Enterprise Storage

Leveraging Hitachi Freedom Storage™ for SAN/NAS Coexistence

The business benefits of implementing a NAS Gateway

White Paper

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Executive Summary

As today's enterprises adopt information-centric models of computing and operation, the next logical step in the evolution of their storage architectures is the convergence of storage area networks and network attached storage—SAN and NAS convergence. As the technologies for full integration are not yet here, the interim step of introducing a NAS gateway will allow the coexistence of SAN and NAS on common storage systems.

This paper discusses today's alternatives in storage architectures and likely directions for future evolution. It also presents the Hitachi Data Systems and Network Appliance (NetApp) co-developed solution—HDS-NetApp® Enterprise NAS Gateway—which takes the major step of centralizing NAS and SAN under common management and software functionality, and positions the enterprise for ultimate convergence of NAS and SAN.

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Introduction

Information has grown in value to become the primary asset of the majority of businesses today, causing the information-centric model of computing to be accepted by most enterprises. The vision for this model is to make information always available—completely shareable by heterogeneous computers from a single data image, anywhere in the world, at any time—with consistent fast access, complete protection from loss, and highly secure, cost-effective centralized management. Hitachi Data Systems is working to achieve this model, which combines SAN/LAN/WAN technologies as complementary parts of the enterprise data network.

Storage Area Network (SAN) technology currently has evolved to meet all of these objectives except for: 1) the ability to share information easily through heterogeneous computers from a single data image, and 2) long distances, as it is limited to 10km and metro distances without channel extenders. Network Attached Storage (NAS), on the other hand, is the best approach today for heterogeneous information sharing, but it has the following drawbacks: 1) storage typically is locked behind the NAS vendor's server and not re-deployable, and 2) NAS systems require separate administration.

The ultimate realization of the information-centric model will be in the eventual convergence of NAS and SAN architectures, with both architectures overcoming their current limitations. SANs must be able to operate over long distances and provide for heterogeneous information sharing, and NAS must be integrated with SANs for high storage utilization and centralized management.

It is no surprise, therefore, that analysts are advising clients today that it is prudent to consider only storage systems with hardware and software commonality that will permit reuse in future SAN/NAS converged infrastructures. This paper discusses today's alternatives in storage architectures and likely directions for future evolution. It also discusses the NAS Gateway strategy offered by Hitachi Data Systems and partner Network Appliance. This strategy not only takes the major step of centralizing NAS and SAN storage under common management and software functionality, but it also positions the enterprise for the ultimate convergence of NAS and SAN over long distances, whether this occurs over FC/IP or TCP/IP.

Trends Driving Storage Networking

The networking of storage has evolved to address the need to provide more open connectivity to data and information and to break the bottlenecks that developed in traditional Direct Attached Storage (DAS) architectures. Two forms of storage networking—NAS and SAN—have evolved to enable management to realize these business benefits. The high costs of managing distributed storage led to the movement to consolidate storage resources and the subsequent need to share access to these consolidated systems. Today, NAS and SAN technologies each offer storage consolidation benefits to enterprise customers, but each also requires the funding and management of its own separate storage architecture.

By uncoupling storage from the servers, a scalable, tiered architecture can be deployed—one that meets changing and increasing data access demands. Just as network switches were required to evolve beyond the limitations of shared bus to switched fabric architectures, today's information architectures must progress toward the openness and scalability of world-class storage systems.

A number of trends in information technology have driven the adoption of storage networking. They include:

- The need to reduce operational and management costs and complexity through consolidation of servers and storage and central simplified administration
- The demand to scale infrastructures easily—without adding staff
- A diverse range of users/applications that require sharing of common information
- The repositioning of resources within an infrastructure to take advantage of cost savings in existing hardware and expertise
- The wide adoption of de facto network standards like TCP/IP, NFS, and CIFS
- A desire to deploy solutions with features that provide competitive business advantages on an application-by-application basis

It is important for network storage architectures to be deployed in a manner that not only meets a company's current business objectives, but also protects its future technology investments. Careful planning and the proper choice of NAS and SAN architectures position an enterprise to achieve continued return on IT investments.

