StoreVault™
A NetApp Division

StoreVault™ and VMware® ESX Server 3.0

Building a Virtual Infrastructure from Server to Storage

Contents

Executive Summary

In recent years, just about every company with an Information Systems department has begun some form of consolidation and virtualization effort with the goal of increasing asset utilization while reducing management and infrastructure costs. The virtualization marketplace is filled with solutions from just about every traditional vendor and a bevy of startups, but the company that is universally acknowledged as a leader in the virtualization space is VMware.

With the release of the VMware Virtual Infrastructure 3.0 Suite, companies can decouple business applications from physical server hardware, which in turn reduces operational costs and provides a much more flexible and dynamic infrastructure. By reducing the amount of physical servers, network ports, floor and rack space, maintenance contracts, and electricity required to run a data center operation, companies can actualize the return on investment from consolidation efforts within months.

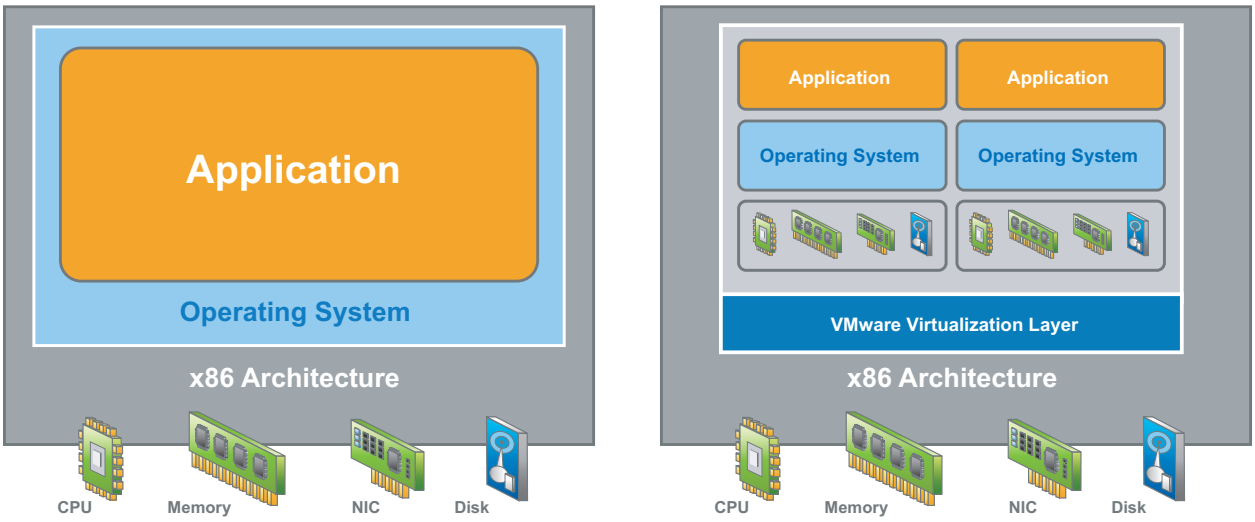
Virtual infrastructures are a fantastic solution to the challenges of a distributed server architecture. However, the native storage virtualization capabilities shipped with VMware ESX Server do not provide the same benefits and hardware reductions as those seen in the server space. Many customers have experienced an increase in storage requirements after implementing their virtual infrastructure. The reasons for this increase are many, including, but not limited to, requirements for a shared storage platform, inefficiencies in the multiple layers of storage virtualization, overprovisioned servers, and challenges with backups that can lead to inefficient disk-to-disk backup solutions.

This white paper demonstrates how integrating StoreVault technologies in a virtual infrastructure can solve the unique challenges inherent with ESX deployments in the areas of performance, storage utilization, data protection, and backups. With StoreVault virtualized storage and data management solutions, customers can make dramatic gains in these areas. This paper explains how simplifying your hardware and server applications with virtualization software provides key improvements to your IT environment.

