

The Benefits of Server-Side Flash with VMware vSphere Flash Read Cache and FlashSoft Software from SanDisk on Hitachi Compute Blade 500

Lab Validation Report

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April 20, 2015

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Server-side flash is best used when leveraged as caching for the purpose of I/O acceleration, and not as primary storage. Read caching (and write through) is currently the best use case for server-side flash, in the context of server and desktop virtualization. This read caching using server-side flash in a VMware environment can be enabled by a VMware native feature called vFlash Read Cache (vFRC) or 3rd party software such as FlashSoft software from SanDisk.

This lab validation report shows an example of how to scale out the number of Virtual Machines (VMs) per ESXi host by using server-side flash, and how 80% VM density improvement was achieved as shown in Figure 1.

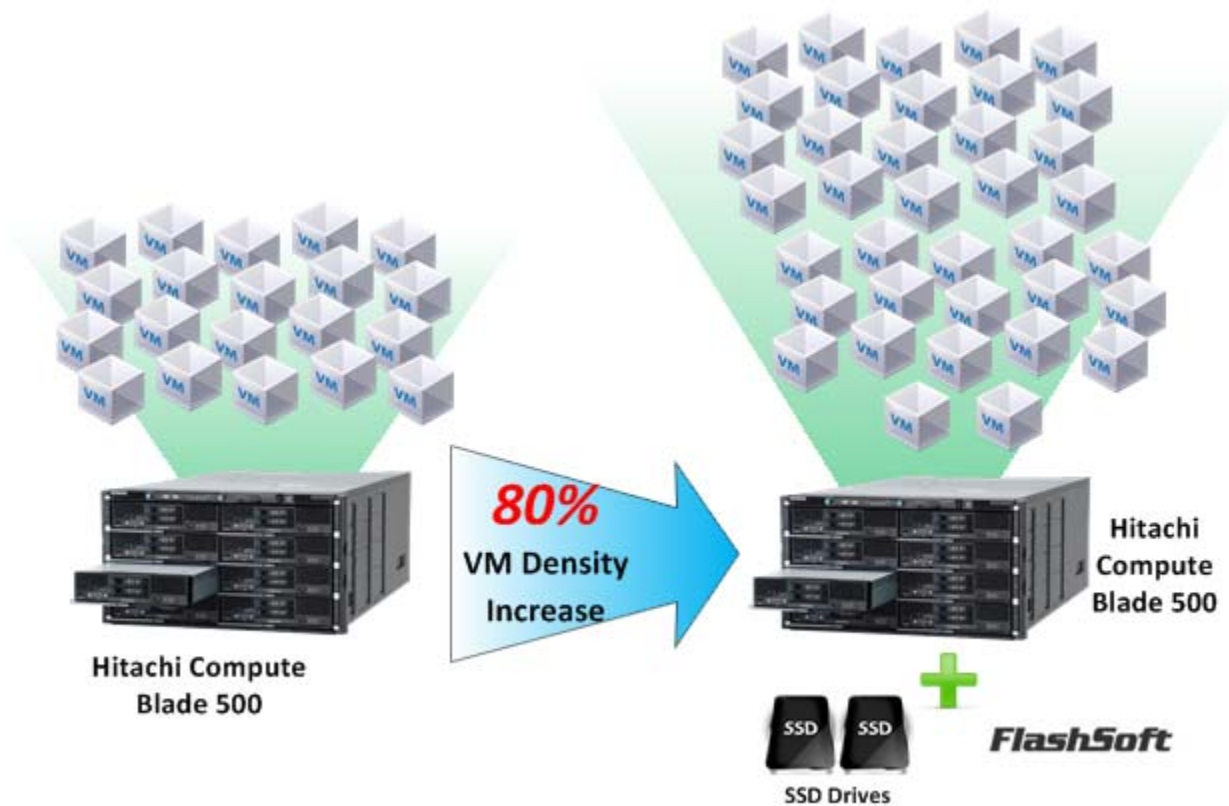


Figure 1

This paper also provides guidance for the following questions:

- What type of workload will benefit from server-side flash?
- Is there a difference between VMware native vFRC and 3rd party software such as FlashSoft software from SanDisk?
- How many more VMs can be deployed with server-side flash with different workloads?

This paper is intended for storage or data center administrators implementing storage within a VMware vSphere environment.

