



NetApp Storage Architecture Proposal

For the FAU Dynamic Data Center



Submitted for:
Mehran Basiratmand
Florida Atlantic University

Submitted by:
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March 21, 2011





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March 21, 2011

Mehran Basiratmand
Florida Atlantic University
777 Glades Road
Boca Raton, Florida 33431

Mehran,

NetApp is pleased to respond to FAU's request for quote for an Enterprise Storage Solution. Equipped with an understanding of your information management requirements and Disaster Recovery needs, NetApp is proposing an innovative solution to provide an infrastructure that will scale to and meet the performance requirements you have today, and into the future as you continue to develop your private cloud.

NetApp is pleased to propose a solution that improves the FAU Enterprise Architecture and exceeds the requested service levels. Our delivery approach fully complies with the key functional components within your program initiatives

The investments made by FAU in the NetApp platform will help realize the following benefits:

- Enhance the protection of data
- Increase storage space and flexible provisioning for FAU projects and various departments
- Reducing system operation and maintenance costs
- Increasing efficiency by consolidating data storage and using devices more efficiently
- Reduction of labor and system costs
- Implementation of industry best practices to effectively manage IT
- Increasing availability due to integrated disaster recovery capabilities

As you and your team review our proposed solution and recommendations, your questions and requests for additional information are welcome. We are confident that this proposal will demonstrate that our solution is the best choice to architect and implement FAU's enterprise storage requirements. We look forward to your feedback and response regarding the opportunity to assist with this strategic initiative.

Regards,

Maureen Hagen
Account Executive
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E-mail: mhagen@netapp.com



NetApp Solution Quotation



Presented to

Florida Atlantic University

March 21, 2011, 2010

Prepared by:

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NetApp US Public Sector, Inc.
1921 Gallows Rd., Suite 600
Vienna, VA 22182

Quote from NetApp

Production Site Configuration

\$312,342.78

FAS3240HA – Production SAN, Boca Raton

- **(2) FAS 3240's; Active-Active; Dual Controllers & IOXM**
- **FCP, NFS, CIFS & iSCSI**
- **Data OnTap OS 8.01**
 - o Includes HTTP, Dedup (ASIS), NearStore, SyncMirror, Cluster Failover, MetroCluster, DSM/MPIO, Multi-Store, FlexCache, System Manager, Ops Manager, Provisioning Manager, Protection Manager
- **(2) Flash Cache PCIe 256GB**
- **(4.5) SATA Disk Shelves**
 - Includes (24) 2 TB Disks per shelf
 - 7.2K RPM
 - Total SATA Storage 216 TB RAW
- **(3) SAS High Performance Disk Shelves**
 - Includes (24) 600 GB Disks per shelf
 - 15K, 3GB
 - Total SAS Storage 72 Disks, 43.2 TB RAW
- Rackmount Kits 4-Port Copper GbE SAS Cards, RJ45 Ethernet Cables, SAS Cable, Loopback Optical Cables, NIC SFP's, 10GB, and shelf switches
- **NetApp Complete Software Bundle** (includes CIFS and NIFS Protocols; FC and iSCSI Protocols)
 - SnapManager® Portfolio (includes SnapManager for Oracle, SnapManager for Exchange, SnapManager for Virtualized Infrastructure and HyperV, SnapManager for SQL Server, SnapManager for SharePoint)
 - SnapVault®, SnapMirror®, SnapRestore®, SnapDrive for Unix®, SnapDrive for Windows, Single Mailbox Recovery, Provisioning Manager; FlexClone®, Multi-Store®, SnapLock®

***Includes 36 Month Support Edge Premium Service Contract, 24x7 4 Hour On-Site Response
30 NetApp Training Units good for up to 1 year from invoice Date.***

Unique NetApp Advantages:

- **Data Cloning Capability**
- **Free Deduplication on Primary Storage**
- **Free SnapShots**
- **Free Thin Provisioning**
- **Data Protection with Raid-DP**

Secondary Site Configuration (Disaster Recovery) \$283,994.45

FAS3240HA – Secondary Site

- **(2) FAS 3240's; Active-Active; Dual Controllers & IOXM**
- **FCP, NFS, CIFS & iSCSI**
- **Data OnTap OS 8.01**
 - o Includes HTTP, Dedup (ASIS), NearStore, SyncMirror, Cluster Failover, MetroCluster, DSM/MPIO, Multi-Store, FlexCache, System Manager, Ops Manager, Provisioning Manager, Protection Manager
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- **Data Cloning Capability**
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- **Data Protection with Raid-DP**