Introduction and Virtualization Defined

Among the leading business challenges confronting CIOs and IT managers today are: cost-effective utilization of IT infrastructure; responsiveness to supporting new business initiatives; and flexibility in adapting to organizational changes. Driving an additional sense of urgency is the continued climate of IT budget constraints and more stringent regulatory requirements. Virtualization is a fundamental technological innovation that allows skilled IT managers to deploy creative solutions to such business challenges.

Figure 1 Virtualization



Before Virtualization:

- Single OS image per machine
- Runnng multiple applications on same machine often creates conflict
- Underutilized resources
- Inflexible and costly infrastructure

After Virtualization:

- Hardware-indepenence of operating system and applications
- Virtual machines can be provisioned to any system
- Can manage OS and application as a single unit by encapsulating them into virtual machines

Virtualization in a Nutshell

Simply put, virtualization is an idea whose time has come. The term virtualization broadly describes the separation of a resource or request for a service from the underlying physical delivery of that service. With virtual memory, for example, computer software gains access to more memory than is physically installed, via the background swapping of data to disk storage. Similarly, virtualization techniques can be applied to other IT infrastructure layers—including networks, storage space, laptop or server hardware, operating systems, and applications.

This blend of virtualization technologies—or **virtual infrastructure**—provides a layer of abstraction between computing, storage and networking hardware, and the applications running on it (see Figure 1). The deployment of virtual infrastructure is nondisruptive, since the user experiences are largely unchanged. However, virtual infrastructure gives administrators the advantage of managing pooled resources across the enterprise, allowing IT managers to be more responsive to dynamic organizational needs and to better leverage infrastructure investments.

StoreVault Appliances

The StoreVault is an all-in-one storage appliance supporting Windows, UNIX and Apple NAS protocols as well as Ethernet and Fibre Channel SAN protocols in the same box. Capacities start at 1TB and can scale to 6TB. The management interface is simple and intuitive, with a familiar Windows® look-and-feel. Running the highly efficient Data ONTAP® StoreVault Edition operating system, StoreVault systems consolidate MacOS®, Linux®, UNIX®, and Windows data in a central location. The storage system's flexibility, scalability and simplicity ensure that it is ready to adapt to all business needs. The simple management interface allows administrators to allocate storage from a central pool to applications and users. Unlike other systems, these allocations can be changed up or down at any time to deliver on-the-fly storage provisioning. Capacity can be simply added to the pool at any time and is instantly available for allocation.

StoreVault advanced data protection is composed of core NetApp® data protection elements that have been hardened in some of the most stringent data center testing environments in the world: NetApp Snapshot™ technology provides the ability to maintain 255 Snapshot copies per volume; SnapRestore® StoreVault Edition provides a way to almost instantaneously restore individual files, a directory, or even a multiterabyte file system; Data ONTAP SVE is based on the highly optimized, scalable, and flexible operating system that powers NetApp enterprise storage solutions; the WAFL® (Write Anywhere File Layout) file system provides availability, flexibility, and high performance; integrated or nonvolatile memory (NVRAM) protects data in cache even in the event of sudden power loss.

StoreVault Advanced Protection Architecture is a collection of NetApp technologies that include predictive failure analysis and self-healing elements. These technologies work together to maintain the availability of networked storage and consist of features like: continuous disk drive monitoring and periodic automated maintenance to alert the system to a potential disk drive failure before it happens; if a drive is diagnosed as being likely to fail, then a global hot spare can be instantly brought online; rapid RAID rebuild enables the contents of the potentially bad drive to be copied in the background to the spare before it fails; single- drive power cycling allows a hung drive to be temporarily shut down and restarted without disrupting the entire array; the firmware for an individual drive can be updated without disruption to the system; with RAID-DP™, mission critical data remains protected even in the event of dual concurrent drive failures.

