

LSI™ MegaRAID® FastPath™ Performance Evaluation in a Web Server Environment

Evaluation report prepared under contract with LSI Corporation

Introduction

Interest in solid-state storage (SSS) is high, and IT professionals are beginning to explore various ways to take advantage of the increased performance and reduced power consumption that SSS offers. Various enterprise applications across the spectrum of size and complexity may be good candidates for SSS.

SSS can be deployed directly as primary storage where the users decide what data to place on the storage, or it can be deployed as a cache in front of traditional storage, where the storage controller determines what data is placed on the SSS or solid state disk (SSD). Each implementation has advantages.

LSI Corporation commissioned Demartek to evaluate MegaRAID FastPath software in a web server environment. This advanced SSD-aware RAID software is a high-performance IO accelerator especially designed for SSD arrays connected to a MegaRAID controller card. FastPath software is an optimized version of LSI's MegaRAID technology that is designed with SSDs in mind, taking advantage of the increased read and write performance of SSDs. FastPath is used for primary storage where the user places files directly on the SSD devices to achieve the highest possible application performance.

Evaluation Environment

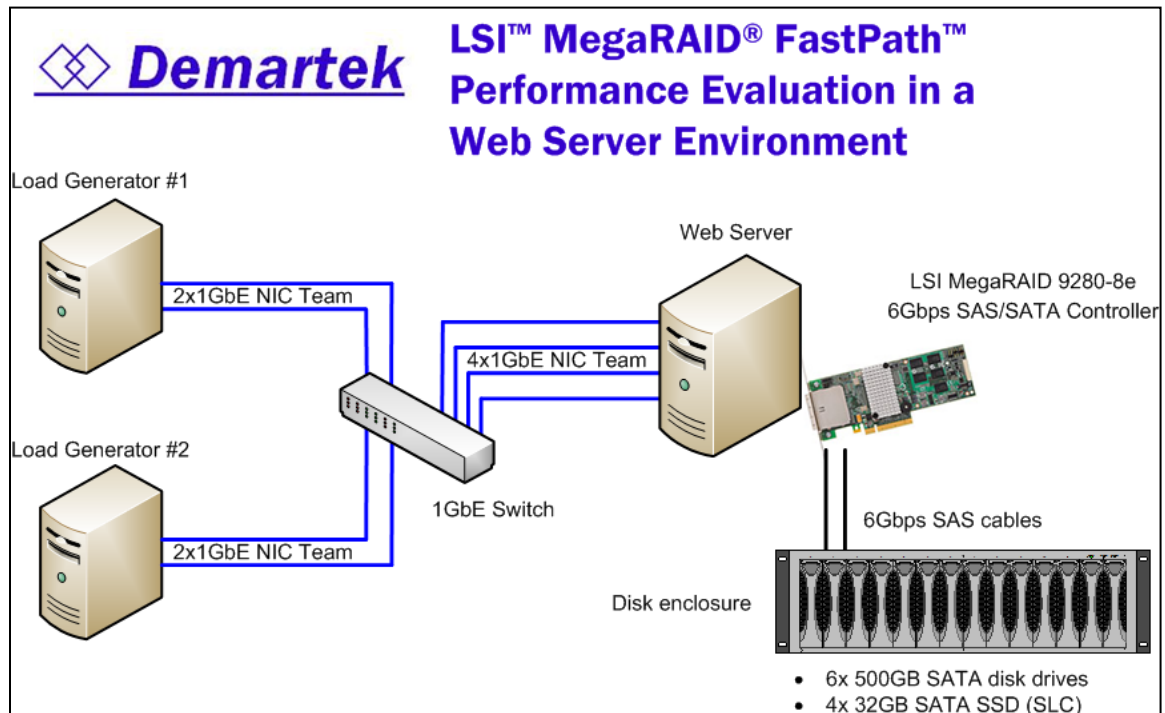
These tests were conducted in the Demartek lab in Arvada, Colorado using Demartek servers, disk drives and networking infrastructure. LSI supplied the MegaRAID controller card and disk enclosure. The web server content was created by Demartek and run on Windows Server 2008 R2 with IIS 7.5.