Note — Testing of this configuration was in a lab environment. Many things affect production environments beyond prediction or duplication in a lab environment. Follow the recommended practice of conducting proof-of-concept testing for acceptable results in a non-production, isolated test environment that otherwise matches your production environment before your production implementation of this solution.

Product Features

The following are the hardware and software products tested for this report.

Hitachi Virtual Storage Platform G1000

Hitachi Virtual Storage Platform G1000 provides an always-available, agile, and automated foundation that you need for a continuous infrastructure cloud. This delivers enterprise-ready software-defined storage, advanced global storage virtualization, and powerful storage.

Supporting always-on operations, Virtual Storage Platform G1000 includes self-service, non-disruptive migration and active-active storage clustering for zero recovery time objectives. Automate your operations with self-optimizing, policy-driven management.

Virtual Storage Platform G1000 supports Oracle RAC and VMware Metro Storage Cluster.

Hitachi Compute Blade 500

[Hitachi Compute Blade 500](#) combines the high-end features with the high compute density and adaptable architecture you need to lower costs and protect investment. Safely mix a wide variety of application workloads on a highly reliable, scalable, and flexible platform. Add server management and system monitoring at no cost with Hitachi Compute Systems Manager, which can seamlessly integrate with Hitachi Command Suite in IT environments using Hitachi storage.

The Hitachi Compute Blade 500 chassis contains internal Fibre Channel and network switches for the high availability requirements of Hitachi Unified Compute Platform for VMware vSphere.

Brocade Storage Area Network Switches

[Brocade and Hitachi Data Systems](#) have collaborated to deliver storage networking and data center solutions. These solutions reduce complexity and cost, as well as enable virtualization and cloud computing to increase business agility.

This lab validation report uses the following Brocade products:

- [Brocade 6510 Switch](#)
- [Brocade VDX 6740 Data Center Switch](#)

VMware vSphere 5

[VMware vSphere 5](#) is a virtualization platform that provides a datacenter infrastructure. It features vSphere Distributed Resource Scheduler (DRS), High Availability, and Fault Tolerance.

VMware vSphere 5 has the following components:

- **ESXi 5** — This is a hypervisor that loads directly on a physical server. It partitions one physical machine into many virtual machines that share hardware resources.
- **vCenter Server** — This allows management of the vSphere environment through a single user interface. With vCenter, there are features available such as vMotion, Storage vMotion, Storage Distributed Resource Scheduler, High Availability, and Fault Tolerance.

VMware vSphere Flash Read Cache

VMware vSphere 5.5 introduces new functionality to leverage flash storage devices on a VMware ESXi host. The vSphere Flash Infrastructure layer is part of the ESXi storage stack for managing flash storage devices that are locally connected to the server. The flash resource created by the vSphere Flash Infrastructure layer can be used for read caching of virtual machine I/O requests (vSphere Flash Read Cache).

The goal of the vSphere Flash Read Cache (vFRC) feature is to enhance performance of certain I/O workloads that exhibit characteristics suitable for caching. Please note that the vFRC feature requires a VMware Enterprise Plus license.

FlashSoft Software from SanDisk for VMware vSphere

[FlashSoft software from SanDisk for VMware vSphere](#) enables a solid-state storage device (SSD) to function as a cache for frequently accessed hot data in a server. FlashSoft software is installed as an ESXi kernel module within the vSphere operating system. By caching the hot data on a high-speed SSD installed on the server, access times are reduced and applications spend less time waiting for data.

Test Environment Configuration

Engineers from Hitachi Data Systems tested this environment in the Hitachi Data System laboratory using Hitachi Compute Blade 500 and Hitachi Virtual Storage Platform G1000.

Table 1 describes the details of the components used.

Table 1. Infrastructure Components

<i>Hardware</i>	<i>Description</i>	<i>Version</i>	<i>Quantity</i>
Hitachi Virtual Storage Platform G1000	<ul style="list-style-type: none"> ■ 4 × 8 Gb/sec Fibre Channel ports ■ 36 GB cache memory allocated by CLPR ■ 24 × 900 GB 10k RPM SAS disks, 2.5 inch SFF used 	80-02-01-00/00	1
Hitachi Compute Blade 500 chassis	<ul style="list-style-type: none"> ■ 8-blade chassis ■ 2 Brocade 5460 Fibre Channel switch modules, each with 6 × 8 Gb/sec uplink ports ■ 2 Brocade DCB 6746 Ethernet switch modules, each with 8 × 10 Gb/sec uplink ports ■ 2 management modules ■ 6 cooling fan modules ■ 4 power supply modules 	SVP: A0231-C-9652 5460: FOS 7.0.2c DCB 6746: NOS 4.1.2	1
520BH3 server blade	<ul style="list-style-type: none"> ■ Half blade ■ 2 × 18-core Intel Xeon E5-2666 processors, 2.30 GHz ■ 256GB RAM <ul style="list-style-type: none"> ■ 6 × 16 GB DIMMs 	BMC/EFI: 74-15	3
Brocade 6510	<ul style="list-style-type: none"> ■ SAN switch with 48 × 8 Gb Fibre Channel ports 	FOS 7.0.0a	2
Brocade VDX 6740	<ul style="list-style-type: none"> ■ Ethernet switch with 40 × 10 Gb/sec ports 	NOS 4.1.2	2