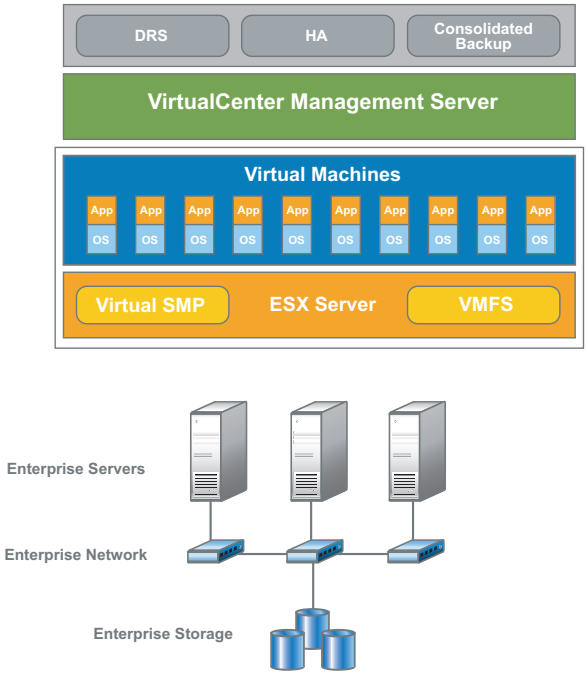
Most importantly, the StoreVault is powerful and flexible enough to become the backbone of any IT center's storage infrastructure. Small and Medium-sized Businesses no longer need to be concerned about the kinds of problems and challenges that they may face in the future. One single system provides the connective technology and the reliability to support multiple solutions, including virtualization.

VMware ESX Server 3.0

VMware Infrastructure is the industry's first full infrastructure virtualization suite that allows enterprises and small businesses alike to transform, manage and optimize their IT systems' infrastructure through virtualization. VMware Infrastructure delivers comprehensive virtualization, management, resource optimization, application availability and operational automation capabilities in an integrated offering.

See Figure 2.

Figure 2
VMware Infrastructure



VMware ESX Server, a key component of VMware Infrastructure, is a production-proven virtualization layer run on physical servers that abstracts processor, memory, storage, and networking resources to be provisioned to multiple virtual machines. ESX Server delivers the highest levels of performance, scalability and robustness required for enterprise IT environments.

ESX Server installs directly on the server hardware, or "bare metal", and inserts a robust virtualization layer between the hardware and the operating system. ESX Server partitions a physical server into multiple secure and portable virtual machines that can run side-by-side on the same physical server. Each virtual machine represents a complete system—with processors, memory, networking, storage and BIOS—so that Windows, Linux, Solaris™ and NetWare® operating systems and software applications run in a virtualized environment without any modification. Sharing the physical server resources among a number of virtual machines increases hardware utilization and dramatically decreases capital cost. The bare metal architecture gives ESX Server complete control over the server resources allocated to each virtual machine and provides for near-native virtual machine performance and enterprise-class scalability.

VMware Server, available for free download, runs as an application within the Microsoft Windows or Linux operating system. Like the ESX Server, VMware Server transforms the physical computer into a pool of virtual machines. Operating systems and applications are isolated in multiple virtual machines that reside on a single piece of hardware. System resources are allocated to any virtual machine based on need, delivering maximum capacity utilization and control over the computing infrastructure. Since VMware Server runs on top of a fully functional operating system,

it provides much broader hardware support inherited from the host operating system.

VMware VirtualCenter delivers centralized management, operational automation, resource optimization, and high availability to IT environments. VirtualCenter lets administrators rapidly provision virtual machines and monitor performance of physical servers and virtual machines. VirtualCenter intelligently optimizes resources, ensures high availability to all applications in virtual machines, and makes the IT environment more responsive with virtualization-based distributed services such as VMware VMotion.

VMware VMotion technology, unique to VMware, leverages the complete virtualization of servers, storage and networking to move an entire running virtual machine instantaneously from one server to another. The entire state of a virtual machine is encapsulated by a set of files stored on shared storage, and VMware's VMFS cluster file system allows both the source and the target ESX Server to access these virtual machine files concurrently. The active memory and precise execution state of a virtual machine can then be rapidly transmitted over a high-speed network. Since the network is also virtualized by ESX Server, the virtual machine retains its network identity and connections, ensuring a seamless migration process.

