

Solving the Top Six Enterprise Storage Issues

Learn How to Meet the Challenges of Rapid Data Growth
with Storage Virtualization

White Paper

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Executive Summary

Nowhere is the exponential growth of data felt more acutely than in the world of enterprise storage. In fact, the growth of storage budgets now threatens to eclipse the growth of an organization's overall IT budget. Instead of continuing to add more storage systems and significantly more management complexity, a more cost-effective, sustainable approach is required. That new approach is storage virtualization.

This white paper offers answers to the question: “What can storage virtualization do for my organization?” Through various use cases and common issues faced by IT organizations, readers will learn the various business issues that can be effectively resolved with storage virtualization technology. Are you experiencing exponential data growth, ongoing capital expenditures and escalating management complexity in your current storage infrastructure? Storage virtualization technology from Hitachi Data Systems provides ready answers.

Readers will learn how much or how little disruption such a technology could cause when implemented in their environments. They will also learn a variety of questions to ask vendors about their virtualization approaches.

Learn how storage virtualization will allow organizations to:

- Reduce operational costs and storage related capital expenditures
- Improve overall efficiency and storage management
- Offer more choice in vendor hardware
- Extend the life of existing storage assets
- Provide better service delivery to internal customers and line-of-business applications
- Incorporate more eco-friendly data center storage practices

Readers will also learn why no company is better positioned than Hitachi Data Systems to help them achieve answers through virtualization.

Building on the company's long history of innovation, Hitachi Data Systems continues to lead the market in its storage virtualization knowledge and customers — with over 7,300 virtual storage controllers shipped worldwide.



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Behind Virtualization: Real Help for Real World IT Issues

Much has already been written about virtualization and storage virtualization in particular. This white paper seeks to bring the virtualization discussion down to a more pragmatic level — focusing instead on the tangible business benefits that enterprise environments have begun to experience with storage virtualization technology. Routinely referenced by analysts as a critical next phase in enterprise network storage architectures, the use of storage virtualization technology is touted as a necessary foundation to:

- Combat exponential data growth
- Increase utilization of existing storage assets
- Reduce storage capital expenditures
- Reduce operating costs and total cost of ownership (TCO)
- Simplify storage management
- Implement a truly successful tiered storage architecture
- Deliver IT (and storage) as a utility, including the ability to deliver “metered” storage resources to specific lines of business and applications
- Reduce power and cooling consumption in the data center


How can a technology offer this much potential? One analyst sums it up as follows:

“ESG believes that storage virtualization will be the way we implement storage networking in the not too distant future and is a key Service Oriented Storage Solutions enabler.... The power of storage virtualization is that it reinvents storage networking while minimizing disruption. For years, we have discussed the notion of a fluid data center, and virtualization is the liquid within this construct.”¹

— Tony Asaro, Enterprise Strategy Group Senior Analyst, 2007

Many people have heard about virtualization as applied to servers and the compute/processing side of the business. The proliferation of virtual server machines with VMware is one example of a successful virtualization strategy currently in use. Other examples of virtualization also exist, where the image of the IT resource or system presented to the end user is logically simplified, or “virtualized” to mask the underlying complexity.

¹ “Service Oriented Storage Solutions,” ESG Report by Tony Asaro, Enterprise Strategy Group, March 2007.



Similarly, **storage virtualization is a way to logically combine storage capacity and resources from various heterogeneous, external storage systems into one virtual pool of storage.** This virtual pool can then be more easily managed and provisioned as needed via a single set of tools and processes able to perform everything from online, any-to-any data migrations to heterogeneous replication.

Help in Solving Six Common Storage Issues

This section demonstrates six specific ways storage virtualization can help solve many of the most common issues IT organizations deal with regarding cost control, management and use of existing resources. In each case, it demonstrates how organizations can use the technology to resolve the issue and create a more adaptive, flexible service-based infrastructure to reflect ongoing changes in business requirements. The top six issues include:

1. Exponential data growth and disruptive storage upgrades
2. Low utilization of existing assets
3. Growing management complexity with flat or decreasing budgets for IT staff head count
4. Increasing hard costs and environmental costs to acquire, run and manage storage
5. Ensuring rapid, high-quality storage service delivery to application and business owners
6. Achieving cost-effective business continuity and data protection

The impact of virtualization on each of these issues is described in the following sections.

Issue Number 1: Exponential Data Growth and Disruptive Storage Upgrades

With average annual data growth rates estimated at over 50 percent,² IT organizations are being called to creatively manage data growth — beyond just buying more storage. In the event more storage needs to be added, avoiding lengthy, painful data migrations and extended application disruptions should be — but seldom is — the goal of any technology refresh, vendor system change-out or storage capacity addition.

Organizations now recognize not all data needs to reside on high-performance storage. Data copies used for backup, archival, test or development may perform fine on lower cost, high-capacity Serial ATA (SATA) disk storage. But, introducing such modular systems into an existing storage infrastructure can lead to isolated storage silos, more management complexity and an inability to easily move data from high-performance storage to lower cost systems.


Solution: Storage Virtualization Offers Nondisruptive Data Migration to Heterogeneous Storage Tiers and Lower Cost, Modular Storage

Analysts often refer to virtualization as either an enabler or the “glue”³ for tiered storage infrastructures. Virtualization technology from Hitachi Data Systems offers a single management interface for nondisruptive data movement amongst all tiers of storage, including disk-based backup and archival tiers that may use SATA disk technology. Some lower level tiers are often designated for use by virtual tape library or archival applications.

In this way, storage virtualization becomes the foundation for building intelligent tiered storage environments. With Hitachi Data Systems, just one set of storage-based data migration and data management tools is required to migrate application or file data in the background — from any to any heterogeneous storage system — all while

² “Archive tools essential as data growth rises, says IDC,” by Miya Knights, *Computer Weekly*, March 13, 2007, <http://www.computerweekly.com/Articles/2007/03/13/222312/archive-tools-essential-as-data-growth-rises-says-idc.htm>.

