TECHNICAL PAPER

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Achieve Enterprise-Class Performance with Hitachi Virtual Storage Platform G400 in VMware vSphere Environments

Lab Validation Report

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April 13, 2015

Hitachi Data Systems

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Achieve Enterprise-Class Performance with Hitachi Virtual Storage Platform G400 in VMware vSphere Environments

Lab Validation Report

This lab validation report shows that Hitachi Virtual Storage Platform G400 accommodated more than twice the general server workloads when compared to Hitachi Unified Storage 150 in a VMware vSphere environment. Virtual Storage Platform G400 is the successor to Unified Storage 150.

Hitachi Compute Blade 500 provided server resources in this comparison.

The tested environments are shown in Figure 1 on page 2.

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.

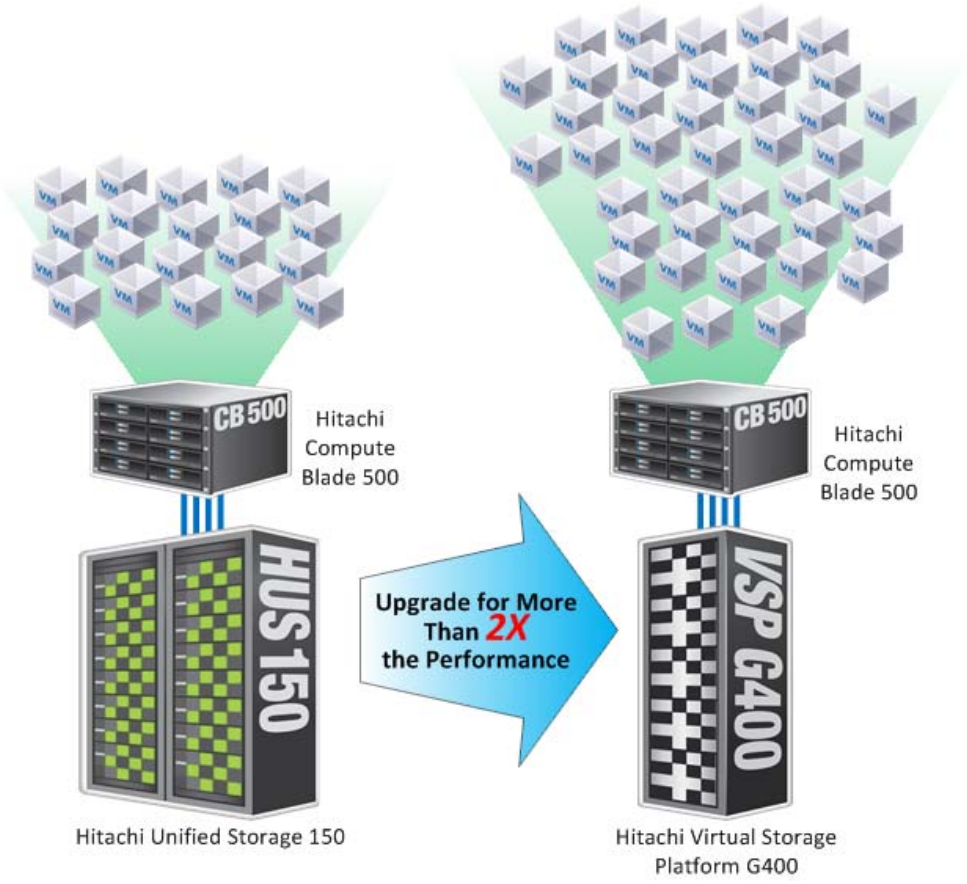
CB 500
Hitachi
Compute
Blade 500
HUS 150
Hitachi Unified Storage 150
Upgrade for More
Than 2X
the Performance
CB 500
Hitachi
Compute
Blade 500
VSP G400
Hitachi Virtual Storage
Platform G400

Figure 1

Product Features

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

Hitachi Virtual Storage Platform Family Systems

The Hitachi Virtual Storage Platform family systems are based on industry-leading enterprise storage technology. With flash-optimized performance, these systems provide advanced capabilities previously available only in high-end storage arrays. With the Virtual Storage Platform family, you can build a high performance, software-defined infrastructure to transform data into valuable information.