Comparing Today's Storage Architecture Options

Before looking at a converged storage environment in more detail, we want to define the three major types of storage architecture. This will provide a foundation of common terminology for understanding different access protocols and connectivity methods as they exist today.

A number of methods are used to access information on storage systems in an information infrastructure. They include, Direct Attached Storage (DAS), Network Attached Storage (NAS), and the Storage Area Network (SAN). These technologies are not mutually exclusive. Instead, they are complementary, and can provide enormous benefits when properly deployed.

Direct Attached Storage

DAS, or Server Enclosed Storage (SES), is the traditional method of locally attaching storage to servers via a dedicated communication path between the server and storage. DAS is commonly implemented as a SCSI connection, but other methods may also be used. DAS storage may be disk drives, a RAID system, or another storage device. The server typically communicates with the storage system using a *block-level interface*. As shown in Figure 1**,** the file system resides on the server and determines which data blocks are needed from storage devices to complete the file requests from applications.

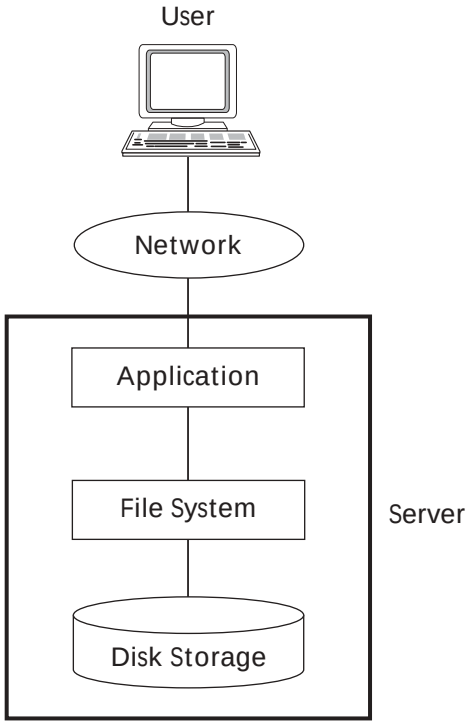

Figure 1: Direct Attached Storage. This traditional method of locally attaching storage to servers uses a dedicated communication path between the server and storage. In this case, the application and file system reside on the server. Storage may be internal or external to the server and determines which data blocks are needed from storage devices to complete application file requests.

Storage Area Network

A SAN is a dedicated storage network designed specifically to connect storage, backup devices, and servers**.** Commonly used to describe Fibre Channel fabric switched networks, SANs have been implemented for some time, with IBM® ESCON® and today with FICON™ in mainframe environments, as well as Fibre Channel. These dedicated, enterprise-class storage networks may be consolidated in a single cabinet, or span a large number of systems and geographic locations. A SAN is connected behind the servers and (like DAS) presents a *block-level interface* to the storage system. As shown in Figure 2, the file system resides in the server. Although SANs today have a practical distance limitation of 10km and metro distances with

channel extenders, there are technologies to further extend SANs over long-distance public networks. These long-distance storage networks use low-cost Internet data transmission and avoid the expense of private leased lines. For example, Nishan Systems® IPS switches can be paired with Hitachi Freedom Storage™ systems to extend Fibre Channel SAN connectivity across speed and distance barriers, thus enabling a "wide area SAN" solution.

