

Optimizing the Hitachi Universal Storage Platform[®] Family in VMware Environments

Best Practices Guide

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January 2011

Feedback

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Best Practices Guide

The many benefits of host virtualization are well known. These include reducing cost of operation, increasing responsiveness, improving availability, enhancing performance, creating more environmentally friendly data centers and improving return on investment. Availability, balanced performance and ease of management are especially critical when mission-critical applications are deployed in virtualized environments like VMware Infrastructure 3.x and vSphere.

The Hitachi Universal Storage Platform[®] family, which is made up of the Hitachi Universal Storage Platform V and the Hitachi Universal Storage Platform VM, brings enterprise-class availability, performance and ease of management to organizations of all sizes that are dealing with an increasing number of virtualized business-critical applications. The Hitachi Universal Storage Platform family with Hitachi Dynamic Provisioning software supports both internal and external virtualized storage, simplifies storage administration and improves performance to help reduce overall power and cooling costs.

The Hitachi Universal Storage Platform family provides end-to-end secure virtualization for VMware Infrastructure 3.x and vSphere environments. With the ability to securely partition port, cache and disk resources, and to mask the complexity of a multivendor storage infrastructure, the Universal Storage Platform VM is an ideal complement to a VMware environment. With up to 1,024 virtual ports for each physical Fibre Channel port, the Universal Storage Platform family provides the connectivity to support large VMware server farms. Virtual storage machines can be created to align the host environment with the storage platform.

Hitachi Data Systems has the expertise to help you maximize availability, performance and ease-of-management capabilities of the Universal Storage Platform family in a VMware environment. The best practice recommendations and configuration details in this document help to ensure successful planning, deployment and maintenance of VMware environments that use Universal Storage Platform family storage systems.

This white paper is intended for use by IT administrators who are in the following situations:

- Planning new deployments of VMware in an existing or new Universal Storage Platform family storage environment
- Studying a move to server virtualization and looking for a storage platform to support their increased need for reliability and performance while reducing total cost of operation
- Adopting storage virtualization to support different data protection schemes

- Replacing older storage systems that require expensive maintenance or are not on the VMware compatibility matrix
- Addressing concerns about storage availability and performance in a virtual server environment
- Seeking ways to reduce the cost and complexity of heterogeneous storage management

This paper is written for VMware Infrastructure 3.x, vSphere and IT administrators with solid working knowledge of VMware and storage.

Hitachi Universal Storage Platform Family Overview

The Universal Storage Platform family is ideal for large and small enterprises seeking a powerful and cost-effective storage solution for managing their growing data retention and business continuity needs. It allows for virtualization and thin provisioning of internal and external storage, resource-efficient thin provisioning with Hitachi Dynamic Provisioning software, all through a single management interface. You can aggregate internal and external storage into one virtualized storage pool, even resources from other storage vendors. Dynamic Provisioning software improves resource utilization and simplifies administration by allowing you to purchase only the storage you need, when you need it.

While this white paper refers primarily to the Universal Storage Platform VM, the best practice recommendations it contains apply to the Universal Storage Platform V. Figure 1 shows the Hitachi Universal Storage Platform VM with external storage attached in a typical VMware Infrastructure 3.x or vSphere environment.