Performance, Advanced Protection Architecture, and Storage Utilization

With every consolidation effort, the consolidation platforms must meet a new set of business challenges that are unique to virtual infrastructures. When considering the acquisition of a storage system, it is important to understand the impacts on disk I/O performance, system protection, and storage utilization. To begin with, a storage system must at a minimum provide the aggregated disk I/O performance of the combined distributed platforms being consolidated. Virtual infrastructures can apply a significant I/O load on disk subsystems. This load is a result of the VMware default storage design. With VMware VMFS datastore, multiple virtual disks (or VMDK files) are stored, which means that multiple virtual machines are concurrently accessing the file system. VMFS datastores are notorious for being extremely random in their read and write requirements. Failure to provide a robust storage system also has a negative impact in areas outside of serving VM data requests. These negative impacts may be experienced in areas such as backing up VM data to tape. For details, see the Virtual Infrastructure 3 SAN Configuration Guide at http://www.vmware.com/pdf/vi3_esx_san_cfg.pdf.

RAID-DP

In addition, a consolidation platform needs to provide a high level of availability, because the business impact of a failure is magnified in direct proportion to the consolidation factor. The cost of data protection should be considered in two ways. First, there is the acquisition cost of the RAID level being implemented; specifically, how many additional hard drives are required to provide fault tolerance. Second, this cost must be measured against the cost of impact to business operations if data is lost.

This increased dependence on disk storage and the need for higher levels of reliability, availability, and performance has led to a dramatic increase in the use of Redundant Array of Independent Disks or RAID technology. The redundancy allows for a disk array to be fault tolerant. The failure of a drive does not lead to loss of data, and the array can be rebuilt from the surviving drives.

Disk mirroring or RAID 1 provides very secure redundancy but at double the cost in terms of capacity. Data sent to a disk is also sent to a mirror disk, so that in the event of any disk failure, the data can be read from the surviving disk. The failed disk can be replaced and the mirror can be rebuilt from the good drive in the pair. Write performance is the same for a single disk but read performance can be higher if the host is able to read from both drives in the pair. RAID 1 is commonly used where the value of the data is more important than the cost considerations of paying double for the cost of the disk drives.

RAID 4 uses a dedicated parity disk to provide redundancy for the RAID group. The difference is that RAID 4 distributes and calculates parity based on block-level data. For those systems that have no RAID awareness, there is a penalty in write performance, which

is why RAID 4 is seldom found in other manufacturers' systems. However, the StoreVault implementation is based on the tight implementation of the Write Anywhere File System (WAFL), the Non-Volatile Random Access Memory (NVRAM), and efficient use of RAID 4. The write penalty normally associated with continuous writing to the parity disk is eliminated because writes are aggregated in the NVRAM and parity is calculated and written only once for each stripe. The compromise in capacity to provide redundancy is one drive per RAID group, the same as for RAID levels 3 and 5.

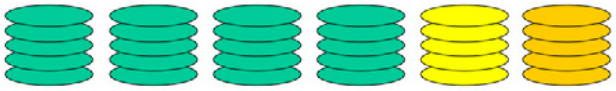
RAID 5 is similar to RAID 4 in that it is a single parity scheme, but instead of writing the parity to a dedicated drive in the group, the parity is rotated amongst all the drives. This was done to enable files systems that are not RAID-aware to be able to overcome the bottleneck of a single parity drive. The cost of redundancy is the same as for RAID levels 3 and 4; the capacity equivalent of n-1 drives in the array is available for data.

RAID levels can be combined to improve reliability or performance. For example, RAID levels 10 and 0+1 both combine striping for performance with mirroring for redundancy. RAID 51 combines RAID 5 with mirroring to provide the capability to survive and recover from multiple drive failures. The capacity compromise reflects the combined redundancy, and there is generally also an adverse performance impact.

