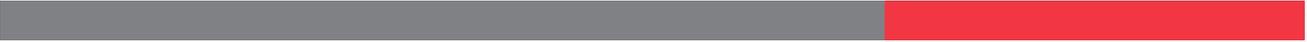


# Virtualization Architecture Synergies: Hitachi Data Systems and VMware

White Paper

*By Michael Williams, Hitachi Data Systems*

May 2008



## Executive Summary

As organizations embrace and expand on their VMware virtual server implementations, they continue to expand their understanding of the inherent savings and operational efficiencies now available to them in such areas as:

- Better IT resource utilization via consolidation and “just in time” provisioning
- Greater resiliency to changes in business-side priorities
- A more streamlined approach to supporting key applications with various “packaged” and policy-based classes of service

This paper describes the unique synergies and complementary architectures VMware server customers can expect from Hitachi Data Systems and its line of industry leading storage virtualization systems, including the Hitachi Universal Storage Platform™ V and the Hitachi Universal Storage Platform VM.

In this case, the two virtualization architectures working together — on both the server side and the storage side — are uniquely suited to build on each other's strengths while allowing organizations to obtain greater benefits than if they were used separately.



# Contents

<b>Overview</b> .....	<b>1</b>
<b>Server Virtualization Drives Storage Virtualization</b> .....	<b>1</b>
<b>Hitachi/VMware: A Mapping of Virtual Architectures</b> .....	<b>3</b>
VMware Architecture for Server Virtualization.....	3
The Hitachi Architecture for Storage Virtualization .....	4
Similarities in Functionality: Virtualization Features .....	7
<b>Areas of Synergy and Complementary Operation</b> .....	<b>8</b>
Server and Storage Consolidation.....	8
Server and Storage Partitioning .....	9
Dynamic Provisioning and Support for Different Classes of Service .....	10
Transparent Migration and Mobility .....	11
<b>Conclusion</b> .....	<b>12</b>

# Virtualization Architecture Synergies: Hitachi Data Systems and VMware

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## Overview

As organizations embrace and expand on their VMware virtual server implementations, they continue to expand their understanding of the inherent savings and operational efficiencies now available to them in such areas as:

- Better IT resource utilization via consolidation and “just in time” provisioning
- Greater resiliency to changes in business-side priorities
- A more streamlined approach to supporting key applications with various “packaged” and policy-based classes of service

Today's VMware-savvy IT organizations have begun to reap the benefits, power and potential found in VMotion — through dynamically moving, copying and provisioning virtual machines to other areas of a server farm, or to other physical servers.

This move has caused many environments to drastically reduce their server-specific capital costs and their physical server footprints. It also shines a new spotlight on the need for shared storage.

As virtual machines are decoupled from their underlying physical resources, such as the CPU and RAM cache required to run their associated applications, the need for a similar virtualized architecture on the storage side has become more apparent and more necessary.

This paper describes the unique synergies and complementary architectures VMware customers can expect from Hitachi Data Systems and its line of industry leading storage virtualization systems, including the Hitachi Universal Storage Platform™ V and the Hitachi Universal Storage Platform VM.

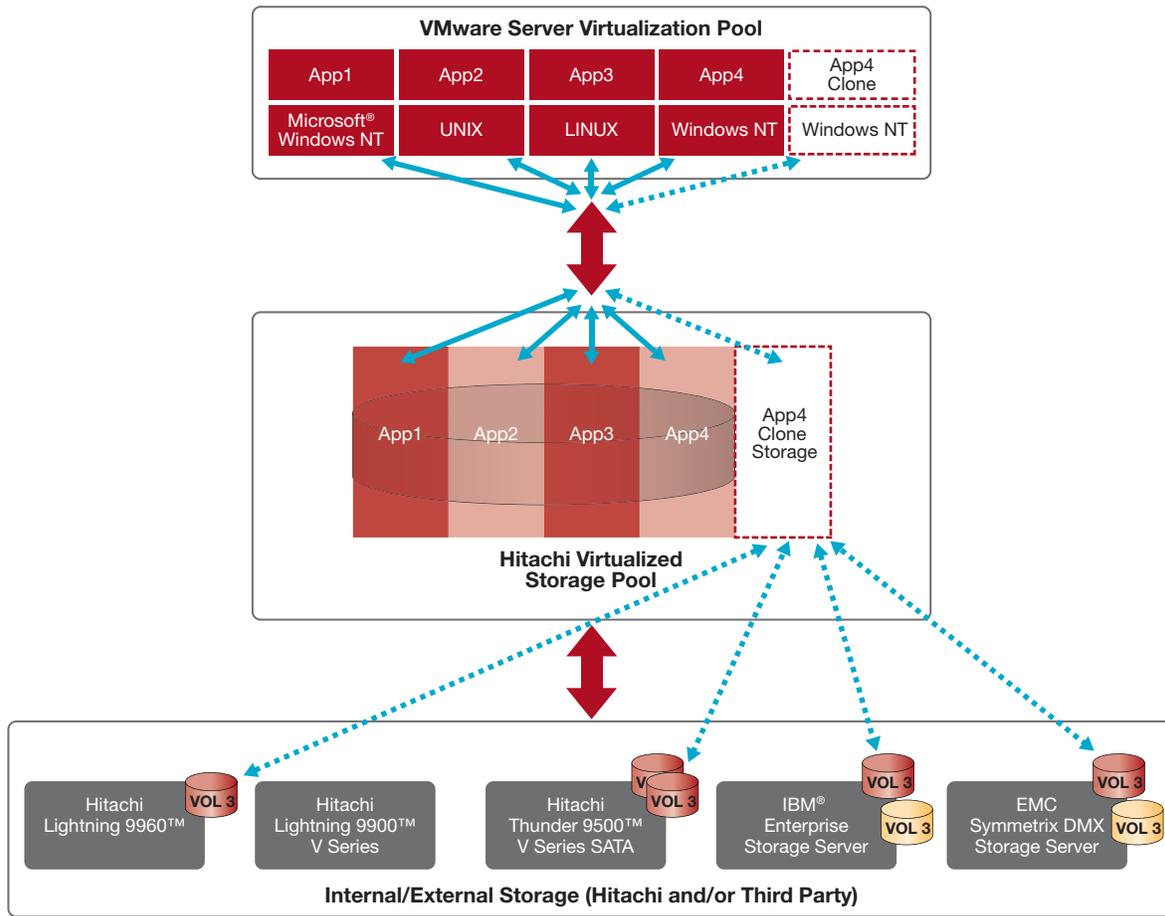
In this case, the two virtualization architectures working together — on both the server side and the storage side — are uniquely suited to build on each other's strengths while allowing customers to obtain greater benefits than if they were used separately.