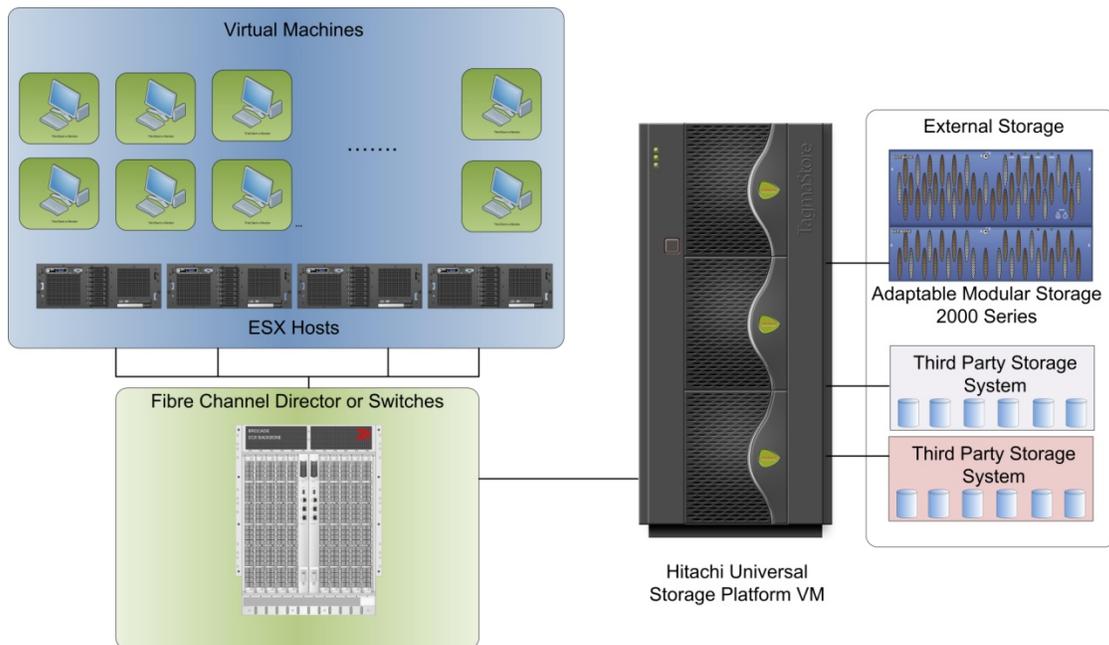


Figure 1

The industry's highest reliability and availability storage solution is backed by a set of storage and data services that include thin provisioning and wide striping across many disks with Hitachi Dynamic Provisioning software, application centric storage management and logical partitioning, as well as simplified, unified data replication across heterogeneous storage systems.

The Hitachi Universal Storage Platform family packages and delivers critical services like these:

- Virtualization of storage from Hitachi and other vendors into one pool
- Thin provisioning through Hitachi Dynamic Provisioning for nondisruptive volume expansion
- Security services, business continuity services and content management services
- Nondisruptive dynamic data migration from Hitachi and other storage systems

The following features of the Hitachi Universal Storage Platform family let you deploy applications in a framework that fully leverages and adds value to current investments and more closely aligns IT to your business objectives:

- **Hitachi Universal Volume Manager Software** — Universal Volume Manager software simplifies migration of datastores to the Universal Storage Platform VM. The software eliminates the need to reformat LUs or perform complex extent mapping, providing a minimally disruptive migration process. Once virtualized behind the Universal Storage Platform VM, external LUNs gain access to all Hitachi storage services.
- **Hitachi Dynamic Provisioning Software** — Hitachi Dynamic Provisioning software provides the Universal Storage Platform VM with thin provisioning services. Thin provisioning gives applications access to virtual storage capacity. Applications accessing virtual, thin provisioned volumes are automatically allocated physical disk space, by the storage system, as they write data. This means volumes use enough physical capacity to hold application data, and no more. All thin provisioned volumes share a common pool of physical disk capacity. Unused capacity in the pool is available to any application using thin provisioned volumes. This eliminates the waste of overallocated and underutilized storage.

Dynamic Provisioning software also simplifies storage provisioning and automates data placement on disk for optimal performance. Administrators do not need to micro-manage application storage allocations or perform complex, manual performance tuning. In addition, physical storage resources can be added to the thin provisioning pool at any time, without application downtime. Dynamic Provisioning also provides performance improvements through automatic optimized wide striping of data across all available disks in a storage pool

For more information, see the Hitachi Universal Storage Platform V and Hitachi Universal Storage Platform VM Overview [brochure](#).

Basic Storage System Setup

Follow the best practices provided in this section to successfully deploy VMware on Hitachi Universal Storage Platform VM systems. The information provided might apply directly to your environment or might need some modifications. Always take into account specific requirements from your environment and check with a Hitachi Data Systems representative.

With the Universal Storage Platform VM, RAID groups are carved into logical devices (LDEV). If standard LUN provisioning is used the LDEV is then assigned a logical unit number (LUN) when the LDEV is assigned to a host group. If Dynamic Provisioning is used, the LDEV is assigned to a Dynamic Provisioning pool and Dynamic Provisioning volumes (DP-VOLs) are then created and assigned a LUN when the DP-VOL is assigned to a host group.

Host Groups per HBA Versus Host Groups per ESX Hosts or VMware Cluster

To present a set of common, shared LUNs to multiple ESX hosts or to a VMware cluster, host groups can be created either per HBA port (that is, per WWPN) or per a group of ESX hosts or VMware cluster.

A host group created on an HBA port basis contains the HBA's WWPN and a set of common, shared LUNs (that is, only one WWPN, multiple LUNs). A host group created per group of ESX hosts or per VMware cluster contains at least one WWPN from every ESX host and multiple LUNs (that is, multiple WWPNs, multiple LUNs). With ESX 3.5 and earlier, every LUN must be presented with the same host LUN ID to every host or the ESX host treats the LUN as a snapshot LUN and disables access to the VMFS by default.

Although both concepts are supported, Hitachi Data Systems recommends creating host groups per HBA port (that is, per WWPN) when ESX clustering is not configured. In the case where ESX clustering is configured for Distributed Resource Scheduling, High Availability, or Fault Tolerance, Hitachi Data Systems recommends a single host group per cluster.

Table 1 lists some advantages and disadvantages of creating host groups per HBA port versus host groups per ESX hosts or VMware cluster.