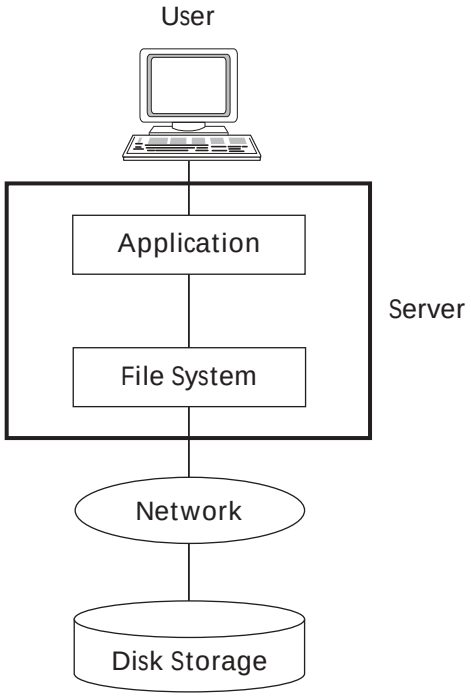

Figure 2: Storage Area Network. Connected behind the server, a SAN provides a block-level interface to the storage system (similar to DAS). The file system resides on the server.

Network Attached Storage

With a NAS server architecture, a storage system with its own file system is directly connected to a network that responds to industry-standard network file system interfaces like NFS (UNIX®), and SMB/CIFS (Microsoft® Windows NT® and Windows® 2000) over LANs. The file requests are sent directly from clients using Remote Procedure Calls (RPCs) to the NAS file system. As shown in Figure 3, NAS file systems are typically multilingual and manage a single image of data on storage systems. Translation of information to the different file formats of Windows and UNIX is done by the NAS multilingual file system. The NAS file system securely locks files and emulates the "file permission" schemes of UNIX and Windows to prevent data corruption as heterogeneous clients read and write to the same file. NAS servers, therefore, provide a *file-level interface* to storage systems. NAS servers typically isolate storage in a captive pool with low storage utilization and require separate management from SAN-attached storage systems.

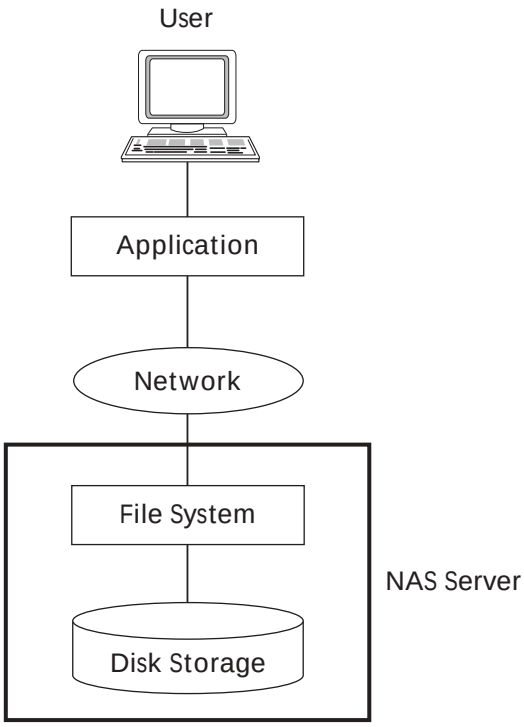

Figure 3: Network Attached Storage. A NAS architecture connects a storage system that has its own file system directly to the network. The file-level interface provided by the NAS server enables clients to send file requests directly to the NAS file system using Remote Procedure Calls (RPCs).

Network Attached Storage Gateways

A NAS gateway operates in much the same way as a NAS server using a *file-level interface*. However, the NAS gateway separates the NAS file system component from the storage system, allowing connections to open storage systems and SANs. These NAS gateways have a major advantage in positioning the enterprise for future NAS/SAN convergence, since all advanced software features of existing storage systems can be used and separate management is not required.

Figure 4 illustrates NAS gateways compared to DAS, SAN, and NAS servers. Captive storage systems, as in DAS and NAS servers, often do not provide the scalability, reliability, bandwidth, response times, management simplicity, or premium software features necessary to meet the objectives of the storage-centric information model.