Software Components

Table 2 describes the software used in this testing.

Table 2. Software Components

<i>Software</i>	<i>Version</i>
Hitachi Storage Navigator	Microcode Dependent
Hitachi Dynamic Provisioning	Microcode Dependent
VMware vCenter server	5.5.0
VMware ESXi with Enterprise Plus license	5.5.0
FlashSoft Software from SanDisk	3.2
Microsoft® Windows Server® 2008	Enterprise edition, R2,SP1

Network Infrastructure

The network design used in this environment provided ample bandwidth and redundancy based on [Hitachi Unified Compute Platform for VMware vSphere](#).

SAN Infrastructure

The Hitachi Virtual Storage Platform G1000 controller used in this environment has 32 ports for connections to the Brocade 6510 enterprise fabric switches.

The Hitachi Compute Blade 500 HBAs were zoned to four ports on the Hitachi Virtual Storage Platform G1000 controller.

Figure 2 illustrates the physical SAN connections. Following best practice, this environment used two Brocade 6510 switches to create two separate fabrics.

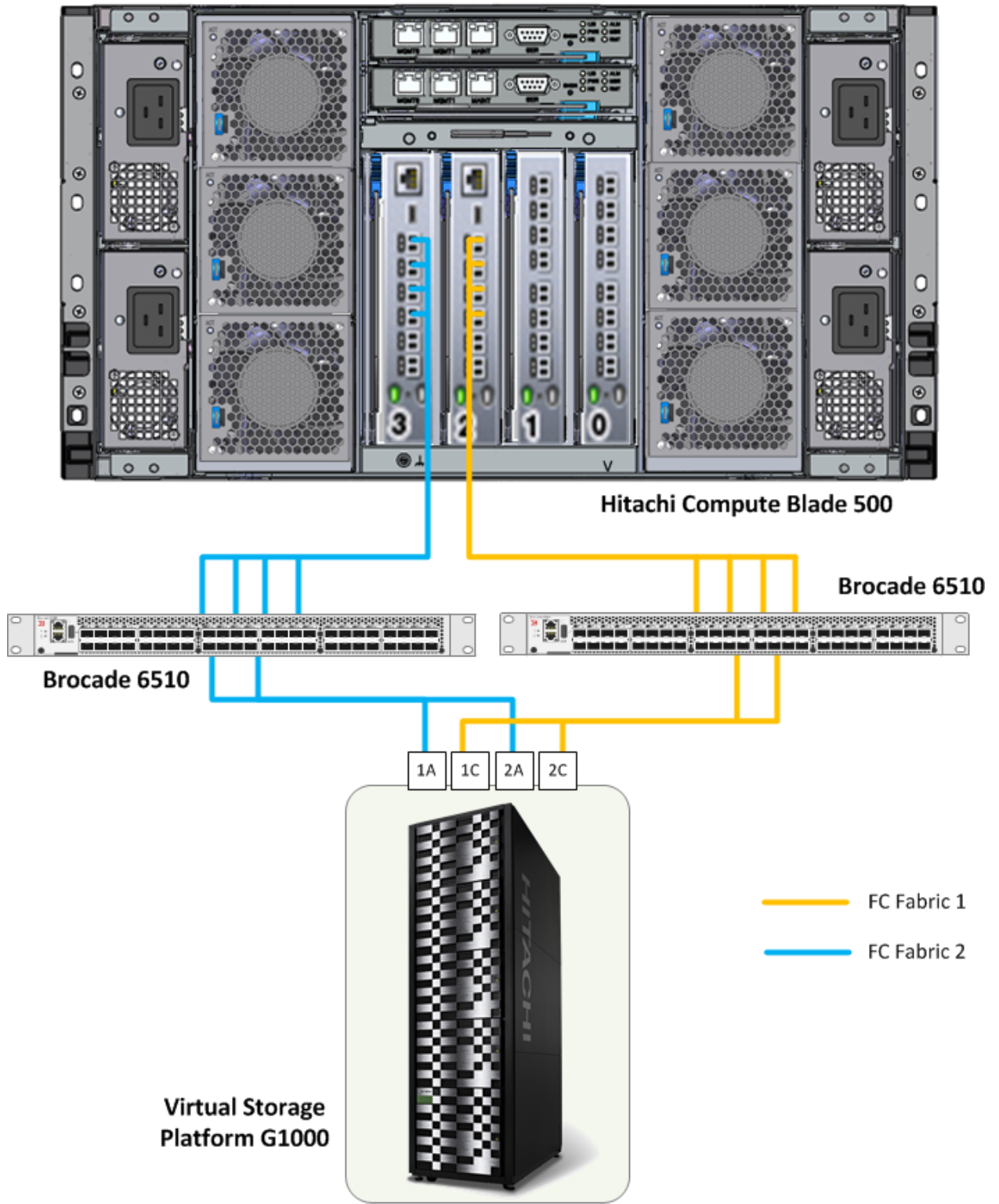


Figure 2