Table 1 Host Group Configuration

<i>Host Group Configuration</i>	<i>Advantages</i>	<i>Disadvantages</i>	<i>Hitachi Recommendation</i>
One host group per HBA (HBA port)	Allows boot from SAN. Better flexibility. Changes to the host group affect only one host. Better troubleshooting possibilities and log analysis.	More host groups to be created and maintained.	Recommended for standalone ESX hosts
One host group per ESX hosts or VMware cluster	Fewer host groups to be created and maintained.	Does not allow ESX hosts to boot from SAN. Less flexibility (for example, an additional LUN cannot be presented to only one ESX host). Changes to the host group might affect all hosts.	Recommended for ESX clusters

Host Modes

To create host groups for ESX hosts, choose **01[VMware]** or **21[VMware extension]** from the **Host Mode** drop-down menu. The **Host Mode 21[VMware extension]** option allows you to expand a LUN using logical unit size expansion (LUSE) while the LUN is mapped to the host.

Storage Provisioning

Capacity and performance cannot be considered independently. Performance always depends on and affects capacity and vice versa. That's why it's very difficult or impossible in real-life scenarios to provide best practices for the best LUN size, the number of virtual machines that can run on a single VMFS and so on without knowing both capacity and performance requirements. However, several factors must be considered when planning storage provisioning for a VMware Infrastructure 3.x or vSphere environment.

Size of LUN

When determining the right LUN size, consider the factors listed in Table 2. These factors are especially important from a storage system perspective. In addition, the individual virtual machine's capacity and performance requirements (basic virtual disk requirements, virtual machine swap space, spare capacity for virtual machine snapshots and so on) must also be considered.

Table 2. LUN Size Considerations

<i>Factor</i>	<i>Comment</i>
Minimum LDEV size	The smallest LDEV that can be created on the Hitachi Universal Storage Platform VM is 96,000 blocks, or approximately 46MB. The smallest VMFS that can be created on an ESX host is approx. 1GB.
Maximum LUN size	The largest internal LUN that can be created on the Hitachi Universal Storage Platform VM is 2.999TB. The largest VMFS that can be created on an ESX host is 2TB without using extents, 64TB when using extents.
Disk queues	More LUNs offer more disk queues and therefore better performance.
SCSI reservations	Because SCSI reservations are set per LUN, more but smaller LUNs typically lead to less SCSI reservation conflicts and therefore better performance.
Volume migration	Smaller LUNs can be migrated using Hitachi Tiered Storage Manager to a broader range of possible target RAID groups.
Data replication	Using more but smaller LUNs offers better flexibility and granularity when replicating a VMFS within a storage system (Hitachi ShadowImage [®] Replication software, Hitachi Copy-on-Write Snapshot software) or across storage systems (Hitachi TrueCopy [®] Synchronous software or Hitachi Universal Replicator software).

<i>Factor</i>	<i>Comment</i>
VMware VMFS upgrades	Using more but smaller LUNs offers better flexibility and granularity when upgrading a VMFS.
VMware vCenter Site Recovery Manager	Using more but smaller LUNs offers better flexibility and granularity when creating protection groups and recovery plans in VMware vCenter Site Recovery Manager.

Considering all of the factors in Table 2, a minimum LUN size to start with is 256GB and maximum LUN size is 2TB. This number might vary from environment to environment.

Hitachi Dynamic Provisioning Software Operations

Hitachi Dynamic Provisioning software uses two primary components: a pool of physical storage capacity (Dynamic Provisioning pool) and Dynamic Provisioning volumes. The Dynamic Provisioning pool is composed of LDEVs. A Dynamic Provisioning volume is a volume of specified size created within a Dynamic Provisioning pool and assigned to a host group. The host sees the LUN as provisioned at the specified size; however, the physical space is allocated from the Dynamic Provisioning pool as needed.

As the application writes data to the Dynamic Provisioning volume, the storage processor allocates physical capacity from the Dynamic Provisioning pool while monitoring multiple thresholds to alert administrators when more physical pool capacity is needed.

The underlying storage for a Dynamic Provisioning pool can be any supported RAID level, for example RAID-5 (3D+1P) or RAID-1+0 (2D+2D), and any supported disk type. However, all storage in a single pool must be the same RAID level and drive type. The Dynamic Provisioning pool presents a striped space across consecutive sets of RAID stripes using 42MB pages. Each 42MB page is allocated as write I/O occurs to the Dynamic Provisioning Volume.

The Dynamic Provisioning volume takes on the RAID characteristics of the underlying RAID and disk type, so plan the Dynamic Provisioning pool accordingly. A larger number of LDEVs, with one LDEV created per RAID group, in the Dynamic Provisioning pool increases the performance of Dynamic Provisioning volumes associated with the Dynamic Provisioning pool. Workload can be balanced across many disks by allocating a large number of disks and assigning Dynamic Provisioning volumes to hosts with a variety of workload needs.