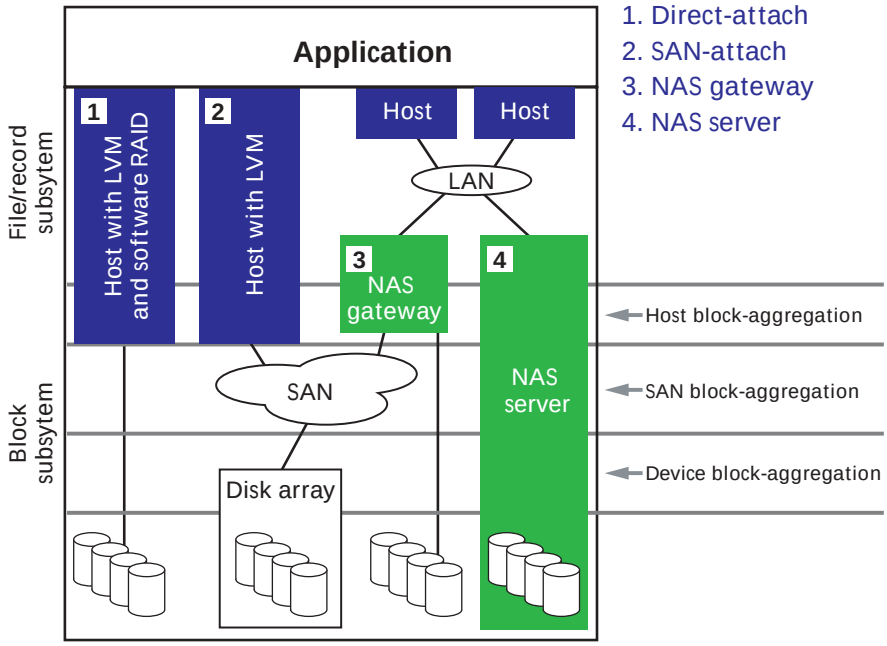

Figure 4: NAS Gateways Compared to DAS, SAN, and NAS Servers. Unlike captive storage with DAS, SAN, and NAS servers, NAS gateways allow connections to open storage systems and SANs. NAS gateways position the enterprise for future NAS/SAN convergence, since all advanced software features of existing storage systems can be used in consolidation of storage on one footprint, and separate management is not required. (Figure 4 is an extract from the Storage Networking Industry Association Technical Council's Shared Storage Model Proposal and Shared Storage Model Architectural Overview, © 2001 SNIA.)

DAS, SAN, and NAS—Each Offer Distinct Advantages

By consolidating storage in one location, customers benefit from efficiencies of management, utilization, and reliability. SANs have become a popular method of providing storage consolidation (for DAS systems) thanks to some of the features Fibre Channel presents in terms of the number of storage nodes, ease of connectivity, and extended distance from host servers. Many of these same benefits are also realized with NAS systems. However, one of the key differences between NAS and SAN is NAS' ability to share heterogeneous information.

SAN and DAS systems present block interfaces, which are appropriate for database engines and large-block I/O operations, while NAS systems present file interfaces, which means they are typically more efficient when sharing files. However, in these scenarios, data sharing can be accomplished only through low-performance software gateways and emulation schemes that are awkward at best and costly to administer. With consolidated storage there is often an increased need for high-bandwidth, low-latency connections to service the large amounts of information from one location. An often overlooked requirement brought about by consolidation is the common need to access storage from many different server or client systems, while sustaining high access speeds to larger amounts of storage.

What is NAS and SAN Convergence?

Convergence is defined as the "merging or uniting of groups or tendencies that were originally opposed or very different." Although their ultimate convergence is the next logical step in storage networking, to date NAS and SAN have evolved as separate storage networking technologies. As a result of this independent evolution, enterprises have been compelled to deploy both storage architectures to meet their needs, in spite of each architecture's separate hardware, software, and administration skills requirements. The enterprise has thus suffered the consequences of greater complexity and expense, as well as the lack of ability to share data easily between UNIX and Windows storage pools. For complete NAS and SAN convergence to occur in the future, universal file systems and locking strategies must be developed. In addition, multilingual Fibre Channel and Ethernet switches need to evolve. However, much can be done today to plan for the ultimate convergence of these architectures. A first step is SAN and NAS coexistence.