## Server Virtualization Drives Storage Virtualization

As an organization implements server virtualization with VMware, the need for storage virtualization becomes more evident and urgent. While this is a very complex topic, a few examples highlight this issue.

A server virtualization pool can not only have multiple applications but also instantly provision a second copy of a given application based on demand driven by VMware. In Figure 1, VMware has created a second copy of Application #4 (called App4 in Figure 1). Hitachi Dynamic Provisioning software capabilities automatically allocate an increased pool of storage for Application #4. Hitachi virtualization capabilities allow the increased storage pool to appear as Hitachi storage but be a “virtual” allocation on externally attached storage from Hitachi Data Systems or third-party vendors such as IBM, EMC and others.

**Figure 1. Automated Storage Enablement of Server Virtualization**



Storage is allocated to applications via Hitachi Dynamic Provisioning capabilities; the increased storage pool appears as Hitachi storage but is a “virtual” allocation from externally attached storage from Hitachi Data Systems and third-party vendors.

To explore this capability in more detail, the following sections compare operations on non-Hitachi storage with operations on Hitachi storage.

**Provisioning without Storage Virtualization:** If each server virtual machine is subsequently provisioned with only a fixed physical amount of storage, then inefficiency could easily result. To add more storage or shuffle storage resources may involve time intensive remapping of logical unit numbers (LUNs) on the underlying storage systems or requisitioning new storage, while other storage system “silos” may still contain significant unused capacity. In these cases, inefficiency, poor use of storage resources and potential application downtime may still result, even though the servers are now being well utilized.

**Provisioning with Storage Virtualization:** Storage virtualization technology offered by Hitachi Data Systems provides an alternative that readily complements the power and streamlined operations of VMware ESX environments. Instead of the earlier inefficient scenario, imagine being able to tie the VMware infrastructure to a virtualized pool of storage. In this way, the virtual machine can be configured with a virtual amount of storage resources — from ready capacity down to the specific number of ports required.



As each virtual machine needs more storage, the Hitachi storage virtualization layer quickly and painlessly allocates any additional storage required via Dynamic Provisioning capabilities. As more virtual machines are created in response to demand, the Hitachi virtual storage layer also helps administrators create the appropriate storage allocations automatically.

**Thin Provisioning:** The Hitachi Universal Storage Platform V and Hitachi Universal Storage Platform VM provide an additional capability — thin provisioning — with Hitachi Dynamic Provisioning software. Thin provisioning dramatically improves storage efficiency well beyond that already offered by Hitachi storage virtualization technology. Thin provisioning allows the VMware administrators to assign the maximum storage needed to each Virtual Machine. However, the storage layer only allocates the storage actually needed at that given point in time. As additional storage demands are made, the Hitachi storage system automatically allocates more storage. The net savings are not only the “hard” savings in minimizing storage hardware but also the “soft” savings of minimizing administrative overhead from the server down to the storage.

**Pooling Third-party Storage Resources Together for Effective Reuse:** Figure 1 demonstrates another important way the Hitachi storage virtualization architecture uniquely complements VMware environments. By unifying and consolidating storage resources from Hitachi storage systems and other external, heterogeneous storage systems from vendors like EMC and IBM, the Hitachi Universal Storage Platform effectively masks the complexity of the underlying heterogeneous storage infrastructure.