Standard Provisioning RAID Group Best Practices

Because all LDEVs on a particular RAID group share the performance and capacity offered by the RAID group, Hitachi Data Systems recommends dedicating RAID groups to an ESX host or a group of ESX hosts (for example, an ESX cluster) and not assigning LDEVs from the same RAID group to the virtual environment and other non-ESX hosts. This prevents the ESX I/O from affecting or being affected by other applications and LDEVs on the same RAID group and makes management cleaner.

For standard RAID group provisioning, follow these best practices:

- Create and dedicate RAID groups to your ESX hosts (that is, VMware cluster)
- Create VMFSs on the LUNs as needed. Consider choosing a datastore name with a reference to the LUN ID.
- Monitor and measure the capacity and performance usage of the RAID group with VMware vCenter Server, Hitachi Tuning Manager software and Hitachi Performance Monitor software.

Hitachi Dynamic Provisioning Software Best Practices

The following sections describe best practices for using Hitachi Dynamic Provisioning software with VMware Infrastructure 3.x or vSphere 4.

Two of vSphere's virtual disk formats are thin friendly, meaning that they only allocate pages from the Dynamic Provisioning pool as required. Thin and zeroedthick format virtual disks are thin friendly, eagerzeroedthick format virtual disks are not. Thin and zeroedthick virtual disk format do not zero the VMFS filesystem blocks on creation. When the first write to each VMFS filesystem block occurs, the VMkernel writes zeroes to the block to assure that any data previously written to this storage cannot be accessed. This additional write produces additional write overhead, commonly called a warm-up anomaly.

The eagerzeroedthick format virtual disk zeroes all VMFS filesystem blocks on creation and therefore allocates 100 percent of the Dynamic Provisioning volume's space in the Dynamic Provisioning pool. While an eagerzeroedthick format virtual disk does not give the benefit of cost savings by overprovisioning storage, it preallocates the pages in the Dynamic Provisioning pool across all disks. This preallocation of pages can improve initial performance of the virtual disk.

For environments that use Hitachi Dynamic Provisioning software, follow these best practices:

- Use a single LDEV per RAID group to reduce contention for disk resources.
- Use at least four LDEVs from four RAID groups in the Dynamic Provisioning pool for maximum wide striping benefit.
- Size the Dynamic Provisioning pools according to the I/O requirements of the virtual disk and application.
- When larger Dynamic Provisioning pools are not possible, separate sequential and random workloads on different Dynamic Provisioning pools.
- For applications that use log recovery, separate the logs from the database on different Dynamic Provisioning pools. This separates the sequential and random workloads and can also help protect data. In the rare case where a dual hardware failure causes the corruption or loss of a Dynamic Provisioning pool, the logs are available for recovery.

Virtual Disk Format with Dynamic Provisioning Key Considerations

Zeroedthick and eagerzeroedthick format virtual disks provide similar performance after the zeroedthick warm-up period. Either virtual disk format provides similar throughput after all blocks are written at least one time, however, zeroedthick initially shows some write latency and lower write throughput.

When deciding whether to use zeroedthick or eagerzeroedthick format virtual disks, keep the following in mind:

- If you plan to use vSphere 4's Fault Tolerance on a virtual machine, you must use the eagerzeroedthick virtual disk format.
- When using Dynamic Provisioning for cost savings, use zeroedthick virtual disk format.
- If minimizing the time to create the virtual disk is more important than maximizing initial write performance, use the zeroedthick virtual disk format.
- If maximizing initial write performance is more important than minimizing the time required to create the virtual disk, use the eagerzeroedthick format.
- If you are using Dynamic Provisioning software for cost savings, do not convert a thin format virtual disk to thick

Note that you can use the thin virtual disk format and achieve similar space savings; however, this creates an additional data point to monitor as storage overprovisioning must be monitored from vCenter and the storage. vSphere thin provisioning can also add ESX CPU overhead and SCSI reservation issues. Hitachi Data Systems recommends using Hitachi Dynamic Provisioning software with zeroedthick virtual disks when thin provisioning is required. This ultimately lessens management tasks for data center administrators.

Scalability Considerations

To determine how to scale your environment, you must monitor and measure the capacity and performance of RAID groups.

- If you are using standard LUNs, keep the following in mind:
 - If all of the capacity offered by the RAID group is used but performance of the RAID group is still good, add RAID groups and therefore more capacity. In this case, consider migrating the LDEVs to a different RAID group with less performance using Hitachi Tiered Storage Manager.
 - If all of the performance offered by the RAID group is used but capacity is still available, do not use the remaining capacity by creating more LDEVs because this leads to even more competition on the RAID group and overall performance for the virtual machines residing on this RAID group is affected. In this case, leave the capacity unused and add LDEVs from additional RAID groups to the ESX hosts, and therefore more performance resources. Also consider migrating the LDEVs to a different RAID group with better performance.

