NetApp Virtualization Technology

Overview

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TECHNOLOGY OVERVIEW

Network Appliance, a pioneer and industry leader in data storage technology, helps organizations understand and meet complex technical challenges with advanced storage solutions and global data management strategies.

Abstract

The Network Appliance™ V-Series product line, an evolution of the enterprise gFiler™ series, is a network-based, scalable storage virtualization solution that virtualizes tiered, heterogeneous storage arrays. The V-Series system is the first and only storage virtualization solution on the market that unifies block and file (NAS, SAN, and IP SAN) storage networking paradigms under a common architecture. Through the use of the advanced virtualization capabilities of Data ONTAP™ 7G and the complete NetApp portfolio of value-added data management, data availability, data protection, and disaster recovery software, the V-Series solution unifies and reinvigorates existing storage infrastructures.

The unique NetApp solution offers customers new levels of performance and scalability and a robust portfolio of proven data management software for sharing, consolidating, protecting, and recovering mission-critical data. V-Series systems seamlessly integrate into mission-critical SAN environments and provide a simple, elegant data management solution for decreasing management complexity, improving asset utilization, and streamlining operations to increase business agility and reduce total cost of ownership.

Table of Contents

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This document provides an overview of the NetApp virtualization technology. We highlight how the NetApp V-Series storage virtualization system provides industry-proven, high-performance scalable virtualization and discuss the heterogeneous data management services available for sharing, consolidating, protecting, and recovering mission-critical data for global enterprise applications and users. Additionally, we discuss how the V-Series systems provide a simple, elegant data management solution decreasing management complexity, increasing asset utilization and return on investment, improving business practices and operational efficiency, increasing your business agility, and reducing your total cost of ownership.

Scenario

One way to get a sense of the NetApp virtualization technologies and how they may benefit your organization is through an in-depth example. Our example, which is based on a fictional production environment, will highlight how NetApp adds real business value.

Background

Scenario Inc., a fictional company known as SI, is an innovative company that specializes in scenario planning for multinational corporations and governments. SI is in the business of analyzing large quantities of data and synthesizing it into likely scenarios. SI heavily leverages technology to gain competitive advantage for its clients. SI's data storage needs include databases, complex simulations running on compute grids, and flat-file data for custom applications that SI prototypes for its clients. Having built its reputation on the timeliness and accuracy of its work product, SI relies on its ability to produce results rapidly.

SI's extensive collection of data is the basis for current and new products and cannot be compromised. However, as SI has become more successful, the company’s storage infrastructure investment has grown and has negatively affected its financial outlook. The company finds itself buying more capacity than it needs simply because it’s so difficult to reallocate and utilize it flexibly as business needs change. SI also uses massive amounts of storage holding duplicate datasets needed for development and QA of its systems.

The cost and complexity of managing their existing storage is a major challenge, and SI is constantly stressed to deliver the level of service and flexibility its corporate vision requires. The company often needs to choose between large investments in staff and training and attractive strategic opportunities. Much of this is due to the fact that the storage arrays are in themselves typically inflexible, incompatible, and complex-to-manage and require a considerable amount of planning for deployment with new or existing applications. In addition, SI currently uses separate vendors and pools of storage for their NAS, SAN, and DAS requirements. These pools are incompatible with each other and must be managed separately, adding to overall costs and complexity.

The Challenge

In today’s dynamic business environment, SI needs to adapt rapidly to changing business requirements. Their currently inflexible and complex storage infrastructure is reducing SI’s agility and their ability to aggressively pursue new opportunities. Charlie, the Scenario Inc. CIO, recently decided that it’s time to do something about the situation. Charlie asked Marcie, the Director of Storage operations, to define a storage strategy that addresses their business challenges. Here’s the e-mail he sent out to capture his requirements:

From: Charlie, CIO
To: Marcie, Director of IT Storage Operations
Subject: Storage Infrastructure Challenges
Date: Monday, 04 April 2005

Marcie,

I'd like your help to develop a storage strategy that addresses our storage infrastructure challenges. In particular, whatever solution we come up with needs to address these four areas:

1. **Increase asset and storage utilization.** Today we're buying more storage than we actually need because it's too hard to manage our environment without lots of extra capacity. Yet we still have some applications constantly starved for storage while other systems have capacity sitting idle. We need something that provides more flexible provisioning capabilities and increases storage utilization. While we're at it, we should also figure out a way to intelligently provision multiple copies of our operational data for our development and testing organizations.

