

WHITE PAPER

# Using VMware Infrastructure 3 with 3PAR Utility Storage in Datacenter Deployments



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# Using VMware Infrastructure 3 with 3PAR Utility Storage to Optimize Datacenter Deployments

## Introduction

VMware technology delivers transformative cost savings as well as increased operational efficiency, flexibility, and IT service levels. VMware Infrastructure deployments deliver these benefits in part by leveraging enterprise storage solutions and using them to produce higher levels of availability and performance than they would otherwise yield. Typically, these enterprise storage solutions consist of traditional storage arrays that, while offering many tangible benefits, can also create additional cost and complexity in enterprise data centers. By using VMware Infrastructure in combination with a storage platform that is highly efficient and flexible, users can dramatically increase the benefits of virtualization.

3PAR® Utility Storage represents a new class of storage whose benefits extend well beyond the boundaries of traditional storage devices. With breakthrough hardware and software innovations, 3PAR Utility Storage enables organizations to overcome the complexities, cost, and functional limitations of other storage solutions. 3PAR helps restore simplicity to open-systems on-line storage environments through a broadly scalable, highly efficient, and controllable storage platform. When deployed together with VMware Infrastructure, 3PAR Utility Storage offers a virtualized environment with significantly improved efficiencies in human and capital resource utilization.

This paper discusses the complementary benefits of combining features of VMware and 3PAR technologies to gain increased performance and avoid the cost of over-provisioning servers and storage in an IT infrastructure. It examines how unnecessary cost can be reduced and even eliminated by combining server virtualization technology with utility storage. The resulting combination of VMware and 3PAR technologies is a powerful virtualized utility computing platform that increases server and storage utilization, provides greater provisioning agility, and simplifies administration and management.

## Business Problems

The leading business challenges confronting CIOs and IT managers today include: cost-effective utilization of IT infrastructure, responsiveness in supporting new business initiatives, and flexibility in adapting to organizational changes. These problems are compounded by tightening IT budget constraints and more stringent regulatory requirements.

Virtualization is a fundamental technological innovation that allows skilled IT managers to deploy creative solutions to address these business challenges. VMware ESX Server and VMware Virtual Machine File System (VMware VMFS) are server virtualization technologies that increase the efficiency and cost-effectiveness of IT operations. When implementing server virtualization, it is also important to address storage inefficiencies that often exist in IT. This section summarizes several key problems that exist with today's traditional storage solutions.

### *Increased Server Density Strains Storage I/O and Bandwidth*

VMware ESX Server increases the efficiency of server hardware deployments by combining many virtual machines into a single physical machine form factor. By reducing unused CPU and storage I/O cycles, VMware customers are getting more work done from their hardware budget. However, the resulting higher server utilization can result in more I/O and bandwidth consumed per storage connection, putting greater strain on storage array resources. To maintain high virtual machine performance, the storage array must be able to provide high I/O rates. Traditional RAID arrays often utilize large caches to manage moderate I/O. But when the I/O loads climb beyond the ability of the storage processor to cache the workload, the array becomes "spindle bound" as those cached I/Os then contend for access to the physical disk. Furthermore, host virtualization often leads to a more diverse workload, with small-block online transaction processing applications competing for I/Os per second and bandwidth with large-block file-serving and streaming applications. The performance characteristics of many traditional storage arrays are often not optimized for the performance needs of highly virtualized server environments.

**Large Storage Provisioning Requests Lead to Stranded Capacity**

To allow for the greatest flexibility and speed to quickly provision new application instances, VMware Infrastructure administrators often prefer to administer fewer, but larger, volumes from their storage arrays. This allows the VMware Infrastructure administrator to have storage volumes readily available and to remove the storage provisioning steps from the application provisioning process.

Just as a file-server administrator might plan for growth by asking for large volumes, the VMware Infrastructure administrator benefits from requesting fewer, larger volumes. A single large volume can host multiple VMware virtual machines, relieving the VMware Infrastructure administrator of the burden of tracking a many-to-many mapping of virtual machines to provisioned volumes. By asking for one or more large volumes up front, the VMware Infrastructure administrator can rapidly provision new virtual machines to meet business demand, and eliminate the time-consuming wait that often occurs with traditional array provisioning.

The VMware Infrastructure administrator's approach to requesting large storage volumes is often in conflict with the storage administrator's strategy to optimize storage utilization by avoiding the provisioning of large volumes. Storage administrators resist large volumes to avoid stranded, underutilized storage. As a result, storage administrators can be at odds with the VMware Infrastructure administrator on provisioning large volumes.

**Storage Over-Provisioning: Causes and Hidden Costs**

Storage purchases in an enterprise environment are typically a significant contributor to the total cost of ownership of the IT infrastructure. Surprisingly, a study completed by Glasshouse Technologies (reported by Stephen Foskett in Storage Magazine, April 2003) of over 750 host systems at over a dozen enterprises showed that only 25 percent of purchased and allocated storage capacity was actually being used, as shown in Figure 1. This means that at any given time, enterprises using traditional storage solutions are over-provisioning by a ratio of 4-to-1. Over-provisioning is costly because it means that a large pool of purchased storage capacity sits empty while continually consuming resources to house, power, cool, and maintain it. Such waste also perpetuates the related over-purchasing of array infrastructure and storage software licenses.

