Hitachi Unified Storage VM with Epic Systems and Hitachi ShadowImage Heterogeneous Replication, using SAS Hard Disk Drives and Solid State Drives

Reference Architecture Guide

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Reference Architecture Guide

This reference architecture guide shows how the entry enterprise storage system Hitachi Unified Storage VM environment provides high performance in an integrated solution for an Epic Systems infrastructure. There is a comparison of results using and not using the following:

- Hitachi ShadowImage® Heterogeneous Replication
- Solid state drives
- 15k and 10k RPM drives

This document is intended for system engineers, support personnel, and administrators of systems involved in the early stages of planning and designing Hitachi Unified Storage VM in an environment with the Epic online transaction processing database. It documents all applicable configuration options that allow the environment to meet established performance targets. You should have knowledge of the following:

- Hitachi Unified Storage VM methods
- Hitachi ShadowImage Heterogeneous Replication methods
- Hitachi Dynamic Provisioning methods

Note — The described architecture in this document was designed specifically for Epic OLTP production and does not reflect other application I/O patterns, nor do they have any influence on the OLTP production by other activities which may run simultaneously on the same array. The guide is strictly for Epic OLTP production type workload and should not be extrapolated to predict performance for other types of workloads on Hitachi Data Systems storage products.
Solution Overview

The Hitachi Unified Storage VM environment provides high performance in an integrated solution for an Epic Systems infrastructure for typical online transaction processing workloads. Tailor your implementation of this solution to meet your specific needs.

Epic makes software for mid-size and large medical groups, hospitals, and integrated healthcare organizations.

This reference architecture guide discusses the effects that the amount of cache and number of drives have on deploying this solution with and without Hitachi ShadowImage Heterogeneous Replication, SAS, and solid state drives. This shows the performance impact of using Hitachi ShadowImage Heterogeneous Replication and different drive speeds.

This reference architecture discusses the following:

- Hitachi Unified Storage VM environment baseline with 15k and 10k RPM SAS drives
- Hitachi Unified Storage VM environment using ShadowImage Heterogeneous replication
- Hitachi Unified Storage VM environment using solid state drives
Key Solution Components

Table 1 and Table 2 list the key hardware and software components used in this reference architecture.

Table 1. Reference Architecture Hardware Components

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
</table>
| Hitachi Unified Storage VM system | ▪ 324 × 600 10k RPM SAS drives  
▪ 264 × 300 GB 15k RPM SAS drives  
▪ 8 x 400 GB SSD drives  
▪ 256 GB total cache | 73-01-33-00 or later |
| IBM® System                  | ▪ 2 × 3 GHz IBM POWER7™ processor cores  
▪ 16 GB RAM  
▪ IBM AIX® 7.1, TL1  
▪ LVM maximum allocation policy, with 16 MB pp size  
▪ JFS2 file system  
▪ CIO mount option  
▪ Four paths per LUN | 73-01-33-00 or later |

Table 2. Reference Architecture Software Components

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi ShadowImage Heterogeneous Replication</td>
<td>73-01-33-00 or later</td>
</tr>
<tr>
<td>Hitachi Dynamic Provisioning (HDP)</td>
<td>73-01-33-00 or later</td>
</tr>
</tbody>
</table>

Hitachi Unified Storage VM

Hitachi Unified Storage VM is an entry-level enterprise storage platform. It combines storage virtualization services with unified block, file, and object data management. This versatile, scalable platform offers a storage virtualization system to provide centralized storage services to existing storage assets.

Unified management delivers end-to-end central storage management of all virtualized internal and external storage on Unified Storage VM. A unique, hardware-accelerated, object-based file system supports intelligent file tiering and migration, as well as virtual NAS functionality, without compromising performance or scalability.
The benefits of Unified Storage VM are the following:

- Enables the move to a new storage platform with less effort and cost when compared to the industry average
- Increases performance and lowers operating cost with automated data placement
- Supports scalable management for growing and complex storage environment while using fewer resources
- Achieves better power efficiency and with more storage capacity for more sustainable data centers
- Lowers operational risk and data loss exposure with data resilience solutions
- Consolidates management with end-to-end virtualization to prevent virtual server sprawl

**Hitachi ShadowImage Heterogeneous Replication**

Hitachi ShadowImage Heterogeneous Replication is a storage-based solution that creates RAID-protected duplicate volumes within Hitachi Virtual Storage Platform family products. ShadowImage Heterogeneous Replication primary volumes (P-VOLs) contain the original data. Up to nine secondary volumes (S-VOLs) can be created as copies.

On Hitachi Virtual Storage Platform, ShadowImage Heterogeneous Replication is used to implement clones - a full copy of the primary data. The clone is available to be used by secondary applications. The unique value of working with a clone is that any operation on the clone has no effect on the primary data.