-

Switches (Both Sites) \$160,933.58

(80) Cisco 10GBase SR SFT+ Optic

36 Month Cisco Onsite 24x7, 4 Hour Response Support

(4) Cisco Switch N5010 Ethernet, 20 Pt 10GE

36 Month Cisco Onsite 24x7, 4 Hour Response Support

(3) 8-PT Brocade 300 Full Fab FC 8GBps

(3) Brocade 300 8-POD for 8GBps

36 Month Support Edge Premium 24x7, 4 Hour Response

(8) Cisco N5010 Power Supply

36 Month Support Edge Premium 24x7, 4 Hour Response

Cisco N5010 Power Supply, Universal Rail Kits, Cables and Install Services

Total Config Production Site	\$312,342.78*
Total Config DR Site	\$283,994.45
SAN Fabric Switches (both sites)	\$160,933.58
NetApp Training Units	*Included – 30 TU's
NetApp Rapid Deployment Services	*Included

**RDS Services Includes storage implementation: base, SAN, SnapMirror, and SnapManager for Oracle*

Total NetApp Storage Investment \$596,337.23

Total NetApp Solution including switches \$757,270.81

Pricing valid through April 7, 2011

NetApp State of Florida Contract Number: 250-000-09-1

1. Introduction

NetApp would like to thank FAU for the opportunity to propose a solution for your *Scale out Storage Requirements for both Primary and DR*. NetApp offers a world-class, best-of-breed Unified Storage Architecture that simultaneously supports NAS, SAN, iSCSI, SCSI and FC connectivity within a single storage array.

Because the entire NetApp product family uses the same operating system and optional software, the proposed storage architecture is particularly cost-effective when implementing a tiered central storage solution accompanied by storage management, data backup and Disaster Recovery (DR) solutions. Both primary storage and secondary storage may be based on high performance 15K SAS disk technology, low cost SATA and Flash Cache for performance enhancement. Both systems run the same operating system, run the same software, and may be managed anywhere in the world by a single management tool. This ensures the lowest Total Cost of Ownership (TCO).

1.1 NetApp Contacts

For additional information or questions related to this document, please contact:

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1.2 NetApp Corporate Overview

NetApp is a world leader in unified (SAN, NAS & iSCSI) enterprise storage, data protection, disaster recovery, and content on demand. Since its inception in 1992, NetApp has pioneered technology, product, and innovation that drive the evolution of enterprise storage. NetApp solutions meet the demanding, high-availability, and high-performance requirements of today's users. They are simple to manage, which is a significant factor in helping IT organizations achieve their cost management goals.

NetApp US Public Sector consistently provides the Federal government with innovative products and services that store, manage, protect, and retain electronic data.

With nationwide office locations, we are engineers and professional service consultants to support the Federal government worldwide. In addition, our organization possesses various levels of security clearances to assist you in mission-critical environments. Our dedication to principles of simplicity, innovation, and customer success has made us one of the fastest-growing storage and data management providers today.

Companies around the world choose NetApp for our “go beyond” approach and broad portfolio of solutions for business applications, storage for virtual servers, disk-to-disk backup, and more. Our solutions provide nonstop availability of critical business data and simplify business processes so you can help your customers deploy new capabilities with confidence and get to revenue faster than ever before. You can rely on our industry-leading solutions to lower the cost of protecting your customers' data, businesses, and reputations.

We bring together the industry's best partners and technology to deliver services that help your customers maximize what they are getting from their infrastructures. Our collaborative approach, working as one team with one goal, means that your customers get a solution that is just right—on time and on budget.

In addition, NetApp provides a range of best practices, architecture, design, implementation, and integration services to ensure that your solutions are rapidly implemented under the full range of commercial and government best practices. Our support also includes developing customized financial planning and procurement strategies that cover storage-on-demand solutions (SODS), versatility in trade-ins, the GSA Schedule, BPAs, Government Contract Vehicles, leasing, and more.

NetApp is firmly committed to the policies and requirements of DOD directive 8500 as shown by our strong participation in both Common Criteria and FIPS testing. NetApp is currently the only storage manufacturer with a validated Common Criteria solution (<http://www.niap-ccevs.org/cc-scheme/st/?vid=10149>). NetApp is also an ISO 9001:2000 certified manufacturer. It has extensive quality control processes and provides employee training to ensure quality throughout the entire company. NetApp has ISO processes in place for every facet of our operation to ensure consistent quality and industry-leading customer satisfaction. Some of the many areas impacted by our ISO processes include Sales order processing, pricing, contract review, shipping, manufacturer receiving, quality audits, inspection & test, RMA, material handling, documentation, Engineering Change Process, records management, test equipment calibration, technical support & maintenance, etc.