Evaluation Summary

The MegaRAID FastPath software provides outstanding performance improvements to the web server tested here. By moving the web server content data to SSDs under FastPath software control, we observed more than 12x performance improvement in overall throughput and an even greater improvement in web server response time. These tests show that the MegaRAID FastPath solution with SSDs can improve the performance of existing web servers or can provide the same performance with fewer web servers, lowering the total cost of ownership. Further, operating expenses can be reduced significantly with the removal of HDDs from the server's storage subsystem.

1 - Test Environment

These tests were conducted using a relatively simple web server design that represents a web hosting server with many websites containing primarily static, read-only data.



Web Server Configuration

- SuperMicro X8DTH-6F, PCIe 2.0
- Dual Intel Xeon E5540, 2.53GHz, 8 total cores, 16 logical processors
- 8GB RAM
- 2x Motherboard 1GbE NIC for general LAN traffic
- 2x Intel PRO/1000 PT dual-port 1GbE Server Adapters (4x1GbE NIC Team) dedicated to web server test traffic
- LSI MegaRAID 9280-8e 6Gbps SAS/SATA RAID controller
 - Firmware 2.100.03-0921
 - Driver: megasas2.sys, 4.30.0.64, July 15, 2010
- Disk enclosure containing
 - 6x Seagate Barracuda 7200.11 500GB SATA disk drives.
 - Test 1: Six-drive RAID-10 disk group configured as two 100GB logical volumes, one for the operating system and one for the web server content.
 - Test 2: Two-drive RAID-1 disk group configured as one 465GB logical volume for the operating system.
 - 4x Intel X25-E 32GB SLC SSDs.
 - Test 1: No SSDs used for Test 1.
 - Test 2: Four-drive RAID-10 disk group configured as one 58GB logical volume for the web server content.

- Windows Server 2008 R2 Enterprise Edition with IIS 7.5

Load Generator Configuration (x2)

- Dell PowerEdge 2900
- Dual Intel Xeon E5345, 2.33 GHz, 8 total cores
- 48GB RAM
- 2x Motherboard 1GbE NIC for general LAN traffic
- Intel PRO/1000 PT dual-port 1GbE Server Adapter (2x1GbE NIC Team) dedicated to web server test traffic
- Windows Server 2008 R2 Enterprise Edition
- NeoLoad 3.1 web load generator software

Network Switch

- Dell PowerConnect 2748, 48-port 1Gb Ethernet switch

Network Configuration

In order to ensure that the network was not the bottleneck, teamed, dual-port 1GbE NICs were installed into the load generators and into the web server to provide increased network bandwidth for the web server test traffic. The teamed NICs were configured with Static Link Aggregation. The web server test traffic was dedicated to the teamed NICs and any general LAN traffic was handled by the 1GbE motherboard NICs. The client load generators and the web server were connected to the same 1Gb Ethernet switch, and the appropriate switch ports were configured into Link Aggregation Groups (LAG). The network latency in this configuration was less than 1 ms between the load generators and the test web server.

Web Server Client Load Generator

A web server load tool, NeoLoad, from Neotys software, was used to generate the client load on the web server. The NeoLoad load generators were installed onto two servers that provided the client workloads. The NeoLoad console was installed onto one of the servers acting as a load generator.

Web Server Content

The web server had the following characteristics:

- Approximately 23GB of content on the operating system volume, including the paging file
- Approximately 40GB of content on the web server data volume
- Approximately 1.48 million files of web content data
 - 80,000 HTML text pages
 - Approximately 1.4 million graphic images (JPEG and PNG)

Web Server Activity

The website requests and responses had the following characteristics:

- Requests randomly referenced the entire 40GB and 1.48 million files approximately evenly over the entire duration of the 90-minute tests.
- Each request for an HTML page returned unique HTML text and eleven or twelve unique graphic images.
- Web server workload tuned to reproduce typical throughput.