- If you are using Dynamic Provisioning volumes, keep the following in mind:
 - If all of the capacity offered by the Dynamic Provisioning pool group is used but performance of the RAID group is still good, add LDEVs to the Dynamic Provisioning pool for more capacity.
 - If all of the performance offered by the Dynamic Provisioning pool is used but capacity is still available, do not use the remaining capacity, instead add LDEVs to the Dynamic Provisioning pool.
 - When adding LDEVs to a Dynamic Provisioning pool, rebalance the pool on completion.

In a real environment, it is not possible to use 100 percent of both capacity and performance of a RAID group, but the usage ratio can be optimized by actively monitoring the systems and moving data to the appropriate storage tier if needed using Hitachi Tiered Storage Manager. An automated solution using these applications from the Hitachi Storage Command Suite helps to reduce the administrative overhead and optimize storage utilization.

Fibre Channel Front-end Ports

Provisioning storage on two Fibre Channel front-end ports (on one port per storage cluster) is sufficient for redundancy on the Hitachi Universal Storage Platform VM. This results in two paths to each LDEV from an ESX host's point of view. You might decide to select additional Fibre Channel front-end ports for availability and business continuity reasons.

Basic ESX Host Setup

Storage in a VMware Infrastructure 3.x or vSphere environment is typically provisioned to a group of ESX hosts in an ESX cluster sharing a common set of LUNs. Too many SCSI reservation conflicts or improper settings for queue depths can lead to performance problems.

Configuring ESX requires some understanding of how I/O flows from a virtual machine through the VMkernel then to the physical disks. Figure 2 shows the I/O stack of ESX 4.

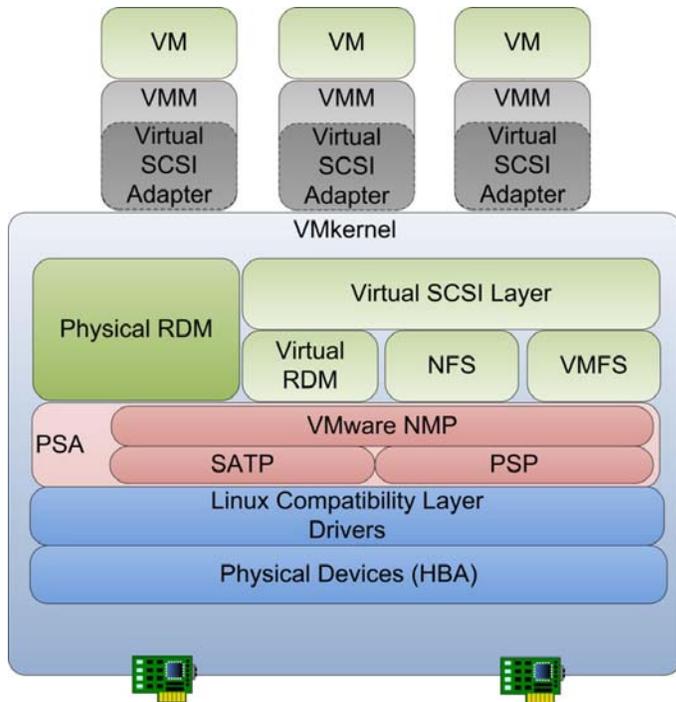


Figure 2

When an application issues an I/O, the guest operating system's virtual adapter driver passes the I/O to the virtual SCSI adapter in virtual machine monitor (VMM). The I/O is then passed to the VMkernel. At this point, the I/O can take different routes based on the kind of virtual disk the virtual machine uses:

- If virtual disks on VMFS are used, the I/O is passed through the virtual SCSI layer, then through the VMFS layer.
- If NFS is used, the I/O passes through the NFS layer.
- If raw device mapping (RDM) is used, it can be virtual or physical. Virtual RDM passes through the virtual SCSI layer where the physical RDM uses the virtual machine guest operating system's SCSI layer and bypasses the virtual SCSI layer.

The I/O is then issued to the pluggable storage architecture (PSA) to determine what path the I/O to be sent. I/O is then passed to the HBA driver queue, then to the storage system.

Path Policies

For ESX 3.5 and earlier, Hitachi recommends using a fixed path policy for all of its storage systems. For ESX 4 and higher, Hitachi recommends using VMware's round robin multipathing policy.

Table 3 describes the advantages and disadvantages of various multipathing policies.