Hitachi Virtual Storage Platform G1000 is built with multiple controllers to provide input-output hardware-based load balancing. For the best performance and reliability, this environment used at least two ports from each controller. At least two unique paths exist from the ESXi host to the storage system to maximize availability. The multipathing policy was set to **round robin** in ESXi.

Figure 3 shows the zone configuration used for this testing.

Table 3. Zone Configuration

<i>Hitachi Compute Blade 500 Blade/Host</i>	<i>Host HBA Number</i>	<i>Fibre Channel Fabric</i>	<i>Zone Name</i>	<i>Storage Port</i>
Blade 0/ESX 0 vFRC	HBA1_1	Fabric 1	CB500_BL0_HBA1_1_ASE47_60_1A_2C	1A, 2C
	HBA1_2	Fabric 2	CB500_BL0_HBA1_2_ASE47_60_1C_2A	1C, 2A
Blade 1/ESX 1 Baseline	HBA1_1	Fabric 1	CB500_BL1_HBA1_1_ASE47_60_1A_2C	1A, 2C
	HBA1_2	Fabric 2	CB500_BL1_HBA1_2_ASE47_60_1C_2A	1C, 2A
Blade 2/ESX 2 FlashSoft	HBA1_1	Fabric 1	CB500_BL2_HBA1_1_ASE47_60_1A_2C	1A, 2C
	HBA1_2	Fabric 2	CB500_BL2_HBA1_2_ASE47_60_1C_2A	1C, 2A

Server-Side Flash – SSD Drive Installation

Two Hitachi Compute Blade 500 server blades were equipped with SSD drives as local cache devices.

Figure 3 shows where to install the SSD drives.

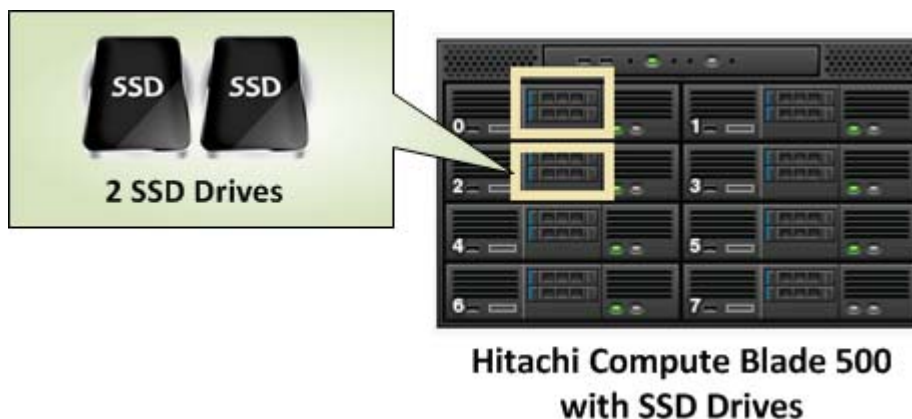


Figure 3

Install two SAS attached SSD drives in the existing 2.5 inch slots.

The ESXi hosts were deployed by VMware Auto Deploy, so no internal storage was used.