³ “Intelligent Tiered Storage: Focus on Hitachi Data Systems,” by Tony Asaro, Enterprise Strategy Group, December 2006.



production applications remain up and running. This also applies for data migrated from mainframe environments to lower cost SATA-based storage.

For Hitachi storage platforms, that means data can be seamlessly migrated between the Hitachi Universal Storage Platform™ V and other Hitachi storage tiers — such as the Hitachi High-performance NAS Platform, powered by BlueArc®, as well as Hitachi Adaptable Modular Storage and Hitachi Workgroup Modular Storage systems. Equally important, storage virtualization technology from Hitachi allows seamless data migration between Hitachi solutions and other heterogeneous tiers of storage from EMC, IBM, NetApp and other suppliers, at rates exceeding 4.0 million I/O per second (IOPS).

When performing routine maintenance, refreshes or upgrades, data volumes are moved to the Hitachi Universal Storage Platform virtual pool temporarily, then moved back to the native device, without disrupting ongoing application or data access. This method is simpler than other storage virtualization methods that often require building an extra "holding" space for intermediate staging volumes to serve as temporary storage during the migration process.

Issue Number 2: Low Utilization of Existing Assets

Most enterprise organizations purchase ever-growing numbers of storage systems, only to find that the average utilization of the storage capacity on most of their systems is often below 50 percent.⁴ That means that over half of the free capacity in most systems remains idle and unused, even while requisitions for new storage systems continue to be filled.

Solution: Virtualization Significantly Increases Storage Capacity Utilization

Storage virtualization technology consolidates isolated silos of stranded storage capacity into a logical pool of storage that can be easily re-provisioned and assigned on an as needed basis to a variety of data needs. Such needs can include primary application data storage, nearline backup or archival, development and testing projects, file shares, etc. Better utilization of existing storage assets can be achieved in a number of ways, including:

Better utilization through thin provisioning. When combined with other virtualization components like Hitachi Dynamic Provisioning software, storage virtualization technology allows organizations to eliminate a large cost of utilization waste: already allocated storage capacity that remains unused yet reserved "just in case" an application may need it in the future. Instead, with Hitachi Dynamic Provisioning software, organizations can use "thin provisioning" functionality to assign large virtual storage volumes of almost any size to the needs of a specific application. In the background, however, the actual physical capacity used is only a fraction of that virtual volume's total size, just enough to accommodate the current needs of the application. Dynamic Provisioning software allows both internal and externally attached heterogeneous storage assets to gain the benefits and increased asset utilization of thin provisioning. This feature alone can significantly extend the life of existing and legacy heterogeneous storage, not to mention postponing the purchase of new storage systems.

Better utilization through tiered storage. Gaining better utilization of different price and performance "tiers" of storage is also mentioned as one key to virtualization, as follows: "Tiered storage is not simply storing data on various storage systems, by different vendors, each having separate operating consoles and functions. Multitiered storage implies a single image pool of storage, with integrated but segmented storage tiers, all controlled by a unified storage architecture. Data can be promoted or demoted seamlessly through the tiers. Optimization of storage to applications and business users is enabled and essential. Multiple products and vendors may be

⁴ "Storage capacity planning: Managing storage inventory," by Brian Peterson, *SearchStorageChannel.com*, February 27, 2007, http://searchstoragechannel.techtarget.com/tip/0,289483,sid98_qci1245480,00.html.

included in the technical architecture, but the storage pools are abstracted above the individual storage systems. Virtualization is implied within multitiered storage.”⁵

By consolidating storage into a single virtual pool, deploying thin provisioning with Dynamic Provisioning software and tiering storage devices, organizations can even achieve upwards of 85 percent utilization, according to industry analyst Carl Greiner.⁶

Issue Number 3: Growing Management Complexity with Flat or Decreasing Budgets for IT Staff Head Count

Many environments face an ever-growing complexity in the underlying infrastructure needed to support their core applications. At the same time, IT organizations are being asked to do more with budgets and staff sizes that remain the same or are decreasing. This makes it more critical than ever to invest in a simplified storage management infrastructure that supports the goal of doing more with less.

Examples of the increased complexity now found in today’s enterprise data center include:

- Support for multiple host operating systems (OSs)
- Data storage for multiple terabytes (TB) or petabytes (PB) of application and file data
- Multiple storage systems in the environment, often from different vendors
- Storage, often existing as isolated “silos,” each with separate management tools
- Application downtime/maintenance that is unacceptable for routine tasks (protection, adding capacity, management) on key production systems
- Growing concern regarding data center “hot spots” and real estate constraints as capacity increases

Solution: Storage Virtualization Simplifies Complexity, Allowing One Administrator to Manage Three to Ten Times More Storage

Storage virtualization technology from Hitachi Data Systems can simplify the management of otherwise complex storage infrastructures in many ways.

Simplified management via one virtual pool. Storage virtualization solutions from Hitachi Data Systems consolidate many physical storage systems from different vendors into one virtual pool capable of scaling up to 247PB of total storage. Virtual pooling functionality masks the complexity of the underlying physical structure, making it easier to manage.

One common management tool set for all heterogeneous storage. A single, standard set of storage management tools can be used to perform common functions across heterogeneous storage systems, including:

- Creating or modifying storage volumes
- Quick provisioning or allocation of storage capacity to applications (via Hitachi Dynamic Provisioning software with thin provisioning functionality for both internal and externally attached heterogeneous storage devices)
- Nondisruptive data or volume migration from any to any storage system
- One unified platform for snapshot, archive, backup and replication (either locally or to remote sites)

⁵ “Tiered Storage Economics: Defining and Calculating the Economic Benefit of Tiered Storage Solutions,” by David A. Merrill, Hitachi Data Systems Corporation, <http://www.hds.com/tools/whitepapers.html>.