**Secure Multitenancy to Support Data from Multiple Applications:** Just as organizations have come to appreciate the simplicity, security and time savings now available through server-based virtual machines, they now also have the opportunity to work with Virtual Storage Machines, a Hitachi Data Systems virtual storage construct that uniquely complements VMware's Virtual Machine concept. The many parallels between Hitachi Virtual Storage Machines and VMware Virtual Machines are explained later in this paper.

**Ensuring Proper Quality of Service for Storage Resources:** Storage allocation policies available within the Hitachi Universal Storage Platform virtual architecture are also able to provide the storage mix best suited to deliver the desired quality of service (QoS) — automatically and without intervention or disruption to virtual machine operations or the ongoing performance of either applications or their underlying data.

While the above thoughts summarize how server virtualization drives storage virtualization, not all storage virtualization approaches are sufficient to meet the needs of server virtualization. The following sections will illustrate how Hitachi virtualization is not only a great fit but also synergistic with VMware's virtualization.

## Hitachi/VMware: A Mapping of Virtual Architectures

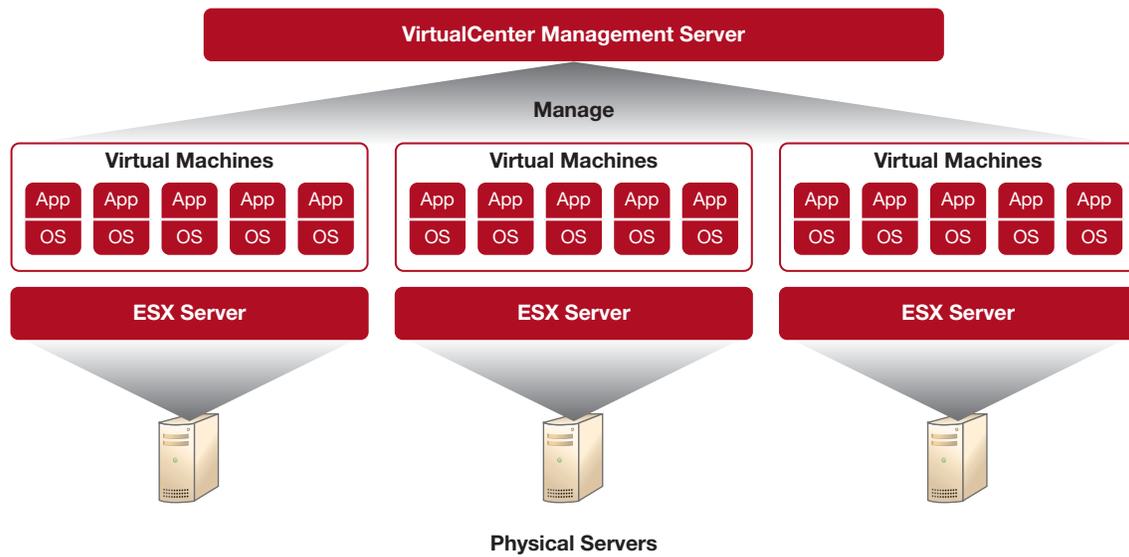
This section describes some of the key ways VMware's architecture maps directly to Hitachi virtual storage equivalents found in the Hitachi Universal Storage Platform V or Hitachi Universal Storage Platform VM. The result is an excellent fit with VMware environments.

One look at the conceptual presentation of each technology offers a glimpse into how closely each virtual architecture mirrors the other. This parallel structure is the major reason why VMware and Hitachi Data Systems have a natural and complementary affinity to each other.

### VMware Architecture for Server Virtualization

Figure 2 demonstrates VMware's server virtualization hypervisor, combined with its higher-level management layers. Readers familiar with VMware readily recognize the beauty of this concept: VMware ESX servers are able to run multiple virtual machines, each with their own allotted server resources as if the virtual machines were truly acting as individual, physical servers. The beauty of VMware is in its ability to decouple the physical resources of the underlying server(s) from the virtual world it subsequently creates.

**Figure 2. Conceptual Overview of the VMware Architecture<sup>1</sup>**



VMware ESX servers can run multiple virtual machines, each with their own allotted server resources.

At a very high level, VMware virtualization architecture has the following aspects:

- Physical resources can be dedicated or shared.
- For shared resources, priorities can be set within and among Virtual Machines.
- Mobility of Virtual Machines is maximized.
- Complexities of the server hardware and operating system are largely hidden.

## The Hitachi Architecture for Storage Virtualization

Just as the VMware architecture is able to abstract and decouple underlying physical resources, then recombine them as part of a virtual pool, the architecture of the Hitachi Universal Storage Platform V and Universal Storage Platform VM does the same for the underlying physical storage system resources. In addition to architecture, the rich set of Hitachi software functionality also drives real world benefits to virtualization.