Test Methodology

This section describes the test methodology used. The purpose of the tests was to do the following:

- Show the benefit of using server-side flash.
- Compare the VM density improvement between vFRC and FlashSoft on various workloads.

A large number of IOPS need to be generated in order to measure the possible maximum number of IOPS that server-side flash devices can accommodate. To better manage large workloads, a benchmark tool called [Vdbench](#) was used. This tool provides the following advantages for this test:

- Easily defines workloads in detail
- Controls IO rate and run behavior
- Capable of running multiple instances and threads to simulate multiple applications

Test Criteria and Baseline VM Sizing

An adequate number of VMs are needed to show the density increase by using server-side flash. The initial goal is to start with more than ten VMs per ESXi host for each workload. The test criteria are listed below:

- The average I/O response time on the VMs must be 15 milliseconds or less.
- Increase the number of VMs until the average I/O response time exceeds 15 milliseconds.

The following steps were used to determine the number of baseline VMs for each workload.

1. Use one VM to run the Vdbench with the max I/O rate to roughly determine the maximum IOPS.
 2. Divide the maximum IOPS into ten VMs and run the test to validate that the response time is still less than 15 milliseconds.
 3. Increase the number of VMs, and still keep the same maximum aggregated IOPS until it reaches the 15 milliseconds response time threshold.
 - For example, for the Web Server workload, a total maximum of 5500 IOPS were kept for every test run. The number of VMs was increased to 20 and it reached 14.4 milliseconds, which is just below the threshold.
 - Therefore for the baseline of Web Server workload, 20 VMs with 275 IOPS/VM was used.
 - $5500 \text{ (Total IOPS)} \div 20 \text{ (VM)} = 275 \text{ (IOPS/VM)}$
-

Table 4 shows the four workload definitions used for this test.

Table 4. Tile Workload Definitions

<i>Workload</i>	<i>Block Size (KB)</i>	<i>Read %</i>	<i>Random %</i>	<i>IOPS/VM</i>
Microsoft SQL Server®	64	66%	100%	277
Web Server	8	95%	75%	275
Exchange 2007	8	55%	80%	266
OLTP	8	70%	100%	267

Once the baseline VM sizing was determined, the VMs were scaled out using the workload profile outlined in Table 4 for each test case.

Storage Configuration

To allocate the fixed amount of storage cache for this testing, 32 GB of Cache Logical Partition (CLPR) was used on the Virtual Storage Platform G1000.

Figure 4 shows the storage configuration and VMDK creation.