2. **Simplify storage management.** The cost and complexity of managing our existing storage is a major headache and is getting worse. We need to deliver the IT capabilities that SI's business objectives demand, and do so without spending a fortune. Right now our training and staffing costs are excessive and always over budget. We have different processes for every type of storage array, and since no one person knows how to manage all the arrays we're wasting lots of time coordinating meetings. Ideally, we would have an infrastructure that gets the best value out of our existing gear and is so simple that any storage administrator can make all the necessary updates. I don't see our budgets growing anytime soon, so reducing this management complexity would be one way to free up some funding for all our other priorities.

3. **Enable flexibility and business agility.** There have been too many close calls where we've been asked to do our part in a new initiative or special project and almost couldn't deliver in time. Remember the Petrograd project? I don't want to ask our customers to relax their Service Level Agreements again. SI's dynamic business environment means we need to adapt rapidly to changing requirements. Inflexible and complex storage gets in the way. We need storage that can adapt and react as quickly as our business demands.

4. **Consolidate storage.** Right now we have separate pools of storage (NAS, SAN, and DAS) to meet different needs. They're incompatible with each other and must be managed separately, adding to overall costs and complexity. It's also frustrating to have a lengthy depreciation period remaining and have available storage space, but find it inaccessible or too fragmented across different storage pools to use where needed. I'd like to find a way to consolidate our existing storage and, ideally, to simplify our management at the same time.

I know you're well-versed in the latest developments in the storage industry, and have the insight and experience of managing our current storage operations. Please take a few days to think about this and get back to me with your suggestions.

Best regards,
Charlie

Charlie's e-mail was just the opportunity Marcie was waiting for. Over the years she has helped grow the existing infrastructure, organically adding systems as new projects required. She has also overseen integration of systems from acquired companies and is very aware of the compromises made along the way. Now her systems are threatening to become too unwieldy, and she very much wants executive support to address the situation. After taking some time to organize her thoughts, here is the reply she sends to Charlie.

From: Marcie, Director of IT Storage Operations
To: Charlie, CIO
Subject: Re: Storage Infrastructure Challenges
Date: Wednesday, 06 April 2005

Charlie,

I've thought about the requirements outlined, and have a proposal I believe addresses our business concerns. Over the years we have deployed NetApp filers in several divisions with great success. As our operations have grown in size and complexity, I've been impressed with the NetApp solution's ability to keep storage management simple. At this point, NetApp has over 10 years of industry-leading experience providing reliable, fast, and scalable storage solutions to the enterprise. We can combine their V-Series storage virtualization solution with our existing storage and NetApp filers to provide consistent and simple management, extend the useful life of our existing storage infrastructure and create a flexible foundation for the future. Here's why I believe NetApp is the right choice to address our business concerns:

Increase asset and storage utilization.

Dynamic Provisioning. NetApp offers the most dynamic provisioning capability in the industry, thereby simplifying capacity allocation without the typical wasted capacity associated with over-provisioning. Using the NetApp FlexVol™ functionality, administrators can instantly resize storage, either increasing or decreasing it, without interrupting operations to meet the demands of the organization. If one project has too much storage and another doesn't have enough, we simply shrink one set of flexible volumes and grow the other.

Thin Provisioning. For even greater flexibility, NetApp provides thin provisioning to increase typical storage utilization levels. We can use this to enhance our internal Service Provider model. We will provide as much storage capacity as departments are willing to "buy," and flexibly provision physical storage as they actually need it. Because NetApp makes nondisruptive redistribution of available capacity so simple, we will be more responsive and efficient and also more profitable.

Space-efficient Virtual Cloning. Best of all, through the use of FlexClone™ software, Data ONTAP can create virtual copies of data for development and testing without incurring the 100% capacity overhead we're struggling with today. This increases utilization of existing storage and decreases the need for added capacity.

Extended Asset Lifespan. With the V-Series systems we can create a storage infrastructure that enables us to repurpose our existing storage assets. We can leverage free capacity on our current systems to deploy new applications or migrate existing data to the V-Series system, and then systematically redeploy additional capacity until we can operate consistently within the simple Network Appliance paradigm. Additionally, we can complete redeploying our current storage arrays to support broader initiatives like information lifecycle management (ILM), compliance, and grid computing.