2. Solution Benefits

2.1 Solution Technical Benefits

NetApp is pleased to provide recommendations on leveraging various technologies and solutions that are in line with the FAU's Enterprise IT initiatives. Based on our various discussions and our review of your requirements, we feel we have developed an understanding of the FAU future architecture and goals. We have summarized the key benefits of a NetApp solution below.

NetApp storage solutions provide a simplified approach to the management of storage and servers, providing significant savings in managing production environments.

- Best Total Cost-of-Ownership
- Unified Storage Architecture
- Scale Out Architecture, Modular and Flexible
- Ease of Management

Optimize Server Utilization and Current Investment

- **Radical Consolidation of File Serving Infrastructure:** NetApp's technology allows customers to significantly reduce the current number of file servers and the costs associated with operating those servers. Depending on the workload and usage profiles, IT organizations may be able to consolidate file servers at ratios of over 100:1. NetApp has customers that have consolidated over 1700 servers onto 5 NetApp storage systems.
- **Improved Resource Utilization:** NetApp solutions enable customers to more effectively utilize storage and CPU resources through optimized load balancing and resource allocation. Customers can redeploy servers or remove traditional file servers after consolidating Windows file services onto NetApp.
- **Reduced System Administration Cost:** The NetApp environment is much simpler to manage than other storage systems. This means customers spend less time managing their storage and more time performing other value-added services for their customers. NetApp offers simple installation, seamless and non-disruptive capacity growth; easy quota management, automatic load balancing, and non-disruptive backup for Windows desktop file storage.
- **Investment Protection:** Business environments change. Whatever your technology mix—NAS or SAN (including iSCSI); Windows, UNIX, or Linux— NetApp's innovative storage solutions will support you. NetApp products share a common technology and modular architecture to provide a continuous upgrade path that leverages any current or previous investment, saving you money and providing you piece of mind.

Increased Performance

- **Fast Data Access:** NetApp offers faster response times and greater system throughput than the traditional Windows file server infrastructure. NetApp's storage microkernel incorporates the highly optimized WAFL (Write Anywhere File Layout) file system and storage virtualization layer, which is designed to minimize disk head movement for efficient writes and reads. With every write to the file system, WAFL stripes data across all the disks in a volume simultaneously. This results in very high performance, while simultaneously and automatically balancing the I/O load across all the available disks in a volume.

- **Near Instantaneous Backups:** NetApp snapshots provide near instantaneous online backups. Backup windows are reduced from hours to seconds, protecting data while minimizing impact on the production environment. Snapshots can eliminate the need to take nightly incremental copies of the file systems.
- **Accelerated Data Recovery:** NetApp can perform a full file system restore of an existing snapshot (point-in-time image) in a matter of seconds and because snapshots are kept online, restores from tape are minimized, thus saving customer's hours of time per restore request. The ability for users to self-recover files also eliminates IT intervention, accelerating the file restore process and reducing IT overhead.
- **Rapid Scalability:** NetApp allows easy storage expansion without disruption to data service or production environments. The NetApp storage system volumes can immediately take advantage of newly added disks. There is no need for time consuming RAID re-build or cumbersome processes to define new LUNs. If storage needs increase beyond the current capacity, larger controllers can be swapped, preserving the disks, volumes, and data on the volumes.

Seamless Microsoft Windows Integration

NetApp is one of the original partners with Microsoft for the Common Internet File System (CIFS) standard. We have thousands of systems that are currently serving files in the Windows environment using the CIFS protocol. Our work in CIFS includes:

- Working with Microsoft on CIFS since 1996, when both companies signed an agreement to cooperate on development of the CIFS protocol.
<http://www.microsoft.com/PressPass/press/1996/jun96/cifs2pr.asp>
- Leading the industry to continue development of the CIFS protocol. This includes setting up working group meetings and sponsoring annual CIFS conferences and interoperability labs.
- Defining the next version of the CIFS protocol. In 1999, the Storage Networking Industry Association (SNIA) took on coordination of efforts to document and standardize the CIFS protocol. NetApp and Microsoft have continued to be active in these efforts as co-sponsors.

