Lab Validation Report

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Hitachi Unified Compute Platform Select for VMware vSphere on Hitachi Unified Storage 150 with Hitachi NAS Deduplication

Lab Validation Report

Today a common problem in the data center is the rapid rate of growth of data. Capacity utilization is increasing. Thin provisioned storage was introduced to help increase efficiency in capacity utilization. However, within a storage system, there are still inefficiencies with capacity utilization since duplicated data is still stored on the disk. Certain drive solutions have higher IOPS but lower capacity. This limits storage density since capacity limits are reached before I/O performance is fully realized leaving storage systems capacity bound.

Hitachi NAS Platform 11.0 introduced fixed-size block level deduplication of WFS-2 file systems. This performs deduplication of blocks within the WFS-2 file system improving capacity efficiencies. Duplication within a virtualized environment like VMware is advantageous since many virtual machines are clones from a given template.
Test Environment Configuration

Testing of Hitachi NAS Deduplication took place in the Hitachi Data Systems laboratory to test the performance differences with deduplication enabled and with deduplication disabled using WFS 4 KB block sizes on the Hitachi Unified Storage and Hitachi Compute Blade 500. The testing environment was configured using Hitachi Unified Compute Platform for VMware vSphere on Hitachi Unified Storage reference architecture. This describes the test environment.

Hitachi NAS Deduplication Testing Environment

Table 1 describes the details of the components used when testing Hitachi NAS deduplication.

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Description</th>
<th>Version</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi NAS Platform 3090</td>
<td>Network attached storage (NAS) platform using 2 10 GbE port, Four 4 Gbit/sec Fiber Channel ports and 32 GB distributed memory</td>
<td>11.1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Hitachi NAS Deduplication basic license key</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hitachi Unified Storage 150</td>
<td>Dual controllers</td>
<td>0917/A-H</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>16 × 8 Gb/sec Fibre Channel ports</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>32 GB cache memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>72 × 600 GB 10k RPM SAS disks, 2.5 inch SFF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hitachi Compute Blade 500</td>
<td>8-blade chassis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chassis</td>
<td>2 Brocade 5460 Fibre Channel switch modules, each with 6 × 8 Gb/sec uplink ports</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Brocade VDX 6746 Ethernet switch modules, each with 8 × 10 Gb/sec uplink ports</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 management modules</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 cooling fan modules</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 power supply modules</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SVP: A0108-B-5923</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5460: FOS 6.3.2d</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VDX6746: NOS 2.0.1_kat4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hitachi Unified Storage 150

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.

<table>
<thead>
<tr>
<th>Table 1. Infrastructure Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>520BH1 server blade</td>
</tr>
<tr>
<td>2 × 8-core Intel Xeon E5-2680</td>
</tr>
<tr>
<td>processor, 2.70 GHz</td>
</tr>
<tr>
<td>96 GB RAM</td>
</tr>
<tr>
<td>6 × 16 DIMMs</td>
</tr>
<tr>
<td>Brocade 6510</td>
</tr>
<tr>
<td>Channel ports</td>
</tr>
<tr>
<td>Brocade VDX 6720 (VCS Enabled)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

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Hitachi NAS Platform
Hitachi NAS Platform is an advanced and integrated network attached storage (NAS) solution. It provides a powerful tool for file sharing, file server consolidation, data protection, and business-critical NAS workloads.

- Powerful hardware-accelerated file system with multi-protocol file services, dynamic provisioning, intelligent tiering, virtualization, and cloud infrastructure
- Seamless integration with Hitachi SAN storage, Hitachi Command Suite, and Hitachi Data Discovery Suite for advanced search and index
- Integration with Hitachi Content Platform for active archiving, regulatory compliance, and large object storage for cloud infrastructure

Take advantage of the following features for better management and tighter integration of your Hitachi NAS environment with your VMware infrastructure.

- **Hitachi NAS Virtual Infrastructure Integrator** — Simplify virtual machine backup, restore, cloning, and NFS datastore management
- **VMware vSphere API for Array Integration** — Enable the ESXi host to offload certain storage operations to the storage array
- **VMware vSphere API for Storage Awareness** — Show storage capabilities
- **Hitachi NAS Deduplication** — Reclaim up to 90% of unstructured data storage capacity, to extend the life of existing storage assets

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 6720 Data Center Switch**

**Software Components**

These are the software components deployed for this lab validation report.

Table 2 describes the software used in this lab validation report.

<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>
<tr>
<td>VDBench</td>
<td>5.02</td>
</tr>
</tbody>
</table>

**VMware vSphere 5**

*VMware vSphere 5* is a virtualization platform that provides a data center 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.
Network Infrastructure

The network design for network attached storage in this solution uses the following:

- Link aggregation (LACP)

  Combine both 10 Gb/sec Ethernet ports into a single logical link to provide increased bandwidth, load balancing, and higher link availability.

  Both 10 Gb/sec Ethernet ports connect to two Brocade VDX6720 switches (1 connection each) in a Brocade VCS Fabric using link aggregation to provide high bandwidth and high availability in case of a switch failure.

