NETAPP TECHNICAL REPORT

The NetApp Performance Acceleration Module in File Services Workloads

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EXAMINING SPECSFS2008 RESULTS WITH THE PERFORMANCE ACCELERATION MODULE

NetApp published the results of three SPEC® SPECsfs2008 benchmarks on February 3, 2008. These results demonstrated the NFSv3 file services performance of the NetApp® FAS3140 platform. Using a system with a large number of drives for a baseline, NetApp also submitted two additional configurations that included the NetApp Performance Acceleration Module (PAM). In each of these results we demonstrated the effect of the PAM technology by reducing the number of drives necessary to reach the same or better performance while decreasing the space and power requirements. In this paper, we will walk you through the submitted results, how the Performance Acceleration Module changed performance, and the configurations of the systems we tested.

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INTRODUCTION

1 SUMMARY OF SPEC®SFS2008 RESULTS

1.1 THE CONFIGURATIONS

NetApp submitted three results for SPECsfs2008 over NFS, each of which was for the FAS3140 storage system. The first submission is based on a FAS3140 controller with 16 disk shelves of 15,000 RPM Fibre Channel drives, totaling 224 disk drives. In the next configuration we used the same drive types but added a Performance Acceleration Module to the solution, enabling the reduction of half the drives (to 112 disks). Also, a configuration with 8 disk shelves of 112 SATA disk drives was submitted. Each of the configurations showed very similar performance characteristics in the results, demonstrating the ability of PAM to provide acceleration while reducing required drive counts.

1.2 SPECSFS2008 PERFORMANCE

The results are described in the SPECsfs2008 user's guide as follows:

SPECsfs2008 results summarize the server's capabilities with respect to the number of operations that can be handled per second, as well as the overall latency of the operations. A minimal SPECsfs2008 result will contain ten load points and the results of the server at each of the requested load points. Each load point presents a requested number of operations per second.

So, when looking at throughput numbers, higher is better. In each of the submitted configurations the throughput was consistent, differing by less than 0.3% from the baseline figure of 40,109 SPECsfs2008_nfs.v3 ops/sec .

Also mentioned in the quote, latency is measured along with throughput at each load point. The load point latencies are then summarized in the results as the Overall Response Time, or ORT. When looking at an ORT, lower is better; the requests are being responded to quicker. In the results, the ORT of the baseline system was 2.59 ms. The system with the PAM card and half the Fibre Channel disk shelves achieved a result 35% lower (faster) with an ORT of 1.68 ms and the SATA-based submission was only 6% off the baseline Fibre Channel configuration with an ORT of 2.75ms.

In addition to these figures, we also include reference points in the table below for storage capacity, electricity usage, and rack space.

SPECSFS2008 SUBMISSIONS AND RESULTS

	Baseline Submission: No PAM, 224 FC Disks	Second Submission: PAM and 112 FC Disks	Third Submission: PAM and 112 SATA Disks
Configuration	FAS3140 controller; 16 x 144GB 15k RPM FC shelves (224 spindles)	FAS3140 controller; 8 x 144GB 15k RPM FC shelves (112 spindles); 1 PAM card per controller	FAS3140 controller; 8 x 500GB SATA shelves (112 spindles); 1 PAM card per controller
Throughput SPECsfs2008_nfs.v3 ops/sec	40,109	**~SAME** (40,107)	**~SAME** (40,011)
Overall Response Time	2.59 ms	**35% faster** (1.68 ms)	6% slower (2.75 ms)
Raw Capacity	~32TB	50% less (~16TB)	**75% more (~56TB)**
Electricity Usage	Reference point	**47% less**	**54% less**
Rack Space	Reference point	**44% less**	**44% less**

Table 1) PAM creates equivalent or better performance for 112-drive SATA and 112-drive Fibre Channel SPECsfs2008 submissions.

2 HOW DOES THE PERFORMANCE ACCELERATION MODULE IMPROVE PERFORMANCE?

The Performance Acceleration Module adds additional capabilities to NetApp storage systems in the form of intelligent caching. It has three modes that provide granularity to the type of data cached. In the submissions, we used the default mode that caches normal user data. The other two modes allow the caching of metadata only: one mode for workloads with exceptionally large working sets and a mode for low-priority data that allows the module to cache items that would normally be kept with a much lower priority. Large sequential reads and recent writes are good examples of this kind of data.