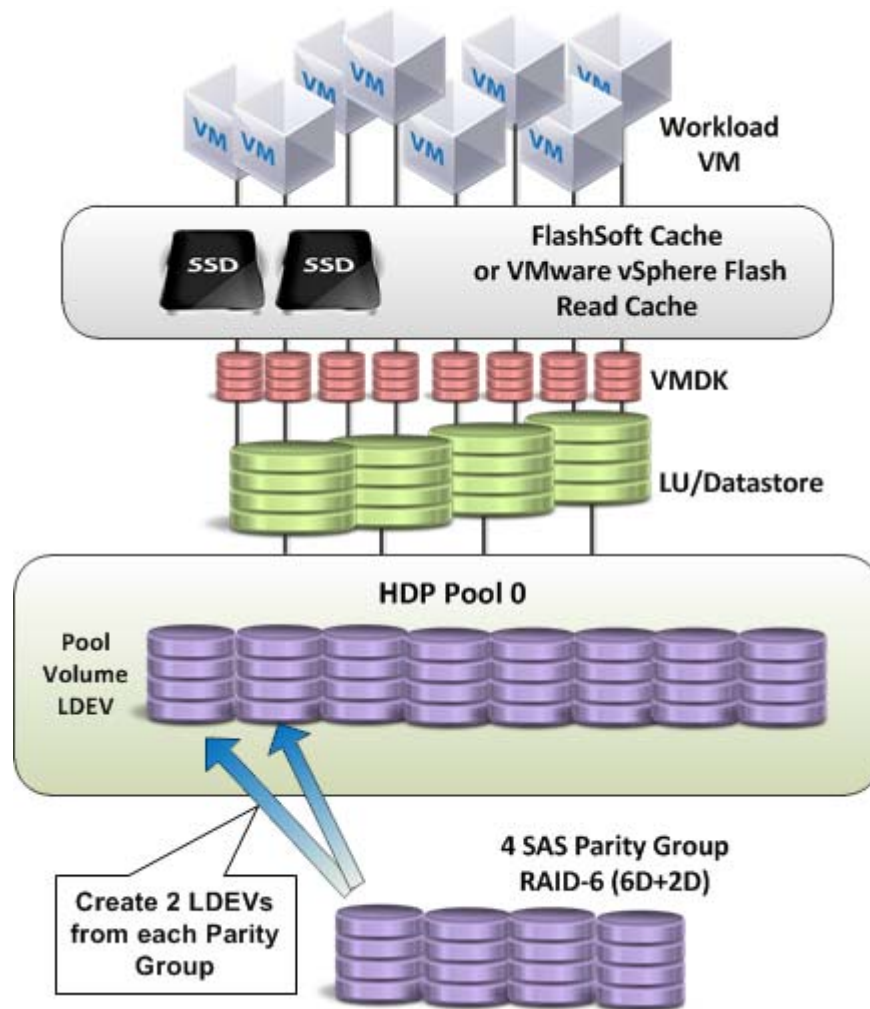


Figure 4

To accommodate a reasonable number of IOPS, four parity groups of RAID-6 (6D+2D) 900 GB 10K SAS were used. The steps for the storage configuration are listed below:

1. Four parity groups of RAID-6 SAS drives were placed in Hitachi Dynamic Provisioning Pool 0. Since the maximum size of an LDEV is 3 TB, to fully utilize the capacity of the 4.7 TB parity group, two LDEVs (3 TB and 1.7 TB) were created as pool volumes.
2. Four virtual volumes were created from Pool 0 and presented as datastores to ESXi hosts.
3. A 40 GB VMDK was created from the datastore and attached to each Vdbench VM as a data volume.
4. For the vFRC test, 8 GB of vFRC cache was manually allocated on each VMDK as VMware recommends 20% of the VMDK capacity.
5. For the FlashSoft test, VM read cache was allocated automatically.

Test Cases

Table 5 lists the three main test cases. All four workloads were executed for each test case. For each workload, the I/O was issued to the target VMDK after four hours of ramp-up run. The data was cached into server-side SSD devices during this ramp-up period.

Table 5. Test Cases

<i>Test Case</i>	<i>Description</i>
Baseline	Run all four workloads without enabling server-side flash features. Determine the IOPS/VM for each workload.
vFRC with SAS SSD	Run all four workloads with vFRC using internal SAS attached SSDs
FlashSoft with SAS SSD	Run all four workloads with FlashSoft using internal SAS attached SSDs

Analysis

This is an analysis from the results of the VMware vSphere Flash Read Cache and FlashSoft software from SanDisk testing.

Figure 5 shows the maximum VM density achieved on each test case. A larger VM number indicates the higher VM density on an ESXi server host.