Simplify storage management.

Common management for heterogeneous storage. NetApp V-Series systems will help us simplify management and reduce operational costs. Once the phased deployment is complete, we will have a common virtualization, provisioning and management model across our heterogeneous block and file storage environment. The single Data ONTAP management model will take the place of the multiple cumbersome storage interfaces we're using across our existing arrays.

Simple Provisioning. Storage provisioning couldn't be simpler. NetApp systems natively use the concept of a storage aggregate that is created from third-party storage LUNs for V-Series systems or

from disks for FAS and NearStore® systems. The storage associated with the aggregates is virtualized using FlexVol technology and then allocated to NAS clients or SAN hosts. We can choose FCP, iSCSI, CIFS, NFS, and other protocols to access the provisioned capacity. The process of configuring back-end arrays to create an aggregate is performed only once and then all ongoing management is done at the virtual volume layer.

Proven unified data management simplicity. Years of actual experience across several divisions has clearly demonstrated the simplicity of the NetApp data management environment. This simplicity translates directly to heterogeneous storage because the NetApp data management tools are identical when used to manage NetApp disks and heterogeneous storage.

Increase flexibility and business agility.

Rapid adaptability. The divisions where we've already deployed NetApp filers have proven themselves able to adapt rapidly and with minimal additional cost. With the V-Series systems, we will be able to add that same agility to our existing, multivendor storage systems. We will be able to create a flexible storage pool that we can draw from as new project requirements come up. When a project completes or slows down, we will simply return the unused storage to the common pool. We'll also be able to dynamically adjust allocations based on shifting project priorities. This flexibility inherent in Data ONTAP 7G, along with the Thin Provisioning functionality, will make dynamic adjustments even easier and more cost-effective.

Unified Multiprotocol Data Access. Storage can be provisioned for use with any open systems data access approach requested by a project team or department. We can provide SAN storage via FCP or iSCSI to all of our existing server systems. For projects that prefer NAS storage, we can build CIFS and NFS file systems and seamlessly share data between them. We can even use some of the spare capacity to act as intranet Web servers so that we don't have to configure and manage additional systems.

Proven Data Management Portfolio. NetApp offers a robust portfolio of proven data management capabilities on the V-Series product line. these are capabilities that our IT department needs to stay dynamic and rapidly accommodate emerging business demands. Our storage administrators will have access to all of the NetApp data management, data availability, data protection, and disaster recovery tools for sharing, consolidating, protecting, and recovering mission-critical data for our global operations. We'll have access to enterprise-proven tools for

- Heterogeneous storage consolidation
- Rapid provisioning and increased utilization
- Space-efficient virtual cloning
- Near-instantaneous data recovery
- Disk-based backup and recovery
- Asynchronous and synchronous network-independent replication for online disaster recovery
- Improved adherence to corporate governance requirements
- Virus protection
- Integration with our critical applications (like Microsoft® Exchange, SQL Server, and Oracle®).

Unify storage today, keep it unified into the future.

Unified Storage Architecture. By deploying a NetApp V-Series system, we will create a completely unified storage architecture. V-Series lets us build that architecture from our heterogeneous storage today and keep the architecture open in the future. That means we will be able to buy additional storage capacity for the best value and integrate it into our existing storage infrastructure. If we acquire more startups, we can easily unify our infrastructures and reuse their gear. It's investment protection at its best. NetApp is also the **only** storage virtualization solution today that can deliver Enterprise-ready NAS, SAN and IP SAN (iSCSI) data services from a single, easy-to-

manage platform.

Heterogeneous Consolidation. Another benefit is that we will be able to consolidate multiple vendors' storage systems (Hitachi, HP, Sun™, IBM, Engenio, STK, etc.) behind a single user interface for simplified management and greater flexibility.

Unified Business Processes. We will also be able to unify our various processes and locations. NetApp offers a wide range of systems, all built from the ground up to be networked and scalable. We can deploy small filers at our remote branch locations, mid-range filers and V-Series systems at our major points of presence, and high-end V-Series systems at our two glass house data centers. Business process unification is now possible without replacing our complete storage infrastructure. NetApp can also provide nearline storage for data protection and business continuity. The beauty of the architecture is that they all run the same fast and easy-to-manage Data ONTAP microkernel and use the same proven data management tools. Our processes can be simple and stay mostly the same regardless of location, and our staff will no longer require specialized training to support our remote branches. Because all systems can provide NAS and SAN storage, the hardware won't need to change if our remote branches or other locations grow quickly and require more sophisticated applications. NetApp offers the only storage architecture that can deliver these features for us today.

