Lab Validation Report

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Feedback

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Hitachi Unified Compute Platform Select for VMware vSphere using Hitachi Dynamic Tiering with Hitachi Accelerated Flash on Hitachi Virtual Storage Platform

Lab Validation Report

This lab validation report validates the advantages of leveraging Hitachi Dynamic Tiering with Hitachi Accelerated Flash on Hitachi Virtual Storage Platform to achieve the following as a part of Hitachi Unified Compute Platform Select for VMware vSphere:

- Maximize benefits and ROI of low latency and high IOPS storage
- Minimize operational complexities in the VMware vSphere environment

Flash technology with Hitachi Dynamic Tiering has the following benefits:

- Enables the virtualization of mission-critical applications that require super low latency and high IOPS rates without compromising the storage capacity.
- Provides a better cost per IOPS ratio and higher consolidation ratio for mixed server 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 the software products tested for this report.

Hitachi Virtual Storage Platform

Hitachi Virtual Storage Platform is the first 3-D scaling storage platform designed for all data types. Its storage architecture flexibly adapts for performance, capacity, and multi-vendor storage. Combined with the unique Hitachi Command Suite management platform, it transforms the data center.

- **Scale Up** — Meet increasing demands by dynamically adding processors, connectivity, and capacity in a single unit. Provide the highest performance for both open and mainframe environments.

- **Scale Out** — Meet multiple demands by dynamically combining multiple units into a single logical system with shared resources. Support increased demand in virtualized server environments. Ensure safe multi-tenancy and quality of service through partitioning of cache and ports.

- **Scale Deep** — Extend storage value by virtualizing new and existing external storage systems dynamically. Extend the advanced functions of Hitachi Virtual Storage Platform to multivendor storage. Offload less demanding data to external tiers to save costs and to optimize the availability of tier-one resources.

Using flash acceleration in Virtual Storage Platform is transparent to Hitachi Dynamic Provisioning, Hitachi Dynamic Tiering, in-system replication, and remote replication. Flash media efficiency increases with more workload consolidation when using flash acceleration.

Flash acceleration raises Virtual Storage Platform scalability. Express host I/O processing targets flash media or a large pool of disk drives. The performance boost increases random I/O throughput of the virtual storage director and lowers I/O response time.

Hitachi Dynamic Tiering

Hitachi Dynamic Tiering eliminates manual data classification and movement between storage tiers. This optimizes tiered storage usage while improving performance.

Instead of manually provisioning space from several storage technologies with different performance and cost characteristics, Hitachi Dynamic Tiering enables the management of multiple storage tiers as a single entity. By leveraging the thin provisioning and wide striping features of Hitachi Dynamic Provisioning, Hitachi Dynamic Tiering presents a virtual volume with embedded smart tiering. It monitors access and moves data at the 42MB page level.

Breaking the volume into pages, Hitachi Dynamic Tiering automatically moves infrequently referenced pages to lower cost tiers of storage. Moving pages instead of entire data sets or files reduces the time and storage space required to migrate data.
After an initial setup process, Hitachi Dynamic Tiering monitors data access in real time. It makes decisions on moving data between the available storage tiers based on actual use. Using this approach, Hitachi Dynamic Tiering improves the availability and performance of your storage systems and the applications using that storage.

Hitachi Dynamic Tiering on Hitachi Virtual Storage Platform allows a single pool to contain tiers made up of differently-arranged RAID groups using any type of disk. It manages data migration between the various tiers within a pool automatically. This eliminates most user management of storage tiers within a storage system, and maintains peak performance under dynamic conditions without storage administrator intervention.

**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 Select 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 6720 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.
Test Environment Configuration

The testing of Hitachi Accelerated Flash took place in the Hitachi Data Systems laboratory using Hitachi Compute Blade 500 and Hitachi Unified Storage VM.

Table 1 describes the details of the components used.

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Description</th>
<th>Version</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi Virtual Storage Platform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardware</td>
<td>Description</td>
<td>Version</td>
<td>Quantity</td>
</tr>
<tr>
<td>Hitachi Compute Blade 500 chassis</td>
<td>8-blade chassis</td>
<td>SVP: A0108-B-5923 5460: FOS 6.3.2d VDX6746: NOS 2.0.1_kat4</td>
<td>1</td>
</tr>
<tr>
<td>520BH1 server blade</td>
<td>Half blade</td>
<td>BMC/EFI: 01-27</td>
<td>2</td>
</tr>
<tr>
<td>Brocade 6510</td>
<td>SAN switch with 48 x 8 Gb Fibre Channel ports</td>
<td>FOS 7.0.1a</td>
<td>2</td>
</tr>
<tr>
<td>Brocade VDX 6720</td>
<td>Ethernet switch with 24 x 10 Gb/sec ports</td>
<td>NOS 2.0.1b</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 2 describes the software used when testing this solution.