Hitachi Storage Virtualization Operating System provides storage virtualization, high availability, superior performance, and advanced data protection for all models in the Virtual Storage Platform family. This proven, mature software provides common features to consolidate assets, reclaim space, extend life, and reduce migration effort. New management software improves ease of use to save time and reduce complexity. The infrastructure of Storage Virtualization Operating System creates a management framework for improved IT response to business demands.

Hitachi Unified Storage

Hitachi Unified Storage is a midrange storage platform for all data. It helps businesses meet their service level agreements for availability, performance, and data protection.

The performance provided by Hitachi Unified Storage is reliable, scalable, and available for block and file data. Unified Storage is simple to manage, optimized for critical business applications, and efficient.

Using Unified Storage requires a smaller capital investment. Deploy this storage, which grows to meet expanding requirements and service level agreements, for critical business applications. Simplify your operations with integrated set-up and management for a quicker time to value.

Unified Storage enables extensive cost savings through file and block consolidation. Build a cloud infrastructure at your own pace to deliver your services.

Hitachi Unified Storage 150 provides reliable, flexible, scalable, and cost-effective modular storage. Its symmetric active-active controllers provide input-output load balancing that is integrated, automated, and hardware-based.

Both controllers in Unified Storage 150 dynamically and automatically assign the access paths from the controller to a logical unit (LU). All LUs are accessible, regardless of the physical port or the server that requests access.

Hitachi Accelerated Flash

Hitachi Accelerated Flash features a flash module built specifically for enterprise-class workloads. Developed for Hitachi Virtual Storage Platform, Accelerated Flash is available for Hitachi Unified Storage VM.

Accelerated Flash features innovative Hitachi-developed embedded flash memory controller technology. Hitachi flash acceleration software speeds I/O processing to increase flash device throughput.

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 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.

- **Brocade 6510 Switch**

  The Brocade 6510 switch delivers market-leading throughput and an affordable switch form factor. The 48 ports produce an aggregate 768 Gb/sec full-duplex throughput. Any eight ports can be trunked for 128 Gb/sec inter-switch links (ISLs).

  Exchange-based dynamic path selection (DPS) optimizes fabric-wide performance and load balancing. It automatically routes data to the most efficient available path in the fabric. It augments ISL trunking to provide more effective load balancing in certain configurations.

- **Brocade VDX 6740 Switch**

  The Brocade VDX 6740 switch delivers VCS Ethernet Fabric technology to meet the needs of the following:

  - Cloud environments
  - Scale-out data center architectures
  - Mission-critical IP storage workloads
  - High performance connectivity to Fibre Channel SANs

  VCS fabric delivers a multipath-based, non-blocking architecture highly optimized for low latency, high bandwidth IP storage traffic. Like Brocade Gen 5 Fibre Channel, VCS fabric provides a highly automated, efficient, and resilient infrastructure.

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.

Test Environment Configuration

The performance comparison testing between Hitachi Virtual Storage Platform G400 and Hitachi Unified Storage 150 took place in the Hitachi Data Systems laboratory using the components listed in this section.

Key Hardware Components

Table 1 describes the key hardware infrastructure components used for testing.

Table 1. Infrastructure Components

Hardware	*Description*	*Version*	*Quantity*
Hitachi Virtual Storage Platform G400	■ 4 × 8 Gb/sec Fibre Channel ports used ■ 32 GB cache memory allocated by CLPR ■ 12 × 1.6 TB Hitachi Accelerated Flash module drives (FMDs) in 1 tray	83-01-01-40/00	1
Hitachi Unified Storage 150	■ 4 × 8 Gb/sec Fibre Channel ports used ■ 32 GB cache memory ■ 12 × 1.6 TB FMDs in 1 tray	0980/A-H	1
Hitachi Compute Blade 500 chassis	■ 8-blade chassis ■ 2 Brocade 6546 Fibre Channel switch modules, each with 6 × 16 Gb/sec uplink ports ■ 2 Brocade VDX 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: A0240-D-9879 6546: FOS 7.2.0_hit DCB 6746: NOS 4.1.3	1