⁶ “Hitachi Extends Its Lead in Controller-based Storage Virtualization,” Carl Greiner, Ovum, May 2007.

Increased data under management per IT administrator. IT environments reaping the operational benefits of using just one set of tools can significantly reduce training costs and manage more data with less staff. This allows staff skill sets to be redeployed on other projects of higher value to the business. While common estimates indicate one administrator can manage up to 10TB of storage, Hitachi Data Systems Chief Scientist Claus Mikkelsen maintains that Hitachi storage virtualization technology can increase that number to between 30TB and 100TB+ that can now be managed with a single head count.⁷

Issue Number 4: Increasing Hard Costs and Environmental Costs to Acquire, Run and Manage Storage

Growing storage complexity and mounting data requirements often lead to related growth in both capital expenditures (CAPEX) and operating expenditures (OPEX) needed to support the storage infrastructure. More storage on the data center floor can also negatively translate into growing environmental impact, as the systems often require more power to run and keep them cool. Other ongoing costs can come from many areas, including:

- Cost of hardware acquisitions and support
- Cost of software licensing
- Increased floor space and real estate required
- Total cost to manage the storage, estimated by analysts at many times more than its cost of acquisition

Solution: Virtualization Reduces CAPEX and TCO While Promoting a More Eco-friendly Data Center

Virtualization technology can lead to significant cost reductions, including:

- Reduced need for redundant software applications and licenses (Both high-performance and low-cost storage systems now “inherit” the same virtualization functionality.)
- Fewer storage systems needed (Hitachi storage virtualization allows consolidation of more data on less hardware. This reduced architecture, in turn, requires less floor space, along with less power and cooling.)
- Reduced number and cost of future acquisitions (fewer overall systems, more modular storage)
- Reduced labor costs to manage, support or train IT staff on using virtualized systems
- Longer utilization of legacy (and lower power consuming) storage systems — now possible (Legacy systems can now go off lease and fulfill asset depreciation schedules, yet still be utilized in the virtual pool. Data safeguards maintain virtual access to data in case of system failure.)

Sample CAPEX/OPEX savings. One example of these types of savings can be found in Fidelity National Information Services, a FORTUNE 500® financial company and Hitachi Data Systems virtualization customer who recently implemented tiered storage to help resolve their current issues. This company was subsequently able to obtain a 188 percent return on investment (ROI) in under 12 months and is also on track to achieve an estimated three-year CAPEX/OPEX savings valued at over US\$27 million.⁸

Virtualization as an eco-friendly solution. Environmentally conscious data centers can reduce their overall data center footprint, power consumption and cooling costs through storage virtualization. Primary ways include:

⁷ “Webcast: Enabling a Virtualized World,” by Claus Mikkelsen, ZDNet, March 8, 2006, http://news.zdnet.com/2422-13569_22-155830.html.

⁸ “Tiered Storage and Virtualization in the Real World,” Hitachi Data Systems Case Study: Fidelity National Information Services, June 2007, <http://www.hds.com/assets/pdf/wp-tiered-storage-in-the-real-world.pdf>.

- Better elimination of data center hot spots — without disruption. If a certain section of disk systems becomes a hot trouble spot, Hitachi storage virtualization makes it easy to migrate the data to other disks and adjust the storage rack's heat distribution, all without having to bring systems down.
- Managing larger quantities of data with a single storage controller. Storage controllers, themselves, consume significant power and cooling resources. Since Hitachi storage virtualization separates one controller (the metadata) from the drives and their underlying, spinning disks, it can more effectively minimize environmental impacts.
- Better use of existing storage assets leading to fewer overall systems in use. Hitachi storage virtualization implementations that incorporate tiered storage or Hitachi Dynamic Provisioning software (for thin provisioning to internal and externally attached storage) can achieve higher asset utilization of existing systems. That means less need to continuously acquire more storage.

Issue Number 5: Ensuring Rapid, High-quality Storage Service Delivery to Application and Business Owners

Most application owners and specific lines of business view the success or failure of IT services on how well their own day-to-day applications are running. This includes the level of services (in terms of access, availability and reliability) that they have come to expect. But for IT, juggling these varied data needs while delivering high quality of service (QoS) can sometimes be a challenge. So can determining how much to “bill” each department for the level of services it requires. Convincing departments to give up control of their own storage “box” in favor of a centralized storage management scheme may also be an issue. Assurance of consistently high application performance and responsiveness must be offered, even when storage resources are pooled or shared with other competing applications on the network.

Solution: Storage Virtualization Enables Delivery of Metered Storage Services and Guaranteed QoS via Application-specific Virtual Storage Machines


Specific to Hitachi virtualization technology is the unique Hitachi Virtual Storage Machine feature, which allows logical partitioning of storage resources into multiple Virtual Storage Machines — each with its own dedicated internal and external capacity, cache and ports. Virtual Storage Machine functionality allows IT organizations to apply storage policies to specific applications, matching business requirements for performance, capacity and availability to designated storage resources. Because each Virtual Storage Machine has its own serial number, IT teams can also associate specific business applications with selected departments and business units, then charge back accordingly. These unique capabilities allow administrators to create a utility model to deliver “metered” storage resources to select business entities. The management of these Virtual Storage Machines can then be addressed centrally or by local administrators.

In this way, organizations can ensure that service level agreements (SLAs) successfully align the performance needs of an application with the commensurate cost required to achieve that QoS.