The PAM module is PCI Express based, with 16GB of DRAM per device. Depending on the system, up to five modules may be installed to provide up to 80GB of contiguous space available to the storage system.

Data that is stored and then retrieved from the PAM module is accessible in about a millisecond or less; a busy disk might take 10 milliseconds or longer for an IO to complete. By replacing disk reads with reads from PAM, the system performance is accelerated and fewer disks are required to reach the same performance levels.

In the baseline submission above, 224 disks are needed to reach the level of throughput: The amount of capacity is mandated by the performance requirement. In the second example, only half (112) of the Fibre Channel disks are needed because the Performance Acceleration Module is able to satisfy operations at much lower latency. This not only resulted in fewer drives in the second submission, but a 35% reduction in the ORT.

The effect is that extra, potentially unneeded storage capacity need not be implemented to meet a performance requirement.

3 HOW DOES THE PERFORMANCE ACCELERATION MODULE IMPROVE DATA CENTER EFFICIENCY?

By decoupling performance requirements from capacity requirements, PAM can allow you to implement only the amount of hardware required for either performance or capacity. The third example in the table above demonstrates this point. When reducing the latency of operations, PAM enables a system with SATA disk drives to closely approach the performance of a system with Fibre Channel drives in a SPECsfs2008 submission. This is accomplished while also reducing by half the number of drives in the test.

The large capacity of SATA drives then brings the additional benefit of 75% more storage capacity, a 44% reduction in electrical power requirements, and 54% less rack space for the solution.

This is particularly significant because of the technology behind SATA. Running at 7,200 RPMs instead of the 15,000 RPMs of Fibre Channel enterprise drives, SATA draws less power and has a higher spatial density. Alone, this is a good combination, but the slower rotational speed means less performance. PAM removes the performance barrier in the third submission, making SATA viable for both its storage capacity and reduced power.

4 TESTED CONFIGURATIONS

In this section, we look at the specifics of the tested configurations. In each of them, the system was based on the NetApp FAS3140; identical clients and networks were also utilized. The only variables were the reduction of drives from the baseline, the addition of PAM to the solution, and the change to SATA drives in the third submission.