### *Similarities in Operation: Virtual Machines and Virtual Storage Machines*

As the products from both VMware and Hitachi Data Systems are architected for virtualization, they have a high affinity out of the box. One's virtualization architecture naturally complements that of the other.

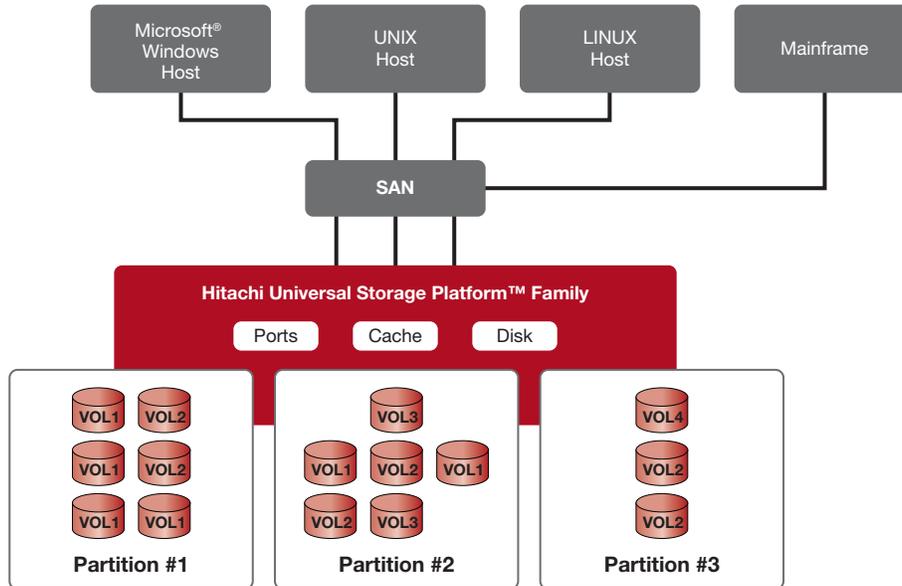
A prime example of this can be found in VMware's server-based Virtual Machine architecture. The Virtual Machine architecture is exactly analogous to Hitachi and its Virtual Storage Machine architecture, which was introduced in 2003 with the launch of the industry's leading storage platform, the Hitachi Universal Storage Platform.

When combined, the two architectures can deliver exceedingly compatible and complementary functionality that turbocharges the benefits of just implementing one solution on its own.

<sup>1</sup> Source: VMware, "VMware Virtual Center" Product Datasheet, 2007, posted to VMware.com at [http://www.vmware.com/files/pdf/virtual\\_center\\_datasheet.pdf](http://www.vmware.com/files/pdf/virtual_center_datasheet.pdf).

Figure 3 demonstrates the unique connectivity, partitioning and security features available with Hitachi Virtual Storage Machines.

**Figure 3. Hitachi Virtual Storage Machine Connectivity and Partitioning Flexibility**



Server-based Virtual Machine architecture from VMware complements Hitachi storage-based Virtual Storage Machine architecture.

Hitachi Storage Virtual Machines embody many of the same, high-level aspects of a VMware Virtual Machine, such as:

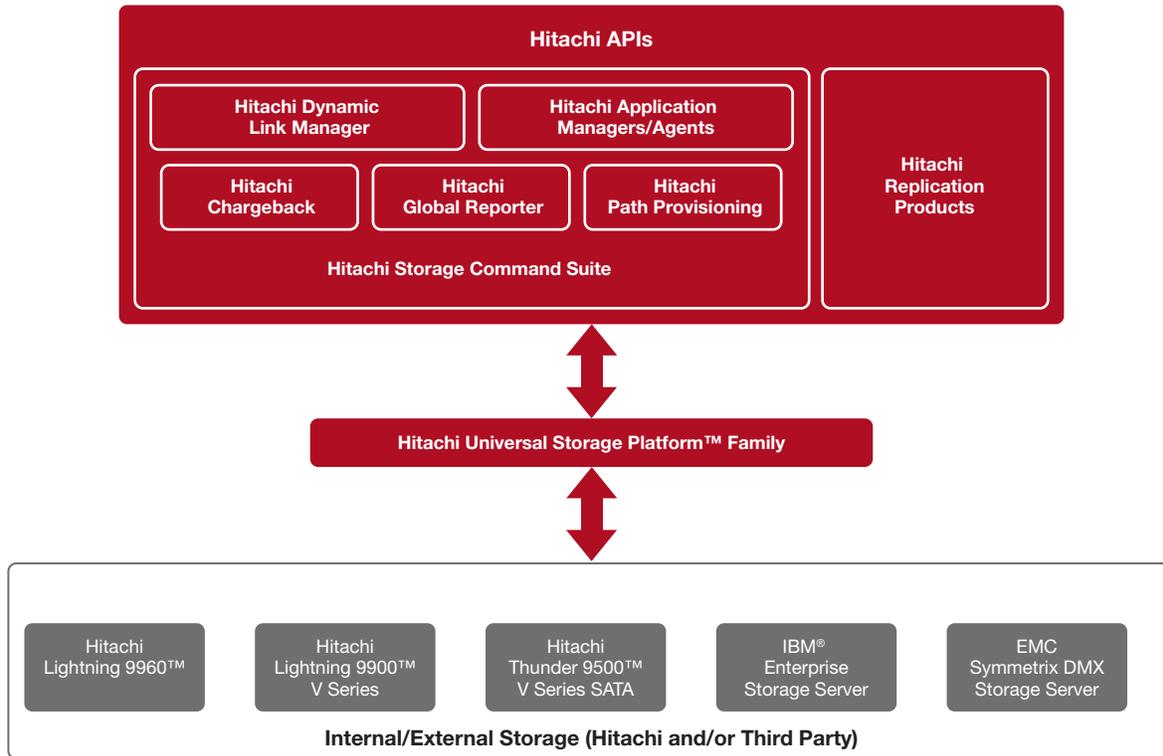
- Physical resources can be dedicated or shared.
- For shared resources, priorities can be set within and among Virtual Storage Machines.
- Mobility of Virtual Machines is maximized.
- Connectivity among different operating systems, even via different networking protocols, is maximized.

