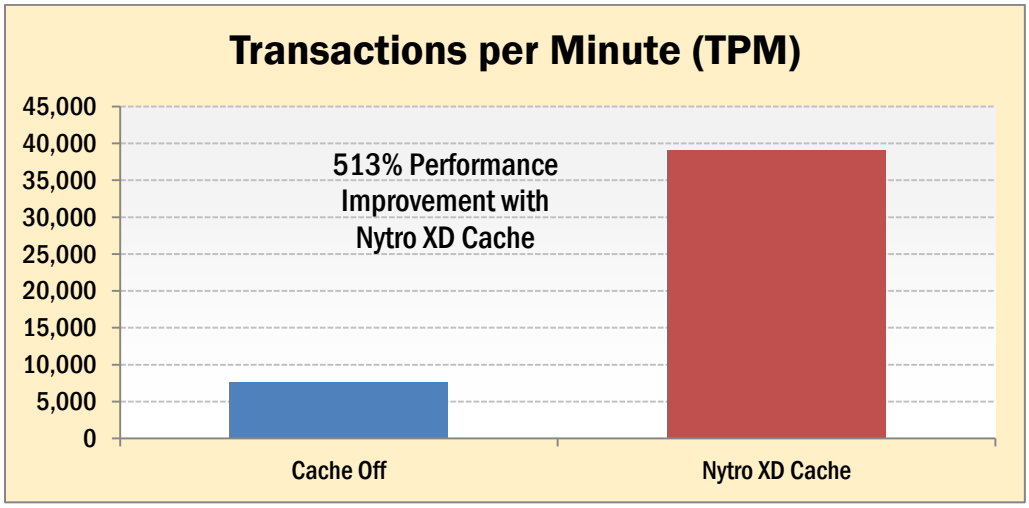
Test Configuration

For these tests, we installed an enterprise database application in a Linux environment on a single server with an iSCSI storage device via a 10GbE connection.

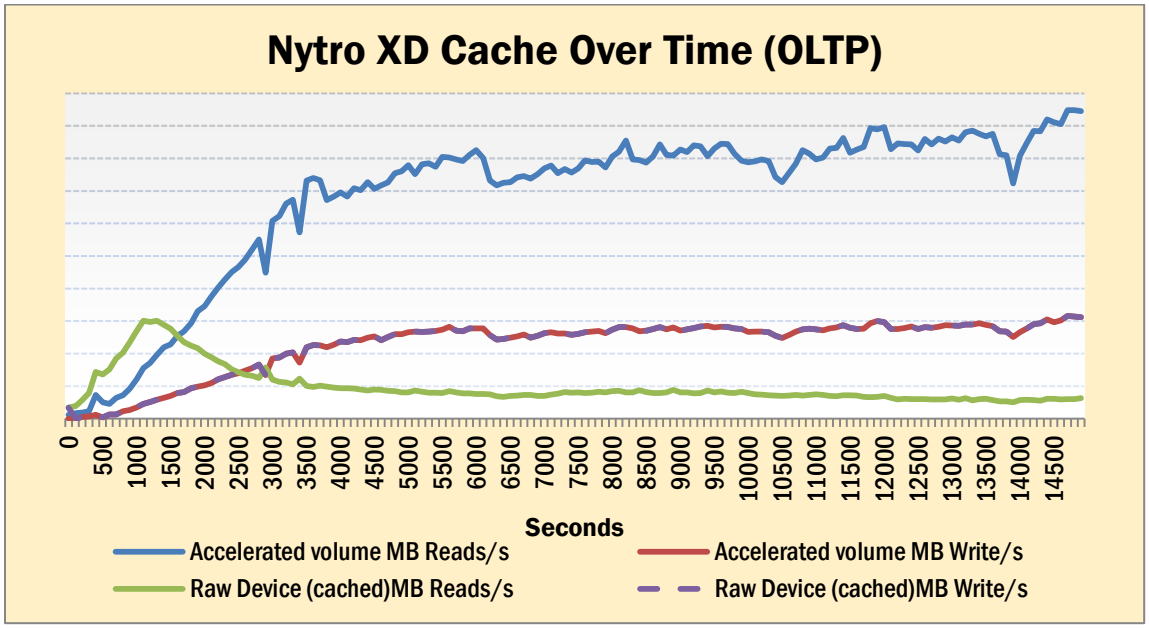


OLTP Performance Results

Transactions per Minute (TPM) are a common metric for OLTP transaction-oriented database applications. We ran this OLTP workload for approximately four hours with and without the Nytro XD solution enabled. We observed a 513% performance improvement with the Nytro XD solution.