Flexibility

- **Unified Storage:** NetApp storage systems provide a single, unified storage architecture. A NetApp storage system can simultaneously connect to multiple storage network topologies including direct host attach, Fibre Channel SAN, and Ethernet. The filer also supports all major storage protocols including iSCSI, Fibre Channel, CIFS, NFS, HTTP, FTP, and DAFS.
- **Secure Multi-Protocol File Sharing:** Enterprises typically have diverse environments that necessitate data sharing across Windows and UNIX platforms. It is imperative that both Windows and UNIX have access to the same data in order to eliminate unnecessary data duplication, and to reduce the complexity of data management. Using *SecureShare*, NetApp Filers allow UNIX clients, using the Network File System (NFS) protocol, and Windows systems, using the Common Internet File System (CIFS), to share files with a high-level of data integrity.
- **Migration with Minimal Impact on Clients/Users:** With NetApp, it is possible to easily consolidate data from multiple servers and make the single storage pool appear as the multiple servers it replaced, even if these legacy servers were in different NIS or Windows domains. Migration of data from the legacy servers to NetApp is simplified by a variety of migration tools. We will ensure that the chosen method minimizes user outages, and that all the data and meta-data can migrate with minimal administrative interaction.

Business Continuity, Improved Reliability and Availability

- **Improved reliability:** NetApp systems are enterprise class storage devices. NetApp uses built-in RAID and checksums to protect against data loss from disk failure, clustered fail-over and redundant components to increase reliability, and hot spares to deliver maximum data availability.
- **Centralized backup:** Instead of multiple tape drives supporting file servers throughout the organization, consolidated file serving on NetApp allows centralized tape solutions. By keeping the snapshots for 30 days (or whatever retention period is required), any recovery may be done from disk (via SnapRestore) without the need for tape.
- **Shrink backup windows and increase backup frequency:** By using NetApp's Snapshot feature; entire file systems may be backed up in just seconds, even for the largest file systems. Up to 255 Snapshots can be kept online. The speed and number of snapshots available allow for more frequent backups, minimizing data loss between backups. Administrators can also more efficiently use their tape backup systems by utilizing online backups for incremental backups and less frequently performing full backups to tape.
- **Low cost Disaster Recovery:** NetApp storage systems can automatically replicate data over existing WAN connections. Using the SnapMirror and the SyncMirror products from NetApp, customers can set up both synchronous and asynchronous data replication in minutes. SnapMirror copies only the changed blocks from the source filer to the destination filer so it efficiently uses bandwidth for remote mirroring configurations. With a set of three commands, the systems administrator can set up a mirror between any two filers in a customer's TCP/IP network. No competitive mirroring technology is as easy to set up or as bandwidth efficient as the NetApp solution.
- **Virus protection:** NetApp offers SnapRestore technology for the system administrator. SnapRestore is a software feature of the NetApp solution that allows someone with administrative authority the ability to make a snapshot into the production version of a file system. Restoring a file system to a point before the invasion of a virus can eliminate viruses after they are detected. NetApp filers also include support for on-access virus scanning for real-time protection against infection.

Reduced Complexity=Reduced Administration

- **Fewer servers/ simpler devices:** Fewer servers mean fewer systems to backup; provide software upgrades, security patches, etc. NetApp products are designed around an appliance philosophy, which means they are simple to install and operate. Every feature and operation of NetApp products is designed to simplify the storing, serving and management of data.
- **Snapshots are easier to manage:** With NetApp Snapshots, the administrator sets a schedule once, and the system takes care of creating new snapshots when desired, and deleting the old ones according to the schedule. Reduced application management and deployment burdens—deploy crucial applications or updates across the enterprise more quickly, and manage the overall software environment more easily, especially with a centralized staff
- **Quotas:** Data ONTAP supports special directories, called qtrees, which allow implementation of user, group and directory level quotas. Quotas can be used to track or limit the amount of disk space allotted to a user, whether UNIX or Windows, allowing greater control over the growth of a heterogeneous storage infrastructure. Quotas can be used in conjunction with NIS and automounter daemons within the UNIX infrastructure, and DFS and Windows AD within the Windows infrastructure, to manage and grow the storage

infrastructure. Once such a heterogeneous infrastructure is deployed, storage can be consolidated onto Filers with minimal interruption in services to clients.

- **Self Serve Recovery:** If a user discovers that they have changed a file inappropriately, they can open their snapshot folder and locate the snapshot of the share that was taken before the error was made. A simple Windows copy and paste operation will copy the file from their snapshot folder into their current folder. The user has then recovered the damaged file without a restore from tape.