2 – SSS Technology as Primary Storage

Deploying SSS as primary storage, where the user places data directly on the solid state media is one of the ways to deploy SSD technology. When the user knows that certain data is or will be frequently accessed, placing it directly on the SSDs provides significant performance improvement over spinning disks, especially for random read and write intensive application workloads. The tasks for the administrator include identifying the appropriate data and configuring the appropriate amount of SSD.

In order to test this primary storage SSD implementation, we deployed a web server with direct attached storage (DAS) using a 6Gb/s SAS MegaRAID controller with the FastPath feature that could be enabled. The DAS storage enclosure included a combination of spinning disk drives and solid state drives. Using a web load generator application, we sent at least 100,000 requests to the web server over 90-minute periods of time, and took several measures of web page and web server performance. We ran two tests, varying the storage configuration for each test. Both tests used six drives in the disk enclosure and used mirroring technology (RAID-1 or RAID-10) for enhanced availability of the operating system and the web server content data.

- **Test 1:** A six-drive, 7200 RPM SATA RAID-10 configuration of spinning drives only were used for the operating system and web content. Two logical volumes of 100GB each were created using the MegaRAID controller, one for the operating system and one for the web server content data.
- **Test 2:** A two-drive, 7200 RPM SATA RAID-1 configuration of spinning drives was used for the operating system and a four-drive RAID-10 configuration of SSDs was used for the 40GB of web server content. One logical volume for each RAID group was used, using the full formatted capacity of each, which was 465GB for the RAID-1 spinning drives and 58GB for the RAID-10 SSDs.

Demartek also evaluated deploying solid state storage as a cache in a similar environment. These reports are part of a series of reports evaluating the LSI MegaRAID SSD management functions. These reports are available at the following locations.

- [Demartek Publishes Evaluation of LSI MegaRAID CacheCade Performance](#)
- [Demartek Publishes Evaluation of LSI MegaRAID FastPath Performance](#)

3 – Test Results

Our tests consisted of 90-minute runs with the client load generators making at least 100,000 web server requests, using different storage configurations. These client requests accessed the entire 40GB of web content randomly and approximately evenly. Many of the web pages were accessed multiple times during each test.

We disabled the default compression of data in IIS 7.5 so that as much data and I/O as possible would be pushed through the storage subsystem. We disabled and removed all “8dot3” short filenames on the web server to improve NTFS metadata processing.

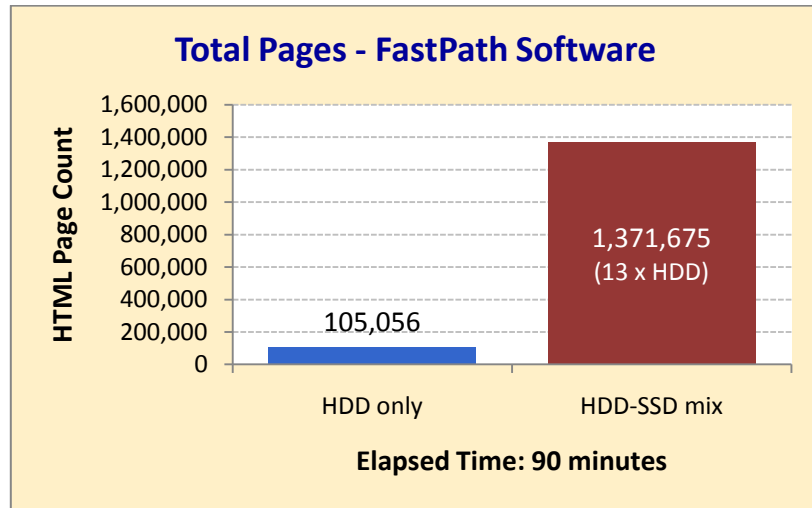
General Performance Overview

As expected, there were significant performance improvements when the web server content data was moved to the SSDs. We also noticed that the SSDs “ramped-up” very quickly to full performance.

Fewer 7200 RPM SATA drives (two-drive RAID-1 versus 6-drive RAID-10) were needed in the Test-2 configuration because all of the web content workload was serviced by the SSDs (four-drive RAID-10), with the two-drive RAID-1 being used for hosting the OS. The result is significantly higher performance with lower overall data storage power consumption.

