

White Paper

VMware Ready

Why VAAI Implementation Matters to Your Business

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Keeping Pace with Virtualization Demands

The server virtualization revolution has taken over IT. In every industry segment, virtual server deployments have grown steadily and strongly over the last couple of years. But while the efficiency and cost benefits of virtualization are well documented, its rapid expansion is creating a new set of IT challenges for organizations. As a result, although server virtualization has delivered enormous benefits in the data center, most companies have not realized a full return on their server virtualization investments.

Reports of degrading virtual machine performance, virtual machine sprawl, slow virtual machine deployment, storage configuration and sizing issues, increasing management complexity, and rising capital and operational costs are now commonplace and—in many situations—are hindering virtualization expansion. However, integration between server and storage environments via technologies such as VMware vStorage APIs for Array Integration (VAAI) holds new promise.

In developing VAAI, VMware has committed to working with its storage partners to improve integration between servers and storage; according to those closest to the situation, IT employees, better integration among infrastructure components, particularly servers and storage, is exactly to they need to improve their chances of meeting virtualization goals.¹

While shifting IO-intensive processes from ESX hosts to the storage array will free up server resources and IO to support virtualized production workloads, the level of benefit organizations will realize from VAAI will depend significantly upon the supporting storage architecture. First, to accommodate rapid VM growth and still maintain or improve performance levels and consolidation densities, highly scalable storage that can provision storage as quickly and efficiently as the VMs its support is needed. Second, a higher performance array with VAAI can enable greater consolidation of VMs sharing that resource, leading to a lower capital and operating cost for VMs.

This white paper looks at the business benefits of VAAI and the supporting storage infrastructure as they enable the next wave of VMware deployment. Particular attention is paid to showing how VAAI features, and those of the storage architecture, translate into key business benefits, including:

- Faster time to value
- Lower capital costs (e.g., lower storage costs per VM) and increased utilization of existing assets
- Improved business responsiveness and agility
- Lower operational costs

VAAI Overview

Features and Benefits

A feature of VMware vSphere 4.1, VAAI addresses the challenges of server virtualization expansion—particularly, storage sizing, VM provisioning, and application performance—by offloading IO-intensive processing from the server environment to supporting storage systems. While VAAI makes more efficient and appropriate use of server resources, relieving the host from data management and returning it to the function for which it was designed (i.e., application processing) VAAI also changes the workload in each domain and, as a result, customers may want to think differently about the performance and cost tiers of storage they are using to support their virtualized server environments.

As more VMs share the same storage resources, IO loads and randomness increase. These demands, along with increasing network bandwidth use, can put a tremendous burden on the storage environment. In the past, customers have tried to get around this issue by provisioning storage to VMs on a 1:1 basis; this is incredibly inefficient, can limit the use of some VMware advanced features, and creates more management headaches. In business terms, it can impact an organization's ability to take advantage of market opportunities, fight off

¹ See: ESG Research Report, [The Evolution of Server Virtualization](#), November 2010.

competitive threats, and achieve revenue and profit objectives. IT administrators end up spending more time managing and fixing the environment and less time deploying new applications that benefit the business. What’s more, overall costs are driven up due to the efficient use of existing resources.

VAAI highlights the importance of server virtualization and the storage infrastructure. These benefits are outlined in Table 1.

Table 1. The Business Impact of VAAI

	Benefit	Business Case
Write Same/Zero	Speeds provisioning of new VMs; key to supporting large-scale VMware or VDI deployments.	<ul style="list-style-type: none"> • CAPEX reduction • Streamlined operational workflow
Hardware Assisted Locking	Removes SCSI reservation conflicts; enables faster locking; improves VM density performance.	<ul style="list-style-type: none"> • Achieve greater consolidation ratios with a tier-1 platform to reduce footprint and complexity
Fast/Full Copy	Speeds up cloning and storage vMotion; allows for faster copies of VMs.	<ul style="list-style-type: none"> • Right-sized capacity • Accelerated VM deployments

- Write Same/Hardware-Accelerated Zero.** Many VMware IO operations—such as new VM Creation, VMotion, Storage VMotion, Cloning, Backup, and VM Snaps—require that data be zeroed out on the VMFS file system using a SCSI write command. This security measure ensures complete data deletion and involves moving many small, identical blocks of zeros from the host to the array. The Write Same API moves one large block of zeroes instead and then executes repeated writes in the array.

Benefit: By eliminating redundant, repetitive, host-based write commands and replacing them with optimized array commands, this API reduces IO and speeds VM creation, particularly for fault-tolerant VMs. Common tasks such as formatting and reallocation can be executed with 10x less IO.