With an extensive portfolio of space-saving technologies, including NetApp's RAID-DP, SnapVault, FlexClone, Snapshot, and FlexVol technologies, NetApp offers FAU's IT team clear and measurable savings in storage consumption.

2.2 Solution Operational Savings

- **Highest availability** – NetApp filers have a field-measured uptime of more than 99.999%. Built-in patented RAID-DP allows an order of magnitudes increase in data availability from disk failure than other storage vendors. Additionally, clustered failover, redundant components, and hot spares deliver maximum data availability. Capacity planning and expansion, storage reconfiguration, and system changes can all be done online. According to Aberdeen, 30% of downtime is caused by storage reconfiguration – and the use of NetApp storage systems can eliminate this cause of downtime.
- **Rapid restore** – Intelligent integrity checks and an always consistent file system lead to fewer data corruption incidents, and therefore better data availability. However, when restore is needed, NetApp offers Snapshots and SnapRestore for instantaneous single file or full volume restores.
- **Rapid deployment** – NetApp's design simplicity and unified architecture dramatically reduces the time for planning and deploying installations.
- **Performance Tuning** – The NetApp file system is self-tuning, which means there is no need for experts in device-level I/O to monitor individual volume performance or to manage physical devices.
- **Impervious to Virus Attacks** – Unlike Windows or UNIX based systems, NetApp systems run a custom designed storage operating system that is not based on a Windows or UNIX operating system. Data ONTAP cannot run third party applications or API's and does not provide network routing. Since there are no "hooks" into the OS, harmful viruses, worm programs, or hackers cannot use the Filer as a distribution mechanism or "jumping off point". This makes the OS impervious to viruses that could corrupt or destroy data on other systems.
- **Windows/UNIX File Sharing** – All NetApp storage systems support sharing a single copy of data to multiple heterogeneous servers. This differs from competing products that require a separate copy for each operating system. This ability allows NetApp systems to share a single copy of data seamlessly between UNIX and Windows environments. Each server may access the data using its native network protocol (NFS, CIFS, HTTP, etc) and multiple servers may access the data simultaneously. This eliminates the cost of storing duplicate data for each environment and the time consuming task of keeping each copy of the data in sync with each other.

2.3 Solution Financial Savings

- **Reduced training & personnel costs** – NetApp’s entire family of storage solutions, from the smallest single shelf system to the largest multi-cabinet system, uses the exact same operating system and software. Once a system administrator is trained to operate a NetApp system, this knowledge may be applied any primary or secondary storage system. Even though each of these sites may have different size or type of NetApp storage (due to the various requirements of each site) the training and experience gained at one site may be leveraged globally, thereby reducing TCO.
- **Simplified management** – NetApp storage solutions lower total cost of ownership (TCO) by automating or eliminating many storage management functions thereby simplifying the day-to-day management tasks *and requiring fewer system administrators*. This allows you to control operational costs and deliver mission requirements with fewer personnel.
- **Better storage utilization** – NetApp Unified Storage solutions eliminates the need to buy storage specific to each server or type of storage (SAN, NAS, or iSCSI). Excess capacity wasted on multiple systems is eliminated. Storage capacity may be deployed or redeployed as mission requirements change. Storage for multiple applications and heterogeneous servers can be consolidated onto a single unified system. Competing solutions typically require separate storage systems with different operating systems thereby increasing acquisition, service, personal, and training cost.
- **Increased useful life** – NetApp’s Unified Architecture provides the ability to rapidly change technology (example: fibre channel to iSCSI WITHOUT moving the data), adapt to growth (example: increase capacity on-the-fly), and change the mission of the storage platform (example: aging primary storage converted to secondary storage at a DR site – even if the server connectivity requirements change from SAN to NAS or iSCSI), thus extending the useful life. NetApp has customers running more than five-year-old equipment in production environments.
- **Disaster Recovery (DR) savings** – NetApp’s family of Unified Storage Systems gives us the capability to offering a cost-effective DR solution that may be managed from a single site with a single management tool.
- **Better utilization of IT staff** – NetApp’s easy-to-manage storage solutions mean that IT staff will spend less time focused on routine management and more time focused on higher value-added services. NetApp customers have been able to scale their data centers by terabytes without having to increase their IT staff.

3. NetApp Technology Overview

3.1 Unified Storage Appliance

Storage to Standardize Architectures

Unified storage is far more than the language used to speak to the storage array. It is being able to have a single array that can meet any requirement, from very large down to the small array. True unified storage provides the same architecture that gives those same capabilities to other vendors' storage arrays.