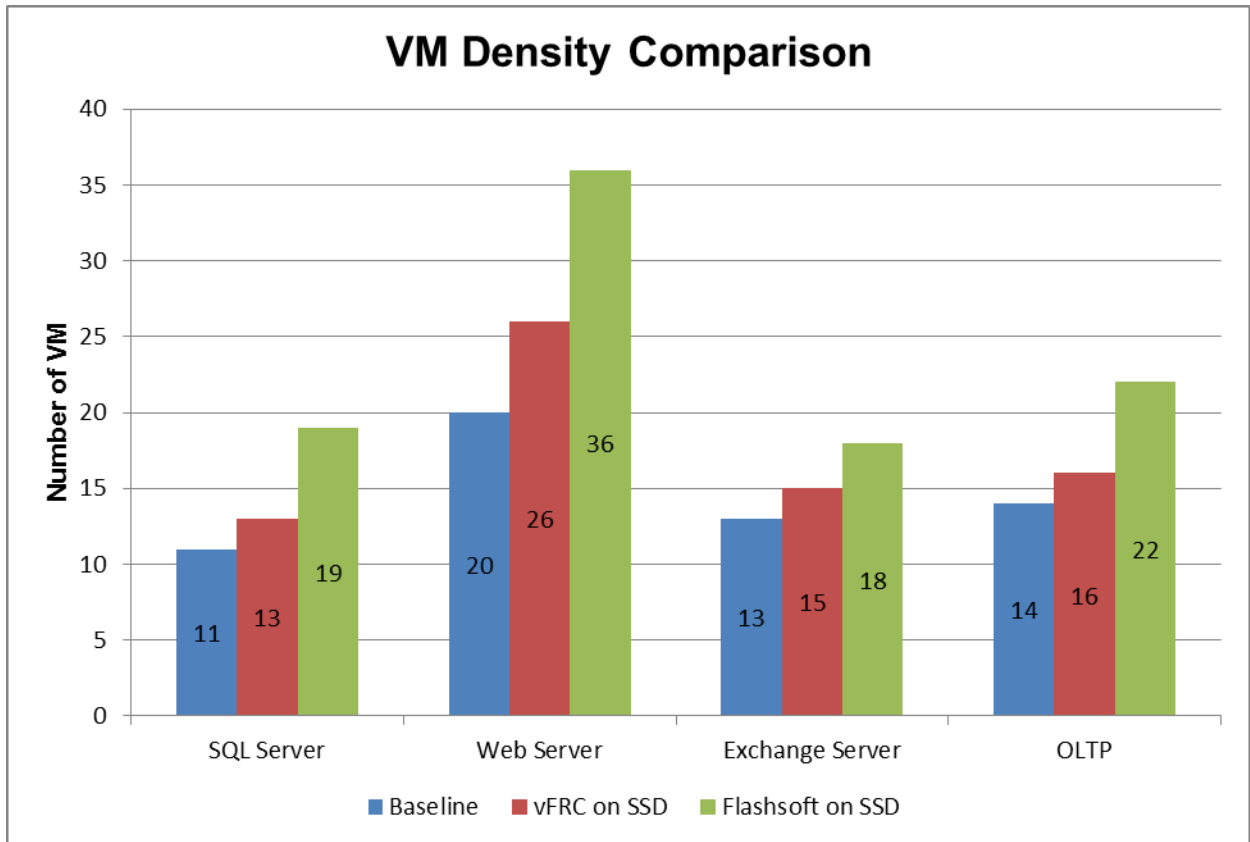


Figure 5

Over all, higher VM density per ESXi host was reached when server-side flash was used. A summary and analysis of the results are listed below:

- For the Web Server workload with FlashSoft, 16 more VMs can be added from the baseline of 20 VMs. This leads to an 80% VM density increase with FlashSoft, whereas vFRC provided a 30% VM density improvement.
 - The server-side flash is most suitable for high-read random workloads like web servers.
 - The results were similar for SQL Server and OLTP workloads. With FlashSoft, the VM density increased between 57% and 72%, and with vFRC, between 14% and 18%.
 - SQL Server and OLTP workloads are also a relatively high-read and random workload, and are candidates for the server-side flash use case.
 - Exchange Server workloads showed the least VM density increase. The improvements were 15% with vFRC and 38% with FlashSoft.
 - Compared to other workloads, the Exchange Server workload has the least read percentage at 55%. This shows that the workload with less read has less benefit from server-side flash.
 - In all workloads, FlashSoft was able to scale out more than vFRC.
 - For vFRC, server-side flash cache needs to be manually allocated to each VM. Following the recommendation from VMware, the capacity of 20% of VMDK size (8 GB cache for 40 GB VMDK) was statically allocated from SSD devices.
 - By default, FlashSoft automatically allocates server-side cache to VMs dynamically. It uses the entire SSD capacity as a pool of cache, and dynamically allocates cache to VMDKs as needed. This leads to better cache usage and higher VM density for FlashSoft.
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Figure 6 shows the average I/O response time for Web Server workload when the test was performed on 20 fixed VMs on each test case. Lower response time indicates higher I/O performance.