4.1 BASELINE SUBMISSION: FAS3140, 224 FC 15,000 RPM DISK DRIVES

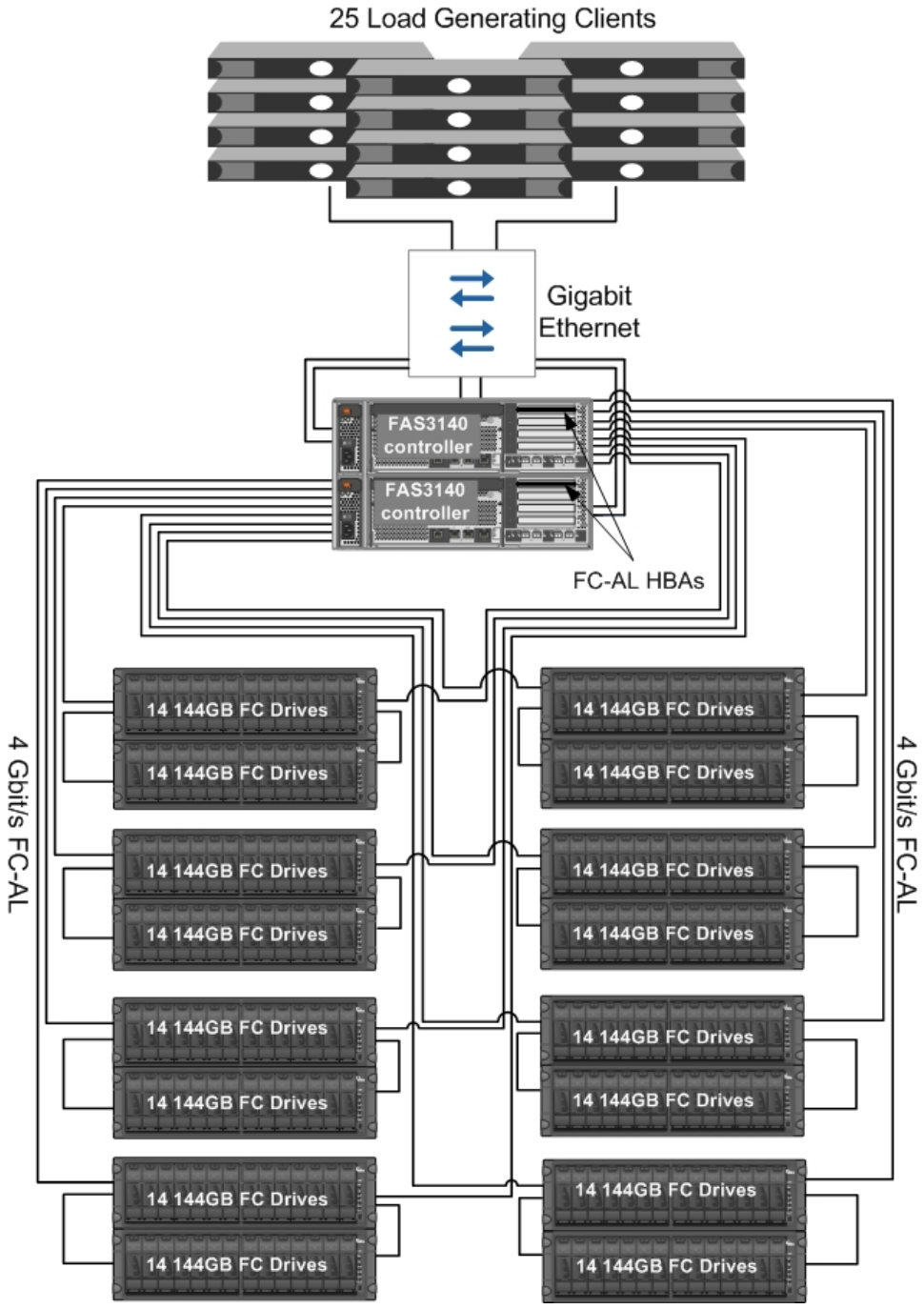

Figure 2) Each storage controller has 8 disk shelves. The shelves are connected with both primary and secondary paths to the controllers. There are a total of 224 disks in the solution.

The baseline submission is based on a FAS3140 controller and 224 Fibre Channel disk drives, and does not include the Performance Acceleration Module. The SPECsfs2008 results for this configuration are 40,109 SPECsfs2008_nfs.v3 ops/sec with an Overall Response Time of 2.59 ms.