Enabling the Coexistence of NAS and SAN Storage

Together, Hitachi Data Systems and Network Appliance (NetApp) have responded to the call for high-availability, cost-efficient data sharing among heterogeneous environments in a way that minimizes the amount of hardware, software, and administration skills that must be duplicated. The co-developed solution—HDS-NetApp Enterprise NAS Gateway—integrates Hitachi Freedom Storage™ technology, leverages SAN infrastructures, consolidates and maximizes storage utilization, and scales in capacity and performance, without compromising reliability. This cutting-edge NAS solution complements existing SANs rather than competing with them.

Hitachi Data Systems and Network Appliance believe the convergence of NAS and SAN architectures will permit IT decision-makers to continue deploying best-of-breed solutions that are optimized to meet their unique business and application challenges. Using mutual Hitachi Freedom Storage systems for NAS and SAN coexistence not only reduces storage management complexity, lowers storage management costs, and provides system architects with the ability to balance block and file I/O for maximum efficiency now, but also prepares the enterprise for future convergence possibilities.

The HDS-NetApp Enterprise NAS Gateway provides simple multiprotocol file access to back-end SAN storage disks that an enterprise chooses to dedicate to specific NAS applications. This architecture can deliver performance advantages and higher data availability by relying on the advanced hardware and software functionality of enterprise-level storage systems, such as the Hitachi Freedom Storage Lightning 9900™ Series and Lightning 9900 V Series or Thunder 9570V™ systems. Many legacy NAS server systems are I/O bottlenecked, so adding a Fibre Channel Host Bus Adapter on a shared PCI bus to connect to SAN storage on the back end may not reduce the I/O bottleneck or may provide only limited I/O gains. Additionally, many legacy NAS servers cannot support SAN interfaces. Therefore, the HDS-NetApp Enterprise NAS Gateway presents an excellent alternative for sharing a SAN back-end from a variety of systems.

SAN architectures have proven themselves ideal for high-bandwidth connectivity between servers and storage nodes. However, with SANs, a concern regarding file access response time remains for many clearly identified applications—Web serving, document imaging, streaming media, video design, telco call centers, CAD/CAM design, and medical systems. In these and other scenarios, the HDS-NetApp Enterprise NAS Gateway allows the user to store information on existing SAN-attached storage systems while making data instantly accessible to numerous clients. As a result, data can be shared and computers integrated throughout the network.

Dramatically Improve Storage Utilization with NAS Gateway Technology

With the HDS-NetApp Enterprise NAS Gateway solution, a portion of existing SAN networks can be allocated to form a consolidated storage pool. Figure 5 shows that Lightning 9900 V Series, Lightning 9900 Series, and Thunder 9570V systems can serve as SAN/NAS storage pools. This is particularly important as data-intensive companies often find that as much as 50 percent of their storage is under-utilized simply because it has not been optimized for a heterogeneous environment. With networking options such as those offered by HDS-NetApp Enterprise NAS Gateway, an enterprise can capitalize on the advantages of SAN, reduce I/O bottlenecks to client applications, and increase storage utilization to 80 percent or more for UNIX and Windows data-sharing applications.

Moving to converged NAS and SAN networked storage makes possible:

- Storage consolidation
- Heterogeneous information sharing from a single data image
- Use of multiple storage connect technologies
- Increased storage utilization for heterogeneous environments
- Dispersed costs for storage acquisition (UNIX and Windows servers can take advantage of technology that was once financially prohibitive)
- Centralized, simplified management, with resulting lower costs