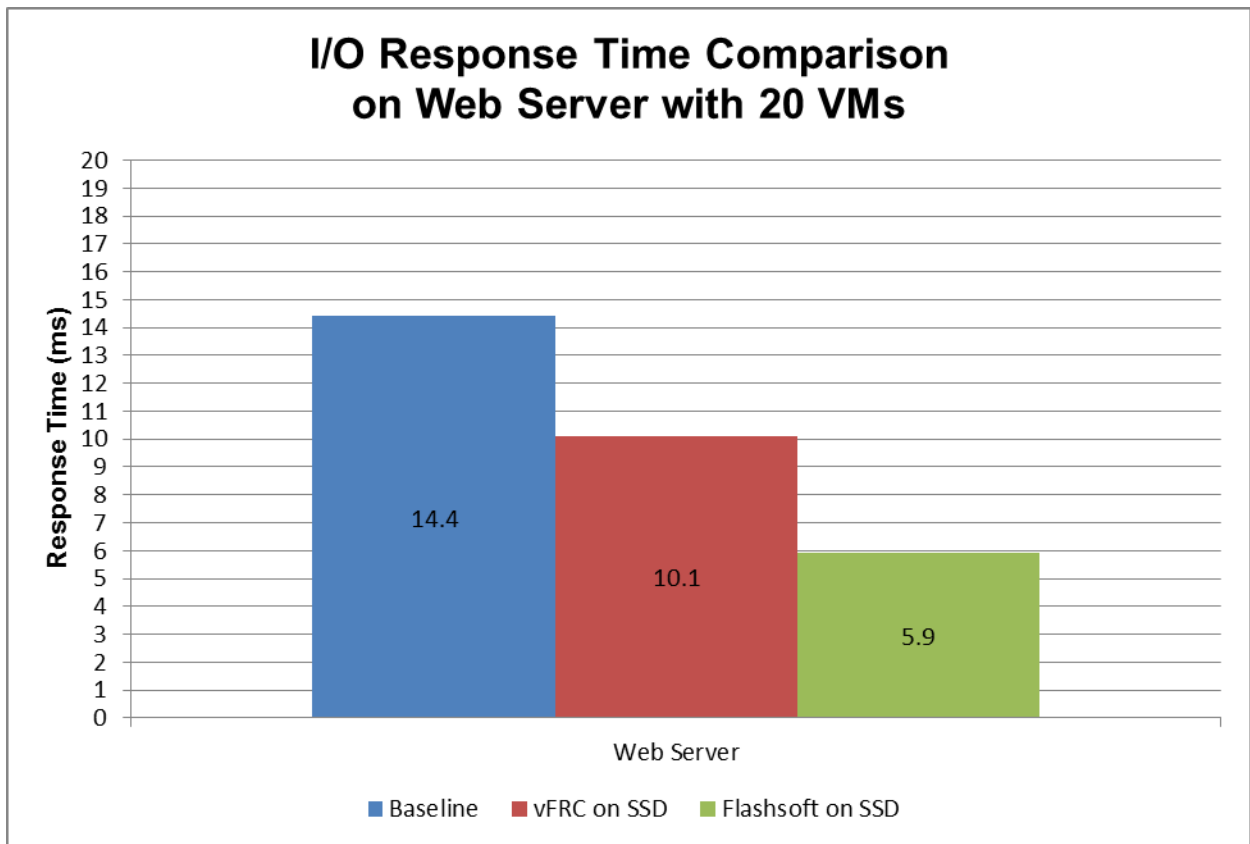


Figure 6

Since the Web Server workload showed the most benefit from server-side flash, the I/O performance data was also captured from the I/O response time perspective. For this workload, I/O response time for FlashSoft improved on average about 59%, and for vFRC it was about 30%. This shows that not only does server-side flash increase VM density per host, it also contributes to overall lower application response times.

Conclusion

On certain workloads, such as high-read random workloads, server-side flash on VMware could provide more VM density per server host, and better application performance. However, not all server-side flash software provides the same amount of improvement and flexibility. From this test, the following characteristics were observed between FlashSoft software from SanDisk and VMware vSphere Flash Read Cache.

- FlashSoft software from SanDisk
 - Entire SSD devices were allocated as a pool of read cache
 - FlashSoft automatically allocates server-side cache to VMs dynamically
 - This could lead to better cache capacity usage and better performance improvement
 - Easier to manage and scale out
- VMware vSphere Flash Read Cache
 - For vFRC, the SSD cache needs to be manually allocated to each VM and VMDK
 - This could lead to underutilized cache capacity and not as much of a performance increase
 - More difficult to size appropriate amount of cache for different workloads
 - Harder to manage and scale out as more manual process is involved

Considerations

The following needs to be considered before deploying VMware server-side flash to your environment.

- The server-side flash provides more benefit if your environment is I/O-bound. This means your applications perform better with faster I/O response. If your environment is bound by other resources, such as CPU, memory, or network, the benefit from server-side flash may be limited.
 - The management and flexibility of server-side flash also become more important as you deploy it in a larger scale.
 - This test was performed as a small scale test without using the full capacity of the SSD devices. The result might be different in larger scale environments.
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Hitachi Data Systems Global Services offers experienced storage consultants, proven methodologies and a comprehensive services portfolio to assist you in implementing Hitachi products and solutions in your environment. For more information, see the Hitachi Data Systems [Global Services](#) website.

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