### Table 2. Software Components

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi Storage Navigator Modular 2</td>
<td>Microcode Dependent</td>
</tr>
<tr>
<td>Hitachi Dynamic Provisioning</td>
<td>Microcode Dependent</td>
</tr>
<tr>
<td>VMware vCenter server</td>
<td>5.1.0</td>
</tr>
<tr>
<td>VMware Virtual Infrastructure Client</td>
<td>5.1.0</td>
</tr>
<tr>
<td>VMware ESXi</td>
<td>5.1.0</td>
</tr>
<tr>
<td>Microsoft® Windows Server® 2008</td>
<td>Enterprise edition, R2</td>
</tr>
<tr>
<td>Microsoft SQL Server® 2008</td>
<td>Enterprise edition, R2</td>
</tr>
</tbody>
</table>

**Network Infrastructure**

The network design used in this solution provided ample bandwidth and redundancy for the following:

- A fully populated infrastructure cell for compute resources
- An infrastructure cell for storage resources
- Up to two expansion cells for compute resources

For more information on the cell architecture used in Hitachi Data System solutions, see [Deploy Hitachi Unified Compute Platform Select for VMware vSphere using Hitachi Unified Storage VM in a Scalable Environment Reference Architecture Guide](PDF, Document AS-187-00).

Figure 1 on page 7 illustrates the physical network architecture.
The network design allows for the utilization of advanced features inherent in the Brocade VDX switch family, such as VCS Fabric technology. This helps provide the following:

- Non-stop networking
- Simplified, automated networks
- An evolutionary approach that protects existing IT investments

See the Brocade website for more information about Brocade VCS Fabric Technology.

SAN Infrastructure

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

The HBAs on Hitachi Compute Blade 500 were zoned to four ports on the Hitachi Virtual Storage Platform controller. Dedicating four ports to each Hitachi Compute Blade 500 chassis ensures bandwidth between the chassis and Hitachi Virtual Storage Platform.

Figure 2 on page 9 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 is built with multiple controllers. This provides 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.

Table 3 shows the zone configuration used for this testing.

<table>
<thead>
<tr>
<th>Hitachi Compute Blade 500 Blade/Host</th>
<th>Host HBA Number</th>
<th>Fibre Channel Fabric</th>
<th>Zone Name</th>
<th>Storage Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blade 0/ESX 0</td>
<td>HBA1_1</td>
<td>Fabric 1</td>
<td>CB500_ESX0_HBA1_1_VSP_1A_2C</td>
<td>1A, 2C</td>
</tr>
<tr>
<td></td>
<td>HBA1_2</td>
<td>Fabric 2</td>
<td>CB500_ESX0_HBA1_2_VSP_1C_2A</td>
<td>1C, 2A</td>
</tr>
<tr>
<td>Blade 1/ESX 1</td>
<td>HBA1_1</td>
<td>Fabric 1</td>
<td>CB500_ESX1_HBA1_1_VSP_1A_2C</td>
<td>1A, 2C</td>
</tr>
<tr>
<td></td>
<td>HBA1_2</td>
<td>Fabric 2</td>
<td>CB500_ESX1_HBA1_2_VSP_1C_2A</td>
<td>1C, 2A</td>
</tr>
</tbody>
</table>

**Storage Configuration**

The test environment used only one parity group consisting of four flash drives in a RAID-10 (2D+2D) configuration.

**Test Case 1 — Baseline**

The storage infrastructure of Test Case 1 consisted of 60 × 600 GB 10k RPM SAS drives in two dynamic provisioning pools with the following configuration:

- **Pool 0** — 20 drives consisting of 5 parity groups in a RAID-10 (2D+2D) configuration
- **Pool 1** — 40 drives consisting of 10 parity groups in a RAID-10 (2D+2D) configuration

Figure 3 on page 11 shows the storage configuration and LU construction for Test Case 1.
RAID-10 was used to maximize the performance for random workloads, which is common with virtualized environments.