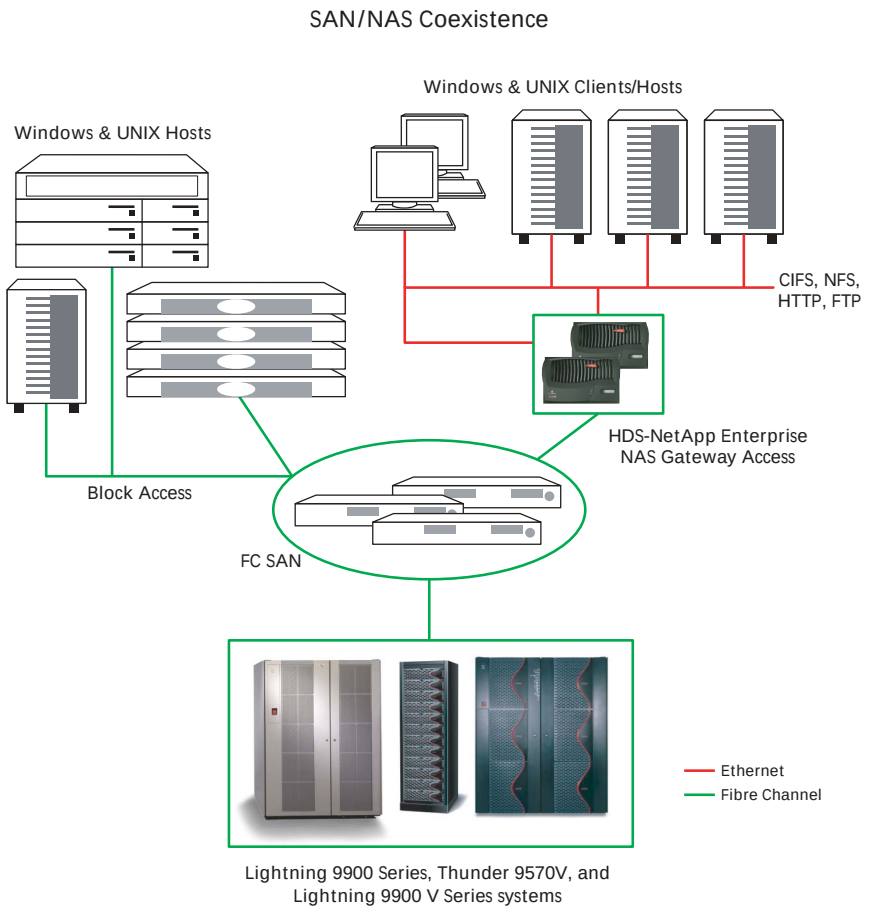

Figure 5: Heterogeneous Connectivity and SAN and NAS Coexistence in a Hitachi Freedom Storage System. This solution allocates a portion of existing SAN networks for network files. By optimizing storage for a heterogeneous environment, an enterprise can capitalize on SAN advantages, reduce I/O bottlenecks to client applications, and increase storage utilization to 80 percent or more for some data-sharing applications.

Provide Maximum SAN Integration Today with a NAS Gateway Architecture

The decision to deploy a NAS Gateway architecture minimizes new hardware, software, and administration skills needed to take advantage of advanced storage features. The HDS-NetApp Enterprise NAS Gateway solution meets this objective since the only new hardware required is the NAS Gateway, and existing Hitachi Freedom Storage systems can be used—taking full advantage of equipment that is already on the floor.

With the HDS-NetApp Enterprise NAS Gateway, the new learning for administration is minimized, as it enables Hitachi Freedom Storage advanced software features to be applied to NAS as well as SANs. Dedicating a portion of an existing SAN infrastructure and storage system to this NAS gateway allows these components to be managed with minimum new investment in skills and complexity. This approach will ensure that an organization can avoid the pitfalls of

maintaining two separate storage systems. Therefore, when NAS and SAN ultimately do converge at the file level, maximum commonality of components is achieved, creating a unified information architecture that meets all objectives of the information-centric vision.