In summary, I believe selecting NetApp enables us to incrementally create a comprehensive solution to address the current challenges of our storage infrastructure, as well as provide the foundation for future dynamic growth.

So what do you think Charlie? When can I get my team together and pursue this further?

Glad you asked,
Marcie

Charlie and Marcie's story gives an appreciation of how NetApp virtualization technologies work and benefit modern information-centric organizations. Although the story was fictionalized, the business value illustrated is real. NetApp customers have experienced the speed, simplicity, and reliability of NetApp systems for over a decade. Next, let's focus on the technology features for a better understanding of the full suite of NetApp offerings.

Virtualization at All Levels of the Storage Hierarchy

NetApp virtualization technology introduces benefits for all aspects of the storage hierarchy. In this section, we will review the NetApp network-based virtualization technology from a broad perspective. The perspective ranges from storage controller virtualization through provisioning, data access and into storage management. We summarize this high-level view graphically in **Error! Reference source not found.**Figure 1 on page 6 and describe it in more detail below.

Over the years NetApp has provided storage virtualization capabilities at every level of the storage hierarchy, including the data access level with support for both file and block virtualization in a unified and easy-to-manage storage architecture. These capabilities are available in all NetApp storage platforms. With the introduction of Data ONTAP 7G and V-Series, we have further expanded our virtualization capabilities.

The V-Series product line, an evolution of the enterprise gFiler series, is a network-based, scalable storage virtualization solution that virtualizes and is capable of consolidating multiple tiered, heterogeneous storage systems behind a single, simple-to-manage interface.

Data ONTAP 7G introduced significant enhancements for volume virtualization, including the concept of a storage aggregate, flexible volumes through the use of FlexVol technology and virtual cloning through the use of FlexClone software.