### **Similarity in Power: Hitachi Provides Virtualization “Tools” for the Real World**

Hitachi Data Systems offers powerful hardware and software offerings with a rich set of functions and tools that take the benefits of virtualization — both server and storage — from the drawing board to reality.

Figure 4 shows a subset of the Hitachi architecture most applicable to enterprise virtualization needs.

**Figure 4. Hitachi Architecture Overview: Real World Tools for Virtualization**



Components of the Hitachi architecture that drive virtualization capabilities include the Universal Storage Platform family and Hitachi Storage Command Suite software.

All parts of the Hitachi Storage Command Suite of software have been tightly integrated into the Hitachi Universal Storage Platform family. The major management-level elements of this architecture include:

- **Hitachi APIs** — These allow customized integration into the Hitachi virtualized storage and management layers.
- **Hitachi Dynamic Link Manager** — This software ensures that if a path is ever broken, another path will be automatically reestablished.
- **Hitachi Application Managers/Agents** — These offer an application oriented view through the operating system and down into the storage in order to gain a more comprehensive, global view of how the resources are currently being used.
- **Hitachi Chargeback** — This functionality allows the IT organization to charge departments for the storage resources they actually use, based on the ongoing data collected.
- **Hitachi Global Reporter** — This functionality reports on the actual usage of storage by the application.
- **Hitachi Path Provisioning** — This functionality provisions the correct path, from application servers and virtual machines down to the data storage itself.

The Hitachi storage virtualization family also offers another unique differentiator when it comes to managing underlying storage resources: the extensibility of managing other, third-party storage solutions — like those from IBM or EMC — all under the same, clean umbrella. In effect, the Hitachi virtualization architecture makes these heterogeneous storage systems look like Hitachi storage, all able to now take advantage of similar Hitachi management functionality. The configuration identified in Figure 4 is also one of the first storage virtualization architectures to be fully qualified by VMware.

Going from the bottom of Figure 4 up to the top, readers see how the Hitachi Universal Storage Platform V (or Universal Storage Platform VM) can take a dispersed and heterogeneous mix of third-party storage systems, unify them into a single virtual storage pool and simultaneously utilize a layer of higher-level intelligent management tools to seamlessly move and manage different tiers and classes of storage allocated to each virtual machine and to each overall ESX server farm.

## Similarities in Functionality: Virtualization Features

With parallel virtualization architectures, the resulting virtualization functionality available when combining VMware and Hitachi is entirely synergistic and comprehensive. With such consistent and complementary functionality, end-to-end virtualization solutions can, for the first time in the industry, be built! Table 1 describes the many parallels in operation between VMware Virtual Machines and Hitachi Virtual Storage Machines.