- Hardware Locking Offload/Hardware-Accelerated Locking.** Numerous VMFS operations cause a LUN to become temporarily locked during writes from a single ESX host, preventing other hosts from accessing the LUN. This API offloads lock management from the host to the storage array, which keeps the LUN available by locking only required blocks and not the entire VMFS file system.

Benefit: This reduces the likelihood of VM resource hogs degrading the performance of other VMs sharing the same server and storage resources. The function is a modification of the ESX kernel, so it is implemented by default, and increases the number of VMs that can be created per datastore by a factor of ten. This simplifies management since there are fewer datastores to manage or consider for provisioning and load balancing.

- Full Copy/Hardware-Accelerated Copy.** Tasks such as Storage VMotion, cloning, and VM creation from templates require data to be read by the host and then written back to the array, utilizing disk and storage network resources. This API leverages the native capabilities of supporting arrays to do the copying, which can dramatically reduce the load on the ESX host, storage array, and network.

Benefit: Organizations can expect up to 10x faster data movement. As an example, with this feature enabled migrating a 100 GB VM can take 10 to 30 minutes versus 30 minutes to 2 1/2 hours.

Solving Common IT Issues, Addressing Business Problems

VAAI has the ability to deliver more efficient, agile, and cost-effective VMware environments. For those vendors that fully support VAAI—and not all will at first—it unlocks performance and efficiency gains and provides for improved business productivity, which, after all is what businesses are after. To illustrate these points, let’s take a look at three specific business cases for VAAI.

Business Case #1: Improved VM Density

Storage administrators have been sizing volumes and configuring RAID groups based on guesswork. They often neglect to consider the need to support IOPS requirements for each individual virtual machine on each ESX host, instead sizing only enough to support one or two VMs. In some cases, they implement workarounds such as isolating workloads or limiting the number of VMs per host to avoid problems in the storage array, keeping consolidation density ratios disappointingly low.

For the business, the inability to increase consolidation densities hinders growth, new application deployment, and fast provisioning for production workloads; it also means higher total infrastructure cost per VM. The key benefit here is that customers can virtualize more when taking advantage of VAAI without having to buy more storage: the existing and new VMs can use storage more efficiently. In many cases, this just requires a microcode update on the array.

Thirty percent of ESG survey respondents plan to achieve a 25:1 consolidation ration over the next 24 months.² This dramatic increase in consolidation cannot be achieved without leveraging features such as those delivered by VAAI. Server virtualization is a complete system that includes an essential storage component that must continue to deliver on the many benefits virtualization has to offer throughout the entire infrastructure stack.

Business Case #2: Improved Performance Management

Another common problem is VMware file system (VMFS) locking, which makes expansion difficult. Numerous VMFS operations cause temporary LUN locking during write operations from a single ESX host, preventing other ESX hosts from accessing that volume simultaneously. This is common with many VMFS operations, particularly when executing mobility-oriented tasks such as Dynamic Resource Scheduling (DRS), vMotion, and Storage vMotion.

The locking problem creates a need for constant rebalancing, which requires administrator time and increases management costs. And yet, a dynamic environment is central to fulfilling VMware's ultimate potential; the right deployment today might be unacceptable tomorrow, so fast and easy rebalancing is required to maintain efficiency gains. For many, the only solution to this problem, until now, has been to move from VMFS to NFS, relinquishing the benefits of VMware's clustered file system: simultaneous volume access with transactional integrity in favor of simpler expansion that takes more hardware. Customers can now confidently virtualize more of their IO-intensive applications knowing that all storage-specific tasks are now offloaded to a high-performance array.

Some organizations have to implement change management processes to keep up with shifting storage requirements; these additional processes reduce the impact of VMware's efficiency and cost benefits. Plus, with vSphere, server, network, and storage administrators passing trouble tickets back and forth, problem solving is not swift, simple, or efficient. In this business case, VAAI has the opportunity to massively improve operational efficiency and organizational alignment.

Business Case #3: Less Management Overhead

VAAI dramatically improves scalability and facilitates larger clusters with more VMs and more and faster VM snapshots. By moving the copy task to the storage array, VAAI eliminates the need to read data into the host and then write back to the array when creating clones or snapshots, creating virtual machines from templates, or leveraging Storage vMotion. This frees up significant server and storage processing power as well as network bandwidth, making them available for higher level functions, enabling faster VM creation and data movement, and returning the business to full operations faster.

This reduces infrastructure cost per VM, eliminates extra management (restoring VMware efficiency gains), speeds provisioning for new virtual applications, and enables better data protection.

² Ibid.

The situation is similar with Storage vMotion or VM cloning: if you want to clone a 100 GB file, your storage array must support reading 100 GB and then copying 100 GB from one place to another—a heavy load. VAAI can move that copy process to the array, which can handle the load.