4.2 SECOND SUBMISSION: FAS3140, 112 FC DRIVES WITH PAM

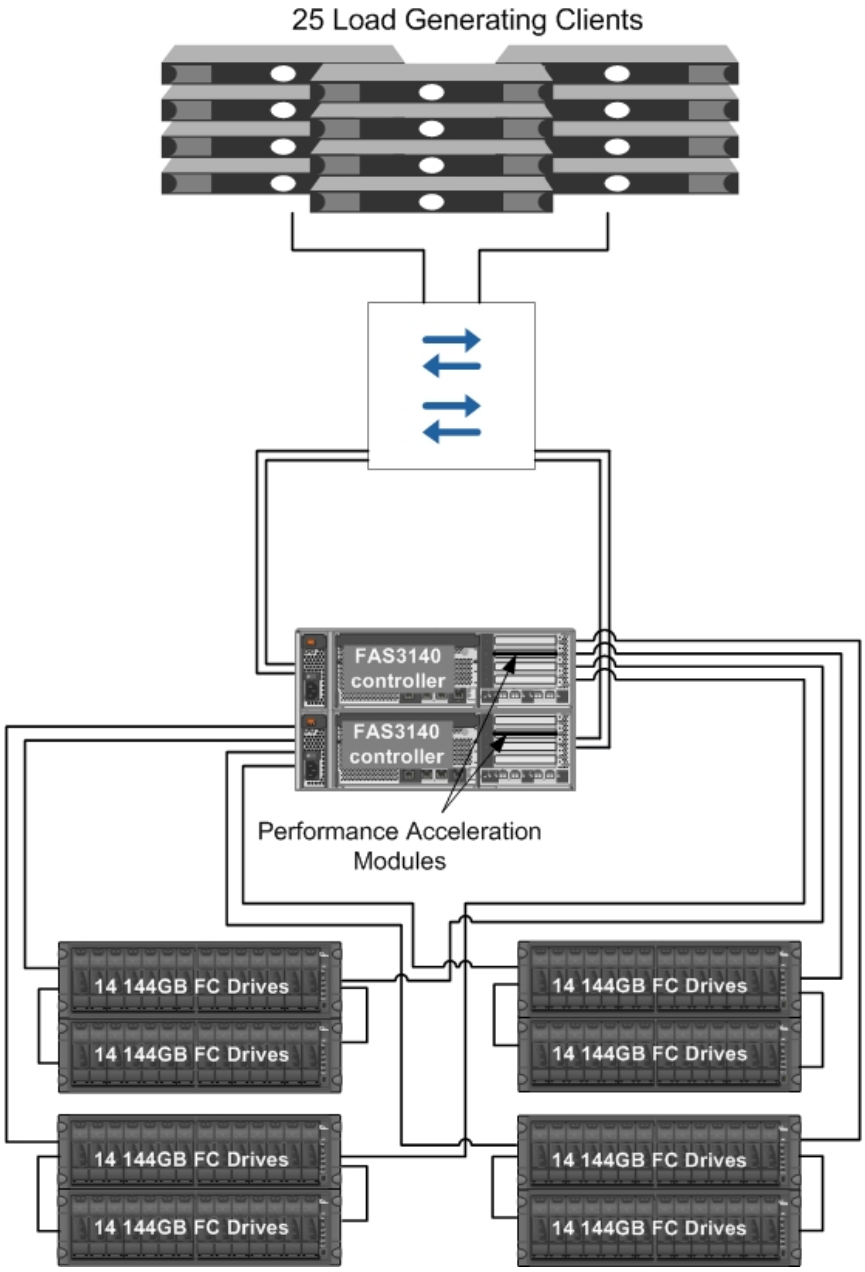

Figure 2) Each storage controller has 4 disk shelves. The shelves are connected with both primary and secondary paths to the controllers. There are a total of 112 disks in the solution.

The second submission used the same FAS3140 controller. It included half the number of drives as the baseline at 112 disks and included two Performance Acceleration Modules, one per controller. The SPECsfs2008 results for throughput were consistent at 40,107 SPECsfs2008_nfs.v3 ops/sec while the Overall Response Time improved by 35% from the baseline to 1.68 ms.

As can be seen in comparing the two diagrams, the reduction in drives resulted in a direct reduction in disk shelves, saving 47% on electricity and reducing rack space by 44%.