Table 3. Multipathing Policies for ESX

<i>Multipathing Policy</i>	<i>HDS Recommendation</i>	<i>Advantage</i>	<i>Disadvantage</i>
Most recently used	Not recommended	None	Manually set path policy for every LU on every ESX host. No control over workload distribution across SAN fabrics and storage ports.
Fixed	Recommended for ESX 3.5 and earlier	This is the default path policy for VMware ESX 3.5 for any Hitachi storage system. No manual changes needed.	Workload must still be balanced across host bus adapters and SAN fabrics.
Round robin	Recommended for ESX 4 and later Experimental support only on ESX 3.5	Workload is automatically balanced across host bus adapters and SAN fabrics.	Manually set path policy for every LUN on every ESX host.

Enterprise symmetric active-active controller architecture and ESX 4's round robin multipathing policy dramatically simplifies the setup and management of a vSphere environment because the workload is automatically balanced across the Fibre Channel ports.

SCSI Reservations

Many operations — such as virtual machine power on or off, VMotion, virtual machines running with virtual disk snapshots or growing a file — require getting a file lock or a metadata lock in VMFS, resulting in a temporary SCSI reservation. During this short period of time, the entire LUN is exclusively reserved and locked by a host and is therefore not accessible by other hosts. Excessive SCSI reservations by one or multiple ESX hosts cause SCSI reservation conflicts and can cause performance degradation on other ESX hosts accessing the same VMFS or LUN.

You can search VMkernel log files for SCSI reservation conflict warnings. For more information about how to reduce SCSI reservations and how to avoid SCSI reservation conflicts, see VMware's Fibre Channel SAN Configuration Guide.

From a storage provisioning point of view, SCSI reservation conflicts can be reduced by creating more but smaller LUNs to achieve a specific capacity.

Queue Depth

The Hitachi Universal Storage Platform VM supports a maximum queue depth per Fibre Channel front-end port of 4,096 using eight port FED features or 2,048 per Fibre Channel front-end port when using 16 port FED features. Each LUN has a nominal queue depth limit of 32. This value determines the maximum queue depth setting on the VMware ESX hosts. A large queue depth does not provide better performance per se. This can cause the response times to rapidly increase while gaining a small increase in achieved IOPS at the host. Instead, monitor the queued commands on the hosts and adjust the HBA queue depth to ensure that the front-end port does not exceed the maximum queue depth of 2,048 or 4,096 per Fibre Channel port. Use the `esx top` command to determine the number of commands queued per ESX host.

Table 4 lists supported maximum queue depth settings.

Table 4. Queue Depth Settings for Hitachi Universal Storage Platform VM

<i>Configuration</i>	<i>Supported Maximum Setting</i>
Path policy fixed or round robin, host groups created per HBA (per host WWPn)	Maximum queue depth of 32 per LUN Maximum aggregated queue depth of 4,096 per Fibre Channel port using 8 port FED features Maximum aggregated queue depth of 2,048 per Fibre Channel port using 16 port FED features
Path policy fixed or round robin, host groups created per ESX cluster	Maximum queue depth 32 divided by the number of ESX hosts (active HBAs) with access to the LUN Example: $32/4=8$ (4 ESX hosts, queue depth of 8 on each ESX hosts HBA) Maximum aggregated queue depth of 4,096 per Fibre Channel port using 8 port FED features Maximum aggregated queue depth of 2,048 per Fibre Channel port using 16 port FED features

Disk Alignment and RAID Stripe Size

Properly aligned storage is important for optimized I/O. Improper alignment can lead to incurring additional I/O when accessing data. A properly aligned system must be aligned at the guest operating system's file system level, ESX's VMFS and on the storage system.

The Universal Storage Platform VM has a stripe size of 512KB per data disk. Multiply this by the number of data disks in the RAID group for the total stripe size.

VMFS3 has a default starting block of 128. If the VMFS datastore is upgraded from ESX 2.x, the VMFS volume might not be aligned. Previous versions have a starting block of 63, which is not aligned along the 512K stripe boundary.

Hitachi Data Systems lab testing shows that using a starting block of 128 yields optimal performance. A starting block of 63 or 256 yields slightly lower performance. Hitachi recommends using the default VMFS3 starting block or 128 and converting any VMFS datastores created under ESX 2.x to VMFS3 with a starting block of 128.

To see if the VMFS is properly aligned, issue the following ESX command:

```
fdisk -l u
```

The output might be similar to this:

Device	Boot	Start	End	Blocks	Id	System
/dev/sdn1		128	2247091874	1123545873+	fb	VMware VMFS

The Start value of 128 indicates an aligned partition. A Start value of 63 indicates that the partition is not aligned. If the VMFS is not properly aligned, consider migrating the VMs to another LU and recreating the volume. If this is not an option, see VMware's [Performance Best Practices for VMware vSphere 4](#) white paper.

With Windows 2008, newly created partitions are properly aligned. New partitions created with previous versions of Windows operating system are not aligned by default. When a partition that was created on earlier versions of Windows is attached to Windows 2008, it carries the same partition properties as when it was created. For more information, see Microsoft's [Disk Partition Alignment Best Practices for SQL Server](#) article.