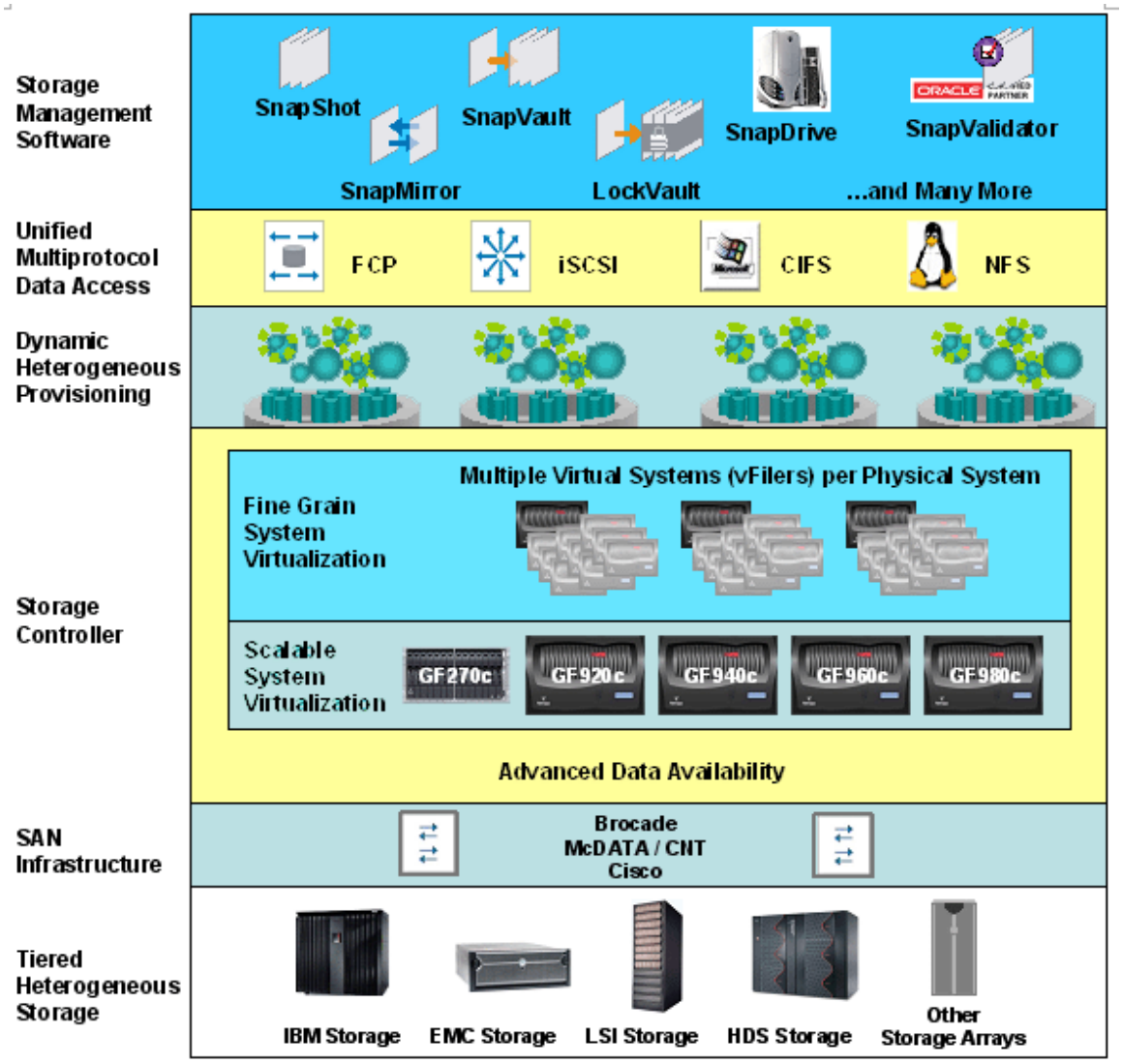

Figure 1) Virtualization at all levels of the storage hierarchy.

Using a hierarchical perspective, the following describes the NetApp virtualization technologies:

Storage Controller Virtualization. NetApp systems support a variety of virtualization technologies to deliver a highly available scalable storage solution. These include

- Scalable System Virtualization. The V-Series product line provides a broad range of scaling flexibility, both through choice of hardware capabilities and by allowing multiple systems to work smoothly together for seamless enterprise management.
  - *Extreme scalability is possible by using multiple systems* for horizontal scalability. DataFabric® Manager provides the integrated multiple systems management for this scalable environment.
  - *SnapMover® software provides load balancing* functionality using no-copy data migration and enables workload distribution across multiple V-Series systems with no or minimal disruption.

- *Scalable read performance for NFS in compute farms and remote data access over NFS* using NetApp FlexCache software. Compute farm customers can scale read I/O bandwidth as they scale out their compute farm and remote offices can cache shared data locally.
- *Users can create a global namespace* for file-based mixed storage environments that aggregates files located on all NetApp systems and Windows® servers to present a single logical "pool" of storage using NetApp Virtual File Manager (VFM™).
- *Complementary integration with switch-based file virtualization* technology further extends the scalable virtualization solution.

- Fine Grain System Virtualization. Finer grain virtualization is available by using NetApp MultiStore® software. This software allows a single system to appear as up to 32 virtual systems (vFilers). Each virtual filer appears on the network just like a regular system, securely partitions available storage, is managed independently, can be nondisruptively migrated between physical appliances for workload balancing and maintenance, and has almost all the capabilities of a physical system.
- Advanced Data Availability Functionality. Complementing the systems' virtualization capabilities, NetApp systems support a robust portfolio of proven data availability technology for ensuring continuous access to block and file data.
  - *NetApp systems support multi-path storage connectivity with load balancing* and failover capabilities for storage array connectivity,. Data checksum protection is also provided to guard against data corruption that may occur for bizarre failures in the data path. Data checksum support on the V-Series systems provide unparalleled reliability and protection and minimize the risk associated with vendor interoperability qualification.
  - *For array-based protection, the NetApp V-Series uses RAID 0* to communicate to the storage array(s) and the storage array(s) provides the RAID functionality. NetApp FAS and NearStore systems support RAID-DP™ (NetApp patented Double Parity RAID), which provides orders of magnitude greater protection than RAID-5 or RAID-1, without the cost of RAID-10. Plus, NetApp RAID is also more flexible—providing the ability to add disks or LUNs to RAID groups on the fly. And to further minimize risk against storage component and array failure, NetApp SyncMirror® software provides a complete redundant copy of data on completely independent hardware. All this translates to continuous protection and simpler and more cost effective management.
  - *NetApp systems use Clustered Failover* for virtualization hardware failure protection,. This active-active clustering provides a nondisruptive way to protect against hardware failures.
  - *NetApp provides a suit of capabilities for IP and FC network connectivity*, to ensure continuous access and protection.