Detailed information on using ShadowImage Heterogeneous Replication is in *Hitachi Command Control Interface User and Reference Guide* (MK-90RD7010).

**Hitachi Dynamic Provisioning**

On Hitachi storage systems, **Hitachi Dynamic Provisioning** provides wide striping and thin provisioning functionalities.

Using Dynamic Provisioning is like using a host-based logical volume manager (LVM), but without incurring host processing overhead. It provides one or more wide-striping pools across many RAID groups. Each pool has one or more dynamic provisioning virtual volumes (DP-VOLs) of a logical size you specify of up to 60 TB created against it without initially allocating any physical space.
Deploying Dynamic Provisioning avoids the routine issue of hot spots that occur on logical devices (LDEVs). These occur within individual RAID groups when the host workload exceeds the IOPS or throughput capacity of that RAID group. Dynamic provisioning distributes the host workload across many RAID groups, which provides a smoothing effect that dramatically reduces hot spots.

When used with Hitachi Unified Storage VM, Hitachi Dynamic Provisioning has the benefit of thin provisioning. Physical space assignment from the pool to the dynamic provisioning volume happens as needed using 42 MB pages, up to the logical size specified for each dynamic provisioning volume. There can be a dynamic expansion or reduction of pool capacity without disruption or downtime. You can rebalance an expanded pool across the current and newly added RAID groups for an even striping of the data and the workload.
Solution Design

This reference architecture implements an entry enterprise storage system Hitachi Unified Storage VM to host on OLTP database for Epic software.

The following are the configuration options for this reference architecture:

- **Cache size** — 128 or 160 GB
- **Hitachi ShadowImage Heterogeneous Replication** — You have the option of whether or not to use ShadowImage Heterogeneous Replication.
- **Use of SAS drives or solid state drives** — You have the option of the following for storage:
  - 10k RPM and 15k RPM SAS drives
    - 32 drives
    - 64 drives
    - 96 drives
    - 128 drives
  - 8 solid state drives

The description of the tested hardware components is in “Key Solution Components” on page 3. Specific infrastructure configuration includes the following:

- **Server** — This architecture uses a single IBM server with an IBM AIX 7.1 TL1 server configuration.
- **Storage System** — This architecture maps LDEVs mapped to each of four ports that are presented to the server as LUNs.
- **SAN Fabric** — CL1 and CL2 zoned to both Fabric A and B. Fabric A (1B, 1D, 1B, 2C) and fabric B (2A, 2B, 2C, 2D)

This is the storage architecture of this reference architecture. It takes into consideration Hitachi Data Systems and Epic recommended practices for the deployment of the storage design.
Storage Configuration
This reference architecture uses RAID groups and storage pools created with Hitachi Dynamic Provisioning on Hitachi Unified Storage VM.

For the 32 drive configuration, there are 8 RAID groups created. For the 64 drive configuration, there are 16 RAID groups created. For the 96 drive configuration, there are 24 RAID groups created. For the 128 drive configuration, there are 32 RAID groups created. These are RAID-10 (2D+2D) for the following reasons:

- Redundancy (blocks are mirrored)
- Performance (blocks are stripped)

Use Hitachi Dynamic Provisioning to eliminate hotspots. In both configurations, create one LDEV out of each RAID group. Add all LDEVs to a pool created with Hitachi Dynamic Provisioning.

Depending on the number of drives configured, create 8, 16, 24 and 32 LUNs and map them to four paths to the hosts.

An Epic environment requires at least a 128 GB CLPR size to maintain a 160 IOPS/drive rate on the backend for a production OLTP database, based on using 15k RPM drives.

- If using a smaller CLPR size, an Epic environment requires more drives to compensate for the drop in the maximum IOPS/drive rate.
- If using 10k RPM drives instead of 15k RPM drives, Epic requires at least double the amount of drives to compensate for the performance difference.
  - In general, Epic recommends using RAID-10 for production OLTP storage for performance purposes. However, the high performance capability of SSDs requires RAID-5.

Server and Application Architecture
The reference architecture uses one AIX server. It includes a single Epic OLTP simulator instance. The OLTP simulator is a set of read processes doing random read operations and write operations writing to memory and flushing data out to disk every 80 seconds. The read-to-write rations is 3:1.

There are two IBM Power 7 cores with 32 GB RAM. This provides the compute power for Epic OLTP to handle a large volume of transaction processing in parallel.

This reference architecture uses AIX volume manager.
SAN Architecture

Map the provisioned LDEVs to multiple ports on Hitachi Unified Storage VM system. These LDEV port assignments provide multiple paths to the storage system from the host for high availability.