VMware Snapshot LUNs

At the moment that an LUN is formatted with the VMFS by an ESX host, it writes a signature that contains the following information to the disk:

- Serial number of the storage system
- LDEV ID (LDKC:CU:LDEV)
- LUN ID (host LUN)

Whenever an ESX host has access to a VMFS, it reads and compares the signature with its current view. If it does not match, the host disables access to the VMFS (not the LUN) by default and generates the following warning:

```
ALERT: LVM: 4941: vmhba0:0:1:1 may be a snapshot: disabling access. See  
resignaturing section in the SAN config guide.
```

In this case, you can enable access to a LUN with one of the following ESX advanced parameters:

- LVM. EnableResignature
- LVM. DisableSnapshotLUN

With vSphere 4 and higher these parameters are set by default, no action is necessary. With ESX 3.5 and earlier the default values of these parameters disable access to the snapshot VMFS.

Table 5 lists the situations where an ESX host might treat a VMFS as a snapshot LUN. In these situations, the host lists and recognizes the LUN in the Storage Adapter screen of VMware Virtual Infrastructure Client. A SAN rescan on the HBA might be necessary to discover the LUN if it is newly mapped. The VMFS might appear in the Storage screen of Virtual Infrastructure Client depending on the situation and the settings of the advanced ESX parameters.

Table 5. ESX Host Treats VMFS as Snapshot LUN Situations

<i>Situation</i>	<i>ESX Behavior</i>
In-system data replication (ShadowImage, Copy-on-Write)	The LUN is treated as a snapshot and access to the VMFS is disabled by default. Reason: At least the LDEV ID changed. It is possible that the LUN ID also changed.
Cross-system data replication (TrueCopy Synchronous, Hitachi Universal Replicator)	The LUN is treated as a snapshot and access to the VMFS is disabled by default. Reason: At least the serial number of the storage system changed. Note: VMware vCenter Site Recovery Manager uses cross-system data replication and handles the situation.
Present LUN to multiple ESX hosts with different host LUNs	The LUN is treated as a snapshot by some or all ESX hosts and access to the VMFS is disabled by default. Reason: The LUN ID (host LUN) has changed for some or all ESX hosts. Note: This applies only to ESX 3.x.
Volume migration	The LUN is not treated as a snapshot, the VMFS is accessible. Reason: Volume migration is transparent and non-disruptive to the host. Neither serial number of the storage system, LDEV ID nor LUN ID changed.
Storage virtualization	For the process only of virtualizing storage (migrating from non-virtualized storage to virtualized storage) the LUN is treated as a snapshot and access to the VMFS is disabled by default. Reason: At least the serial number of the storage system and the LDEV ID changed.

Universal Volume Manager

The Hitachi Universal Storage Platform VM offers built-in storage virtualization that allows other storage systems (from Hitachi and from third parties) to be attached (or virtualized) behind the Hitachi Universal Storage Platform VM. From an ESX host's point of view, virtualized storage is accessed through the Hitachi Universal Storage Platform VM and appears like internal, native storage capacity. The virtualized storage systems immediately inherit every feature available on the Hitachi Universal Storage Platform VM and thus enable management and replication using Hitachi software.

External storage systems can be connected to the Universal Storage Platform VM in one of two ways:

- Direct attached
- Switched SAN

In both cases, the Fibre Channel ports on the Universal Storage Platform VM are configured as external. Load balancing and failover are automatically configured by the Universal Storage Platform VM when multiple Fibre Channel ports are connected to the same external storage system LUNs.

After the external storage system's LUNs are available on the Universal Storage Platform VM, you can use them as standard LUNs or you can add them to a Dynamic Provisioning pool.

Figure 3 shows an Adaptable Modular Storage 2000 family storage system connected to a Universal Storage Platform VM using Universal Volume Manager. The LUNs from the external storage are configured in a Dynamic Provisioning pool on the Universal Storage Platform VM.