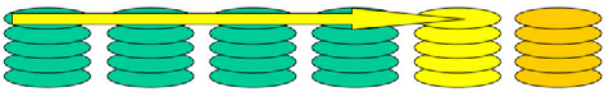
In short, StoreVault RAID-DP uniquely addresses the challenge of providing the highest level of data protection while requiring a minimal amount of storage and no performance overhead. RAID-DP is a new level of data protection for an array of drives. It enables recovery from simultaneous failure of two drives in a single RAID group. RAID-DP offers can be up to 10,000 times more reliable than RAID 5.

Figure 3

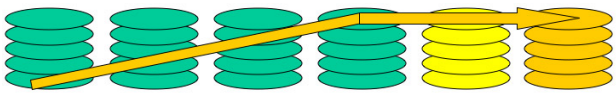
RAID Distributed Parity



RAID-DP is like RAID 4 but with an additional parity disk.



Parity is calculated for the first parity disk exactly like RAID 4 by looking at a horizontal stripe of data.



For the second parity disk, a diagonal view of the data is used to calculate parity.

Figure 4: Examples of RAID Efficiencies

RAID Level	Capacity Impact	Data Protection	Write Performance	Read Performance
RAID 0	No impact	None	Very Good	Very Good
RAID 1	50%	Good	OK	OK
RAID 3	n-1	Good	Poor	Very Good
RAID 4	n-1	Good	Very Good*	Very Good
RAID 5	n-1	Good	Good	Very Good
RAID-DP	n-2	Very Good	Very Good	Very Good

Global Hot Spare

Having a hot spare reduces the time required to rebuild if a disk fails by automatically starting the rebuild process as soon as a failed drive, or a drive that is about to fail, is detected. Typically, in the event of a disk drive failure, the failed disk is replaced with a new drive and the RAID group is rebuilt. As the name suggests, a hot spare is a spare drive that is in the StoreVault product, and ready to be used, but not currently used for data. Data ONTAP StoreVault Edition detects the presence of a drive that has failed or is showing signs of imminent failure. The hot spare is immediately brought online and built in the background to replace the failed drive. The administrator is notified of the event and can physically replace the failed drive at a convenient time.

This immediate failover significantly reduces the likelihood of a second drive failure occurring while the array is being rebuilt. Additional protection from dual-drive failure can be provided by the RAID-DP implementation.

Block Checksums

NetApp uses an advanced method of ensuring the consistency of data written to the disks. For every eight data blocks (each comprised of 512 bytes) the ninth block contains checksum information about the preceding eight data blocks. The checksum information is read in the same I/O request, so there is no performance hit. The checksum information is compared to what was expected, and if it does not match, then the bad block can be immediately reconstructed from the other drives. With RAID-DP this can be done even if a disk has failed or is missing.

Block checksums can be monitored to ensure the continuous integrity of the data on the disk. If multiple inconsistencies are detected, then Data ONTAP StoreVault Edition can initiate a Rapid RAID Rebuild in the background.

Rapid RAID Rebuild

Disk drive capacity is growing faster than performance rates ,meaning that the time to rebuild can be many, many hours. Rapid RAID Rebuild is a NetApp technology that combines drive monitoring and a global hot spare. When potential failure of a drive is detected, Rapid RAID Rebuild enables the contents of the potentially bad drive to be copied in the background to the hot spare before failure occurs. If the flagged drive fails before the full contents are copied, then only the remainder needs to be rebuilt from parity calculation, dramatically reducing the time needed to make a full recovery. This background rebuild does not incur the performance penalty that a normal RAID rebuild inflicts on users and applications.

Other NetApp technologies that work together behind the scenes to ensure the highest levels of data availability include drive power cycling, nondisruptive firmware updates, drive monitoring and maintenance, and environmental monitoring. Continuous disk drive monitoring and periodic automated maintenance can alert the system to a potential disk drive failure before it happens. If a drive is diagnosed as being likely to fail, then a global hot spare can be instantly brought online. Single-drive power cycling allows a hung drive to be temporarily shut down and restarted without disrupting the entire array. Even the firmware for an individual drive can be updated without disruption to the system.