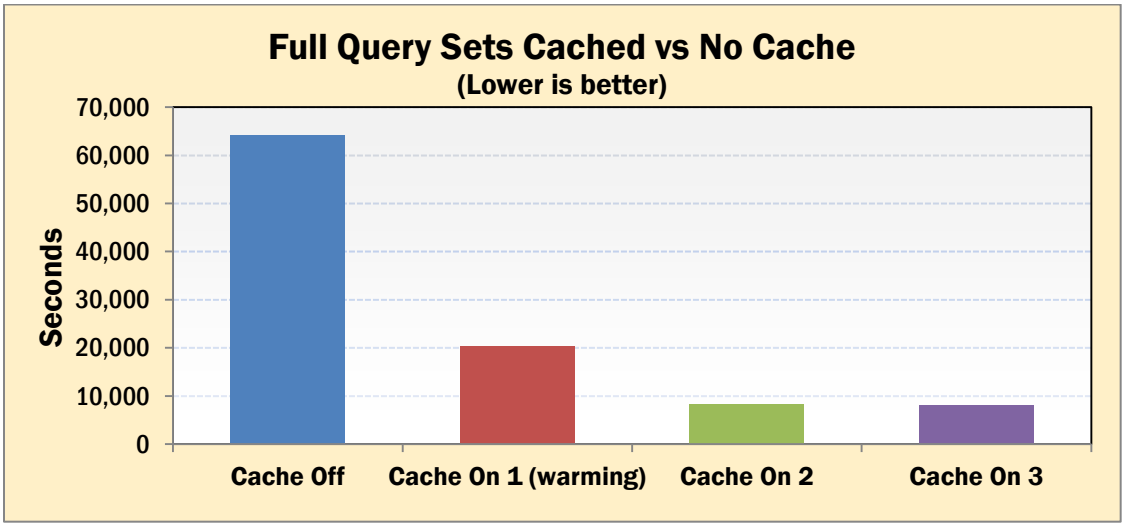


We measured the difference between the performance of the raw device (back-end storage) and the cache device from the host operating system viewpoint. The following chart shows the throughput for reads and writes to the cache device and raw device as the cache warmed. As expected, the writes to the cache device and raw device were identical, as the cache writes are performed in a write-through manner. Also as expected, the reads to the raw device decreased over time as a higher percentage of the reads were satisfied by the flash-based cache.