Table 1. Infrastructure Components (Continued)

Hardware	Description	Version	Quantity
520B H3 server blade	■ Half blade ■ 2 × 18-core Intel Xeon E5-2699 v3 processors, 2.30 GHz ■ 256GB RAM ■ 6 × 16 GB DIMMs ■ 4 ports on-board 10 GE CNA ■ 1 × 2 ports Hitachi 16 Gb/sec Fibre Channel mezzanine card	08-22	2
Brocade 6510	■ SAN switch with 48 × 8 Gb/sec Fibre Channel ports	FOS 7.0.0a	2
Brocade VDX 6740	■ Ethernet switch with 40 × 10 Gb/sec ports	NOS 4.1.2	2

Key Software Components

Table 2 describes the key software components used for testing.

Table 2. Software Components

Software	Version
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
SUSE Linux Enterprise Server (Installed on Web server and OLTP workload virtual machines)	11 SP2
Microsoft® Windows Server® 2008 (Installed on Microsoft Exchange and Microsoft SQL Server® workload virtual machines)	SP2

Storage Configuration

To match with the amount of storage cache installed on Hitachi Unified Storage 150 for this test, 32 GB of cache logical partition (CLPR) was used on Hitachi Virtual Storage Platform G400. Following best practice, the VMware VAAI primitives were enabled on Virtual Storage Platform G400.

Figure 2 shows the storage configuration and VMDK layout.

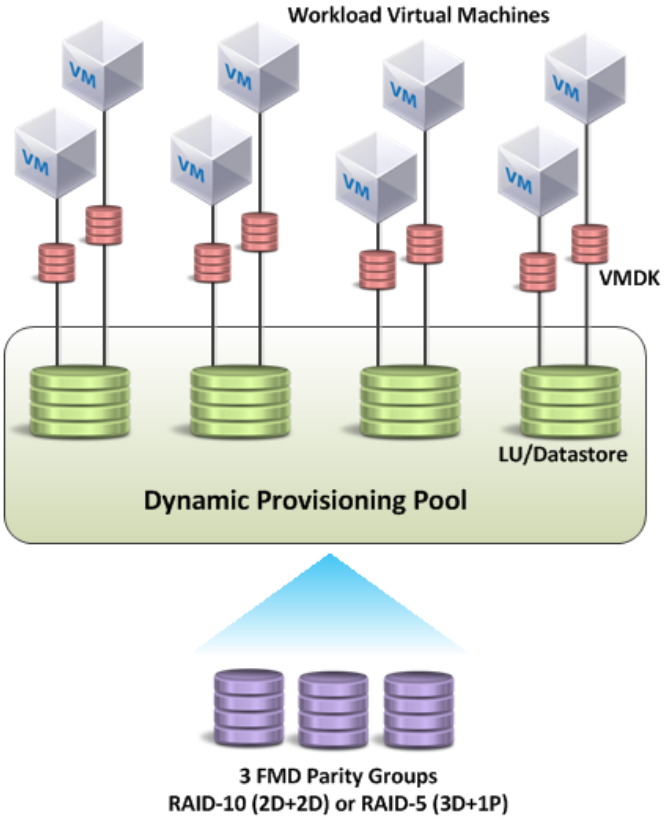

Figure 2

To accommodate a large number of IOPS, three parity groups with 1.6 TB FMD were used. Depending on the test case, the FMD was configured in either RAID-10 (2D+2D) or RAID-5 (3D+1P). The steps for the storage configuration are listed below:

1. Three parity groups of FMD were placed in a dynamic provisioning pool using Hitachi Dynamic Provisioning.
2. Four virtual volumes were created from the dynamic provisioning pool and presented as VMFS datastores to two VMware ESXi hosts.
3. A 100 GB VMDK was created as Eager Zeroed Thick from the datastore and attached to each workload virtual machine as a data volume.
4. Workload virtual machines were evenly distributed across all four datastores and two ESXi hosts.