The HDS-NetApp Enterprise NAS Gateway: A Closer Look

HDS-NetApp Enterprise NAS Gateways provide significant benefits for file sharing when configured with Hitachi Freedom Storage systems to store and facilitate data backup:

- Improve utilization of storage assets
- Extend investment protection
- Reduce storage management complexity
- Lower storage management costs

The solution further helps customers leverage SAN infrastructures, consolidate disparate islands of UNIX, Microsoft Windows, or Web filer servers to maximize storage utilization, and scale in capacity and performance without compromising reliability. HDS-NetApp Gateway models include:

- **GF960**—provides industry-leading performance for thousands of independent users and large, high-bandwidth applications, managing up to 24TB of data in a single NAS, while meeting the demands of virtually any enterprise
- **GF960c (clustered)**—provides simultaneous active-active file access to 48TB of data across two independent systems configured for secure failover
- **GF940**—scales up to 9TB and offers flexibility and performance capabilities that make possible a broad range of applications, including large home directory consolidation, and Web serving
- **GF940c (clustered)**—provides simultaneous active-active file access to 18TB of data across two independent systems configured for secure failover
- **GF825**—provides industry-leading performance for a broad range of applications and is ideal for data-intensive environments, managing up to 3TB of data in a single NAS Gateway
- **GF825c (clustered)**—provides simultaneous active-active file access to 6TB of data across two independent systems configured for secure failover protection

Market Segment	High-end	Midrange	Entry-level
Gateway Models	GF960/GF960c	GF940/GF940c	GF825/GF825c
Raw Usable Data Capacity	Up to 24TB/48TB	Up to 9TB/18TB	Up to 3TB/6TB
Hitachi Freedom Storage™ Systems	Lightning 9900™ V/ Lightning 9900 Series and Thunder 9570V™		Thunder 9570V

Table 1: Market Segments and Correlating HDS-NetApp Gateway Models. Available gateway models address capacity needs of entry-level, midrange, and high-end market segments, and can best be used with the Hitachi Freedom Storage systems indicated in this table.

Network Appliance Data ONTAP™ Software optimizes data storage and serving

HDS-NetApp Enterprise NAS Gateways are configured with Network Appliance Data ONTAP™ software, a highly optimized and scalable operating system that simplifies administration, provides multi protocol support for heterogeneous data sharing, and ensures data availability through clustering and mirroring capabilities.

Supporting our Hitachi TrueNorth™ standards-based approach to interoperability, Data ONTAP software seamlessly integrates into UNIX, Windows, and Web environments, enabling greater efficiency and productivity and consequently reducing total cost of ownership.

Write Anywhere File Layout (WAFL®) file systems offer improved performance over other NAS solutions. And the optimized microkernel design coupled with non-volatile RAM ensures transactions are not lost in the event of a disruption, while providing extremely fast client response times without complex hardware configurations or manual performance tuning.

NetApp Software for data availability and protection enhances gateway capabilities, and includes:

- Snapshot™—instant data volume protection
- SnapRestore®—instant file or data volume recovery
- SnapManager®—backup/recovery for Microsoft Exchange 2000
- SnapVault™—extended and centralized disk-based backup
- SnapMirror®—remote replication at high speeds over a LAN or WAN
- Clustered Failover—safeguard against hardware failures by automatic takeover

NetApp Data Management™ Software includes:

- FilerView®—GUI- based remote administration
- MultiStore™—virtual storage partitioning and management for consolidation
- SnapDrive™—simplified storage management for Windows environments
- SecureAdmin—secure system administration

Summary

Hitachi Data Systems supports the information-centric model of computing and storage networking. We believe that the convergence of NAS and SAN is the next logical step in storage networking. We see the value and need for this convergence as a key element of cost-effective, enterprise-level computing in the future.

While ultimate NAS and SAN technologies continue to evolve toward convergence, today's enterprises should focus on minimizing the need for new hardware, software, and administration skills as much as possible. Continuing to deploy DAS or NAS servers with captive storage will perpetuate the need to manage separate storage pools and make the ultimate integration of NAS and SAN that much more difficult. The new HDS-NetApp Enterprise NAS Gateway solution avoids this and, in fact, minimizes complexity. The only new hardware it requires is the NAS Gateway, and it allows enterprises to use existing SAN-enabled storage systems and SAN infrastructures to their full advantage with equipment, software, and management practices that are already in place.

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