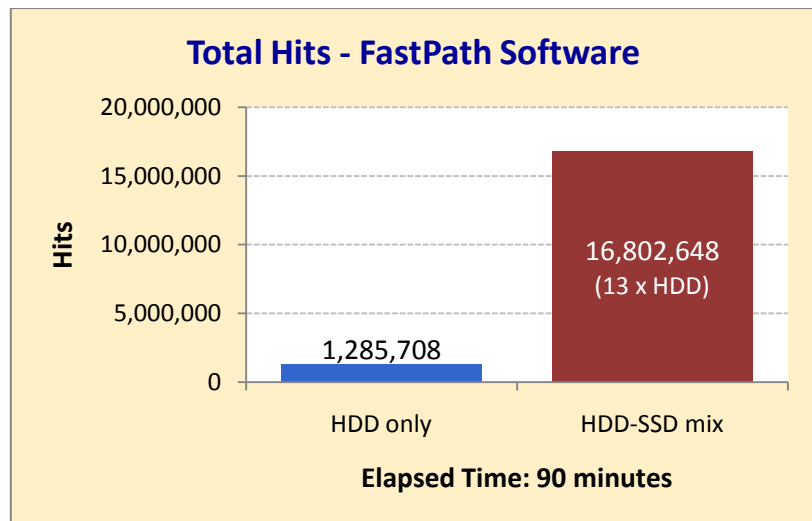
Total Pages

There were 80,000 unique HTML pages of web content. The client load generators accessed these pages randomly and evenly throughout the tests.



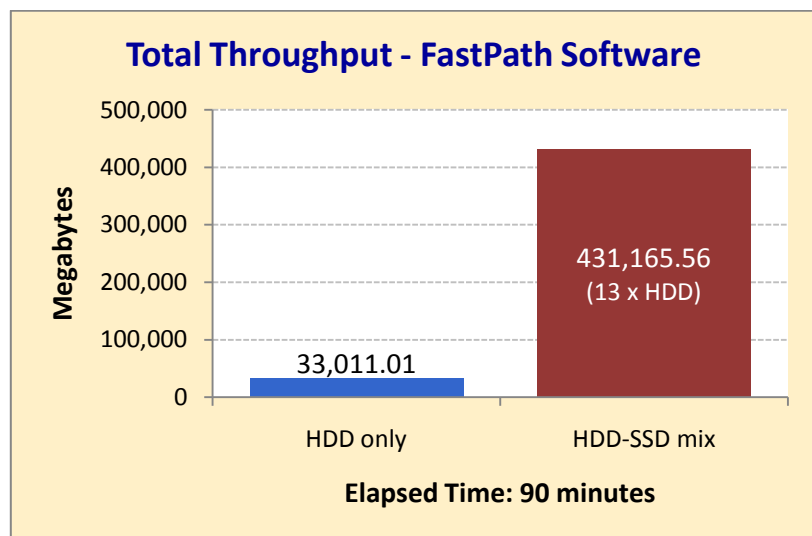
Total Hits

A web “hit” is an access of any file on the web server. For these tests, each HTML page request resulted in the access of one page of text and eleven or twelve graphic images, resulting in twelve or thirteen “hits” per request.



Total Throughput

Throughput is a measure of the total number of Megabytes transferred from the web server to the clients over the duration of the test.