In a typical IT environment, storage purchases are often over-provisioned for a number of reasons. The most common source of this problem is the difficulty of predicting how much storage a given application may need over a given period of time or its lifetime overall. To avoid frequent future downtime and reconfiguration complexities inherent with traditional storage technologies, administrators often intentionally overestimate

future storage needs or buffer capacity requests. This leads to excess capacity that is purchased up front and must be continually maintained even though it is never actually used.

In a real-life example from Glasshouse, an application user requested 10GB of storage, which was then buffered to 15GB by a database administrator. The Linux administrator then buffered this capacity to 22GB, and finally the storage administrator placed a purchase order for 34GB of raw storage. The result was that more than triple the initial requested capacity was deployed.

Intentional buffering and overestimation of required capacity are just some of the inefficiencies that lead to low capacity utilization rates. Actual capacity utilization can be driven even lower when, for various reasons, applications do not meet their initial growth expectations. Unfortunately, this carries two additional negative impacts. First, storage that has been over-provisioned for applications such as databases typically cannot be reclaimed for other use. Second, most data replication services replicate the entire set of provisioned storage, meaning that much empty unused capacity is also being mirrored, thus leading to additional waste. Organizations are ritually implementing inefficient, over-provisioned storage.

**Lack of Agility: The Difficulty in Changing Storage Service Levels**

Traditional enterprise storage solutions require a significant investment of time and planning to create the appropriate number and configuration of LUNs and volumes needed to support the desired application service levels. For example, a storage administrator must decide what number, capacity, and speed of disk drives to use. Then the administrator must choose an appropriate RAID level (for example, RAID 1 or RAID 5) to

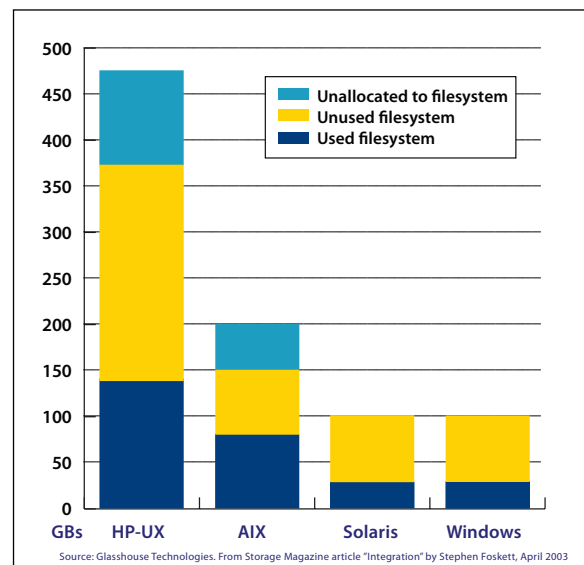


Figure 1: Unused allocated capacity

balance performance, cost, and availability. In addition, that administrator may have to decide which portions of the disk (outer or inner) should be used when laying out the volume. Once storage has been provisioned for an application, it is generally a painstaking task to lay out volume contents again if service level needs change (for example, converting from RAID 5 to RAID 1).

Because a given traditional array is typically suitable for a defined price/performance level, users often invest in multiple different platforms to cover their broad price/performance requirements. However, the optimization of data service levels over time requires large capital, training, and administrative investment in multiple storage platforms and data migration techniques. Even if a storage administrator is willing to go to the trouble of reconfiguring volumes when needs change, this is often a disruptive process, requiring applications to be brought offline. If an administrator were to decide that data should be migrated from higher performing Fibre Channel disks to more economical nearline disks for optimal cost savings, this operation would typically mean migrating data within or between systems — a time- and labor-intensive process that requires extensive planning and typically causes application downtime. As a result, it is common that service level optimization is simply not performed. Organizations are often forced to tolerate volumes that are not optimized and simply give up on pursuing the cost savings or service improvements that optimization could deliver.

## Elements of the Solution

VMware Infrastructure and 3PAR storage technologies provide the key elements needed to meet changing storage needs flexibly and without provisioning more storage than needed.

### *VMware ESX Server, VMware VMFS, and VMware VMotion*

VMware ESX Server is the foundation for delivering virtualization-based distributed services to IT environments. A core building block of VMware Infrastructure, ESX Server is a robust, production-proven virtualization layer that abstracts processor, memory, storage, and networking resources into multiple virtual machines that run side by side on the same physical server. Sharing hardware resources across a large number of virtual machines increases hardware utilization and dramatically decreases capital and operating cost. Virtual machines can be equipped with high-availability, resource-optimization, operational-automation, and security features that provide optimal service levels to even the most resource-intensive mission-critical applications. ESX Server delivers the highest levels of performance, scalability, and robustness required for enterprise IT environments.

Two VMware technologies that are particularly related to utility storage are VMware VMFS and VMware VMotion™. VMware VMFS is a high-performance cluster file system for ESX Server virtual machines. Each virtual machine is encapsulated in a small set of files and VMware VMFS is the default storage system for these files on physical SCSI disks and partitions. VMware VMFS greatly simplifies virtual machine provisioning and administration by efficiently storing the entire virtual machine state in a central location. VMotion enables the live migration of running virtual machines from one physical server to another with zero downtime, continuous service availability, and complete transaction integrity. VMotion is a key enabling component of the automated, self-optimizing data center.