Mixing the server application with virtual machine workloads defined in Table 3. Tile Workload Definitions in Test Method and Virtual Machine Sizing using the storage configuration described in Figure 2 generates a highly random and storage intensive environment that stresses the storage arrays to yield conservative performance results. The goal of this test configuration is to provide a realistic server virtual machine environment for comparison between the two storage systems.

Network Infrastructure

The network design used in this environment provided ample bandwidth and redundancy. The environment is based on Hitachi Unified Compute Platform for VMware vSphere.

SAN Infrastructure

In this environment, 16 Fibre Channel ports from the Hitachi Virtual Storage Platform G400 controller and Hitachi Unified Storage 150 controller were connected to Brocade 6510 enterprise fabric switches.

The Hitachi Compute Blade 500 HBAs were zoned to four ports on the Virtual Storage Platform G400 controller and Unified Storage 150 controller.

Figure 3 illustrates the physical SAN connections. Following best practice, this environment used two Brocade 6510 switches to create two separate fabrics.

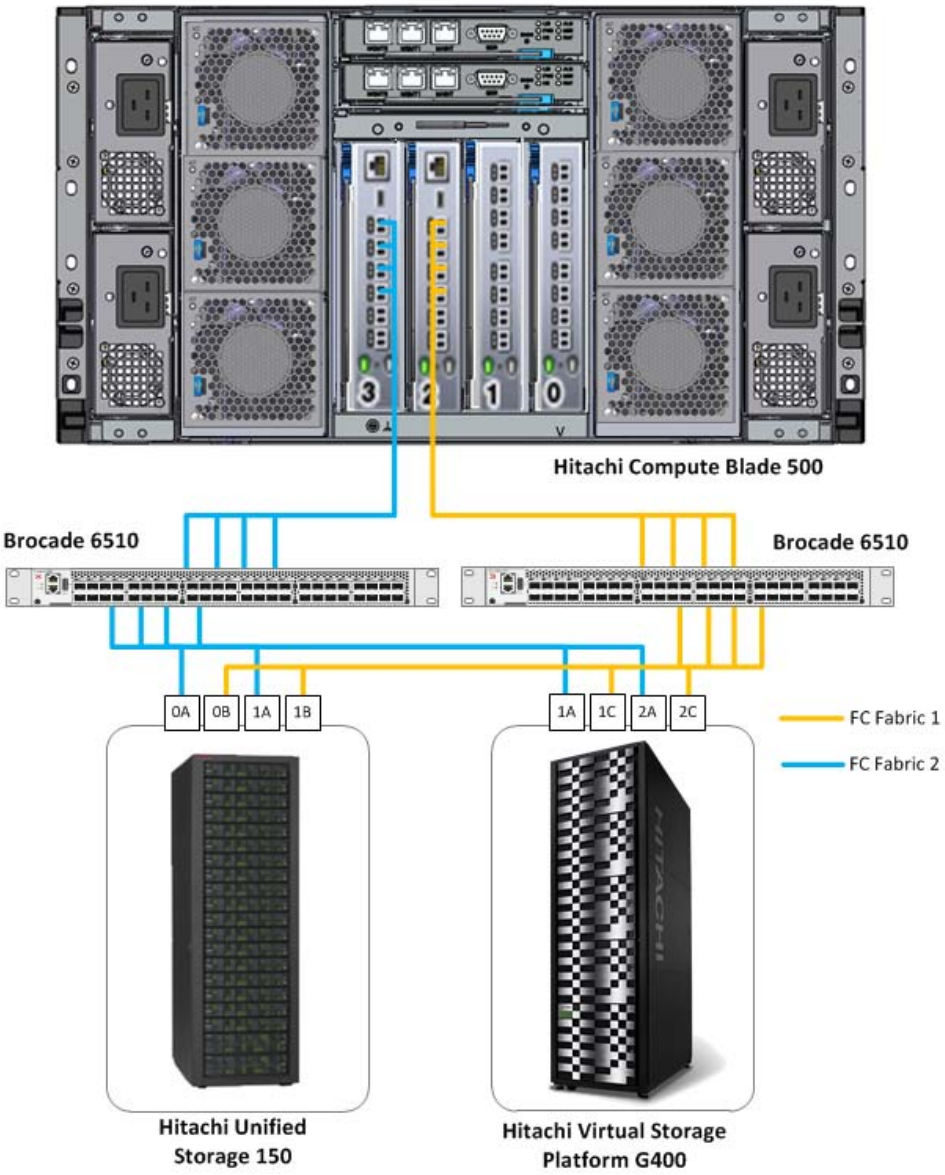

Figure 3

Hitachi storage subsystems are 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 VMware ESXi host to the storage system to maximize availability. The multipathing policy was set to **round robin** in ESXi.

Test Methodology

This is the test methodology used. The purpose of the tests was to determine the performance difference between Hitachi Unified Storage 150 and Hitachi Virtual Storage Platform G400 on a VMware vSphere server workload environment.

A large number of IOPS need to be generated in order to measure the possible maximum number of IOPS that storage controllers 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 I/O rate and run behavior
- Capable of running multiple instances and threads to simulate multiple applications

Test Method and Virtual Machine Sizing

To simulate the general server workloads in the mixed virtualized environment, testing used the workloads listed in Table 3. A set of these four virtual machines with four different workloads is defined as a tile in this paper.

Table 3. Tile Workload Definitions

Workload	*Block Size (KB)*	*Read Percent*	*Random Percent*	*IOPS/ Virtual Machine*	*VMDK Size*