Issue Number 6: Achieving Cost-effective Business Continuity and Data Protection

Closely linked to the prior issue of application-level QoS is the topic of data protection. From an overall corporate governance perspective, this issue widens to encompass contingencies and processes in place for application-specific, local data center and site-wide disaster recovery and business continuity. Many reports find the cost of just an hour of system downtime in most enterprise organizations can be staggering.⁹ But, likewise, the typical cost to implement robust disaster recovery practices can mount when including the cost of replication software often available in enterprise-class storage systems, not to mention the cost of replicating critical data to one (or

⁹ "2001 Cost of Downtime Online Survey," by Contingency Planning Research, a division of Eagle Rock Alliance, West Orange, N.J., <http://www.contingencyplanningresearch.com/2001%20Survey.pdf>.



even two) remote data centers, which may contain other storage and servers. Achieving the right mix of protection and investment can require tough decisions.

Solution: Virtualization Allows for Heterogeneous, Any-to-any Replication with Just One Set of Tools and a Common Interface

Storage virtualization technology from Hitachi Data Systems makes the same, high-performance data replication services available to each externally attached storage system — including lower cost modular devices, direct attached storage (DAS), network attached storage (NAS) or just-a-bunch-of-disks (JBOD) storage. This means lower licensing costs as the process is standardized and applied across the organization’s infrastructure.

Features include:

- Local replication of multiple copies of data — within the same storage tier or a different tier
- Distance replication from any to any storage system and one or more target locations that are any distance away (Hitachi virtualization technology supports both synchronous and asynchronous data replication.)

Evaluating Your Options for Virtualization

After an IT organization decides it should explore different storage virtualization options, it is often difficult to sort out the various vendor offerings presented in the marketplace.

From an architectural perspective, many vendors will talk about “where the virtualization resides” in an IT environment. This relates to where the virtualization software layer and functionality have been set up to operate. In general, vendors offer three main virtualization architectures:

- **Host-based virtualization** — where storage virtualization functionality is handled by the host or servers that have access to the underlying physical storage systems.
- **Network-based virtualization** — where virtualization functionality is offered from somewhere within the storage network fabric or “cloud” — between the path of servers and underlying physical storage devices. Typical implementations of network-based virtualization include virtualization appliances and “intelligent” switch-based virtualization solutions.
- **Storage controller-based virtualization** — where storage virtualization is offered as a component of an enterprise storage controller’s functionality, such as the functionality built into a high-performance storage system. Depending on the solution, this virtualization functionality may also be available as a standalone storage system controller, without accompanying internal storage.

Hitachi Data Systems offers the storage controller-based approach to virtualization in its Hitachi Universal Storage Platform™ family, which includes the Universal Storage Platform V and Universal Storage Platform VM. Widely heralded for its innovation, simplicity, scalability and feature set since its original launch in September 2004, the Hitachi Universal Storage Platform has since been shipped to over 7,300 enterprise installations worldwide.

The benefits of the Hitachi approach are described by Evaluator Group Senior Analyst Tom Trainer: *“Hitachi has separated the ‘brain’ from the ‘body’ of storage — the innovation from the commodity. Hitachi has clearly changed the playing field with its breakthrough in simplicity via its controller-based virtualization technology while competitors have continued to focus on monolithic disk arrays based on aging 20th century designs and increased network complexity.”*¹⁰

¹⁰ “Storage Virtualization: Spin Free! Is more network complexity necessary?” by Tom Trainer, Evaluator Group, Inc., January 9, 2007, http://www.hds.com/pdf/ar_virtualization_no_spin.pdf.

15 Questions to Ask Your Vendor

Technical differences are involved in each architectural approach. These are described further in technical papers, such as the Hitachi Data Systems white paper: *"Hitachi Universal Storage Platform: Virtualization without Limits."*¹¹

Rather than itemize specific technical differences, this section offers a set of 15 questions to ask vendors when evaluating virtualization solutions. The questions include the following:

1. Where does the virtualization functionality reside?
2. Will the solution make my current infrastructure more complicated?
3. How many enterprise customers currently use the solution?
4. How much extra latency will the solution add to performance (such as ongoing disk read/write operations)?
5. How well does the solution scale to support large installations, and even petabytes of storage?
6. Does the solution let you logically partition storage capacity, cache and ports?
7. Can the solution be implemented in smaller phases? How easy is it to roll back?
8. How well does the solution support clients or hosts running other operating systems?
9. How well does the solution support use of external, low-cost disk systems from other vendors?
10. How reliable is the tiered storage model currently supported by the virtualization solution?
11. Will the solution cost more than my current high-performance storage system?
12. How do you ensure extra virtualization elements won't decrease system reliability or availability?
13. Does the vendor's vision adequately support the enterprise organization's current and future goals?
14. How easy is it to migrate or replicate data between systems or back out once you begin the migration process?
15. What would be required to move to a different virtualization platform (or vendor solution) later?

Table 1 provides more background on each of these questions, along with some ways that Hitachi Data Systems virtualization solutions compare.

¹¹ Technical resources regarding virtualization can be found at <http://www.hds.com/solutions/storage-strategies/virtualization-resource-center/>.