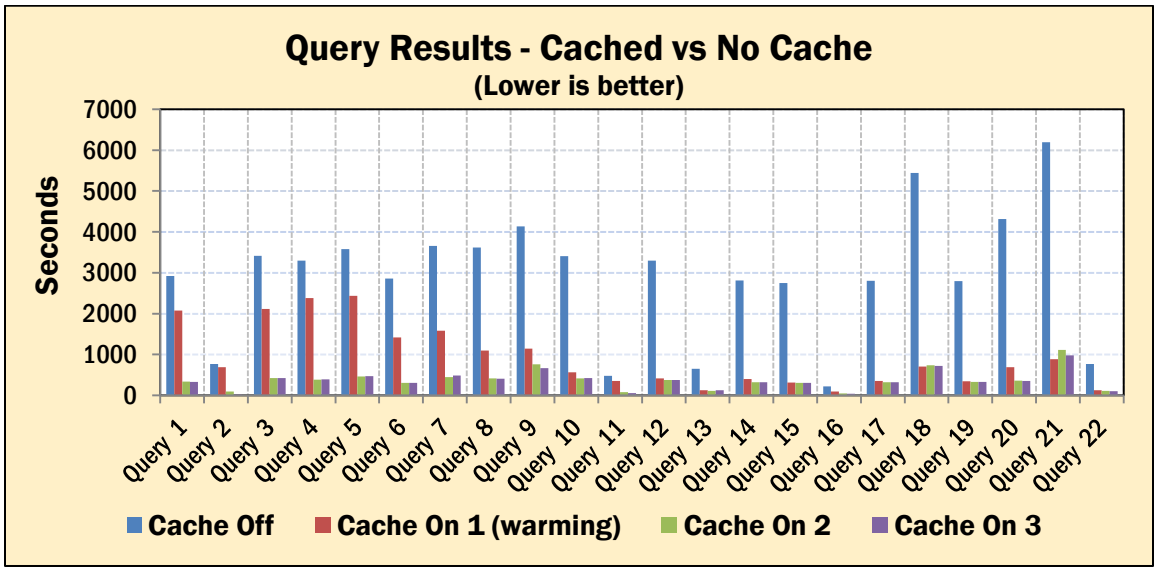


Decision Support Workload

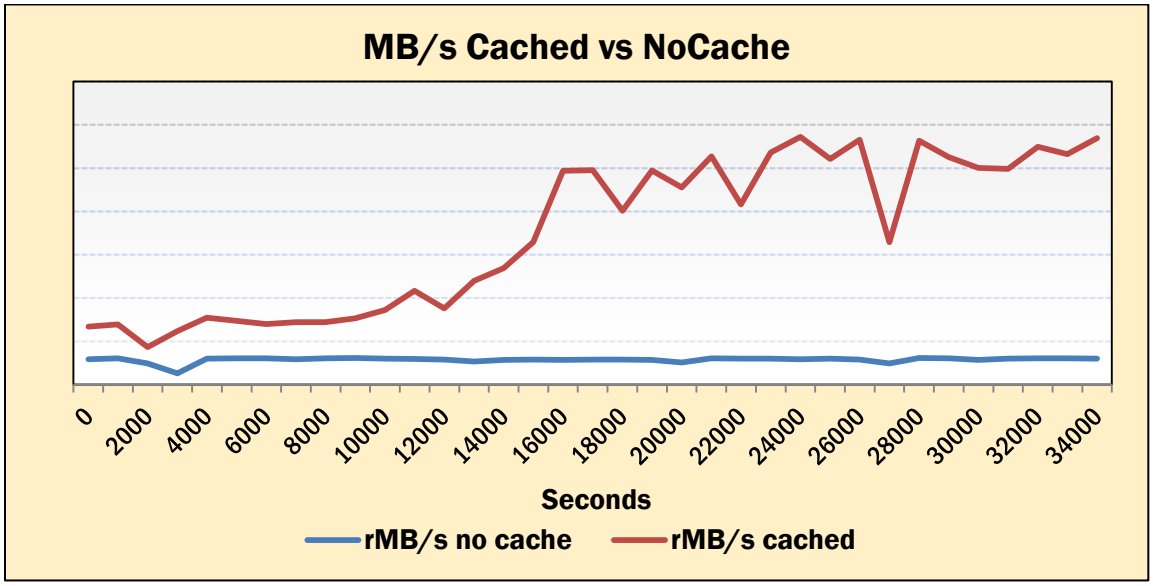
For the Decision Support workload, we repeated the test four times. The first time was with the cache disabled. Beginning with the second test, the cache was enabled. We repeated the tests with the cache enabled to see the effects of a pre-warmed cache, which would be the typical operating mode for a decision support workload where many ad-hoc queries are run on a slowly changing dataset. As expected, the third and fourth tests show higher performance than the first test with no cache and the second test with a partially warmed cache. These tests measure the time to complete the workload, so a lower score is better.