Storage Virtualization: Realizing Thin Provisioning

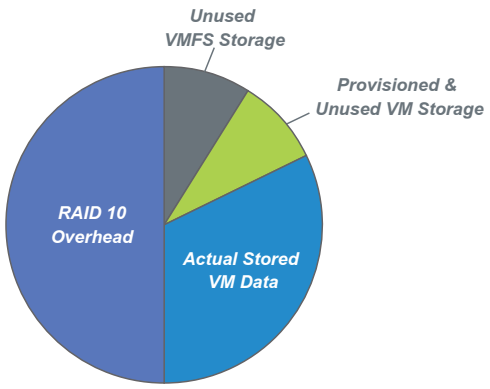
Storage utilization goes beyond the cost and overhead required to provide fault tolerance or just provisioning storage. With every host connected to a fabric-attached storage array, there are multiple layers of storage virtualization and management, which in turn have their own level of utilization. Typical storage environments include the RAID layer, a volume management layer, and a file system layer. This section reviews storage provisioning that is specific to a VMware ESX server environment. When using virtual disks with an ESX Server, the storage administrator has to provision storage to the ESX Server. This provisioned storage is formatted with the VMware ESX File System (VMFS). The VMFS area represents the volume manager layer inside ESX. At this layer, the ESX administrator creates and assigns virtual disks to virtual machines (VMs). Virtual disks, or VMDK files, are flat files that are presented to VMs as SCSI disk drives connected to a local SCSI bus.

In the area of storage utilization, Data ONTAP StoreVault Edition contains unique NetApp technologies, including FlexVol®, which allows capacity to be allocated on the fly without disrupting users or applications. Volumes can also be easily resized on the fly, both up and down, also without disruption to users or applications. FlexVols are an example of thin provisioning, where the total storage perceived by users can be portrayed as greater than the actual available physical storage. As storage is consumed, a StoreVault monitors the total system capacity and provides alerts when defined thresholds are reached. Additional disk can be added only when needed. FlexVols allow for volume growth automatically and easily, but only when needed, enabling more efficient use of storage, lower costs, and reduced management effort, because the storage allocation process is essentially set to autopilot. Note that for StoreVault systems, the best way to take advantage of FlexVols is through NAS protocols like NFS. See our best practices guide for more information.

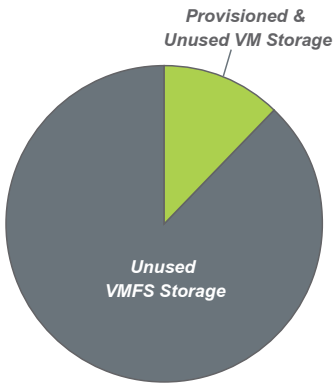
With traditional models, storage is pre-allocated, or reserved in advance of any data actually being written. Once storage has been provisioned, it becomes inflexible and any excess in the provisioning becomes, in essence, wasted space waiting for data to someday be stored in it.

Figures 5 & 6

RAID 10 Utilization and RAID-DP Utilization with Thin Provisioning



RAID 10 Utilization



RAID-DP Utilization with Thin Provisioning

In summary, it is critical for a consolidation platform to provide high availability, because the impact of a failure is multiplied when compared to a distributed deployment.

StoreVault is unique in the storage industry in that it provides all of the requirements for the ideal storage platform for virtual infrastructures.

VMware Virtual Machine Backups and Disaster Recovery

Completing backups of virtual infrastructures can be a major challenge for many customers. The challenges are due to the disproportionate ratio of data to physical bandwidth, which is created by consolidating physical servers to a single virtual server. With ESX there are several methods to complete a backup. However, it is important to note that each solution provides its own set of pros and cons. In order to determine the best backup strategy for your environment, it is critical to identify your company's backup and recovery goals to determine which solution best aligns with those goals.

Although VMware provides several methods of backing up the data served in each virtual machine, this paper focuses on the choices available in the area of completing a "hot" or "operational" backup. A hot backup is defined as a backup process that is completed while the VM is up and servicing requests.