Performance Ramp-up

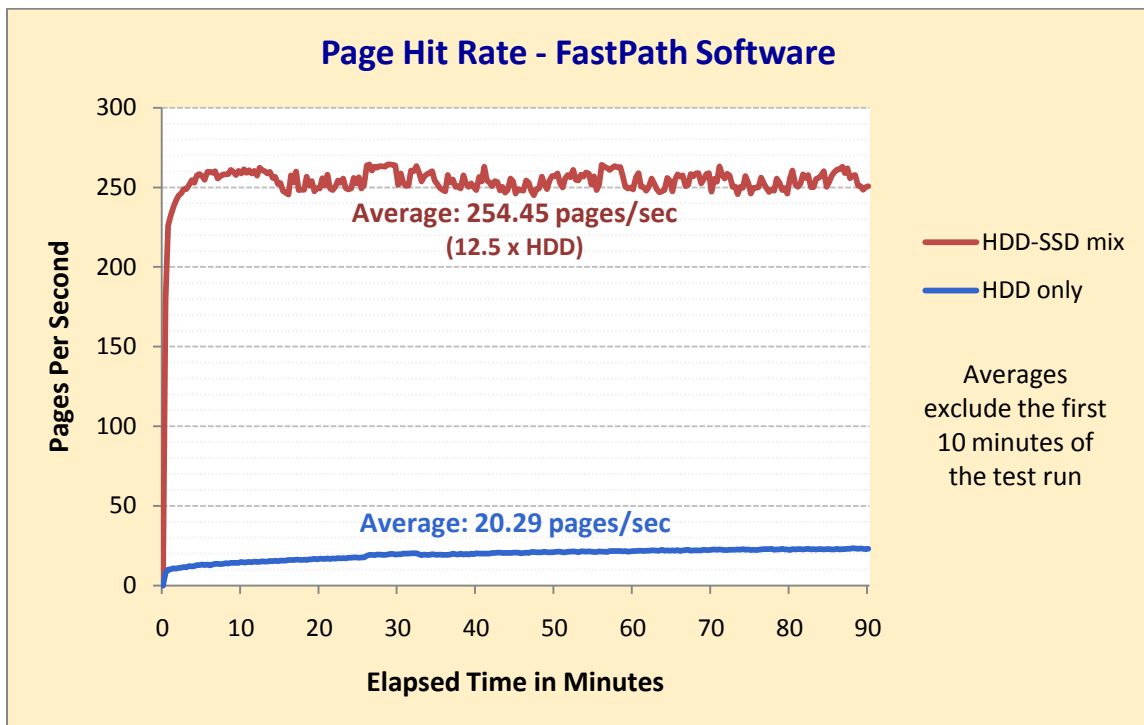
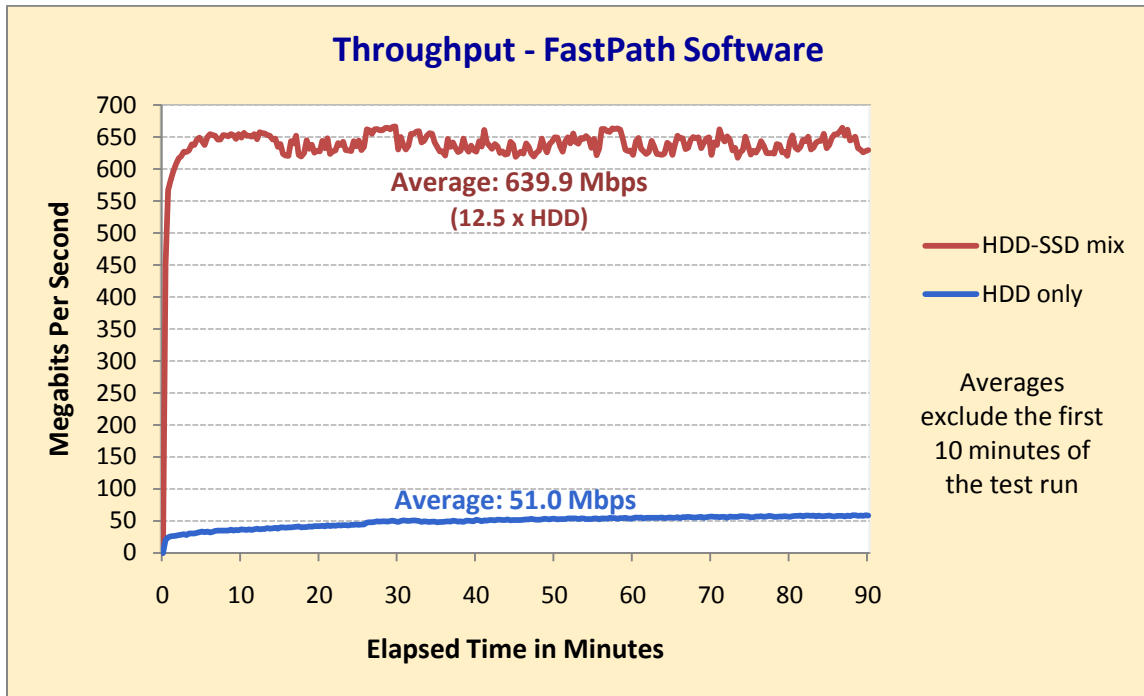
Before each test run, the web server and load generators were rebooted to insure that there was no data leftover in their system and storage caches.