Microsoft SQL Server	64	66%	100%	1280	100 GB
Web Server	8	95%	75%	1280	100 GB
Microsoft Exchange 2007	8	55%	80%	1280	100 GB
OLTP	8	70%	100%	1280	100 GB

For each virtual machine, a 100 GB VMDK size was allocated for the data volume. This allows the number of virtual machines to scale-out up to 96. The virtual machines still fit in the capacity of the 1.6TB FMD in a RAID-10 configuration. The operating system volume for each virtual machine was placed on separate storage to avoid mixing operating system-generated IOPS with the workloads defined above.

In order to measure the maximum performance of the storage from the VMware environment scale-out perspective, the workload was increased incrementally until reaching the maximum. The following workload increments were used.

- Two tiles, or eight virtual machines, per workload increment
  - Evenly distribute workloads to two VMware ESXi hosts
  - One tile, or four virtual machines, per ESXi host
- Increase workload by 10240 (10K) IOPS at a time
  - With eight virtual machines, each virtual machine produces 1280 IOPS

Testing incrementally deploying virtual machines with general server workloads until the storage was unable to meet the target IOPS. This simulated the scaling out the number of virtual machines in phases in a data center.

Test Cases

Table 4 lists the four main test cases. For each test case, the workload was increased by an increment of 10K IOPS and was run for 20 minutes.

Table 4. Test Cases

Test Case	*Description*
RAID-10 (2D+2D) FMD on Hitachi Unified Storage 150	1. Configure FMD to RAID-10 (2D+2D) on Unified Storage 150. 2. Scale out the workload virtual machines. 3. Measure the maximum performance.
RAID-10 (2D+2D) FMD on Hitachi Virtual Storage Platform G400	4. Configure FMD to RAID-10 (2D+2D) on Virtual Storage Platform G400. 5. Scale out the workload virtual machines. 6. Measure the maximum performance.
RAID-5 (3D+1P) FMD on Unified Storage 150	7. Configure FMD to RAID-5 (3D+1P) on Unified Storage 150. 8. Scale out the workload virtual machines. 9. Measure the maximum performance.
RAID-5 (3D+1P) FMD on Virtual Storage Platform G400	10. Configure FMD to RAID-5 (3D+1P) on Virtual Storage Platform G400. 11. Scale out the workload virtual machines. 12. Measure the maximum performance.

Analysis

This is an analysis from the results of the Hitachi Virtual Storage Platform G400 and Hitachi Unified Storage 150 comparative performance testing.