This section considers the following backup methodologies: traditional file-based, storage-based, and consolidated backup server. This section will also discuss how StoreVault functionality can extend the capabilities of these technologies.

Traditional File-Based Backups

A traditional backup (also known as a file-based backup) is one in which each VM is backed up and restored as if it were a physical server. Backing up each VM in this manner is ideal from an operations standpoint, because procedurally no changes are required. Virtual machines are handled exactly like the physical servers in the environment. The challenge with this method is that, by its nature, the lowest level of granularity of a traditional backup is at the file level. In addition, traditional backups are very redundant in their functioning. This type of backup process typically attempts to complete a full backup of the entire infrastructure on some schedule, usually once a week.

Because of the disproportionate amount of data being addressed by each individual ESX Server, the ability to back up all of the data stored in an operational backup window is difficult at best. Many customers have found that the only way to meet their backup window is to implement alternative backup solutions such as Storage-Based Backups or VMware's Consolidated Backup.

Storage-Based Backups

Many administrators who have experienced the challenges of backing up VMs as physical servers have elected to backup their VMware environment by backing up the files that make up the VM (the virtual disk files and configuration files). Backing up this data directly to tape drives results in the same challenges as those described for traditional file-based backups. There is generally too much data behind each physical server to back up in a traditional backup window.

To maintain high utilization ratios, many customers have asked their storage vendors to implement some form of storage-based backup for their virtual infrastructure. With this method the virtual machines are placed in a hot backup mode; the virtual disks are locked and all new data is written to temporary log files. Once in this state, the virtual disks are backed up. When the virtual disks have been successfully backed up, the locks are released and the contents of the temporary files are flushed back into the virtual disks.

Disk-based backup practices include copying the VMDK file from the production disk to a second set of disks, or—for customers who want a faster operation—some form of split mirror backup technology. Although both of these solutions provide a much faster backup than backing up directly from the production system to tape, both solutions require 100% additional storage for every backup, and that storage needs to be completed and kept online. This requirement for additional storage is so counter to the utilization goals associated with VMware deployments that it should not be considered. Some storage vendors offer copy-out snapshot technologies as alternatives to the 100% additional storage required with split mirror technologies. The I/O overhead required with copy-out snapshot technologies, and the subsequent performance impact, prevent these solutions from being implemented.

The inherent negative features of traditional disk-based backups do not apply to the NetApp patented Snapshot™ technology. With NetApp technology there is no performance penalty for taking Snapshot copies, because the data is never moved, as it is with copy-out technologies. The cost for Snapshot copies is only at the rate of block level changes, not 100% for each backup as

with mirror copies. By combining NetApp Snapshot technology with VMware ESX server, administrators can back up their entire virtual infrastructure in seconds and open up a number of other data management possibilities. The NetApp Snapshot copies can be backed up to tape and/or replicated to another facility with StoreVault Replication, VMs can be restored almost instantly, individual files can be quickly and easily recovered, and VM copies can be easily created for test and development environments.

NetApp Snapshot Technology

A Snapshot copy is a point-in-time image of the file system, which is taken instantly with no impact on system performance and with very little impact on storage capacity. Snapshot copies can be browsed in a directory structure that looks just like the original; in fact, the only difference is that the Snapshot directory is a read only image of the file system frozen in time. A Snapshot copy can be recovered instantaneously to "revert back" to that point in time for an individual file, a folder, a directory, or even for the entire file system. Research has shown that the majority of restore requests are for individual files, but reverting the file system might be useful in the event of a virus infection or to reestablish a baseline environment for testing. The power of NetApp Snapshot technology is its simplicity—end users can even be authorized to recover their own files and directories from a Snapshot copy without the intervention of a system administrator.

NetApp Snapshot technology is unique in the way that it captures images of data, resulting in reduced storage costs and system administration time.