The following charts show various measures of the performance characteristics over the duration of the test runs. These performance rates are measured at the clients and include the full end-to-end transaction.

- **Throughput** - Megabits per second of data transfer from the web server to the clients as a results of the client requests
- **Page Hit Rate** - Hits per second of the HTML web content files accessed by the clients. This total counts the HTML text page and all the graphics images for that page as one page hit.
- **Average Page Response Time** - This is the average time, in seconds, to return the complete HTML page from the web server to the client.
- **Average Time to First Byte (TTFB)** - This is the average time, in seconds, for the client to receive the first byte of the response from the web server.

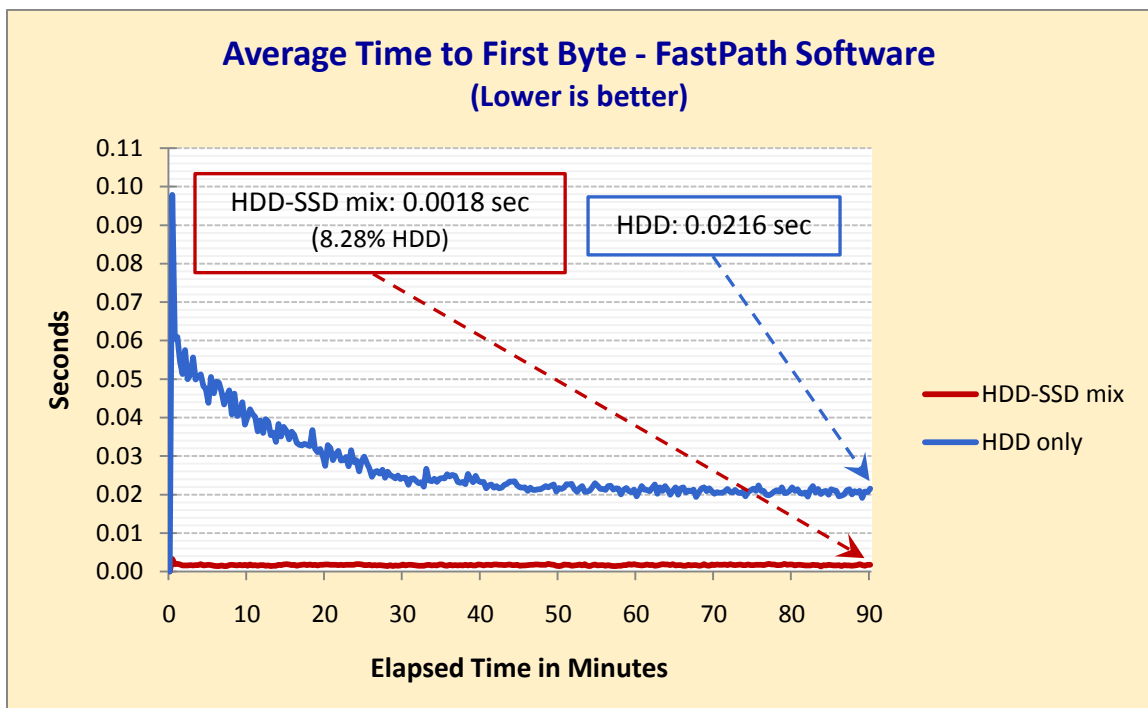
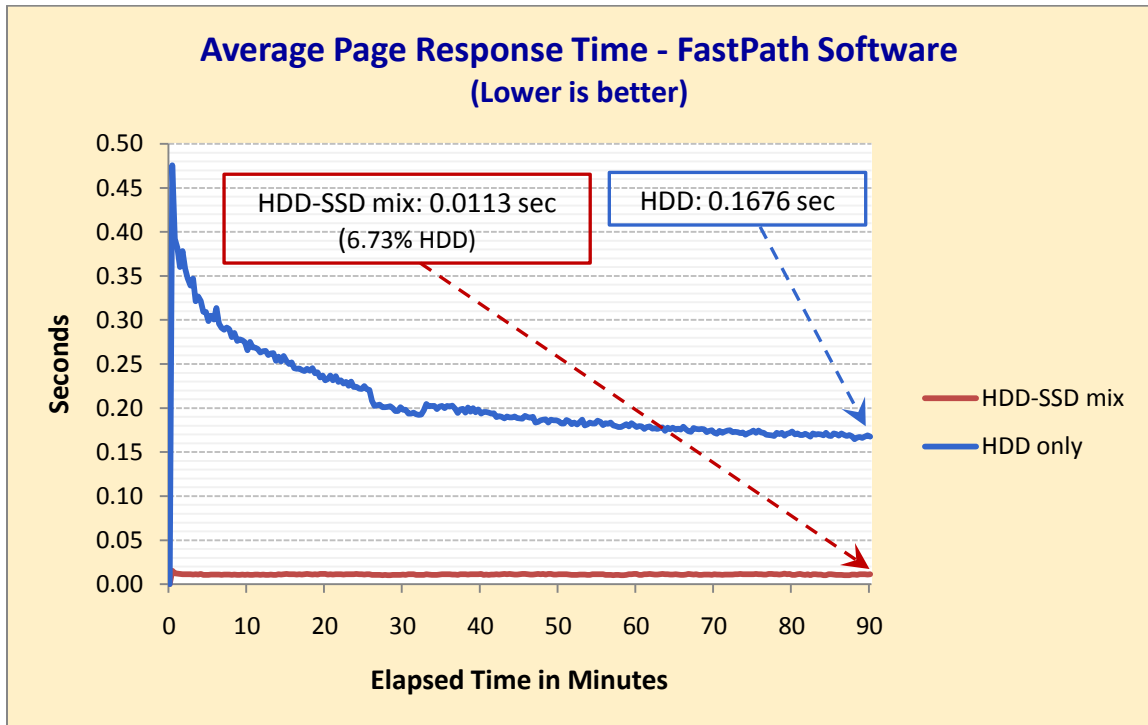
The difference in performance for these web server tests was dramatic. The SSD configuration performance climbed to its maximum performance levels within the first few minutes and sustained those rates for the duration of the test.