Dynamic Heterogeneous Storage Provisioning. The V-Series system is an ideal platform for aggregating, consolidating, and managing heterogeneous storage. It supports a robust portfolio of dynamic storage provisioning for increased storage utilization:

- The NetApp V-Series system builds dynamically reconfigurable aggregates from LUNs exported from the storage array. These aggregates provide a large, high-performance pool of storage that can be allocated and reallocated as needs change. Different Aggregates with varying performance characteristics are available when created with LUN from different class of storage.
- NetApp offers dynamic provisioning that simplifies capacity allocation without the typical wasted capacity associated with over-provisioning. Using the NetApp FlexVol functionality, administrators can instantly resize storage, either increasing or decreasing it, without interrupting operations to meet the demands of the organization.
- For even greater flexibility, NetApp provides thin provisioning to increase typical storage utilization levels. This provides an ability to oversubscribe the physical storage resources that are being virtualized, enabling maximum resource utilization of physical storage assets.

- NetApp provide space-efficient instantaneous virtual cloning through the use of NetApp FlexClone software. Data ONTAP can create virtual copies of data without requiring complete duplication of the underlying physical storage capacity increasing utilization of existing storage. Instantaneous volume cloning enables unprecedented efficiencies in development and test environments.

Unified Multiprotocol Data Access. NetApp virtualization technology unifies many storage access modes in a single, easy-to-manage appliance.

- A single V-Series system can virtualize SAN LUNs into CIFS and NFS file systems, iSCSI LUNs, and FCP LUNs. This unification provides unprecedented economies and flexibility, opening the door to simplified storage administration and greater returns on technology investment.
- NetApp systems virtualize target LUNs, allowing the appliance to present iSCSI and FCP LUNs to hosts. The same LUN can be presented over iSCSI or FCP, providing simplified upgrade paths as the need for higher performance and resiliency grows. The LUNs can be resized in seconds, simplifying allocation decisions and reducing management costs.

Proven Portfolio of Data Protection and Disaster Recovery Software. NetApp systems support a robust portfolio of proven data protection and disaster recovery capabilities for business continuity.

- Near-instantaneous, transparent on-disk backup using Snapshots™. Snapshots provide effortless protection from mistakes and are often a key part of our customers' storage management strategy. For general details on how Snapshots work, see
  - File System Design for an NFS File Server Appliance
    http://www.netapp.com/tech_library/3002.html
- Rapid information recovery using SnapRestore®. In seconds, SnapRestore software can recover anything from an individual file/LUN to a multiterabyte volume so that operations can be quickly resumed. NetApp SnapRestore software makes recovering your data fast and easy. For details on SnapRestore and other data protection and recovery tools, see
  - Data Protection Strategies for Network Appliance Filers
    http://www.netapp.com/tech_library/3066.html
- Synchronous, semi-synchronous, and asynchronous remote/local replication with bandwidth provisioning over transport independent LAN, WAN, MAN, or SAN networks using NetApp SnapMirror® software. SnapMirror provides a simple, efficient way to replicate data between systems. Allowing for choice of transport mechanisms (IP & FC) and frequency (synchronous, semi-synchronous, and asynchronous), all while transferring only changed blocks. For details see
  - Synchronous SnapMirror Design and Implementation Guide
    http://www.netapp.com/tech_library/3326.html
  - Synchronous SnapMirror for Disaster Protection with Block-Access Protocols
    http://www.netapp.com/tech_library/ftp/3324.pdf
- Centralized disk-based backup for heterogeneous storage environments using NetApp SnapVault® software. SnapVault extends and centralizes disk-based backup for filers by backing up Snapshots to another appliance on the network and integrates with a variety of Open Systems applications. For details on SnapVault, see
  - SnapVault Deployment and Configuration
    http://www.netapp.com/tech_library/3240.html
  - SnapVault: Enabling Rapid Recovery with SnapVault
    http://www.netapp.com/tech_library/3252.html
  - Leveraging Network Appliance SnapVault for Heterogeneous Environments
    http://www.netapp.com/tech_library/3234.html
- High-performance and high-security nonrewritable data permanence functionality that enables reliance with government records-retention for disk-based nearline and primary storage using SnapLock™ Enterprise. For further information see