Table 1. 15 Questions to Ask Your Vendor

1. Where does the virtualization functionality reside?

Technical IT staffers and systems architects should explore whether the vendor's virtualization functionality resides on the host, on the switch/appliance or in a storage controller, including the pros and cons.¹²

How Hitachi Data Systems compares: Solutions from Hitachi Data Systems offer virtualization from the storage controller. These extend the mature controller-based storage services Hitachi developed to support both internal and external heterogeneous storage. Noted by industry analysts as one of the simplest yet most robust ways to implement virtualization, the Hitachi approach still has no direct competition since its introduction in 2004. Identifying it as the first example of a new evolution in storage architectures, IDC coined the term “network storage controller” to describe the Hitachi approach.¹³

2. Will the solution make my current infrastructure more complicated?

Some virtualization solutions may add extra hardware, extra management tools, APIs and newly emerging standards to the infrastructure. *"Some virtualization solutions require a whole new layer of management complexity defining disk extents, and mapping them to virtual volumes through a mapping table that requires additional SAN zones to be established,"* said Hitachi Data Systems CTO Hu Yoshida.¹⁴

How Hitachi Data Systems compares: Instead of needing extra hardware layers (management servers, application blades, new switches and separate management software), Hitachi virtualization is easily deployed by enabling an existing software key within its family of Universal Storage Platform storage solutions. Yoshida sums up the simplicity of this approach as follows: *"The Hitachi Data Systems solution has none of this complexity since we do virtualization and tiering through our controller for external storage just as we do for internal storage."*¹⁵

3. How many enterprise customers currently use the solution?

Some virtualization solutions are so new that they may have difficulty naming many enterprise-level reference customers who have already deployed the solution in their environment. This is critical for learning how the solution is operating in the real world.

How Hitachi Data Systems compares: Hitachi Data Systems has shipped more than 7,300 virtual controllers, many of which have been employed by the largest data centers in the world. Hitachi virtualization technology is based on some of the most mature and field proven virtualization features in the storage industry, for use by both open systems and IBM® mainframe environments.

¹² Ibid.

¹³ "New Options for Managing Tiers of Storage in the Enterprise: The Role of the Networked Storage Controller," by Richard L. Villars, IDC, January 2005.

¹⁴ "Intelligent Tiered Storage – No Need to Wait!" Podcast, by Hu Yoshida, October 19, 2006, <http://blogs.hds.com/podcasts/2006/10/19/intelligent-tiered-storage-no-need-to-wait/>.

¹⁵ Ibid.

4. How much extra latency will the solution add to performance (such as ongoing disk read/write operations)?

Some virtualization solutions can introduce added I/O latency due to the following conditions:

- Opening Fibre Channel packets; I/O must then be redirected with other systems
- Maintaining, updating and referencing a separate mapping table, with the use of extents or added LUNs that maintain the ongoing relationship between the underlying physical and logical volumes
- Additional control path processing that may be required for servers or appliances to communicate with an intelligent switch
- The added impact of virtualized replication, migration or mirroring services on core directors or switches

How Hitachi Data Systems compares: Hitachi Universal Storage Platform solutions do not introduce significant latency. Shortly after the release of the groundbreaking Hitachi Universal Storage Platform, analyst firms like IDC acknowledged the enterprise levels of performance the solution provided. Since then, Universal Storage Platform solutions have continued to increase in performance and reliability.

For example, the Universal Storage Platform V offers the following high-performance features:

- Massively parallel, scalable crossbar switch architecture able to process 4.0 million I/Os per second, **106GB/sec aggregate internal bandwidth**
- **Superior scalability up to 247PB of total storage capacity, including as much as 332TB of internal storage**
- High-speed global cache to boost performance/migrations
- Best-in-class performance platform for intelligent tiered storage
- Hitachi Dynamic Provisioning software to apply thin provisioning practices to both internal and externally attached storage, thereby simplifying storage management and capacity planning while reducing TCO

5. How well does the solution scale to support large installations, and even petabytes of storage?

While many virtualization solutions claim to support many terabytes of storage, exactly how easily or how well they scale may still be in question. Some network-based virtualization solutions indicate they can be scaled up or out through the addition of more storage routers. This may add complexity, as more data transactions are required to keep the routers in synch. Some of these solutions also may not be able to virtualize and scale out other storage services beyond capacity (such as the ability to scale cache or access ports as well).

How Hitachi Data Systems compares: The Universal Storage Platform V scales to support tens of thousands of host connections and petabytes of storage. The system's superior scalability includes 247PB of total storage capacity and up to 332TB of internal storage. Just as importantly, the system includes not just the ability to scale storage capacity, but also the ability to scale and virtualize storage services like cache and access ports. This allows IT teams to develop secure, private, Virtual Storage Machines that assign the right mix of storage, cache and ports in order to ensure high QoS on an application-by-application basis.

At the core of the Universal Storage Platform V and Universal Storage Platform VM is the massively parallel and scalable Hitachi Universal Star Network™ crossbar switch architecture, which is now in its fourth generation.

6. Does the solution let you logically partition storage capacity, cache and ports?

Some analysts maintain that logical partitioning is a critical component of a successful tiered storage architecture. This functionality allows other storage resources to be virtualized and re-provisioned as well, including capacity, cache and ports, so that specific applications have the guaranteed processing resources they need to maintain steady service levels and be able to charge back using a "utility" model to internal customers.

How Hitachi Data Systems compares: Hitachi virtualization technology provides the most extensive logical partitioning functionality on the market today. This includes the ability to partition storage resources into multiple Virtual Storage Machines — each with its own dedicated internal and external capacity, cache and ports. Hitachi Virtual Storage Machine functionality allows IT organizations to apply storage policies to specific applications, thereby matching business requirements for performance, capacity and availability to designated storage resources. Because each Virtual Storage Machine has its own serial number, IT teams can associate specific business applications with selected departments and business units, then charge back accordingly. These unique capabilities allow organizations to create a utility model to deliver "metered" storage resources to select business entities. Subsequent management of Virtual Storage Machines can be addressed centrally or by local administrators. In this way, organizations can make sure that service level agreements (SLAs) successfully align the performance needs of an application with the commensurate cost required to achieve that QoS.

7. Can the solution be implemented in smaller phases? How easy is it to roll back?

Some sites may prefer to pilot a virtualization solution's data migration or replication functionality, or develop a small tiered storage environment associated with a key application and then add other applications or business groups over time. Others might want to revamp the entire architecture with virtualization. Learn whether the solution offers these options, as well as any rollback options for reverting to the "pre-virtualized" configuration.