The “X” Factor

Why Storage Selection Does Matter

The benefits of VAAI are directly related to the capabilities of the storage array. A high-performance storage array is going to provide more benefit than others, especially over time. It is important to keep focused on long term goals and VAAI offers a compelling reason to rethink the storage architecture. IT organizations that are standardizing on virtualization will benefit from its ability to deploy more VMs on fewer, high-performance enterprise-class arrays. This consolidation is a critical step to achieving cloud computing.

Storage arrays are not all alike: architectures, software features, performance, supported protocols, capacity limits, and myriad other details vary. The ability to leverage the features of VAAI depends on the level of sophistication of the array. It is extremely helpful for VAAI to offload processing from the ESX host to the array as long as the array can handle the additional load required. Particularly in growing environments, the additional load can bring some storage arrays to their knees. While many storage arrays will support VAAI capabilities, it becomes important to understand how different storage systems can fully utilize VAAI’s benefits.

- Large disk pools with many spindles to support boot capacity and IO-driven workloads on the same system.
- VAAI offloads processing to the storage array; the array needs to have the available overhead to support these operations.
- Storage virtualization for maximum utilization and capacity planning to match growing virtualization demands.
- Some storage systems will offer VAAI enablement on heterogeneous storage arrays to pass through VAAI capabilities to storage arrays that do not natively support its capabilities.

These decisions will impact long-term server virtualization success, ease of deployment, application performance, and key success metrics. Companies like Hitachi are well entrenched in the data center and have some unique capabilities with VAAI that are worth exploring further.

Why Hitachi?

There are many reasons why a [Hitachi Data Systems](#) (HDS) storage solution is optimal for leveraging VAAI in a virtual deployment, not the least of which is that Hitachi and VMware have been working together as partners since 2002. Hitachi is an elite level VMware Technology Alliance Program partner and one of the few vendors to support VAAI at vSphere 4.1 launch. Hitachi further sets itself apart by extending this functionality to existing disk arrays.

Hitachi’s complete line of enterprise-class storage systems, which includes the Hitachi Adaptable Modular Series 2000 Family, the new Hitachi Virtual Storage Platform (VSP), and the Hitachi Universal Storage Platform (USP) V and VM, supports VAAI. VAAI is enabled by Hitachi on these platforms via a simple, free of charge microcode update. Of course, to take advantage of VAAI from VMware, customers will need to upgrade to vSphere 4.1 or later. Hitachi supports all three VAAI primitives on all three platforms, including FC and external storage (SVD) on VSP and USP V/VM.

Hitachi’s symmetric active-active controller architecture, pre-fetch algorithms, and other high-end features such as Hitachi Dynamic Provisioning and Hitachi Dynamic Tiering—and storage virtualization—make it a top contender for large virtualized tier-1 and tier-2 production workloads, including databases.

- **Symmetric Active-Active Load Balancing Controller:** These intelligent controllers eliminate manual load balancing, reducing performance bottlenecks and freeing up administrator time. Unlike asymmetric controller designs, Hitachi’s active-active symmetric design allows any host port to accept IO for any LUN

without a performance penalty for accessing the “wrong” port; as a result, it maintains workload response times during heavy access and prevents bottlenecks when workloads consume more than a single HBA port can handle. All of Hitachi’s array technologies plug into the vStorage API for Multipathing and are able to leverage the native Path Selection Policy and provide full active/active direct load balancing without requiring additional multipathing software to optimize.

Benefit: This saves money and time in terms of application performance, operational effort, and elimination of bottlenecks. Virtualized environments are becoming denser with focus on higher tier workloads. As businesses accelerate their virtualization efforts, a system that can efficiently scale and match the performance demands helps IT transparently migrate workloads with minimal impact to the core business.

- **Hitachi Dynamic Provisioning (HDP):** HDP allows disk pool creation, enabling IT to wide stripe VMFS volumes across multiple spindles and RAID groups, and offers hardware thin provisioning. This has several advantages: reclamation of storage capacity for lower costs, distribution of read/write tasks for faster performance, and dynamic expansion for scalability. Performance can be scaled up by adding spindles and RAID Groups to the HDP pool, capacity can be scaled out by expanding virtual volumes. Hitachi Dynamic Provisioning also does additional performance management by automatically rebalancing the volume.

Performance and scalability improvements are generated by wide striping, load balancing, and dynamic expansion; high-performance thin provisioning creates the optimal VM workload and density. HDP can dynamically re-balance data pages of VMFS volumes to ensure that all virtual machines operate efficiently and effectively.

Benefit: The unified resource pool simplifies storage management; thin provisioning reduces costs and increases storage utilization for maximum efficiency. It enables a more streamlined, efficient, and dynamic storage environment that supports and optimizes virtual server efficiencies. The ultimate result is simpler management, better IO performance, and lower CAPEX and OPEX.