Unified storage blends the types of technology that FAU uses to match cost and performance objectives. Companies generally have many applications in their data centers using different types of storage to satisfy the requirements of each application.

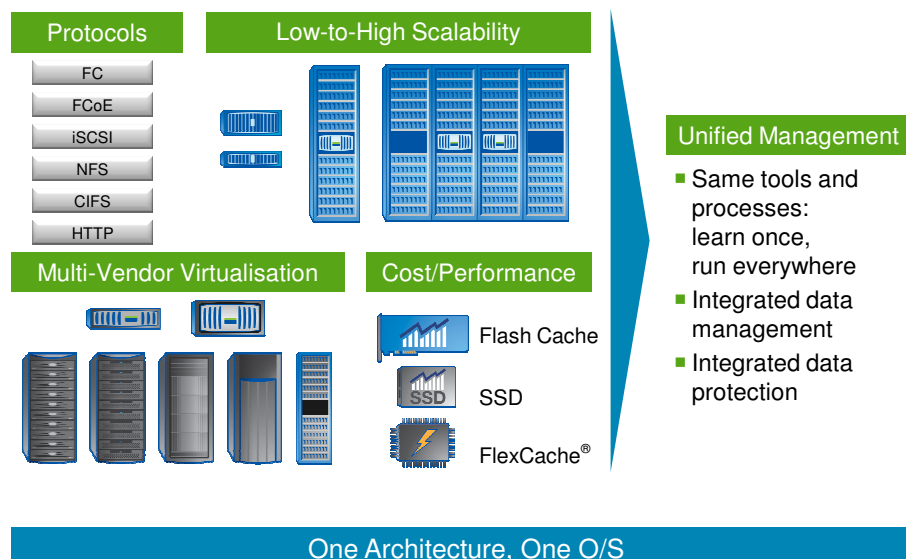


Figure Error! Bookmark not defined.: Unified storage: much more than multiprotocol. – With NetApp® Data ONTAP®, FAU can run the same operating system across a variety of storage controllers, taking advantage of a feature set that gives flexibility to virtualize storage on other vendors' disk arrays, accelerate datasets with SSDs, and operate it from a single pane of glass. This simplified management approach allows FAU to focus on performance, growth, and efficiency.

Having a truly unified architecture not only covers the protocol. It is an architecture that can be adapted, customized, and configured to support different types of workloads. It is not only for primary workloads. More and more companies now use disk as secondary storage and secondary storage for backup, disaster recovery, retention, and compliance purposes.

Real unified storage allows FAU to address all of these requirements through a single storage platform.

Storage to Consolidate Systems and Data Centers

In the early days, the only way to upgrade was to scale up, get the bigger system, the better controller. With Ethernet networks and the emergence of the Internet, many environments scale out with more systems. But with a unified architecture FAU can now scale for capacity, allowing applications to get the performance and quality of storage necessary to run your business.

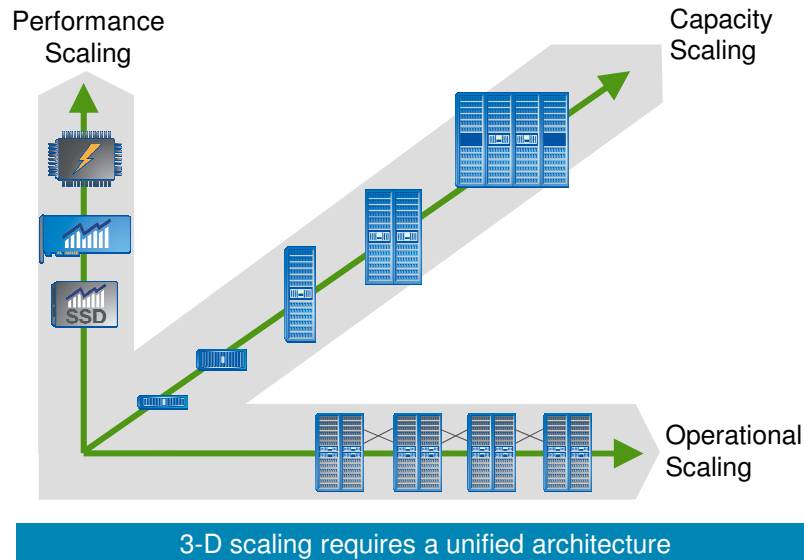


Figure 3: Scaling: Required on three dimensions. – FAU needs the ability to be able to scale your requirements in three dimensions to meet differing operational needs.