4.3 THIRD SUBMISSION: FAS3140, 112 SATA DRIVES WITH PAM

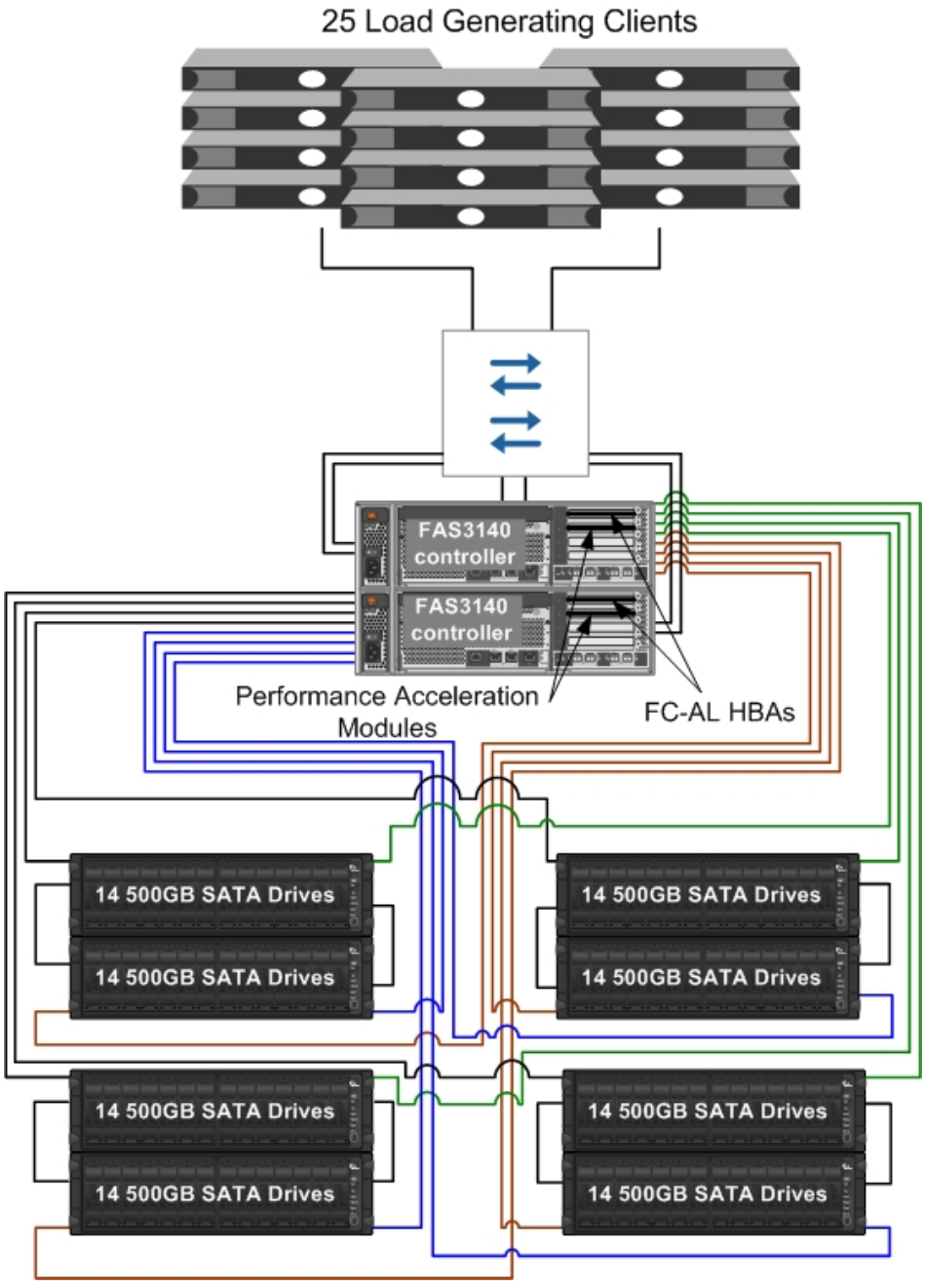

Figure 3) For each shelf pair, half the disks were owned by one storage controller. There are a total of 112 disks in the solution.

The third submission used the same FAS3140 controller. The disk drives in the solution changed from Fibre Channel to SATA and used half the number of drives as the baseline at 112 disks. It included two Performance Acceleration Modules, one per controller. The SPECsfs2008 results for throughput were consistent at 40,011 SPECsfs2008_nfs.v3 ops/sec while the Overall Response Time increased by 6% to 2.75 ms.

As can be seen in comparing the diagrams, the reduction in drives resulted in a direct reduction in disk shelves, saving 54% on electricity and reducing rack space by 44%. The use of the larger capacity SATA drives also increased storage capacity by 75% over the baseline.

5 LINKS TO SPECSFS2008 RESULTS

The results and other information about SPECsfs2008 can be found at http://www.spec.org. For each specific result:

Baseline Submission: FAS3140 with 224 Fibre Channel drives

http://www.spec.org/sfs2008/results/res2009q1/sfs2008-20081215-00110.html

Second Submission: FAS3140 with 112 Fibre Channel drives plus PAM

http://www.spec.org/sfs2008/results/res2009q1/sfs2008-20081215-00111.html

Third Submission: FAS3140 with 112 SATA drives plus PAM

http://www.spec.org/sfs2008/results/res2009q1/sfs2008-20081215-00112.html

6 WHY YOU CAN'T COMPARE SPECSFS2008 WITH SPECSFS97

SPECsfs2008 includes a number of changes to the benchmark that make it unrealistic to compare or extrapolate performance from the older versions. Its documentation includes the following guidance:

The SPECsfs2008 release of the benchmark includes major workload and functionality changes, as well as clarification of run rules. The code changes compared to earlier SFS versions were NOT performance neutral, therefore ***comparing SPECsfs2008 results with SFS 3.0 results is NOT allowed****.*

In accordance with this guidance, NetApp recommends only comparing SPECsfs2008 to other SPECsfs2008 submissions. Any other comparisons will not prove useful .

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