        - Using SnapLock Compliance and SnapLock Enterprise with Data ONTAP 7G http://www.netapp.com/tech_library/ftp/3342.pdf
        - WORM Storage on Magnetic Disks Using SnapLock on NearStore Appliances http://www.netapp.com/tech_library/3263.html)
    - Host- and client-independent tape-based backup functionality compatible with a diverse set of connectivity, tape drive, and tape library options using most industry standard backup software. Virtual tape library solutions are also available. For more details see
        - Data Protection for Backup and Recovery http://www.netapp.com/solutions/data_protection-br.html
        - Virtual Tape Library Backup Solutions

          http://www.netapp.com/ftp/vtl-backup.pdf
    - NetApp SnapDrive software provides simplified management and increased availability and reliability of application data. Key functionality includes error free application storage provisioning, consistent data snapshot, rapid application recovery and online growth of application data.__For more details see
        - SnapDrive 2.0: A Technical Overview

          http://www.netapp.com/tech_library/3197.html

    - Comprehensive Microsoft Exchange and SQL Server data management solutions for hosting and automating backup and restore using NetApp SnapManager® software. SnapManager provides near-instantaneous hot backups and near-online restores, delivering the highest level of availability, scalability, and reliability for Microsoft environments, at an unmatched low total cost of ownership. For further information on SnapManager and MS-Exchange and SQL Server see
        - Microsoft Exchange and Data ONTAP 7G: Flexible Storage for Microsoft Exchange http://www.netapp.com/tech_library/ftp/3350.pdf
        - Microsoft SQL Server 2000: Best Practices for SnapManager http://www.netapp.com/tech_library/3323.html
        - Microsoft SQL Server 2000: Sizing and Capacity Planning Guidelines http://www.netapp.com/tech_library/ftp/3363.pdf
        - SnapManager for Microsoft Exchange 2000 Technical Overview http://www.netapp.com/tech_library/3198.html
        - SnapManager for Microsoft SQL Server 2000 Best Practices http://www.netapp.com/tech_library/3233.html

    - Site failure protection that enables quick and easy continued mission-critical operation at a remote site within a campus or metropolitan area with no data loss using NetApp MetroCluster software. For more details see
        - Data Protection and Recovery for Network-Attached Storage over IP/Ethernet Networks http://www.netapp.com/tech_library/3163.html
    - Oracle HARD initiative support using NetApp SnapValidator™ software. SnapValidator software provides the highest possible level of protection for Oracle data. It detects and prevents potential corruptions of Oracle data before they happen. SnapValidator enables this powerful protection for any storage system virtualized by V-Series. For further SnapValidator information see
        - SnapValidator Software http://www.netapp.com/products/software/snapvalidator.html

Add it all up, and the picture is clear: NetApp provides superior virtualization technology that consolidates all of the storage features required by today's enterprises into a simple, scalable appliance.

Summary

Virtualization has been inherent in NetApp systems since our beginnings, and V-Series systems extend NetApp capabilities to heterogeneous storage arrays. We address virtualization at every level of the storage hierarchy and provide a unique, elegant solution that enables our customers to architect a fast, simple, and flexible storage infrastructure. Our complete portfolio of software answers a broad range of operational challenges. With V-Series, you have the full power of NetApp data management technologies for use with other vendors' storage arrays, and it allows you to carry forward your existing storage into next-generation storage grids.

NetApp takes the most logical approach to virtualization: adding simplifying and unifying intelligence to open storage subsystems, rather than further complicating our customers' storage network infrastructure with complex routing technology that can't fully integrate with edge storage devices without expensive single-vendor solutions and vendor lock-in. Instead, NetApp virtualization technology decreases storage management costs while protecting and leveraging current storage investment, improves utilization of existing storage investments, augments protection of critical business data, and lets you preserve your investment as your storage architecture evolves.

To learn more about NetApp solutions and the V-Series storage virtualization system, contact your local NetApp representative or visit us on the Web at http://www.netapp.com/products/v-series/.

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