How Hitachi Data Systems compares: Virtualization technology in the Universal Storage Platform solutions can be turned on or off, and rolled out in either big implementations or small pilot projects. Organizations also have the option to choose whether to use the system as just another storage system or fully activate its existing virtualization functionality. The system can also be deployed as just another storage system and then used to easily "discover" any externally attached heterogeneous storage volumes, which can be assigned in the Universal Storage Platform V or Universal Storage Platform VM as virtual volumes.

8. How well does the solution support clients or hosts running other operating systems?

Learn what support and connectivity the virtualization solution offers clients using different operating systems.

How Hitachi Data Systems compares: Hitachi virtualization solutions support multiple OS clients, including mainframes, Fibre Channel or iSCSI SAN, Fibre Channel DAS, and NAS via standard transport protocols (supports CIFS, NFS, FCIP, iSCSI, IBM® FICON®/ESCON® for mainframe connectivity).

9. How well does the solution support use of external, low-cost disk systems from other vendors?

Many high-end storage systems that integrate with virtualization software do not support external storage. Learn what type of support is offered for low-cost disk systems from other vendors. This is an integral component to a tiered storage architecture.

How Hitachi Data Systems compares: Hitachi Data Systems has mastered the ability to integrate lower cost heterogeneous disk systems into existing enterprise storage infrastructures. Hitachi Data Systems also offers the only virtualized solution to support use of low-cost storage for mainframe environments, via more economical FICON or ESCON connections.

10. How reliable is the tiered storage model currently supported by the virtualization solution?

Some high-end storage systems support the use of high-capacity, lower cost storage tiers from within the same storage "frame" as that which houses their high-end (or Tier 1) storage disk drives. In the event the actual frame is damaged or destroyed, this can result in a potential "single point of failure" situation that may risk the loss of not only critical Tier 1 data, but also any Tier 2/Tier 3 backup copies, which may have been stored in the same storage unit.

How Hitachi Data Systems compares: Hitachi Data Systems believes in supporting lower cost, high-capacity tiers of storage as externally attached but physically separated storage frames from those of the high-end, Tier 1 storage. This not only offers greater customer buying choice and the option to reuse legacy systems as lower level storage tiers, but also eliminates the "single point of failure" risk to both tiers of data. This physical separation of tiers also allows any rebuild efforts ultimately required on high-capacity disks to be more easily isolated with no impact on the performance and availability of any surrounding application data. Since Hitachi virtualization technology allows data to be seamlessly migrated in the background during such rebuilds, access to the impacted tier's data is also assured even during this type of maintenance activity.

11. Will the solution cost more than my current high-performance storage system?

Hitachi Data Systems notes that tiered storage should cost less than Tier 1 (high-performance) storage. This includes the cost of software and hardware to move the data between tiers.

How Hitachi Data Systems compares: Hitachi virtualization functionality does not require increasing the cost of the infrastructure with additional SAN network hardware, servers or switches. Instead, the solution requires only enabling a Hitachi Universal Volume Manager software license to turn on the virtualization functionality found in the controller. Then, the related storage services can also be used by other connected storage systems. This makes it less expensive to implement on enterprise or midrange systems. Hitachi virtualization also offers different price points of entry for implementation in either its Hitachi Universal Storage Platform V or Universal Storage Platform VM solutions.

12. How do you ensure extra virtualization elements won't decrease system reliability or availability?

Some network-based solutions may require additional clustered servers or appliances to support their availability goals. While offering limited availability, performance of these virtualization solutions can still be dramatically reduced by as much as 50 percent in the event that half of the cluster goes down.

How Hitachi Data Systems compares: Reliability and availability levels for the Universal Storage Platform V and Universal Storage Platform VM do not rely on clustering technology. Instead, these are based on the already mature and proven reliability of the underlying Hitachi storage controller, which has already been field proven for reliability in large enterprise storage environments.

13. Does the vendor's vision adequately support the enterprise organization's current and future goals?

Given the relatively young nature of virtualization technology, it is important to focus on vendors that seem to offer a pattern of ongoing innovation and integration in their current virtualization offering and technology road map.

How Hitachi Data Systems compares: Widely acknowledged for its ability to accurately predict technology changes in the market, Hitachi Data Systems won newfound respect and recognition when it launched the Universal Storage Platform in September 2004 as the first of a kind, storage controller-based virtualization platform that was now capable of extending virtualization functionality to externally attached, heterogeneous storage. Heralded as everything from a "new category" in storage, to "game-changing technology," the Universal Storage Platform garnered comments from analysts regarding how much its introduction had dramatically shifted the underlying storage landscape for both customers and competing vendors. Following the introduction of the Hitachi Universal Storage Platform V in 2007, Hitachi also announced another market first: an enterprise-class implementation of virtualization with thin provisioning (Hitachi Dynamic Provisioning software) for both internal and externally attached heterogeneous storage.

"With the Universal Storage Platform V, Hitachi has achieved what other storage companies have yet to envision and has clearly extended its leadership position in high-end, enterprise storage solutions," said Hitachi Data Systems CTO Hu Yoshida.

14. How easy is it to migrate or replicate data between systems or back out once you begin the migration process?

Learn how much support virtualization solutions offer for data migration or replication across heterogeneous systems and different price and performance storage tiers. Watch for:

- *Any added storage capacity required* to "stage" interim volumes during migration to the virtual layer
- *Potential vendor lock-in after data is migrated into the virtual layer*; ask specifically how easy it is for data to return to the native storage mode of the underlying physical controller
- *Maturity of replication and data migration functions*; some virtualization solutions that place virtualization functionality farther away from the data have had to redevelop and re-architect the use of common storage services like replication and data migration.