- Jumbo frames

  Configure the link aggregate interface MTU size to 9000 to support jumbo frames.

  Configure the VDX6720 switch ports MTU size to 9100 to support jumbo frames.

- VLANs

  Separate NFS traffic from VMware vSphere management, VMware vMotion, and virtual machine network traffic.
Figure 1 illustrates the physical network architecture.

The Brocade FCX switch provides 1 Gb/sec management connectivity for all hardware components in this solution.

The network design also allows for the utilization of advanced features in the Brocade VDX switch family such as Brocade VCS Fabric technology:

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

Figure 1
SAN Infrastructure

The Hitachi Unified Storage 150 controller used for this solution has 16 ports for connections to the Brocade 6510 enterprise fabric switches.

The Hitachi Compute Blade 500 HBAs were zoned to four ports on the Hitachi Unified Storage 150 controller, two ports per controller.

Dedicating four ports to each Hitachi Compute Blade 500 chassis ensures bandwidth between the chassis and Hitachi Unified Storage 150.

Figure 2 illustrates the physical SAN architecture of the infrastructure cell for compute resources.

**Hitachi Unified Compute for VMware on HNAS with HUS VM**

**SAN Diagram Over View**

During the testing of Hitachi NAS Deduplication, Hitachi HUS 150 with 72 10k RPM 600 GB Small Form Factor hard disks were grouped into 18 RAID 10 2D + 2D parity groups. Then each parity group was presented to the Hitachi NAS as an HUS 150 LUN.
Figure 3 shows the storage required for general workload and Exchange database virtual machines.

**Storage for General Workload and Exchange Database Virtual Machines**

- **RAID Group**
  - RAID 10 (2D+2D)
- **HUS 150 LDEV**
- **48 Drives Configured in 12 RAID-10 2D+2D Parity Groups**
- **Each RAID-10 (2D+2D) Parity Group Configured in an HUS 150 LUN**

**HUS 150 System Objects**

**HNAS System Objects**

- Each LUN is a System Drive on HNAS 3090
- 12 System Drives create 1 Storage Pool
- 2 HNAS 3090 File Systems are created from the Storage Pool
  - 1 for Exchange Mail Store
  - 1 for General Workload VM
- 2 Datastores Exported as
  - HNAS NFS Target
  - 1 for Exchange Mail Store
  - 1 for General Workload VM

Figure 3
Figure 4 shows the storage required for database VMs.

On the Hitachi NAS 3090, each LDEV was presented as a System Drive, and each System Drive was a System Drive Group. The System Drive Groups were divided into two Storage Pools. One Storage Pool had 12 System Drives divided into 2 File Systems, one for the Exchange Data Stores and the second for the general workload virtual machines. A second Storage Pool was created with the remaining 6 System Drives for the DVD Store Virtual machines.
All File Systems were formatted using WFS version WFS-2 with a 4KB Block Size. Read Ahead Cache was disabled on the file system.

VDBench virtual machines workloads were run on the NFS Export for the general workload virtual machines.

**Virtual Machine Configuration**

**Deduplication Ratio Testing**

General server workload testing was performed using VMMark. The VMMark benchmarking tool’s workloads represent a general purpose environment for VMware vSphere.

Each tile consists of the following virtual machines listed in Table 3.

<table>
<thead>
<tr>
<th>Quantity</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>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

Four tiles were used during deduplication ratio testing.

**Deduplication Performance Testing**

The impact of deduplication process invocation was tested with VDBench. Four virtual machines were built to run a simulated database workload.

The configuration of each virtual machines is listed:

- 4 vCPU
- 4 GB Memory
- 2 Hard Disk - 1 for guest OS and VDBench application and 1 for the VDBench workload
The VDBench simulated database workload was configured as listed:

- 8 threads
- 8 KB packet size
- 100 percent random
- 75 percent read / 25 percent write
- I/O Rate set to 1110 I/O

Each of the virtual machines used during testing were running a database workload. Each virtual machine contained two virtual disks.

- Virtual Disk 1: Contained the NTFS formatted virtual disk where the Windows 2008 R2 was installed and the VDBench application.
- Virtual Disk 2: Unformatted virtual disk where I/Os were issued to and from VDBench. This virtual disk was unformatted so the file system does become a factor when determining raw I/O performance.
Test Methodology

This describes the methodology for Hitachi NAS Deduplication. DRS was not enabled during this testing so virtual machine host placement was controlled.

VMMark Test Methodology

VMMark was used to test the deduplication ratio on workloads such as Microsoft Exchange and general workloads overall. During the testing the Microsoft Exchange databases deduplication ratios were measured after a single tile was run, then again after 2 tiles and then 3 and 4 tiles. The same was done with the general workloads for the tiles in their entirety.

VDBench Test Methodology

The Hitachi NAS Deduplication test methodology involved testing with Hitachi NAS Deduplication disabled (as a baseline measure with the original data), during an NFS file system undergoing a full deduplication, and lastly after a full deduplication completed with the dehydrated data. Performance at each test run was collected and compared.