RAID-10 (2D+2D) Performance Comparison

Figure 4 compares the average IOPS and response time between Hitachi Virtual Storage Platform G400 and Hitachi Unified Storage 150 using FMD in a RAID-10 (2D+2D) configuration. These matrices were measured from workload virtual machines.

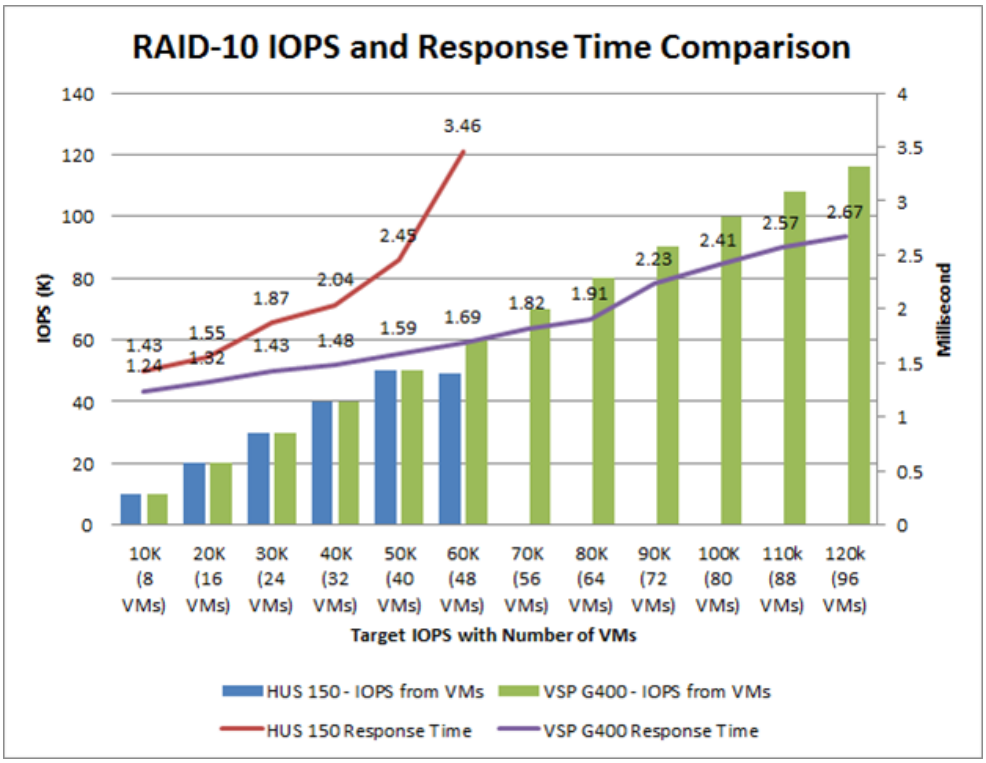

Figure 4

Virtual Storage Platform G400 achieved more than twice the performance when compared to Unified Storage 150 using FMD in a RAID-10 configuration. An analysis of the results follows:

- The maximum number of IOPS reached on Virtual Storage Platform G400 was 119,091 at an average response time of 2.6 milliseconds when the target 120K IOPS was issued from 96 virtual machines.
- The maximum number of IOPS reached on Unified Storage 150 was 51,200 at an average response time of 2.45 milliseconds when the target 50K IOPS was issued from 40 virtual machines.
  - When the target 60K IOPS was issued with 48 virtual machines, the achieved IOPS dropped to 49.1K, and response time increased significantly. This indicates that 60K target IOPS was significantly higher than what the Unified Storage 150 controller can process.
- Virtual Storage Platform G400 achieved 232.6% of IOPS compared to Unified Storage 150 with similar response time.

Figure 5 shows the average processor usage on Virtual Storage Platform G400 and Unified Storage 150.