**Table 1. Parallels between Virtual Machines and Virtual Storage Machines**

<b>Category</b>	<b>Functionality of VMware Server Virtual Machines (VMs)</b>	<b>Functionality of Hitachi Virtual Storage Machines (VSMs)</b>
<b>1. Control over Resources and Environment</b>	A VM appears to have all its own server resources — cycles, port(s), cache, administrator(s) and more.	A VSM appears to have all its own storage resources — disk, port(s), cache, administrator(s) and more.
<b>2. Security</b>	VMs are isolated from other VMs.	VSMs are isolated from other VSMs.
<b>3. Administration</b>	VMs can have their own administrator as well as a central administrator.	VSMs can have their own administrator as well as a central administrator.
<b>4. Users</b>	Users can be dedicated to a particular VM.	Users can be dedicated to a particular VSM.
<b>5. Addressing</b>	Applications can believe that they have particular ranges of server addresses.	Applications can believe that they have particular ranges of storage (LUN) addresses, such as LUN 0.
<b>6. Metering and Chargeback</b>	VMs track their utilization of resources from the “physical” server. Therefore, chargeback to a particular department is possible.	The Hitachi storage virtualization architecture granularly tracks actual resource utilization in a number of ways to enable robust chargeback capabilities by default.
<b>7. Mobility, both Command Line and Policy</b>	VMs enable ready mobility among server platforms and operating systems.	The Hitachi storage virtualization architecture enables ready mobility among storage devices, tiers of storage, etc.
<b>8. Provisioning</b>	VMs enable server resources to be added transparently and nondisruptively.	The Hitachi storage virtualization architecture enables storage resources to be added transparently and nondisruptively.
<b>9. Consistency of Behavior</b>	VMs behave consistently, regardless of the server platform on which they are (physically) running.	VSMs behave consistently, regardless of the storage platform on which they are (physically) running.
<b>10. Isolation</b>	VMs isolate the environment so that effective development, testing, and SaaS approaches can be run.	VSMs isolate the environment so that effective development, testing and SaaS approaches can be run.

### **Bottom Line: Hitachi and VMware Technologies Are Perfect Complements**

In conclusion, both VMware and Hitachi technologies were architected from the ground up with virtualization in mind. Given that the objectives were identical, the resulting similarity in operation, powerful tools and functionality are a direct result. These similarities drive synergies in a broad range of areas.

The next section will show how these synergies in architecture directly drive improved capabilities, increased efficiencies and reduced costs in Hitachi/VMware environments.

## Areas of Synergy and Complementary Operation

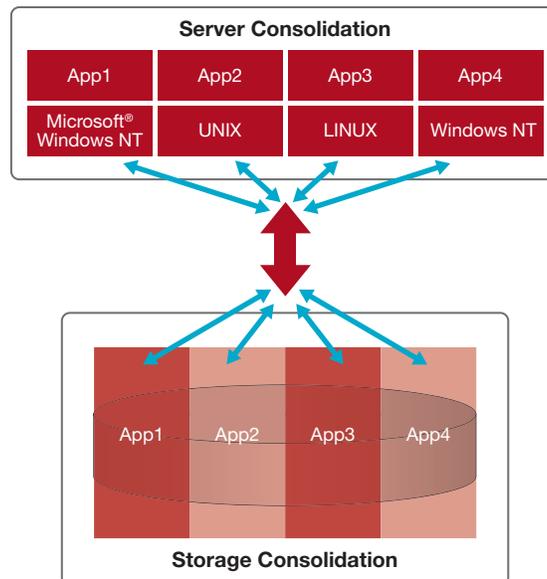
This section describes several ways a Hitachi storage virtualization architecture aids in the operation and continued savings of a VMware server environment. These areas include the use of a Hitachi Universal Storage Platform V or Hitachi Universal Storage Platform VM in conjunction with VMware for:

- Server and storage consolidation
- Server and storage partitioning
- Dynamic provisioning and support for different classes of service
- Transparent migration and mobility

### Server and Storage Consolidation

The Hitachi Data Systems storage virtualization architecture offers significant storage consolidation benefits, similar to the server consolidation benefits enjoyed in a VMware environment. Use of a Hitachi virtual shared storage environment, as shown in Figure 5, also makes it easier to support virtual machines and their related applications.

**Figure 5. Optimizing Storage for Server Consolidation**



*Consolidating and reusing virtual storage resources with VMware and Hitachi technologies enables both a many-to-one and one-to-many relationship.*

Consolidation examples from the use of the Hitachi Universal Storage Platform family, when combined with VMware, include the establishment of both a many-to-one and a one-to-many virtualization relationship. This means the Hitachi Universal Storage Platform is able to first present the storage resources of both Hitachi storage and many heterogeneous, third-party storage systems — all as one unified, virtual storage pool. This process then allows administrators to carve up storage resources into multiple pools of storage for the needs of each virtual machine.

Using the concept of virtual storage machines, the Hitachi system is able to isolate each server's virtual slice of storage and keep it secure and independent of another server's storage. This is referred to as safe multitenancy or "fencing."

As noted in an earlier section, the Hitachi and VMware technologies provide secure multitenancy to support data from multiple applications. Just as organizations have come to appreciate the simplicity, security and time savings now available through server-based Virtual Machines, they now also have the opportunity to work with Virtual Storage Machines, a Hitachi virtual storage construct which uniquely complements VMware's Virtual Machine concept.

Different tiers or classes of service, as well as the number of users and administration, can be clearly defined and managed within their own isolated slice of storage for each Virtual Machine or ESX server — even though the separate slice of storage continues to draw from the same unified storage pool.