### 3PAR Scalable Performance

3PAR Utility Storage is uniquely positioned for VMware Infrastructure deployments because its massively parallel architecture ensures all spindles are utilized behind volumes presented to ESX Server. As a result, 3PAR delivers exceptional I/O performance and ensures that “dense” virtual machines can be provisioned and are not handicapped by poor storage performance. Higher virtual machine density means customers can realize optimum cost savings in their VMware Infrastructure deployments using 3PAR Utility Storage. 3PAR’s ability to deliver high I/O throughput encourages customers to consolidate many applications running on several servers with VMware virtual machines running in an ESX Server cluster. Instead of host virtualization being restricted by traditional array performance, an ESX Server cluster can benefit from increased storage scaling capability when coupled with the performance profile of 3PAR InServ® Storage Servers.

The 3PAR InServ Storage Server has the unique capability of sustaining high I/O workloads to disk, even as customers scale their workloads with I/O-dense hosts such as ESX Server. 3PAR’s massively parallelized architecture stripes volumes across every disk in the array to deliver maximum I/Os. This approach addresses the issue of I/O bound or spindle-bound performance that is often seen with traditional arrays. 3PAR’s ability to absorb high I/O throughput encourages customers to continue to consolidate many applications running on several servers into VMware virtual machines running on an ESX Server cluster. Unlike traditional RAID storage arrays, 3PAR Virtual Volumes also retain their high-performance characteristics with large volume capacities, even when deployed with capacity-efficient

RAID-5 protection. The high performance and scalability of 3PAR Virtual Volumes also encourage the use of the large volumes that VMware Infrastructure administrators are requesting. Instead of host virtualization being restricted by traditional array performance, ESX Server clusters can benefit from increased storage scaling capability when coupled with the performance profile of 3PAR InServ Storage Servers.

### 3PAR Thin Provisioning

3PAR also addresses the potential conflict between the large volume provisioning needs of the system administrator and the capacity planning resistance of the storage administrator to limit stranded capacity and over-allocation. 3PAR Thin Provisioning works in conjunction with the 3PAR InForm® operating system on 3PAR InServ Utility Storage arrays to provide a simple solution to the problem of unused allocated capacity by using deduplicate-on-write technology. With Thin Provisioning, IT departments can safely allocate as much logical capacity to an application as is conceivably required over the lifetime of that application. Meanwhile, actual physical capacity is drawn and configured from a common pool of purchased storage on a fine-grained, as-needed basis, as shown in Figure 2. That is, physical capacity is actually committed from the storage pool and used for written data only when application writes occur.

By breaking the traditional link between allocated and purchased capacity, Thin Provisioning allows application costs to grow in direct accordance with application use and growth. Users can continue to request and receive desired amounts of

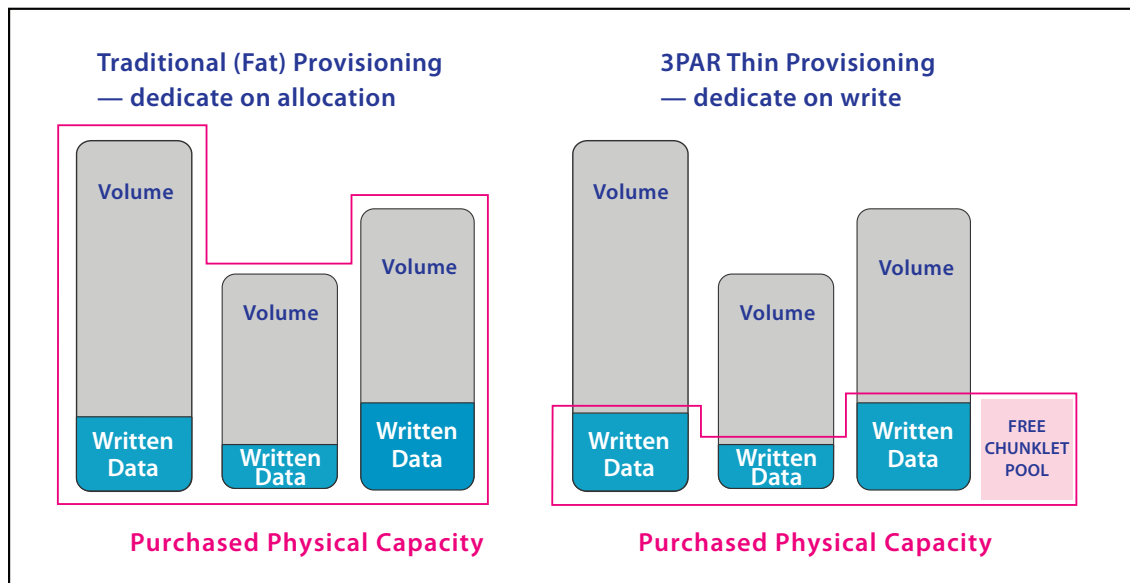


Figure 2: Thin Provisioning

capacity, but such capacity no longer needs to be purchased up front. With Thin Provisioning, purchasing is determined by actual utilization, so costs are less dependent on the ultimate success of the application and there is no wasted capacity when an application doesn't use as much storage as was originally anticipated.