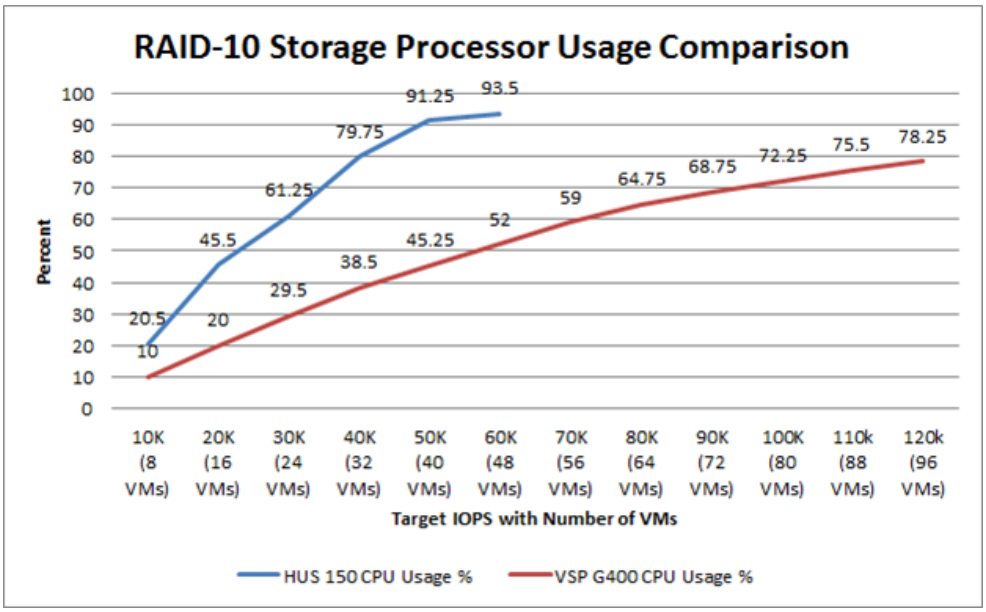

Figure 5

The result shows that the processor usage on Virtual Storage Platform G400 was more than 50% less when compared to the processor usage on Unified Storage 150.

RAID-5 (3D+1P) Performance Comparison

Figure 6 shows the average IOPS and response times of Hitachi Virtual Storage Platform G400 and Hitachi Unified Storage 150 using FMD in RAID-5 (3D+1P) configuration. These matrices were measured from virtual machines.