How Hitachi Data Systems compares: Any-to-any replication, seamless data migration and centralized data management are part of Hitachi virtualization functionality. Hitachi controller-based virtualization (in the form of the Universal Storage Platform family) has been carefully integrated with Universal Volume Manager and other Hitachi software. This results in a single set of management tools for performing snapshot, migration, archiving, backup and replication of data across heterogeneous storage systems — even from mainframe systems to lower cost open systems.

15. What would be required to move to a different virtualization platform (or vendor solution) later?

Once storage volumes in some solutions have been "virtualized," their data contents may now exist under a new, proprietary volume format that the originating physical storage device may not be able to read. This encourages vendor lock-in and may make it difficult for an IT organization to decide to try a different virtualization solution later.

How Hitachi Data Systems compares: Data migrated and subsequently stored on Hitachi virtual volumes is still stored in the native format of the originating external device, instead of a proprietary data format or one that uses intermediate mapping schemes. If the user wants to discontinue use of Hitachi virtualization technology, they can switch back to managing the data from within the external device's interface.¹⁶

The Hitachi Data Systems Approach to Virtualization

Introduced in September 2004 with the company's flagship solution — the Hitachi Universal Storage Platform — this controller-based virtualization approach offered by Hitachi Data Systems has since been heralded as the first of its kind to pair both enterprise-class storage system functionality with robust virtualization functionality. With the introduction of the Hitachi Universal Platform V in May 2007, followed by its new midrange offering, the Universal Storage Platform VM, Hitachi went on to announce another market first: an enterprise-class implementation of virtualization with Hitachi Dynamic Provisioning software that extends the capacity savings of thin provisioning to both internal and externally attached heterogeneous storage.¹⁷

¹⁶ See <http://blogs.hds.com/hu> to browse blogs by Hu Yoshida.

¹⁷ For more reference materials surrounding the Hitachi Data Systems virtualization approach, see <http://www.hds.com/solutions/storage-strategies/virtualization-resource-center/>.

Figure 1. The Hitachi Universal Storage Platform V and Universal Storage Platform VM.



Fulfilling a Promise of Simplicity

With the introduction of the Universal Storage Platform, Hitachi Data Systems mapped a course in virtualization based on its fundamental belief that virtualization functionality should be simple and easy to implement into existing enterprise environments.

This simplified approach differs significantly from competing virtualization solutions that tend to come with many new layers of either software or hardware that may serve to increase an organization's cost and complexity of managing storage. Whether they come billed as "host-based virtualization," "network-based virtualization" or "switch-based virtualization," Hitachi Data Systems avoids adding to these solutions complex new hardware components and intermediate mapping schemes that would be otherwise required to move physical resources into a logical or virtual world.

Implementing Hitachi virtualization technology also fulfills the promise of simplification. Hitachi built a powerful, yet straightforward, virtualization layer it now calls Hitachi Universal Volume Manager software on top of its already mature storage system controller functionality. To take advantage of this virtualization layer, organizations just need to be using a Hitachi virtualization-enabled storage solution. When they are ready to "turn on" virtualization functionality — for use with either a smaller pilot or test application or even a large-scale implementation — they just need to obtain a Universal Volume Manager license key for use with that solution.

Then, they can externally attach storage systems from EMC, IBM, Hewlett Packard or Sun, among other vendors, and are ready to start managing these resources from the virtual pool of storage within the Universal Storage Platform. It's that simple.

Benefits of This Approach

Now, with over 7,300 virtual storage controllers shipped, the Hitachi approach to virtualization lives up to its promise to reduce costs and simplify storage infrastructures. By providing one platform for all data and eliminating the barriers to sharing storage capacity among different vendors' hardware and various storage tiers, the Hitachi approach to storage virtualization helps organizations achieve sustainable, long-term savings on the cost of storage management, while being able to defer the purchase of new storage assets.

Hitachi is the only storage vendor that provides true heterogeneous data migration, replication and management services through a storage controller-based virtualization approach, regardless of the manufacturer of the underlying storage system. That means organizations can now attach, combine, migrate, replicate and universally manage external, heterogeneous storage from vendors such as Hitachi, EMC, IBM and Sun, among others.

Organizations use a single logical pool and a single set of management interface tools to simplify their storage operations. They have been able to implement intelligent tiered storage and perform nondisruptive data migrations as well as data replication from any system to any other storage system. Many are also benefiting from their ability to reuse legacy assets.

No vendor lock-in. The Universal Storage Platform V and Universal Storage Platform VM do not use intricate mapping schemes. Instead, they communicate with each external system in the system's own native SCSI command format. This allows Hitachi Data Systems customers to have extra peace of mind that they are not being "locked in" to the Hitachi Data Systems vendor path to virtualization once they make the move. Since volume data is always stored in its native system format, storage systems can be just as easily "unplugged" from the Universal Storage Platform V or Universal Storage Platform VM at any point in the future and returned to operation in native format, without incurring new migration penalties.

A strong foundation for tiered storage and data lifecycle management. True progress in areas like data lifecycle management and tiered storage means that data or volumes can be easily assigned to the needs of specific applications or classes of data. It also means data can be easily migrated between different price and performance tiers of storage as its usefulness and frequency of access changes over time. With Hitachi virtualization in the Universal Storage Platform V and Universal Storage Platform VM, organizations can:

- Assign pooled resources in the SAN to the needs of specific applications, or to key storage tiers
- Assign legacy storage systems for use as lower level tiers, which now become part of the virtual pool of storage
- Perform transparent data migration from any to any heterogeneous storage system, including to pools of virtual storage assigned to a specific tiers
- Develop and automate policies to effectively handle data movement at preset intervals, or in accordance with specific events

Integration with a rich storage management suite. A virtualization solution's ability to present a unified, virtual pool of storage capacity is only as good as the accompanying tools used to manipulate and manage the now unified storage assets. Here, the Universal Storage Platform V and Universal Storage Platform VM models benefit from deep integration with the best-in-class Hitachi Storage Management and HiCommand® Suite software products. Specifically available for the Universal Storage Platform family of solutions (and also able to be utilized in conjunction with ANY externally attached storage system with a single Universal Volume Manager license) are key Hitachi storage services, as shown in Table 2.