For IT organizations there is another important benefit with Thin Provisioning: the pain and complexity of provisioning is dramatically reduced. By allocating relatively generous amounts of logical capacity to an application up front, they eliminate follow-on provisioning tasks and workflow. Administrators need to allocate storage to an application only once, safely and economically.

For example, assume an Oracle application in a VMware virtual machine initially requires 50GB of storage for data. Over time, rapid data growth is expected, but it is difficult to predict how much storage might truly be needed during the next two years. With Thin Provisioning, the administrator can choose to over-provision 2TB from the 3PAR InServ Storage Server for use with VMware VMFS and the Oracle database applications that run on the Oracle Database 10g.

Oracle 10g databases administrators can take advantage of 3PAR Thin Provisioning by using the Oracle AutoExtend feature. For details, see [www.oracle.com/technology/products/database/asm/pdf/oracle\\_3par\\_wp\\_final.pdf](http://www.oracle.com/technology/products/database/asm/pdf/oracle_3par_wp_final.pdf).

The Oracle application will see 2TB of capacity is available. However, if the Oracle application writes only 50GB of data, only 50GB of capacity is actually dedicated and consumed. The unused capacity remains free and available for other applica-

tions to use. As more storage is consumed by the Oracle application, additional capacity is automatically dedicated online without disruption and without any need for further provisioning by the administrator.

### 3PAR Dynamic Optimization

3PAR Dynamic Optimization allows an administrator to convert a data volume from one service level to another in seconds and with a single command, as shown in Figure 3. The administrator can do this online and without disruption within an InServ Storage Server, a massively scalable tiered storage array. Customers can seamlessly optimize data service levels across their consolidated storage tiers and related stages of the disk-based data lifecycle, thus achieving optimal data service levels at the lowest possible cost.

With Dynamic Optimization, administrators can adjust several independent volume parameters for more control over the balance between cost and performance. For example, they can convert a volume from RAID 10 to RAID 50 to adjust prioritization of cost and performance. For any given volume, the degree of resource utilization can be adjusted by varying the use of selected controllers and drives. Administrators may also selectively constrain placement of a volume's data to the inner or outer tracks of disk platters for additional control over performance. Finally, administrators can assign the placement of volumes to high performance Fibre Channel drives or more economical nearline drives as they see fit.

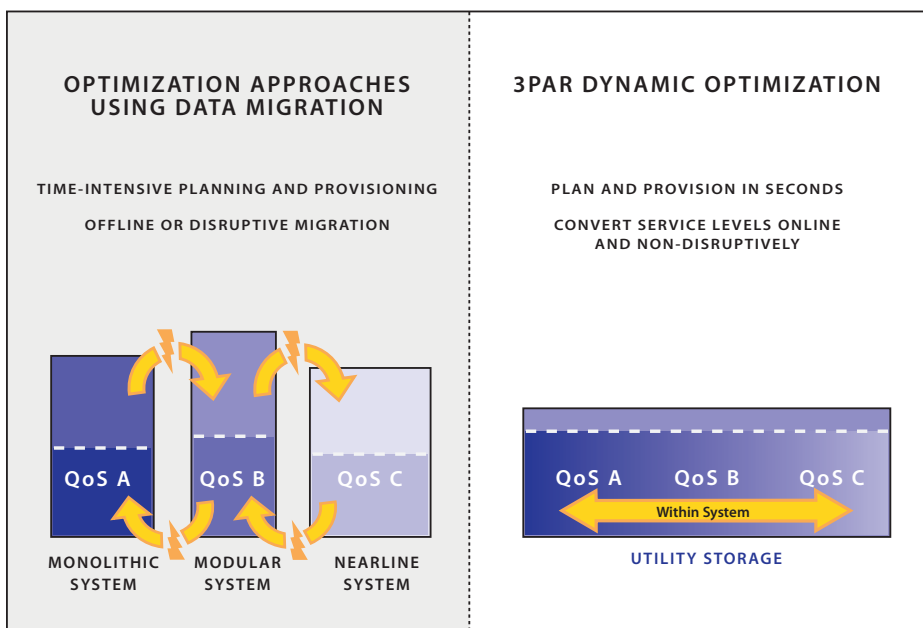


Figure 3: Dynamic Optimization

### Benefits of ESX Server and 3PAR Utility Storage

Administrators can easily use the capabilities of 3PAR storage technologies to provide flexible, high-performance storage for VMware virtual machines.

#### Using Standard Volumes

Traditionally, an administrator used a shared storage device with volumes formatted using VMware VMFS to simplify virtual machine provisioning and administration, as shown in Figure 4 below. The storage administrator typically formatted usable capacity (a LUN) with VMware VMFS, and that storage in turn was configured with multiple virtual disk drives for various VMware virtual machines. With traditional enterprise arrays, the typical way in which storage is provisioned is a one-time configuration and export of volumes. With the 3PAR InServ, this translates into a simple, one-time process of creating standard base volumes and exporting them as a pool of storage for use with ESX Server hosts. Within ESX Server, these standard base volumes are then allocated as needed to the virtual machines.

To support different service levels, it is possible to format multiple traditional or thin provisioned volumes with VMware VMFS. This allows administrators to achieve different storage service levels tailored to the requirements of the virtual machines. Each volume can be presented to ESX Server hosts and ultimately to the appropriate virtual machine. As service level requirements change, the specific volumes can be modified with Dynamic Optimization to meet the changed

requirements. Single volumes can also be exported across multiple virtual machines, in which case service level change to the volume is seen by any associated virtual machines.