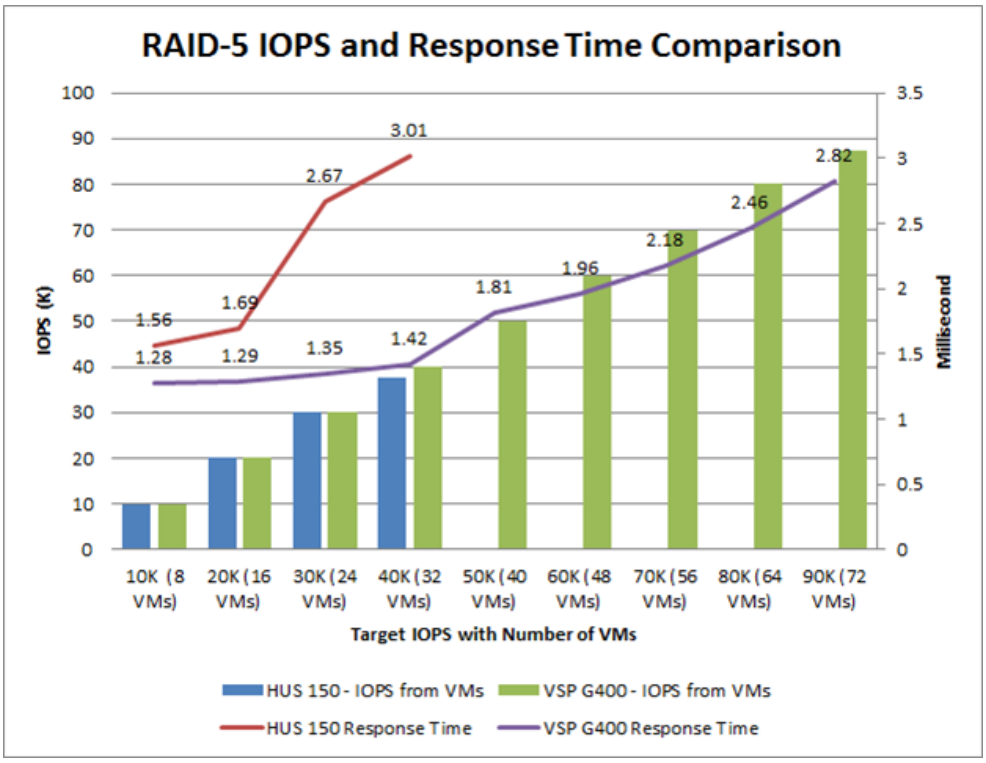

Figure 6

Similar to the RAID-10 configuration, Virtual Storage Platform G400 achieved more than twice of the performance compared to Unified Storage 150 in the RAID-5 configuration. An analysis of the results follows:

- The maximum number of IOPS reached on Virtual Storage Platform G400 was 89,324 at an average response time of 2.82 milliseconds when the target 90K IOPS was issued from 72 virtual machines.
- The maximum number of IOPS reached on Unified Storage 150 was 38,676 at an average response time of 3.01 milliseconds when the target 40K IOPS was issued from 32 virtual machines.
- Virtual Storage Platform G400 achieved 231% of the IOPS when compared to Unified Storage 150 with a similar response time.

Figure 7 shows the average processor usage on Virtual Storage Platform G400 and Unified Storage 150.

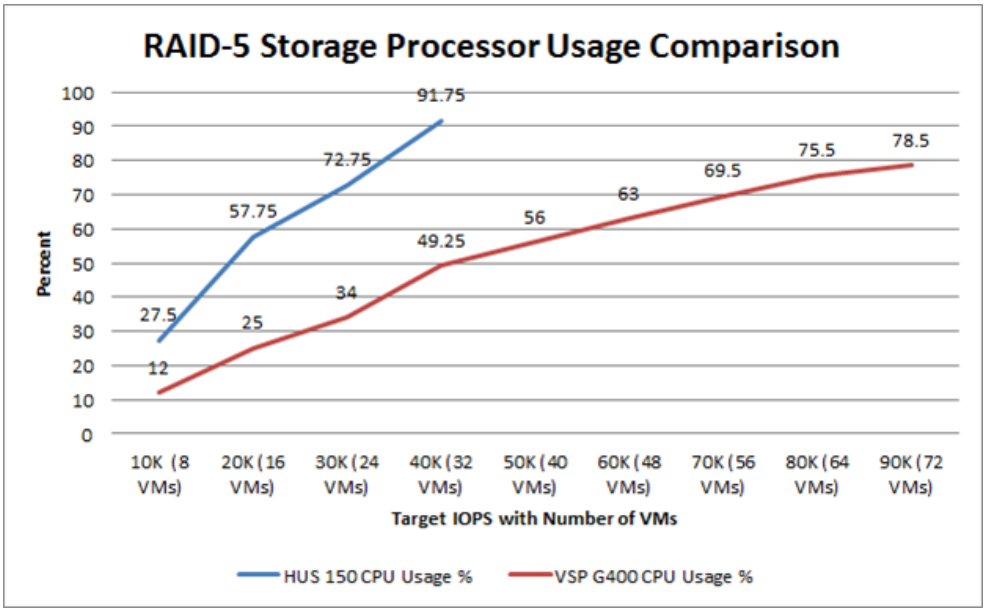

Figure 7

The result shows that the processor usage on Virtual Storage Platform G400 was about 50% less when compared to the processor usage on Unified Storage 150.

Conclusion

From the results of testing using FMD in RAID-10 (2D+2D) and RAID-5 (3D+1P) configurations, Hitachi Virtual Storage Platform G400 accommodated more than twice of the general server workloads compared to Hitachi Unified Storage 150.

For More Information

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.

Live and recorded product demonstrations are available for many Hitachi products. To schedule a live demonstration, contact a sales representative. To view a recorded demonstration, see the Hitachi Data Systems Corporate Resources website. Click the **Product Demos** tab for a list of available recorded demonstrations.

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