For the SAS environment, two dynamic provisioning pools were created. This separated the virtual machine workloads with different performance characteristics.

Because of its wide striping capability, Hitachi Dynamic Provisioning can balance the I/O load across RAID groups in a pool. Mixing workloads in a single dynamic provisioning pool is possible to obtain certain levels of performance. However, grouping virtual machines with similar I/O profiles optimizes storage performance and results in a more efficient use of SAS disk resources.
A total of eight tiles were used. Table 4 shows the tiles distribution on the SAS drives.

Table 4. Tile Distribution Across Compute and Storage Resources on SAS Drives

<table>
<thead>
<tr>
<th>Tile 1</th>
<th>Tile 2</th>
<th>Tile 3</th>
<th>Tile 4</th>
<th>Tile 5</th>
<th>Tile 6</th>
<th>Tile 7</th>
<th>Tile 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESXi Host</td>
<td>ESX0</td>
<td>ESX0</td>
<td>ESX0</td>
<td>ESX0</td>
<td>ESX1</td>
<td>ESX0</td>
<td>ESX1</td>
</tr>
<tr>
<td>DP Pool 0</td>
<td>DP Pool 1</td>
<td>LUN 1: DVD Store 2 Database Servers</td>
<td>LUN 2: Mail Servers 1-3</td>
<td>LUN 3: Mail Servers 4-6</td>
<td>LUN 4: Mail Servers 7-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUN 5: DVD Store 2 Web Servers, Olio Web Servers, Olio Database Servers</td>
<td>LUN 6: Standby Servers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Due to their higher random read and I/O intensive workload characterization, the DVD Store 2 database servers were placed on DP Pool 0.

All other servers had similar higher random write workload characterization. They were placed on DP Pool 1. Due to their high I/O profile, no more than three mail server virtual machines were stored on a LUN to avoid LUN queue depth issues.

Test Case 2 through Test Case 6 with Hitachi Dynamic Tiering

Hitachi Dynamic Tiering was used for Test Case 2 through Test Case 6.

One pool volume LDEV, created from one parity group of RAID-10 (2D+2D) a drive with Hitachi Accelerated Flash, was placed into Tier 1. All SAS hard drive LDEVs were placed into Tier 2.

All pool monitoring properties were set to default except for the following:

- The monitoring cycle was changed to 30 minutes.
- The monitoring mode was changed to Period Mode to accelerate the page relocation.

Figure 4 on page 13 shows the Test Case 5 storage configuration as an example.
All workloads spread across 4 LUs

Create 200 GB LDEV from 1 Parity Group of Hitachi Accelerated Flash

Hitachi Accelerated Flash Parity Group RAID-10 (2D+2D)

Create 1 LDEV from Each of Parity Groups of SAS

SAS Parity Group RAID-10 (2D+2D)

Figure 4
Due to the increased I/O throughput available from Hitachi Accelerated Flash in Tier 0, only four LUs were created from the pool.

A total of eight tiles were used. Table 5 shows how the tiles were distributed on LUs.

Table 5. Tile Distribution Across Compute and Storage Resources on Hitachi Accelerated Flash

|------|-----------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|

Eight tiles were evenly distributed to four LUs. They were also placed evenly into two ESXi hosts so that each host accesses all four LUs evenly during the test. This minimizes the host HBA LUN queue depth issue.
Test Methodology

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

- Show the benefits of using Hitachi Dynamic Tiering with Hitachi Accelerated Flash
- Show an example of how to size Hitachi Dynamic Tiering
- For validation purposes, testing used a mixed server workload benchmark tool from VMware called VMmark. This tool generates a score after each test completes according to the throughput and latency of applications.
- Several test cases capture the behavior of Hitachi Dynamic Tiering with different storage configurations. The VMmark score was used as an overall performance measure of the virtualized server environment with the different storage configurations.

VMmark Overview

VMmark testing used a mixed workload of the following:

- Email messages
- Web pages
- Online transaction processing (OLTP)

The workload was grouped into a tile-based system to measure application performance and scalability. Each tile contained mixed workloads that stress critical compute and storage resources. These workloads represent a general purpose environment for VMware vSphere.

Each tile consists of the following virtual machines listed in Table 6.