#### Using Thin Provisioned Volumes

3PAR Thin Provisioning reduces capital expenditures by permanently eliminating unused allocated capacity, as shown in Figure 5.

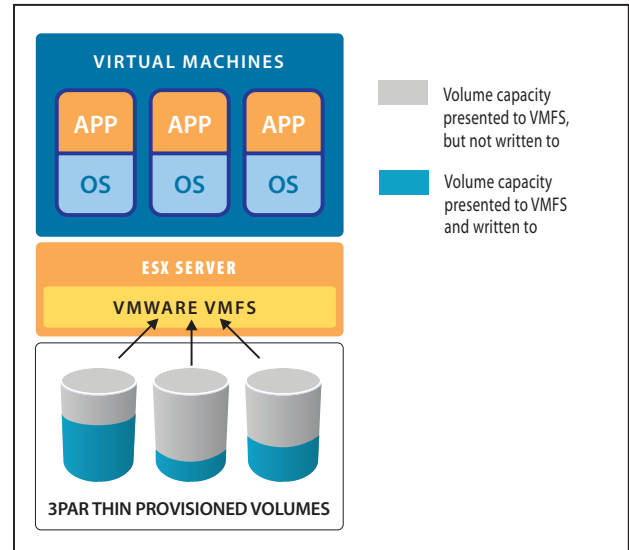


Figure 5: Using Thin Provisioned volumes

With 3PAR Thin Provisioning, it is therefore possible for storage administrators to more efficiently provision storage for use

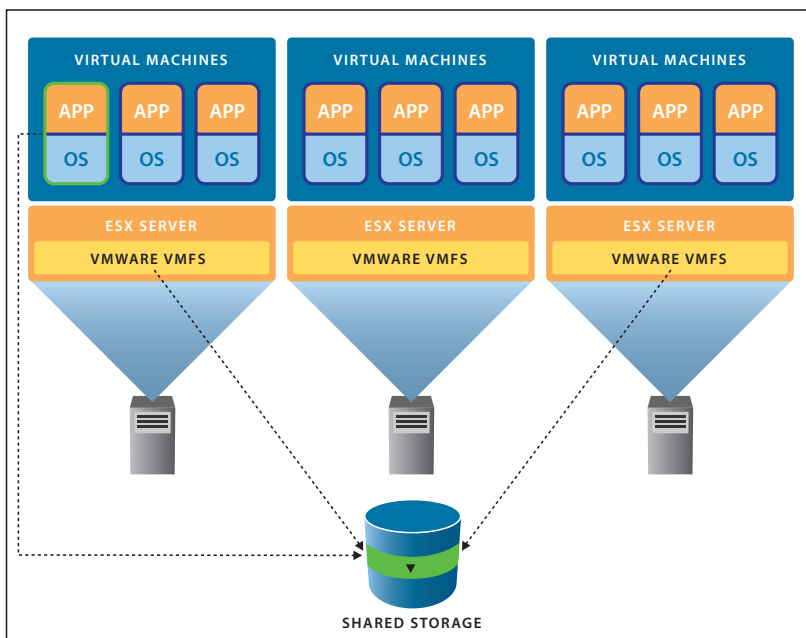


Figure 4: Using standard volumes

with ESX Server. Thin provisioned volumes that are created and exported to ESX Server hosts consume only the physical capacity needed for written data. For example, if 500GB of capacity is assigned for use, but only 200GB of that capacity has actually been written to, only 200GB is physically used within the storage array. On the 3PAR InServ, achieving this flexibility is as simple as ensuring that the volumes exported to ESX Server hosts have been designated as thin provisioned volumes.

Thin provisioning can be deployed confidently with demanding performance applications without significant performance trade-offs. For instance, Oracle conducted tests that demonstrate no significant performance difference exists between 3PAR Thin Provisioned volumes and 3PAR standard volumes. For details, see the joint Oracle and 3PARdata technical white paper mentioned above.

Thin provisioned volumes are highly instrumented to provide notification on the amount of storage actually in use. The administrator can define (at the time of provisioning or afterwards) notification and alert set-points at the individual volume level and at the array level, based on the percentage of storage consumed. The ability to easily manage the amount of unwritten storage and to know exactly and at all times how much free space remains in the InServ is a key feature of 3PAR Thin Provisioning.

Thin Provisioning enables a greater number of projects for less cost. Within a given budget, Thin Provisioning allows more virtual machines to be deployed, with each one costing significantly less than with traditional storage platforms. Just as

important, virtual machines can be deployed faster. No longer is IT required to wait until needed storage is planned, sized, negotiated, procured, and installed before it can be allocated. By maintaining a small buffer of physical capacity, IT can quickly and easily deploy new virtual machines as and when they are needed for maximum agility and responsiveness.

VMware ESX Server was validated for interoperability with 3PAR Thin Provisioning, with details provided in Appendix A. Information on maximizing the efficiency of 3PAR Thin Provisioning when used with the ESX Server `vmkfstools` command line utility can be found in Appendix B.