## Server and Storage Partitioning

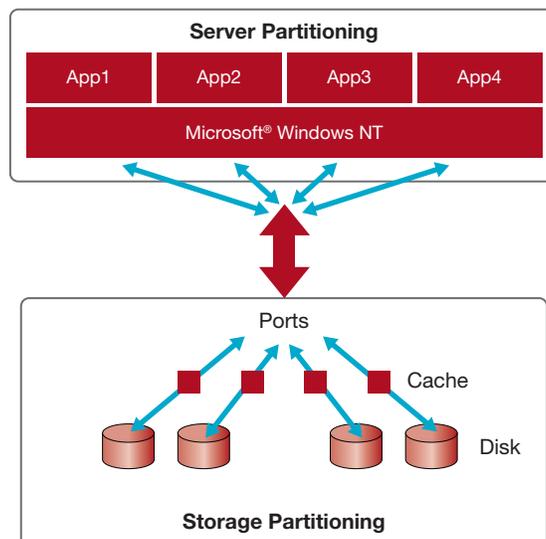
Hitachi provides storage partitioning (via Virtual Storage Machines) in line with VMware's Virtual Machine capabilities. Hitachi also has dynamic resource allocations, as discussed below.

Just as VMware offers secure partitioning of server resources — in the area of CPU and memory cache utilized — so too does the Hitachi Universal Storage Platform family offer partitioned storage resources from its central, virtualized pool. Users can now define various Virtual Storage Machines, each with its own set of dynamically allocated:

- Dedicated or shared virtual ports
- Storage system cache
- Disk capacity

Figure 6 shows thicker lines in the storage partitioning box to demonstrate how some applications may be configured with more dedicated storage resources than others. This directly impacts the QoS guarantees an IT team can make to support different applications. Metering and chargeback functionality also allow storage resource usage to be clearly tracked back to the application or department level. Flexibility to dynamically grow and provision each storage partition without disruption is also a critical factor to success with Hitachi Data Systems.

**Figure 6. Optimizing Storage for Server Partitioning**

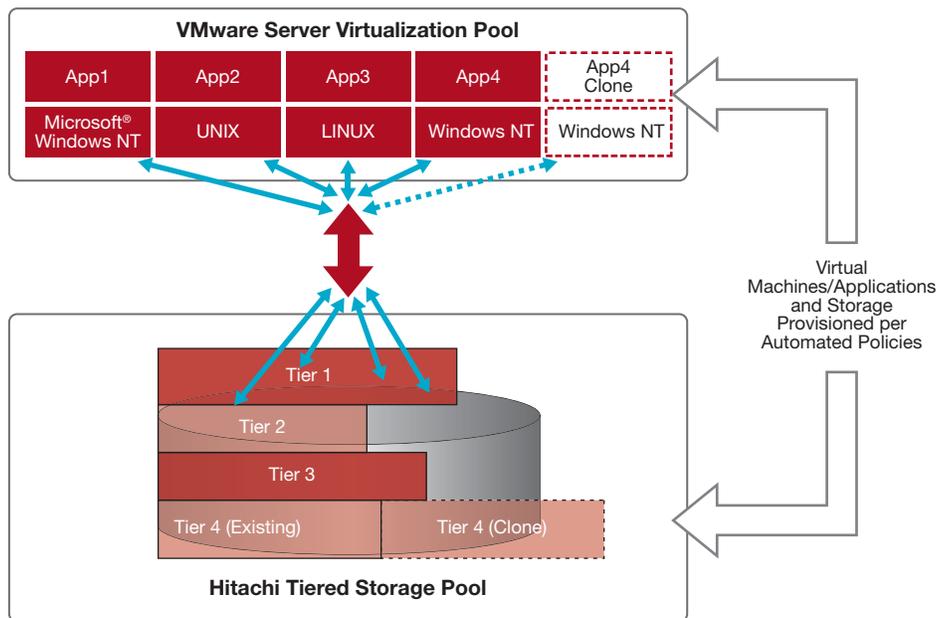


*This conceptual view of server and storage partitioning demonstrates how some applications may be configured with more dedicated storage resources than others.*

## Dynamic Provisioning and Support for Different Classes of Service

Both VMware and Hitachi Data Systems virtual architectures provide the ability to dynamically provision resources per automated policies. Figure 7 demonstrates this connection, which can come out in the form of different virtual tiers of storage, each exhibiting different classes of service to closely complement the needs of each assigned application or set of Virtual Machines.

**Figure 7. Virtualization at Multiple Levels**



Virtual architectures from both VMware and Hitachi Data Systems provide the ability to dynamically provision resources per automated policies.