Table 2. Sample of Storage Services Available to Any Attached, Heterogeneous Storage Systems

Storage Management Services	Description
Hitachi ShadowImage® Heterogeneous Replication software	Offers local, nondisruptive point-in-time (PiT) replication for any pool of storage virtualized by any model of the Hitachi Universal Storage Platform. A mature technology, ShadowImage software allows rapid, high-speed copies to be made of a consistency group of related data, including copies of an entire system, database or any related volume sets. ShadowImage copies are also used as the basis for more remote replication processes, such as those handled by Hitachi TrueCopy® Synchronous and TrueCopy Asynchronous software.
Hitachi HiCommand® Tiered Storage Manager software	The foundation of Hitachi intelligent tiered storage functionality, Hitachi Tiered Storage Manager software allows granular data sets (or whole volumes) to be dynamically and nondisruptively migrated from one tier of storage to another without impacting production applications. Tiered Storage Manager allows true, any-to-any heterogeneous data migration.

Table 2. Sample of Storage Services Available to Any Attached, Heterogeneous Storage Systems (Continued)

Hitachi TrueCopy® Synchronous software	Having already solved the problem of "any-to-any" remote replication within its own product lines with Hitachi TrueCopy software, Hitachi was able to easily extend this mature cross-copy functionality to other external storage systems attached via the Universal Storage Platform V and VM solutions. Cross-system copying occurs without adding a new replication appliance or creating new intermediate software for the process. TrueCopy software's remote replication functionality allows for ShadowImage copies of data to be replicated — either synchronously or asynchronously up to 50 kilometers away (or more). Hitachi TrueCopy software also enables data copies to be replicated between two disparate storage systems attached via the Universal Storage Platform solutions.
Hitachi TrueCopy Asynchronous software	
Hitachi Universal Replicator software	Hitachi Universal Replicator software extends the concept of remote replication to allow any-to-any replication, up to any distance, using a unique "pull" (not "push") architecture that minimizes bandwidth, cache usage and latency at the primary site. When combined with the Universal Storage Platform solutions, Universal Replicator software now makes it possible to select any storage system target and any storage initiator at multiple data centers spread around the world in order to retain replicated versions of volumes, data sets or entire systems.
Hitachi Universal Volume Manager software	This is the fundamental virtualization functionality that allows all other storage services in this table to be used with externally attached storage. This virtualization function can be simply "turned on" within an existing Universal Storage Platform solution using a software key obtained from Hitachi.
Hitachi Virtual Partition Manager software	Hitachi Virtual Partition Manager software is an interface that allows administrators to set up as many as 32 Virtual Storage Machines with virtual serial numbers that allow partitioning of certain amounts of pooled capacity, ports and cache. This functionality supports the secure, multitenancy requirements and service levels of specific applications.


Conclusion

Hitachi Data Systems believes an inevitable shift in storage infrastructure is underway. This shift depends on virtualization as the interlocking layer to smooth out the rough edges between disparate, underlying systems. In that supposition, Hitachi Data Systems is joined not only by analyst opinion but, more importantly, by a growing, 7,300 strong customer base that has already acquired Hitachi virtualization technology.

Storage virtualization is a critical next step in storage that Hitachi Data Systems believes will be needed in order for enterprise organizations to achieve many of the expanding goals now before them: optimized operations; faster, more agile data movement; tiered storage; and more advanced-stage storage consolidation.

If your organization consistently struggles with maintaining storage costs, managing capacity growth, ensuring effective service levels and an overly taxed IT staff, why not explore what Hitachi storage virtualization solutions could do for you?

Hitachi virtualization solutions avoid complexity while offering a varied path to implementation. CTO Hu Yoshida compared the key difference between Hitachi and other virtualization solutions as follows:



“Some virtualization solutions require a whole new layer of management complexity, defining disk extents and mapping them to virtual volumes through a mapping table, and requiring additional SAN zones to be established. The Hitachi Data Systems solution has none of this complexity since we do virtualization and tiering through our controller for external storage just as we do for internal storage.”¹⁸

— Hu Yoshida, CTO, Hitachi Data Systems

In terms of its breadth of virtualization capabilities, product innovation and overall maturity, ESG's Tony Asaro also reiterates exactly how far ahead the Hitachi Universal Storage Platform is from the competition:

“To this day, Hitachi is the only leading storage vendor to support external storage virtualization within their flagship products... Hitachi has been successfully leveraging its external storage virtualization capabilities within the USP — a leading Enterprise-class storage system — for over three years now, with several thousand product implementations worldwide. End-user customers really are using it to create and intelligent tiered storage environment that consists of various external storage systems, including those from competitive third-party vendors.”¹⁹

— Tony Asaro, ESG Senior Analyst, 2007

To explore how virtualization may work for your organization — including its potential cost savings or the different paths available for implementation — please contact your local Hitachi Data Systems representative. For more information, please go to <http://www.hds.com/virtualization>.

¹⁸ See <http://blogs.hds.com/hu> to browse blogs by Hu Yoshida.

¹⁹ “Hitachi USP VM: An Important Step Toward Virtualizing the Data Center,” Storage Systems Brief by Tony Asaro, Enterprise Strategy Group, September 2007.

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