VDBench was used to generate the workload in each VM. Each VM ran VDBench to simulate a database workload as mentioned in the virtual machine configuration.

VMMark and VDBench workloads were run separately from each other, not run concurrently.

Test Case 1: Workloads with Deduplication Disabled

- The VDBench tests were first run without deduplication enabled to establish a baseline. The goal of this was to compare the results found here to later tests.

Test Case 2: Workloads with Deduplication Enabled and During a Full Conversion

- Testing was then run with deduplication enabled, after the default value of 1TB of changes occurred to the file system triggering a deduplication operation to see if there was any impact in performance compared to the workload without the deduplication service running.
Test Case 3: Workloads with Deduplication Enabled and after the Completion of a Full Conversion

- Lastly the VDBench workload was run after the deduplication service had completed its operation. This was done to test for any impact of deduplication on the file system after the deduplication service was completed.
Analysis

This is an analysis of the results for the Hitachi NAS Deduplication testing.

VMMark Deduplication Ratio

Exchange Deduplication Ratio
During testing of Microsoft Exchange Servers deduplication ratio, four Microsoft Exchange Servers were used and workload was created using Microsoft Exchange Load Generator for Exchange Server 2007.

The total used capacity of the file system that stored the four VMDKs for the Microsoft Exchange Server 2007’s mail stores was 192.98 GB before the deduplication service was run.

The total used capacity of the file system that stored the four VMDKs for the Microsoft Exchange Server 2007’s mail stores was 147.69 GB after the deduplication service was run, reclaiming 46.49 GB or 24% of the disk space.

General Workload Deduplication Ratio
During the test of General Workloads deduplication ratio virtual machines were used as described in Table 3, “Virtual Machines for Each Testing Tile,” on page 11 of this document.

Testing was conducted by first running a single tile, then upon completion of the first tile a second was added and ran. After the second was added then a third was ran and then a fourth. The deduplication ratio for each of the four tests are cataloged in Table 4 below.

<table>
<thead>
<tr>
<th>Number of Tiles</th>
<th>Microsoft Exchange 2007 Mail Store Only deduplication Percent</th>
<th>DVD Store Virtual Machine deduplication Percent</th>
<th>Exchange Server OS and Application, Olio Web Server, Standby Virtual Machines deduplication Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11%</td>
<td>13%</td>
<td>37%</td>
</tr>
<tr>
<td>2</td>
<td>15%</td>
<td>33%</td>
<td>69%</td>
</tr>
<tr>
<td>3</td>
<td>15%</td>
<td>41%</td>
<td>73%</td>
</tr>
<tr>
<td>4</td>
<td>24%</td>
<td>46%</td>
<td>78%</td>
</tr>
</tbody>
</table>

The total used capacity of the file system that stored the VMDKs for the general workload virtual machines was 903.5 GB before the deduplication service was run.

The total used capacity of the file system that stores the VMDKs for the general workload virtual machines was 301.5 after the deduplication service was run, reclaiming 602 GB or 78% of the disk space.
Deduplication I/O Performance

Test Case 1: Workloads with Deduplication Disabled
The baseline testing with VMMark and VDBench performed as expected.

Test Case 2: Workloads with Deduplication Enabled and During a Full Conversion
Running VDBench while the deduplication service was performing a conversion, the application I/O dropped by an average of 21 percent.

Figure 5

Figure 6
Users of Hitachi HNAS who plan to use the deduplication product should conduct a performance test in their environments first. It should be based on test results and application requirements and use the scheduling feature of the Hitachi HNAS to achieve optimum performance.

**Test Case 3: VDBench Workloads with Deduplication Enabled and after the completion of the Deduplication service**

After the deduplication service completed its operation, application workloads returned to pre deduplication levels.

![VMMark I/O Pre, During, and Post De-Duplication](image)

**Figure 7**

Testing with this workload, deduplication had no impact on the application performance after the deduplication service completed its operation.

**Hardware Utilization Information: Pre Deduplication, During Deduplication, and Post Deduplication**

The hardware utilization during testing was moderate and representative of what should be expected in most production environments.
On the HUS 150 the disk utilization was moderate. Figure 8 below shows the disk utilization for pre, during, and post deduplication.

Figure 8
As Figure 8 shows, during both pre and post deduplication, the disk percent busy was within normal operating range and the disk percent busy was the same both pre deduplication and post deduplication. During the deduplication services operation the disk utilization was higher, and this was expected.

The Hitachi NAS system utilization was also low as Figure 9 shows.

Figure 9
The ESXi host had a dedicated 10 Gbps NIC for NFS traffic to and from the Hitachi NAS. Figure 10 shows the amount of traffic that traveled over these NICs.

![Graph showing ESXi Host1 and Host 2 10 Gbps NFS Nic Average Mbits/Sec](image)

**Figure 10**

As Figure 10 shows the 10 Gbps NICs utilization left plenty of room for expansion.
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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