### Using 3PAR Dynamic Optimization

The simplicity and efficiency of 3PAR Dynamic Optimization means that administrators never have to over- or under-provision again. Administrators can optimize their environments at any time without scheduling or planning and without impact on application performance, as shown in Figure 6. In addition, Dynamic Optimization enables administrators to address common business problems in a new and more efficient manner by giving them the ability to meet service level or SLA change orders on demand. For example, it provides the ability to increase data service levels proactively before peak demand periods (such as the end of a quarter), then revert to standard levels as demand subsides.

VMware VMotion enables the live migration of running virtual machines from one physical server to another with zero downtime, continuous service availability, and complete transaction integrity. Live migration of virtual machines enables companies to perform hardware maintenance without scheduling downtime and disrupting business operations. VMotion

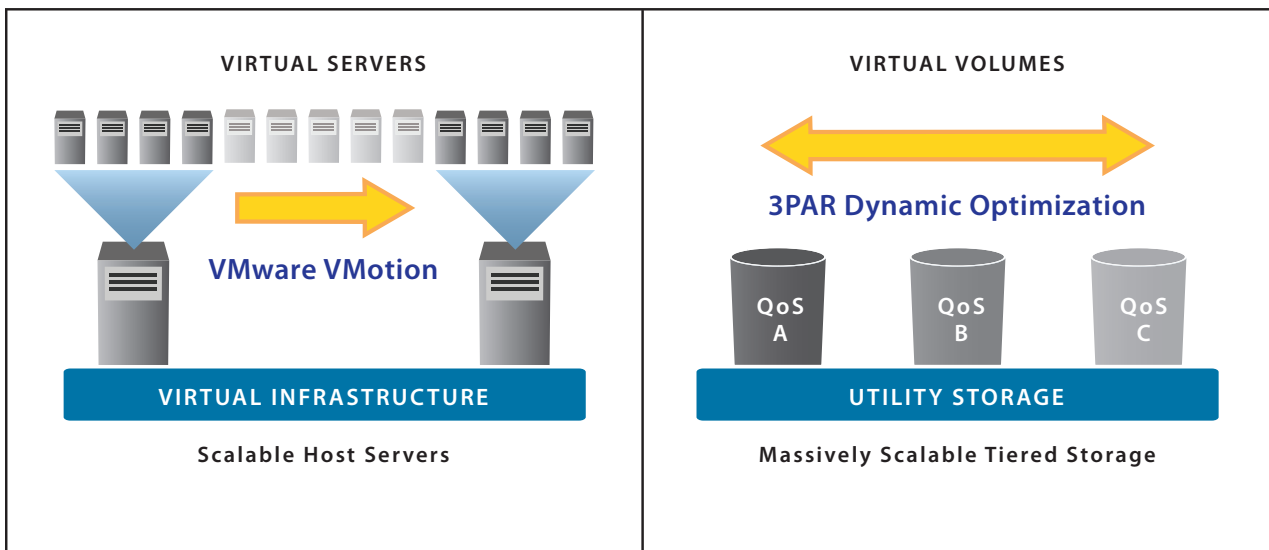


Figure 6: A fully virtualized computing environment

also allows virtual machines to be continuously and automatically optimized within resource pools for maximum hardware utilization, flexibility, and availability. VMotion is a key enabling component of the dynamic, automated, and self-optimizing data center.

Using VMware VMotion, administrators can leverage the complete virtualization of servers, storage, and networking to move an entire running virtual machine instantaneously from one server to another. Within seconds, virtual machines can be migrated to hardware that provides the desired level of utilization and service.

With 3PAR Dynamic Optimization, once virtual server migration has been completed, storage associated with that virtual server can then be customized as well. Dynamic Optimization can be used to adjust the service levels for the associated storage. The combination of VMware VMotion and 3PAR Dynamic Optimization gives administrators the flexibility to tune their application environments to match processing and storage needs appropriately.

For example, consider a VMware virtual machine that is serving a retail commerce application. During the holiday season, increased usage requires the application to be migrated with VMware VMotion from a two-way server to a more powerful four-way server. To optimize storage performance, Dynamic Optimization can also be used to redistribute the application's data from fewer or lower-performing disks to more or higher-performing disks. When the holiday period passes, the resources can be optimized again to return resources to IT for new projects.

In another example, if an IT department is staging a server for deployment in an existing environment, VMotion can be used to rebalance the existing virtual machines to make space for the prototype server. Storage provisioned for the prototype server might initially be laid out as RAID 5 (7+1), since the initial load on the server is low and not mission-critical. Once IT is ready to promote the server into production, VMotion can be used to allocate more processing resources. Dynamic Optimization can also be used to seamlessly reconfigure the underlying storage to a higher service level, for instance RAID 1, as required for production.

### ***Leveraging High-Performance Utility Storage for Greater Virtual Server Consolidation***

The number of VMware virtual machines that customers are able to support on a given physical server is often a matter of expected or observed performance. One sizing consideration for some applications and environments is the expected performance of virtual memory for a given ESX Server host. VMware virtual machines can be granted more virtual memory than physically exists on a given ESX Server host by carefully managing the combination of both physical, page sharing and

use of disk-based swap space. Typically a virtual machine that is not using much of its reserved memory may have that memory swapped to disk. When it becomes active again, the speed at which this disk-based virtual memory can be read back into physical memory can affect how many virtual machines can be run on one ESX Server host for optimal performance. In a very densely consolidated and active environment, the ESX Server host can make extensive use of such virtual disk-based memory, so application performance and therefore application consolidation can be affected by the performance of the underlying storage. The higher the percentage of writes to and reads from disk that can be done at near memory speeds (cached), the less this use of virtual disk-based memory will adversely affect the consolidated workload performance.