Three critical operational requirements that need to be satisfied concurrently include:

Performance is clearly a requirement. Some FAU users might need very little capacity, but need high performance

Capacity scaling might be required when performance is less important, but there is a need to support very large capacities for secondary storage requirements.

Operational scaling is needed as FAU grows your infrastructure and at the same time you need more performance and capacity. How can FAU nondisruptively introduce these technologies?

This is unified storage, and the value that NetApp brings is that we are innovating across all three of these areas.

When FAU puts in the right storage array, regardless of what application running, you should be able to put a very simple policy in place to make sure that the application and its data are protected and that the storage is completely integrated.

NetApp provides these capabilities today so that FAU can immediately benefit from:

Data protection can be rapidly deployed because it is built into the NetApp Data ONTAP operating system

Continuous data availability with array-based clustering and mirroring

Recovery within minutes with backups and replication in native format

End-to-end efficiency with Snapshot™ copies, deduplication, and compression

A virtual environment that can flex and stay protected

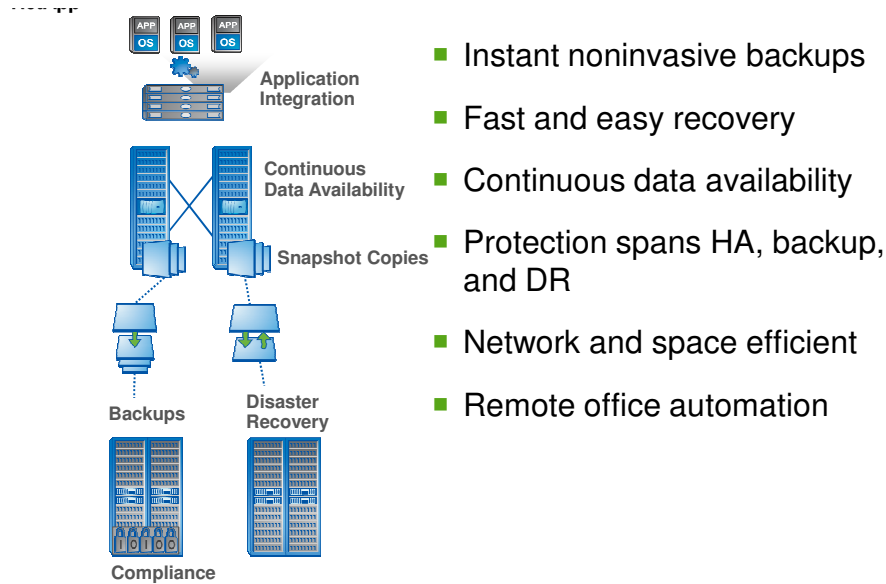


Figure 4: Integrated Data Protection. – FAU can enjoy “set it and forget it” protection utilizing NetApp storage with its integrated data protection.

Storage to Virtualize “Everything”

Servers have been virtualized for a number of different reasons. When FAU virtualizes, consider the following SLA implications:

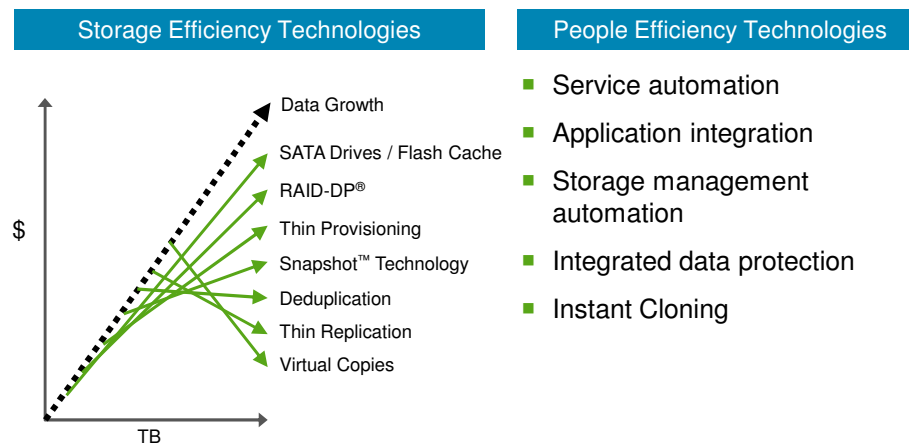
Guarantee of quality of service

Guarantee of security

Seamless and nondisruptive movement of virtual servers from one location to another

Storage to Optimize Efficiency

NetApp has focused on capabilities such as serial ATA to provide higher capacity, lower cost, thin provisioning to drive up utilization and deduplication to reduce the storage required. All of this helps to reduce capital expenditures and the amount of disk needed.