When designing your SAN architecture, follow these recommended practices for a secure, high-performance, and scalable database deployment:

- Use at least two HBAs and place them on different I/O buses within the server. This distributes the workload over the PCI-e bus architecture of the server.
- Use dual SAN fabrics and host-based multipathing software in a business-critical deployment. Connecting two or more paths from the database servers to two independent SAN fabrics provides the redundancy required for critical applications.
- Zone your fabric to handle multiple, unique paths from HBAs to storage ports. Use single initiator zoning where each zone has only a single HBA and one or more storage ports.

Network Architecture

This reference architecture has two on-board 1 Gb/sec NIC ports for connectivity and redundancy.
Engineering Validation

This is how the OLTP database used by Epic was validated on the entry enterprise storage system Hitachi Unified Storage VM.

Test Methodology

The tests used the RampRun.pl script from Epic. This script calls the Epic simulation tool GenerateIO. While RampRun.pl is responsible for kicking off various monitoring tools to capture metrics throughout the test, GenerateIO is the simulator that generates the I/O workload and patterns similar to an OLTP production environment using Epic. GenerateIO ramped up the I/O load to cover a wide range of IOPS levels, as expected in production environments.

The I/O latency data gathered during these tests include the following:

- Read response time measured by the Ranread utility from Epic
  - The Ranread utility is used in production environments to measure read response times.
- Write response time and write cycle length logged by the GenerateIO simulator

Epic determined a list of I/O performance targets to ensure end-user experience is not affected by any bottleneck at the storage level. These are the I/O performance targets:

- Average read latencies must be 12 m/sec or less
- 99% of read latencies must be below 60 m/sec
- 99.9% of read latencies must be below 200 m/sec
- 99.99% of read latencies must be below 600 m/sec
- Complete the write cycle within 30 seconds

Workload

Testing included scenarios to ensure the following:

- The write response time was below 1 m/sec, preferably in the 0.4 m/sec to 0.6 m/sec range
- The write daemon cycle in the 30 second range

Testing Procedure

When testing the environment, run the tests for each of these server cache size partitions:

- 128 GB
- 160 GB
To validate the solution, this testing was done on the reference architecture:

1. Ran the testing procedure on the environment for each of the server cache sizes to establish the performance baseline data without using the following:
   - Hitachi ShadowImage Heterogeneous Replication
   - Solid state drives
2. Ran the testing procedure on the environment adding Hitachi ShadowImage Heterogeneous Replication to the base configuration.
3. Ran the testing procedure on the environment adding solid state drives to the base configuration and Hitachi ShadowImage Heterogeneous Replication

The GenerateIO Test testing procedure measured the following in the environment with the different cache sizes and number of drives:

- Front and back-end IOPS
- Read and write latency
- "iostat"

**Data Gathering**

Performance statistics were collected at the following levels:

- **Storage**
  - Hitachi Storage Navigator collected storage performance data
- **Operating System**
  - GenerateIO collected operating system statistics
Test Results

This summarizes the key observations from the test results for using an OLTP database with Epic with Hitachi Unified Storage VM.

Baseline Configuration Test

This summarizes the results from the baseline configuration test.

- There is a significant difference in terms of read performance between 10k RPM and 15k RPM SAS drives under an Epic workload.
- The 99-percentile of random read latency depends on the cache logical partition (CLPR) size.
  - Meeting the 99-percentile requirement of 60 m/sec or less required a larger CLPR.
    - For the 15k RPM drive configurations, a 128 GB CLPR size is required.
    - For 10k RPM drive configurations, a similar trend was observed.

Hitachi ShadowImage Heterogeneous Replication Configuration Test

In this test we set up the target disks or secondary volume (s-VOL) with RAID-5 (3D+1P) disk groups with fewer drives than the primary volume (p-VOL).

Comparing the results to the baseline configuration, a larger size CLRP size is recommended. The minimum CLRP size recommended is 160 GB.

Solid State Drive Configuration Test

These are the results of the solid state drive configuration test.

- Using SSDs in Hitachi Unified Storage VM exhibits performance characteristics similar to SAS drives, although using SSDs support a much higher IOPS/drive rate.
  - A cache size of 64 GB can drive up to 27,000 host IOPS with eight SSDs while meeting all the I/O performance targets.
Conclusion

The major finding is the 99-percentile of read latency dependency on the cache partition size. With one of the I/O performance targets being 60 m/sec or less for the 99-percentile of read response time and to accommodate the write daemon cycle every 80 seconds, the cache size must be set to 128 GB if Hitachi ShadowImage Heterogeneous Replication is not present, and to 160 GB if using Hitachi ShadowImage Heterogeneous Replication to guarantee that.

For cache optimization, a cache partition dedicated to the production OLTP database for Epic must be used and LUNs must be distributed across all MP blades.
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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