Table 6. Virtual Machines for Each Testing Tile

<table>
<thead>
<tr>
<th></th>
<th>Microsoft Exchange 2007</th>
<th>Olio Web Server</th>
<th>Olio Database Server</th>
<th>DVD Store 2 Database Server</th>
<th>DVD Store 2 Web Server</th>
<th>Standby</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CPU</td>
<td>4 vCPUs</td>
<td>4 vCPUs</td>
<td>2 vCPUs</td>
<td>4 vCPUs</td>
<td>2 vCPUs</td>
<td>1 vCPUs</td>
</tr>
<tr>
<td>Memory</td>
<td>8192 MB</td>
<td>6144 MB</td>
<td>2048 MB</td>
<td>4096 MB</td>
<td>2048 MB</td>
<td>512 MB</td>
</tr>
</tbody>
</table>
Each tile represented a simulation of the following types of workloads:

- Microsoft Exchange 2007 mail servers for general email workloads
- Olio web and database servers for Web 2.0 workloads
- DVD Store 2 web and database servers for OLTP workloads
- Standby servers for idle general infrastructure workload

Testing used eight tiles between two ESXi hosts in the application cell for VMware vSphere. There were a total of the following:

- 64 virtual machines
- 168 virtual CPUs
- 212 GB of configured virtual machine memory

A single client controls each tile. A primary client controls each tile client. The clients ran in other hosts, outside of the ESXi hosts for the workload virtual machines.

Table 7 shows the tile workload definitions.

<table>
<thead>
<tr>
<th>Workloads</th>
<th>Applications</th>
<th>Virtual Machine Platform</th>
<th>Simulated Load per Tile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mail Server</td>
<td>Microsoft Exchange 2007</td>
<td>Microsoft Windows Server 2008 R2 (64 Bit)</td>
<td>1000 users with a heavy workload profile</td>
</tr>
<tr>
<td></td>
<td>Microsoft Exchange LoadGen</td>
<td>4 vCPU</td>
<td>8 GB RAM</td>
</tr>
<tr>
<td>Standby</td>
<td>None</td>
<td>Microsoft Windows® 2003 (32 Bit)</td>
<td>Non-load based functional test to activate idle resources for on-demand usage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 vCPU</td>
<td>512 MB RAM</td>
</tr>
<tr>
<td>Workloads</td>
<td>Applications</td>
<td>Virtual Machine Platform</td>
<td>Simulated Load per Tile</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------</td>
<td>--------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Web 2.0 load simulation</td>
<td>Olio DB</td>
<td>Database:</td>
<td>400 concurrent users</td>
</tr>
<tr>
<td></td>
<td>Web application servers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-tier Java-based implementation of the Olio workload, including the following operations:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HomePage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Login</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TagSearch</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EventDetail</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PersonDetail</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AddPerson</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AddEvent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Web server:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-commerce simulation</td>
<td>DVD Store 2</td>
<td>Database:</td>
<td>10 constant driver thread loads from one web server</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 burst-based driver threads from two web servers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Performance metric is transactions per minute (TPM)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Front end (×3):</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Database:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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</tr>
</tbody>
</table>
Test Cases

The test cases assume the following situation:

- There is a limited number of flash drives available to use in the environment. To meet storage capacity needs, the environment uses SAS hard disk drives.
- The environment uses Hitachi Accelerated Flash to optimize flash resource utilization.

If your applications are relatively bounded by the I/O performance, one advantage of using Hitachi Dynamic Tiering is to add a small amount of flash storage to the storage pool. This does the following to support the workload of the storage pool:

- Increases the performance
- Reduces the total number of drives necessary

Table 8 on page 19 lists each test case used to validate this advantage. The configuration for all parity groups, whether using Hitachi Accelerated Flash and SAS hard disk drives, was RAID-10 (2D+2D). Each test case used a different capacity of flash drives and hard disk drives:

- **Hitachi Accelerated Flash** — Each test case after establishing the baseline used 1 parity group of different capacities. The baseline case did not use Accelerated Flash.
- **SAS Hard Disk Drives** — Each test case after establishing the baseline varied the number of parity groups and number of hard disk drives so performance equaled the baseline performance.