Additionally Hitachi’s storage heritage delivers:

- **Hitachi Dynamic Tiering (HDT):** HDT expands on the benefits of HDP, providing policy-based intelligent dynamic tiering. HDT allows individual data pages within a VMFS volume to be placed on different tiers of storage based on access patterns. Frequently-accessed data is placed on highest-performing storage tiers and data accessed less frequently is placed on lower-performing tiers.

Wide striping and hardware thin provisioning bring several advantages:

- Intelligent tiering for scalability, performance, and cost reduction.
- Distribution of read/write tasks for faster performance.
- Reclamation of storage capacity for lower costs. Performance and scalability improvements are generated by wide striping and intelligent tiering; high-performance thin provisioning creates the optimal VM workload and density. HDT can dynamically tier a single VMFS volume to ensure that all VMs operate efficiently and effectively.

Benefit: The unified resource pool simplifies storage management; thin provisioning reduces costs and increases storage utilization for maximum efficiency. It enables a more streamlined, efficient, and dynamic storage environment that supports and optimizes virtual server efficiencies. The ultimate result, again, is simpler management, better IO performance, and lower CAPEX and OPEX.

- **Storage Virtualization:** Hitachi VAAI support on the Hitachi Virtual Storage Platform (VSP) extends VAAI to more than 100 virtualized multivendor storage arrays. This enables VAAI, caching pre-fetch, etc., on existing infrastructure and eliminates the need to rip and replace. VAAI has the opportunity to accelerate virtualization deployments across the next tier of application with predictable performance, reliability, and efficient scale.

The benefits of Hitachi's virtualized storage technology extend beyond VAAI. Hitachi's intelligent data tiering, symmetric active-active load balancing, and other advanced features can be extended to multi-vendor storage arrays virtualized by Hitachi.

Benefit: Extending VAAI integration provides customers with flexibility and scalability for existing investments. Using VAAI, VSP customers will be able to improve application performance, scalability, and VM density without migrating hundreds or thousands of VMs away from external, heterogeneous storage. This protects technology investments and enables them to easily upgrade to vSphere 4.1 to take advantage of its enhancements.

- **Scale-out Servers ... and Scale-up Storage:** Hitachi's VSP storage system can help VMware administrators with the ESX "scale-up versus scale-out" dilemma. By moving some IO-intensive processing from the server to the supporting storage system, VAAI reduces the overall load on the ESX host environment, allowing it to function more efficiently and better handle key VMware tasks, such as vMotion. This means VMware administrators can choose to scale out their server environments with multi-blade servers versus scaling up their environments with large, multi-core systems.

But what about the storage environment supporting this environment? Virtual server environments, particularly enterprise workloads, benefit from storage architectures that not only support VAAI but also easily adapt to changes in the virtual server environment by scaling up and out as needed.

Benefit: With Hitachi VSP and VAAI, specifically, storage administrators can provision volumes up to 2 TB managed with a single management interface, a single backup solution, and a single replication solution. This type of scale-up approach can dramatically reduce management effort and overall infrastructure costs per VM.

The Bigger Truth

VAAI increases the operational benefits of VMware, simplifies management, and returns servers to the functions for which they were designed. By leveraging the storage array's intelligence and processing power, a more flexible, agile, dynamic virtual environment is created. Performance improvement reduces management costs while speeding business operations; storage reclamation reduces capacity requirements and costs. VAAI makes expanding server virtualization deployments much simpler and enables IT to retain virtualization's benefits and still efficiently scale. Given the expected expansion ESG research indicates, these benefits will be welcome.

VAAI does require an upgrade to vSphere 4.1 Enterprise plus, but for most storage arrays VAAI is usually a free microcode update. By making this investment, IT organizations can utilize existing infrastructure more efficiently, restart server virtualization initiatives stalled by new infrastructure needs or performance concerns, and simplify administration.

As mentioned, organizations are beginning to see the value of cloud computing for cost reduction—together, VAAI and Hitachi storage solutions can make the cloud viable by:

- Simplifying planning
- Improving consolidation ratios
- Increasing ROI

Together, VAAI and Hitachi platforms allow IT to support the business with a “service catalog” approach. IT can create several types of storage volumes based on performance, data protection, and other factors, and make them available immediately when the business finds a need. The tight integration generated by VAAI in an enterprise-class array can make this viable in the real world.

Virtualization initiatives continue to accelerate. VAAI is a tremendous help in offloading server functions to storage to improve performance and scalability; combined with enterprise-class storage solutions like those from Hitachi, the sky's the limit. The ability to target VMs at large scale will let organizations finally virtualize mission-critical applications, expand virtualization deployments, and deliver the performance their business applications require. A joint VMware/Hitachi architecture can make infrastructure-as-a-service a reality.



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