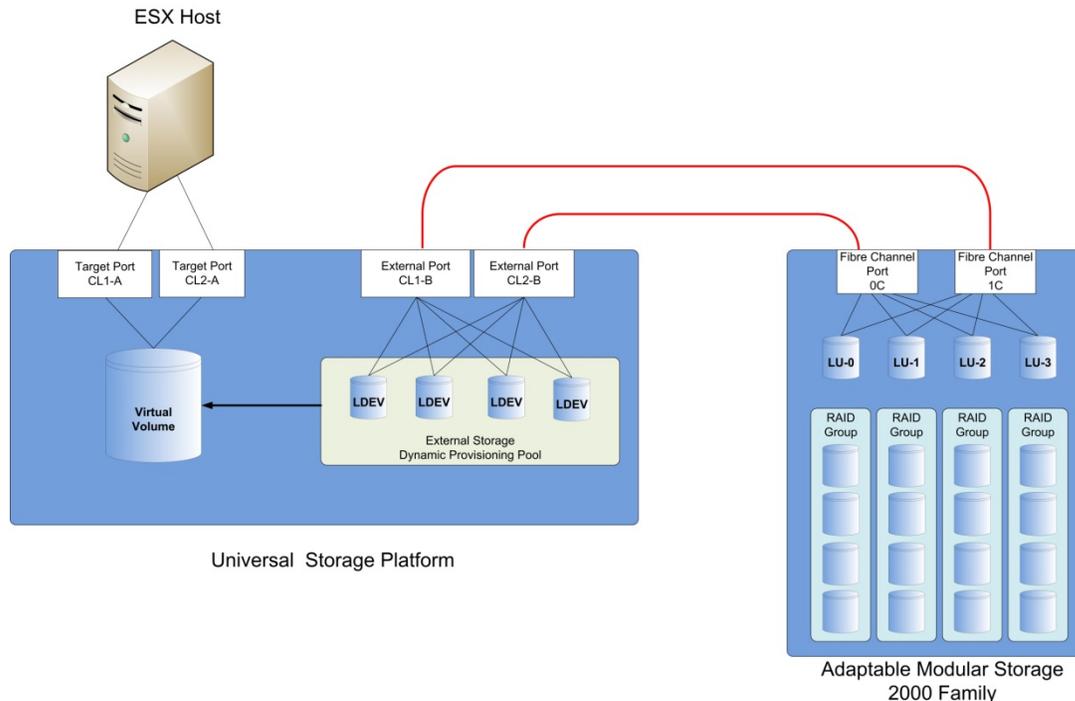


Figure 3

Universal Volume Manager offers two cache mode settings:

- **Cache Mode = Enable** — Processes I/O to external LDEVs exactly the same as internal LDEVs. When a host write occurs the data is duplexed in cache and an immediate I/O complete response is sent back to the host
- **Cache Mode = Disable** — Default; tells the Universal Storage Platform VM to hold off on sending an I/O complete response to the host until the I/O is committed to the external storage system.

The cache mode setting does not change the cache handling for read I/Os. On a read request, the Universal Storage Platform VM examines the cache to see if the data is available in cache. If the data is available, it returns the data from cache. If the data is not available, it retrieves the data from the external storage system.

Slower external storage systems can cause cache write pending rates to rise and affect the throughput of other hosts or LDEVs. Do not use the **Cache Mode = Enable** setting when you expect high IOPS to the external storage system.

Universal Volume Manager offers the ability to set the queue depth on the external storage connected to the Universal Storage Platform VM. Keep the following in mind when adjusting the queue depth setting:

- The range of queue depth values is 2 to 128 with a default of 8.
- Increasing the queue depth from the default setting of 8 to 32, 64 or 128 can have a positive effect on the response time of OLTP type applications.
- The maximum queue depth on an external port is 256, so if multiple external storage systems are attached, be sure to set the queue depth to not exceed 256 total for all external LUNs.

Dynamic Provisioning on External Storage

In a Universal Volume Manager configuration that uses a Hitachi Adaptable Modular Storage 2000 family storage system connected as external storage, Dynamic Provisioning pools can be created on the Universal Storage Platform VM system, the Adaptable Modular Storage 2000 family or both.

Hitachi Data System recommends placing the Dynamic Provisioning pool on the Universal Storage Platform VM only. Placing a Dynamic Provisioning pool on the Adaptable Modular Storage 2000 family system can result in administrative overhead, poor performance and poor utilization of the thin provisioning feature of Dynamic Provisioning.

Conclusion

This white paper describes best practices for implementing the Hitachi Universal Storage family in a Virtual Infrastructure 3.x or vSphere environment. Following these best practices helps to ensure that your infrastructure is robust, offering high performance, scalability, high availability, ease of management, better resource utilization and increased uptime.

Table 6 summarizes best practice recommendations in this document.

Table 6. Best Practices Summary

<i>Item</i>	<i>Best Practice</i>
Host group configuration	For standalone ESX hosts, use a single host group for each ESX host. For ESX clusters, use a single host group for each cluster.
Host mode	Use host mode 01 [VMware] .
LUN size	Configure LUNs to be between 256GB and 2TB.
Dynamic Provisioning software virtual disk formats	For maximum space savings use zeroedthick virtual disk format For maximum initial performance use eagerzeroedthick format
Multipathing policies	For ESX 3.x, use the fixed path policy. For ESX 4.x, use the round robin path policy.
Disk alignment	Use a starting block of 128. Convert any VMFS2 file systems to VMFS3.
External storage	Set cache mode to disable. Increase queue depth for improved OLTP performance.
External storage with Dynamic Provisioning software	Place the Dynamic Provisioning pool on the Universal Storage Platform family storage system.

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