<table>
<thead>
<tr>
<th>Workloads</th>
<th>Applications</th>
<th>Virtual Machine Platform</th>
<th>Simulated Load per Tile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic virtual machine relocation</td>
<td>VMware vMotion</td>
<td>- Olio database selected at random in round robin fashion (see specifications above)</td>
<td>Concurrent relocations Increase per number of tiles Metric is measured in Relocations Per Hour (RPH)</td>
</tr>
<tr>
<td></td>
<td>■ Relocation and then wait 3 Minutes to repeat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automated load balancing (vMotion)</td>
<td>VMware Distributed Resource Scheduler</td>
<td>■ All</td>
<td>Infrastructure Functionality to load balance tile workload.</td>
</tr>
<tr>
<td></td>
<td>■ Set to aggressive</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Tile Workload Definitions (Continued)
The following are the test procedures used to validate the test cases:

- **Test Case 1— Baseline without using Hitachi Accelerated Flash**
  
The VMmark score from this test case was the baseline used to measure the storage performance in other test cases.

  The baseline used 60 SAS hard drives in dynamic provisioning pools created with Hitachi Dynamic Provisioning. Hitachi Accelerated Flash was not used to establish the baseline.

  The VMmark workload required using 60 SAS hard drives for I/O performance, and not for the capacity.

- **Test Case 2 through Test Case 6 — Testing while using Hitachi Accelerated Flash**
  
  Hitachi Dynamic Tiering enabled dynamic provisioning pools.

  - **Test Case 2 though Test Case 4 – Reduce the amount of Hitachi Accelerated Flash used**
    
    These test cases used 10 parity groups of 40 SAS hard drives for Tier 2 as the constant.

    Testing determined the capacity of Hitachi Accelerated Flash that could be reduced from the environment while maintaining a similar VMmark score to the baseline results. Adjustments were made in the properties of Hitachi Dynamic Tiering to maintain performance.

  - **Test Case 5 and Test Case 6 — Reduced the number of SAS hard drives used**
    
    Using the results from Test Case 2 through Test Case 4, this test case used 200 GB of Hitachi Accelerated Flash as the constant.

    Testing determined the number of SAS hard drives that could be removed from the environment while maintaining a similar VMmark score to the baseline.

---

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Hitachi Accelerated Flash Capacity Allocated to the Dynamic Provisioning Pool</th>
<th>Number of Parity Groups for SAS Hard Disk Drives</th>
<th>Number of SAS Hard Disk Drives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 GB</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>800 GB</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>400 GB</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>200 GB</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>200 GB</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>6</td>
<td>200 GB</td>
<td>6</td>
<td>24</td>
</tr>
</tbody>
</table>
Analysis

This is an analysis from the results of the VMware VMmark general purpose server workload tests performed on Hitachi Dynamic Tiering with Hitachi Accelerated Flash.

Test Results

Table 9 lists the VMmark test score for each test case. Again, the VMmark test scores were used for comparison of how applications performed on a virtualized environment with different storage configuration.

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Hitachi Accelerated Flash Capacity Allocated to the Dynamic Provisioning Pool</th>
<th>Number of SAS Parity Groups Used</th>
<th>Number of SAS Drives Used</th>
<th>VMmark Application Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 GB</td>
<td>15</td>
<td>60</td>
<td>10.55</td>
</tr>
<tr>
<td>2</td>
<td>800 GB</td>
<td>10</td>
<td>40</td>
<td>11.86</td>
</tr>
<tr>
<td>3</td>
<td>400 GB</td>
<td>10</td>
<td>40</td>
<td>11.80</td>
</tr>
<tr>
<td>4</td>
<td>200 GB</td>
<td>10</td>
<td>40</td>
<td>11.46</td>
</tr>
<tr>
<td>5</td>
<td>200 GB</td>
<td>7</td>
<td>28</td>
<td>11.15</td>
</tr>
<tr>
<td>6</td>
<td>200 GB</td>
<td>6</td>
<td>24</td>
<td>10.86</td>
</tr>
</tbody>
</table>

These are the results of each test case:

- **Test Case 1**
  The VMmark application score of this test case served as a baseline. It used 15 parity groups of SAS hard drives. The score was 10.55. For this lab validation, any score above 10.55 is an improvement in storage performance.

- **Test Case 2**
  The pool was constructed with Hitachi Dynamic Tiering using 800 GB of Hitachi Accelerated Flash and 10 parity groups of SAS hard drives.
  The highest score was 11.86.

- **Test Case 3**
  The capacity of Hitachi Accelerated Flash was reduced to 400 GB.
  The score remained high at 11.80.

- **Test Case 4**
  The capacity of Hitachi Accelerated Flash was reduced to 200 GB.
  The score was 11.46, which is well above the baseline score of 10.55.
Test Case 5

The capacity of Hitachi Accelerated Flash was kept at 200 GB. The number of SAS parity groups was reduced from 10 to 7.