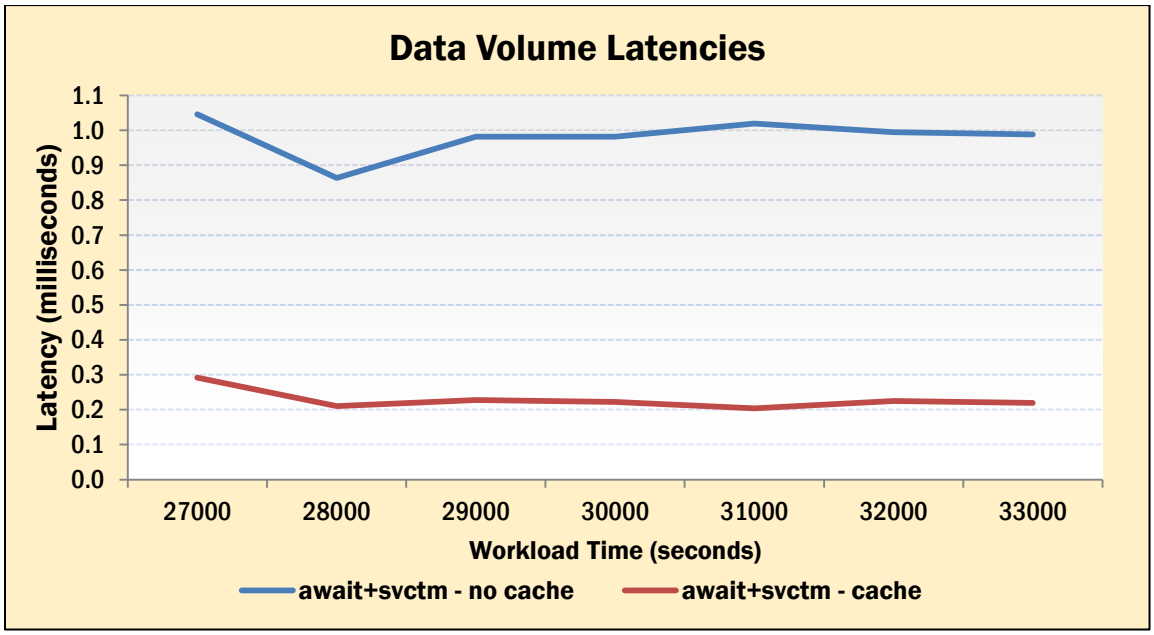
This particular workload issues 22 different queries during the test. We captured the time to complete the workload by query for each of the four runs of the test. By the time of query 10 of run #2, the cache was warmed so the time to complete for the rest of run #2 and runs #3 and #4 took full advantage of the flash-based cache.



We measured the throughput rate of these read-intensive tests, with and without the cache enabled. The throughput for the cache enabled portion reached more than 800% of the same test without the cache enabled.



Another important measure of performance improvement is the response time, or latency. A good server-side flash-based caching system will significantly reduce the latency for I/O requests. The following graph shows a sample of the latencies towards the end of the runs. While the NetApp array provided respectable responses leveraging its NVRAM-based controller cache, the Nytro XD caching solution dropped the average latency almost 5x to less than 0.3 milliseconds. Where there is a class of applications where latency is critical, the Nytro XD solution is ideal.



Storage System Functions

One of the important features of the LSI Nytro XD solution is that is does not adversely affect the normal operations of the back-end storage. In order to demonstrate this, we took a snapshot of the database while the Nytro XD solution's cache was enabled. We followed normal best practices by using the steps outlined below.

1. Enabled Nytro XD solution cache
2. Ran a database workload
3. Quiesced the database
4. Issued a snapshot command from the back-end storage system
5. Restored the data volumes from the snapshot
6. Brought the database back online
7. Ran another database workload

We were able to perform a database quiesce, a back-end storage system snapshot and other related functions while the Nytro XD solution's cache was enabled and all of the database and storage system functions operated correctly. As expected, the Nytro XD solution did not interfere with any of the storage system features and functions.

Conclusion

The LSI Nytro XD Application Acceleration solution performed in an outstanding manner, increasing database application performance by at least 500% and as much as 800%, depending on the specific workload. The Nytro XD solution also reduced latency by almost 5x to less than 0.3 milliseconds in one set of tests. All of these gains were obtained without changing the application or the back-end storage system.

For those IT professionals seeking significant performance improvements, the Nytro XD solution is an excellent product.

Additional information regarding the Nytro XD solution is available at www.TheSmarterWayToFaster.com and from www.LSI.com/acceleration.

Appendix – Evaluation Environment

All the tests were run in the Demartek lab in Colorado, and were run on a single server.

Server – DMRTK-SRVR-J

- 2x Intel Xeon X5680, 3.33 GHz, 12 cores, 24 threads ("Westmere")
- 144 GB RAM
- PCI-Express 2.0 slots
- RedHat Enterprise Linux 6.1, kernel 2.6.32-131.0.15.el6.x86_64
- Boot drive: SSD connected to a motherboard SATA port
- LSI Nytro WarpDrive 200 GB PCI-Express flash-based card
- Intel X520-SR 10GbE dual-port NIC
- Enterprise Database application

Network Switch

- Cisco Nexus 5020

Storage

- NetApp FAS3240

Database Storage

- 300 GB Database Log Partition
- 1000 TB TPC-C partition with 600 GB data file holding ~400 GB data
- 500 GB TPC-H partition with 300 GB data file holding ~100 GB data

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