These tests show that adding SSDs with FastPath software improves the website user experience and supports more concurrent users with fewer web servers or significantly extends the performance of existing web servers, any or all resulting in a reduced total cost of ownership.

Server Performance

Server Responsiveness

Various studies have shown that even slight improvements in web site responsiveness improve the user's perception of the quality of the web site. FastPath software with SSDs provides dramatic improvement in responsiveness by reducing the average response time to less than 0.02 seconds.



4 – Total Cost of Ownership

Total cost of ownership (TCO) calculations should be included when making technology acquisition decisions. TCO includes not only the initial capital expense (CapEx) but also includes ongoing operational expenses (OpEx).

FastPath and CapEx

The capital expense for server data storage is typically higher when replacing HDDs with SSDs. However, by using FastPath software with SSDs, the total capital expense is reduced because the total number of servers needed to satisfy performance requirements is reduced.

FastPath and OpEx

Operational expenses are also reduced by using FastPath software and SSDs. Each web server in this type of configuration consumes less electric power than it would using the same number of spinning hard disk drives. Power consumption can be further reduced by using fewer servers each configured with FastPath software and SSDs.

Summary and Conclusion

The LSI MegaRAID FastPath software for SSD primary storage provides outstanding performance improvements for the web server application that we tested. In addition, the SSDs that we added to this configuration are less expensive than adding DRAM memory in order to achieve similar performance benefits.

We observed at least 12x performance improvements in all measurements that we collected when comparing the hard-drive-only performance to the SSD performance for the web server content data. This performance improvement was observed in raw throughput and in response time.

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