3PAR Utility Storage uses a massively parallel architecture so that all storage workloads are completely and automatically balanced across all internal system resources (disks, ports, processors, cache, loops, etc.). This architecture ensures that very high and predictable performance levels are delivered for provisioned volumes. These performance levels include consistently low latencies and response times — performance characteristics that have been shown in some customer environments to provide greater virtual (disk-based) memory performance, thus permitting greater virtual server consolidation on given physical server resources.

### **Summary: Flexibility, Scalability, High Performance with Reduced Cost**

The combination of VMware Infrastructure and 3PAR Utility Storage delivers many significant benefits including reduced infrastructure costs, reduced management overhead, and improved agility to rapidly provision resources as needed. Customers can deploy a highly scalable server/storage platform that maximizes server and storage utilization and significantly reduces infrastructure costs. The combined solution also significantly reduces management overhead to further reduce costs. And by enabling rapid reconfiguration of server and storage resources, the combined solution enables IT to rapidly meet changing business needs. The end result is customers who use VMware and 3PAR technologies can implement a robust utility data center that serves more applications with fewer hardware resources and reduced management and allows greater ability to react to change.

VMware ESX Server, VMware VMFS, and VMware VMotion provide a flexible, scalable, high-performance virtualization solution that gives enterprise IT departments a powerful tool for efficient server deployment. The 3PAR InServ Storage Server easily absorbs high I/O loads to disk, providing efficient, scalable

performance that enhances the ability of VMware Infrastructure to scale and consolidate. IT departments seeking to maximize asset utilization by implementing VMware Infrastructure can also leverage 3PAR Thin Provisioning to realize even greater benefits and storage cost savings. Additionally, VMware VMotion can be used with 3PAR Dynamic Optimization to tune application service levels by adjusting server and storage resources seamlessly. The result is deployments are best optimized for cost and performance.

For more information on the benefits of VMware Infrastructure, visit [www.vmware.com](http://www.vmware.com).

For more information on the benefits of 3PAR Utility Storage, visit [www.3par.com](http://www.3par.com).

### Appendix A: Validation of Thin Provisioning with ESX Server

3PAR Utility Storage is tested and certified with VMware ESX Server 2.5.x and ESX Server 3.0.x. For details, see the SAN compatibility guides for ESX Server 2.x and ESX Server 3.x.

Besides the standard HCL testing required by VMware, additional testing was performed using VMware ESX Server 3.0 with VMware VMFS and 3PAR Thin Provisioning to validate the interoperability of VMware VMFS with Thin Provisioning. The additional tests demonstrate that the dedicate-on-write feature of Thin Provisioning can significantly reduce the physical storage footprint for VMware VMFS. Only written space is dedicated within the volume. Thus, nearly 100 percent volume utilization can be obtained when Thin Provisioning is used with VMware VMFS.

A sample test provisioned a 2TB thin-provisioned volume to VMware ESX Server 3.0 as a VMware VMFS volume. After VMware VMFS initialized the volume, of the 2TB provisioned, only 80MB of storage space was actually consumed and dedicated by the 3PAR Storage Server. When using Thin Provisioning, you should use nondestructive formatting. Otherwise, a full format writes zeros across the entire partition, which consumes the entire volume, negating the benefit of Thin Provisioning.

The 2TB volume was then partitioned using VMware VMFS into one 10GB virtual disk and five 60GB virtual disks. The disks were formatted with the default disk format **zeroedthick**, a non-destructive format that does not zero out the entire partition. Appendix B covers this concept in more detail.

Once the volume was partitioned, Windows 2003 was installed in a virtual machine using the 10GB virtual hard disk, and the

five 60GB drives were available for data. Despite presenting 310GB of partitioned, formatted capacity to the virtual machine, the 3PAR InServ showed total consumed space of approximately 2GB.

Test environment:

- VMware ESX Server 3.0 with VMware VMFS 3
- IBM eServer BladeCenter HS20, 1 CPU (Intel Xeon 3.2GHz) running Windows Server 2003
- 3PAR InServ S400 with InForm OS v2.2.2
- 3PAR Thin Provisioning — exporting a 2TB LUN

### Appendix B: Efficient and Optimal Maintenance Options for Use with Thin Provisioning and VMware ESX Server

3PAR Thin Provisioning benefits are based on dedicate-on-write technology, reserving physical disk resources only when they are consumed by the application, not at the time of storage provisioning. Administrative, application, or operating system actions that zero out or write to the entire free space can be considered inefficient for Thin Provisioning Inefficient, while those that do not zero out the free space are efficient for Thin Provisioning. The Inefficient actions are still compatible and will work with Thin Provisioning, but they negate the benefits of 3PAR Thin Provisioning by preallocating all available blocks at the time of the action. An example that 3PAR storage administrators are familiar with is the use of Quick Format with NTFS volumes, which is an efficient method for formatting a volume in Microsoft Windows environments when Thin Provisioning is used.