NetApp Snapshot technology is integral to the way the file system works. The WAFL file system was developed by NetApp to enable high-performance, high-integrity storage systems. By using a set of pointers to the individual blocks of data, the file system knows where everything is. By making a copy of those pointers, and not the data, an instantaneous image of the entire file system can be captured. As data blocks are changed, pointers in the live file system are redirected to new blocks; however, the Snapshot pointers still point to the original blocks to preserve that point-in-time image. When another Snapshot copy is taken, the new pointers are recorded against the current live file system. Also, the backup window becomes a thing of the past, because backups to tape can be performed on a Snapshot copy at any time. For more information on NetApp Snapshot technology, see http://www.storevault.com/products/tech_snapshot.html.

SnapRestore

SnapRestore provides a way to instantaneously restore an entire volume, including individual files, a directory, or a multiterabyte file system at the touch of a button. In contrast, alternative storage solutions copy all of the data and require much more time and disk storage for the backup-and-restore operations. SnapRestore enables IT generalists to quickly revert an entire volume to a previous point in time and skip restoring individual files and directories.

Consolidated Backups

The VMware Virtual Infrastructure 3.0 suite introduced an additional method of backup, in which the workload of backups is moved from the production ESX Server to a standalone Windows server whose sole purpose is to connect to storage-based backups and back up their contents to tape. This solution is called a VMware consolidated backup (VCB). The problem of not being able to complete the back up of all VM data within a designated backup window is solved with a consolidated backup, because with this solution a nonproduction server can send the backup data to tape, taking as long as needed. Note that although the I/O load is no longer affecting the production ESX Servers, the backups are being drawn from and will still affect the production disk subsystem. Therefore, you should take the time to properly size your storage solution.

There are some limitations to this design. First, VM data will have a separate backup and recovery process from the physical infrastructure. Second, your backup software must not utilize the archive bit as a method for computing incremental backups, and at the time this paper was published only Fibre Channel connectivity and Windows VMs were supported. For more information on VMware consolidated backups, see http://www.vmware.com/pdf/vi3_consolidated_backup.pdf.

Disaster Recovery of a Virtual Infrastructure Using StoreVault Replication Technology

As virtual infrastructure implementations mature, and more mission-critical applications are run on virtual machines, site disaster recovery becomes a larger issue in the virtual infrastructure backup and recovery space. The limitations of the tape medium can cause difficulty in a disaster recovery scenario, because the limitations of tape device data transfer speeds and the physical distance between a primary data center and its DR equivalent can mean extended service outages in the event of a site disaster.

Administrators who are storing their VMware virtual machines on a StoreVault storage system can use StoreVault Replication technology to dramatically reduce the impact of a site disaster on business processes. With StoreVault Replication, an entire virtual infrastructure can be easily replicated over the wire to a remote StoreVault system offsite. With this technology, recovering a complete virtual machine affected by a site disaster can be completed in minutes instead of the hours or days required by other storage solutions. Customers can leverage the replicated copy of their virtual infrastructure for uses such as test and development or tape archiving. For more information on StoreVault Replication technology, see http://www.storevault.com/products/tech_replication.html.

Summary

Many enterprises are in some stage of either upgrading their existing storage or migrating to a virtual infrastructure. StoreVault provides advanced storage virtualization technologies and storage solutions in the areas of advanced system and data protection, thin provisioning, and replication for remote backup and recovery solutions. StoreVault systems are the ideal storage platform for a virtual infrastructure, providing solutions to VMware challenges that are unparalleled in the storage market.

As products that support virtual infrastructures mature, customers will inevitably begin to leverage and require support for additional storage technologies such as NAS, iSCSI, and SATA. As a market leader in these spaces, StoreVault will continue to offer unique and innovative solutions in the virtual infrastructure market.

NetApp®

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About Network Appliance

Network Appliance is a world leader in network storage solutions for today's data-intensive world. Since its inception in 1992, Network Appliance has delivered technology, product, and partner firsts that simplify data management. Information about Network Appliance solutions and services is available at www.netapp.com.

For more information on StoreVault, a NetApp division, go to www.storevault.com.

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