The score dropped to 11.15. This was still much higher than the baseline.

Test Case 6

The capacity of Hitachi Accelerated Flash was kept at 200 GB. The number of SAS parity groups was reduced to six.

The score dropped to 10.86. This was a small performance improvement over the baseline score of 10.55.

Based on the results of test cases, Test Case 5 is the most efficient storage configuration to use for the eight tile VMmark workload. It shows reasonable storage performance improvement over the SAS-only baseline.

Performance Graph Analysis and Sizing

View Tier Properties from Hitachi Storage Navigator provides some of the most useful information regarding the dynamic tiering pool.

Figure 5 on page 22 shows the tier properties and performance graph captured during Test Case 2. This test case had the most Hitachi Accelerated Flash placed in Tier 1 of the pool. From the graph, the Tier1 Range horizontal line is at 10 I/O per hour. That means any pages with more than 10 I/O were placed in Tier 1.

- One parity group of Hitachi Accelerated Flash can consume much more I/O than 10 I/O per hour. Large amount of Tier 1 was wasted.

- Since Hitachi Accelerated Flash is a high I/O performance device, the target Tier 1 range was set to roughly 1000 I/O per hour. That leads to a capacity of about 200 GB.

- Test Case 4 through Test Case 6 also showed that allocating 200 GB of Hitachi Accelerated Flash was a reasonable amount of capacity to place in the pool with Hitachi Dynamic Tiering for the VMmark workload.
The performance graph of Test Case 5 shown in Figure 6 on page 23 is the most efficient storage configuration.
Figure 6

Test 5:
200 GB HAF
28 SAS Drives
With only 200 GB of Hitachi Accelerated Flash, the Tier1 Range line moved to about 1900 I/O per hour when compared to Test Case 2.

- The number of SAS parity groups was reduced to seven. With that, the Tier 2 performance utilization became 82%. This is considered a little high. The recommended utilization value is below 60% for non-flash disks. In a production environment, add a little more capacity in Tier 1 or one more parity groups of SAS hard drives in Tier 2 to reduce the performance utilization.

- Tier 1 performance utilization was 100%. This is acceptable, since the flash drives can deliver relatively good response times even when 100% busy.

Benefits of Using Hitachi Dynamic Tiering with Hitachi Accelerated Flash

Hitachi Dynamic Tiering with Hitachi Accelerated Flash provides tremendous advantages if your environment requires high I/O intensive applications with high storage capacity requirements.

The following benefits can be realized when using Hitachi Dynamic Tiering with Hitachi Accelerated Flash in an I/O-bound virtualized environment:

- As illustrated in Figure 7, placing a small portion of Hitachi Accelerated Flash modules into a pool, the total number of SAS drives can be reduced dramatically while increasing or maintaining I/O performance.

- By reducing the total number of drives, you can realize space consolidation and energy savings.
Performance can be increased with the addition of more capacity of Hitachi Accelerated Flash into the pool.

Capacity can be increased with the addition of more SAS or SATA drives into the lower tier of the pool.

As illustrated in Figure 8, Hitachi Dynamic Tiering simplifies storage pool management. You can place all mixed workloads together into a single pool.

Due to the high I/O throughput of Hitachi Accelerated Flash, the number of LUs and datastores can be reduced to simplify LUN management.

Recommended Settings and Best Practices

When using Hitachi Accelerated Flash with Hitachi Dynamic Tiering in a VMware vSphere environment, the following settings are recommended:

- **Flash Acceleration Microcode** – Enable
- **SOM 901 on Hitachi Virtual Storage Platform** — Enable
  - SOM 901 permits an SSD/FMD tier to reach 100% performance utilization. By default, Hitachi Dynamic Tiering tries to keep all tiers at or below 60% performance utilization to improve response time. A SSD/FMD tier can deliver relatively good response times, even when 100% busy.
- **SOM 917 on Hitachi Virtual Storage Platform** — Enable
  - SOM 917 balances page placement across parity groups rather than pool volumes.
- **DPVOL (LU) Ownership** — Distribute evenly to all MPUs
- **Host Group Mode** — 21[VMware Extension], and enable following:
  - 54-Support Option for the EXTENDED COPY command
  - 63-Support option for vStorage APIs based on T10 standards
- **Multipathing Policy in ESXi Host** — Round Robin
- **Virtual Machine Placement on each ESXi host** — Place evenly on the LUs to balance the I/O loads
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.

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