VMware has developed a rich set of tools that integrate effectively with 3PAR Thin Provisioning, providing administrative functions that are efficient for Thin Provisioning and avoiding the needless consumption of storage that might occur otherwise. For example, when creating a new virtual disk, ESX Server 3.0 now defaults to a virtual disk format that is efficient for Thin Provisioning, as ESX Server does not zero out the virtual disk file. ESX Server also includes a powerful command line tool called **vmkfstools** that has command-line switches that allow the administrator to take administrative and maintenance actions in a manner that is efficient for Thin Provisioning.

### Creating New VMware Virtual Disks

When you use the VMware Virtual Infrastructure Client to create and manage virtual disks, it creates virtual disks with the equivalent of the **zeroedthick** option in **vmkfstools**. **vmkfstools** is the ESX Server command-line utility for manually creating, extending, cloning, importing, and exporting virtual disk files. The following table summarizes the various disk format options, their interaction with 3PAR Thin Provisioned volumes, and whether the options are efficient or inefficient for Thin Provisioning.

vmkfstools Option	VMware ESX Server Notes	3PAR Thin Provisioning Notes
<b>zeroedthick</b> (default)	Space required for the virtual disk is allocated during creation. Any data remaining on the physical device is not erased during creation but will be zeroed out at a later time during virtual machine read and write operations.	Efficient for Thin Provisioning. ESX Server does not immediately zero the data. (ESX Server returns zeros or null data when asked to read from unwritten areas but doesn't actually write the zeros to disk.)
<b>eagerzeroedthick</b>	Space required for the virtual disk is allocated at creation time. Unlike what happens with the <b>zeroedthick</b> format, the data remaining on the physical device is zeroed out during creation. Disks in this format might take much longer to create than other types of disks.	Inefficient for Thin Provisioning. ESX Server writes zeros to the entire virtual disk. Use the <b>zeroedthick</b> option instead if the intention is to wipe or zero the virtual disk.
<b>thick</b>	Space required for the virtual disk is allocated during creation. This type of formatting doesn't zero out any old data that might be present on this allocated space.	Efficient for Thin Provisioning. ESX Server does not zero the disk.
<b>thin</b>	Thin-provisioned virtual disk. Unlike what happens with the thick format, space required for the virtual disk is not allocated during creation but is supplied, zeroed out, on demand at a later time.	Efficient for Thin Provisioning. Consider using either array-based Thin Provisioning or VMFS-based Thin Provisioning but not both at the same time. (If you use thin volumes on 3PAR Thin Provisioned volumes, you must consult multiple management applications in order to fully understand total allocation of storage. If you use only 3PAR Thin Provisioning, you can see the complete allocated vs. written scenario from a single 3PARdata application.)
<b>rdm</b>	Virtual compatibility mode raw disk mapping.	Efficient for Thin Provisioning.
<b>rdmp</b>	Physical compatibility mode (pass-through) raw disk mapping.	Efficient for Thin Provisioning.
<b>raw</b>	Raw device	Efficient for Thin Provisioning.
<b>2gsparse</b>	A sparse disk with 2GB maximum extent size. Disks in this format can be used with other VMware products.	Efficient for Thin Provisioning. Sparse disks have manageability concerns similar to those for VMware thin provisioned disks. (If you use 2gsparse volumes on 3PAR Thin Provisioned volumes, you must consult multiple management applications in order to fully understand total allocation of storage. If you use only 3PAR Thin Provisioning, you can see the complete allocated vs. written scenario from a single 3PARdata application.)

### *Cloning VMware Virtual Disks with 3PAR Thin Provisioned Virtual Volumes*

When cloning a VMware virtual disk onto a 3PAR thin provisioned Virtual Volume, **vmkfstools** writes, byte for byte, a copy of the **importfile** or source virtual disk file to the new cloned virtual disk. **vmkfstools** offers disk format options during cloning that are similar to those offered by the creation command, but the list is limited to **rdm**, **rdmp**, **raw**, and **thin** formats.

In a typical cloning operation, an administrator might use a small “golden image” of a bootable operating system disk, use **vmkfstools** to clone it, and boot another machine. Ideally the golden image is small, utilizing just enough space to load the operating system, while the cloned machine may require significantly more storage. The challenge comes in trying to meet the needs for a larger volume without over-allocating storage. To obtain optimal storage utilization, you can use cloning in conjunction with 3PAR Thin Provisioned volumes.

There are two ways to create clones that continue to preserve space. The preferred method in most cases is to create a small boot operating system image, clone it with **vmkfstools**, then use the **vmkfstools -x** option to extend the size of the virtual disk to the desired, larger virtual disk capacity. When **vmkfstools** extends virtual disks, it does so without zeroing out the underlying volume, resulting in a virtual disk that is efficient for 3PAR thin provisioning.

The alternate is to use the **vmkfstools -d thin** option when cloning the image. This option creates a VMware virtual volume of the same size as the original, which could also be using the VMware thin volume disk format. The challenge with this approach is that the administrator is now managing thin provisioning at two levels, once at the VMware virtual disk level and once at the 3PAR Virtual Volume layer. This can make it somewhat difficult to see what percentage of over-allocation may have occurred. To avoid this difficulty, it is simpler to manage the environment if you use the **vmkfstools -x** option.

### References

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