Increased utilization and streamlined resource provisioning features you'll find with the combination of Hitachi and VMware include:

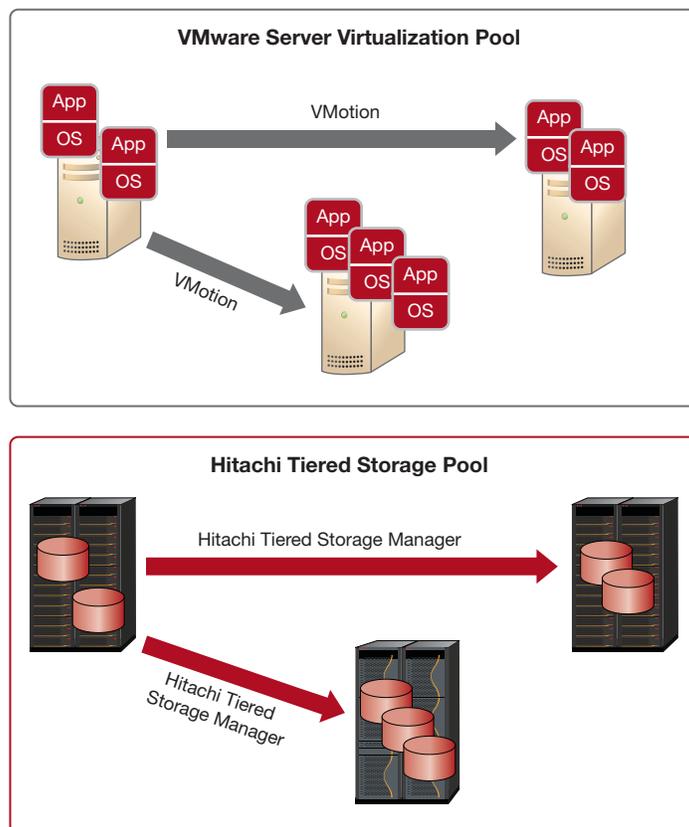
- **Tiering:** As shown in the Figure 7, technologies from both Hitachi Data Systems and VMware enable tiering of different applications and users. Tiering enables the class of service to be matched to the device's capabilities. This way, all applications do not utilize the most expensive and fastest performing resources. Saving money is a natural by-product.
- **"Thin" Provisioning:** Hitachi Dynamic Provisioning software enables thin provisioning functionality, within the Hitachi Universal Storage Platform V and Hitachi Universal Storage Platform VM, which allows applications to believe that they have access to nearly unlimited amounts of storage, even though the application may only realistically have a portion of the physical capacity currently allocated. As the application requires more storage, Hitachi utilities add just the storage needed. The net impact? Dramatic savings in administration, hardware and holding costs.
- **Eco-friendly Infrastructure:** By increasing utilization, whole banks of servers can be shut down with VMware's functionality. Similarly, Hitachi Data Systems offers "power down" functionality, which enables storage drives to be shut down until the data is needed.
- **Quality of Service:** Storage allocation policies available within the Hitachi Universal Storage Platform family's virtual architecture are also able to provide the storage mix best suited to deliver the desired QoS — automatically and without intervention or disruption to Virtual Storage Machine operations or the ongoing performance of either applications or their underlying data.

## Transparent Migration and Mobility

Both virtualization architectures are parallel constructs to each other. This parallel structure is the major reason why virtualization solutions from VMware and Hitachi Data Systems are so complementary “out of the box.” One of the most obvious ways this parallel approach aids administrators is in the ease with which applications, virtual machines and their underlying data sets can now be migrated or copied to other parts of the infrastructure.

Figure 8 demonstrates this seamless mobility with the use of VMware VMotion on the server side and Hitachi Tiered Storage Manager software on the storage side.

**Figure 8. Hitachi and VMware Virtualization Operations: Transparent Mobility**



*Seamless migration of applications, virtual machines and underlying data sets to other parts of the infrastructure is accomplished with ease.*

Some of the aspects of this complementary virtual server/virtual storage infrastructure include:

- Seamless and transparent migrations or failovers of both virtual machines and their underlying storage are enabled.
- Higher resource utilization is accomplished by combining resources via server clusters and tiered pools of heterogeneous storage allow available resources to be shared and utilized by all.
- Both server and storage virtualization architectures leverage hardware assisted functionality at the server and storage controller levels.



## Conclusion

The benefits of VMware for server virtualization are already widely apparent. Analysts and more than 7,500 customers of the Hitachi Universal Storage Platform family also attest to the many benefits available from the complementary storage virtualization platform offered by Hitachi Data Systems.

Explore how even greater utilization, responsiveness and flexibility can be gained by combining VMware's server virtualization architecture with Hitachi® storage virtualization technology. Benefits include:

- **End-to-end Utilization:** Increasing the number of virtual machines does not save resources if the result is wasted storage. Efficient storage utilization can be wasted if server resources aren't allocated efficiently. The combination of both VMware Virtual Machines and Hitachi Virtual Storage Machines enables savings up and down the IT resource stack, thereby saving money.
- **Responsiveness:** The ability to either debug or respond automatically via Virtual Center or Hitachi Tuning Manager software enables real time (or near to real time) responsiveness.
- **Flexibility:** By combining the best of both approaches, including policies for cloning virtual machines as well as policies for provisioning storage, the environment can be made incredibly flexible for changing workloads, priorities and needs.

Learn more today about the ease of building an end-to-end virtualization infrastructure with Hitachi Data Systems and VMware. For more information, contact a Hitachi Data Systems representative or authorized reseller. You can also go to: <http://www.hds.com/contact-sales.html>.

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