3.1.1 Scalable Storage / Single Operating System & Management Interface

NetApp utilizes a single, scalable system architecture requiring only one operating system and management interface across its entire family of storage systems. The power of the NetApp architecture is its ability to scale from entry level systems of less than 1 TB to high end enterprise systems containing in excess of 1000 TB, manage both primary and secondary storage systems, and seamlessly exchange data between all systems – **all using a single operating system and management GUI**. Additionally, data may be replicated between the primary storage (using high performance fibre channel disk drives) and secondary storage (using low-cost ATA disk drives). This unique ability to seamlessly replicate data between primary storage and lower cost secondary storage at the DR site AND manage both types of storage using the same interface and skill sets, ensures a much lower TCO than other vendors that must use expensive “primary” storage at both sites.

If multiple sites have a broad range of storage requirements, most other storage vendors would use different and incompatible storage systems (one for entry level/midrange, another for enterprise class, another for NAS, etc). Each of these systems typically has different operating systems and management interfaces, therefore increasing training costs. NetApp's Unified Storage Architecture ensures that customers may manage their enterprise consistently across a scalable family of storage systems.

3.1.2 Fabric Attached Storage (FAS)

For primary and secondary storage applications, the NetApp Fabric-Attached Storage (FAS) family of storage systems offers scalable, high performance, and highly available storage solutions (99.999% data availability). Modular architecture and powerful virtualization capabilities enables ‘right-sized’ pay-as-you-grow advantage while promoting optimal hardware and management resource utilization and flexible provisioning yielding excellent ROI benefits.

NetApp storage systems are easy-to-manage appliances, specifically designed for today's scalable, network-centric IT system architectures. NetApp NearStore storage solutions can consolidate storage from many servers over the entire enterprise, while managing the storage effectively in a mixed-server environment. This reduces the costs of data-center operations, simplifies disaster recovery planning, and ensures business continuance under a variety of scenarios.



The family of systems range in capacity from less than 1 TB to over 1000 TB and are available in single or dual controller configurations. Storage capacity may be increased on-the-fly with no disruption to normal data I/O. Additionally, as the maximum capacity limits of each model is reached, a simple “controller swap” is all that is required to upgrade from one model to any other. During the upgrade, all data remains in place and is typically completed in less than 30 minutes. All NetApp storage systems use the same operating system, optional software, and management interface so no retraining will be required. NetApp's FAS family of primary storage

also supports mixing Fibre-Channel disks and Serial-ATA disks in order to provide maximum flexibility in choosing the right storage resources for each individual application.

Primary storage is best suited for workloads that require constant, high-volume access to data, such as intensive database activity and frequently accessed user data. Secondary storage is the ideal solution for workloads that require quicker random access compared with tape, but do not require the continuous, high-volume activity provided by primary storage. Secondary storage (SATA Disk) is an ideal solution that fills the price/performance gap between fast but costly primary storage (fibre channel disk) and less-costly but slow archival (tape and optical) storage.

The NetApp FAS family provides near-primary storage performance at near-tape storage costs. NetApp storage systems perfectly complements and dramatically improves existing tape backup, archiving, and data protection schemes by inserting economical SATA disk-based storage between the application's primary storage and offline storage (tape libraries) in a three-tier (D2D2T) storage architecture.

For backing up and restoring data, NetApp FAS systems can enhance existing tape backup operations by acting as a large disk cache or replace tape backup devices altogether. Many traditional software backup vendors, such as Veritas, fully support this model. Additionally, these systems may be located remotely providing an economical but disaster tolerant environment.

The high throughput and instant data access of disk based secondary storage results in much faster data recovery than is possible with tape. With NetApp, you may restart your critical applications in minutes, dramatically reducing the impact of unplanned outages.

By providing cost-effective, high-capacity secondary storage, NetApp FAS systems increases the affordability of data protection strategies, speeds data recovery, and can even serve in emergencies as a primary storage device.

3.1.3 NetApp Unified Storage Appliance Models

NetApp's Storage Systems (pictured below) has been implemented via a broad range of models, all using a single architecture but with differences in capacity, performance, connectivity options, and back-end drive type (fibre channel, SATA, or mixed). The drawing below shows the current models of NetApp's Unified Storage Appliance Family.

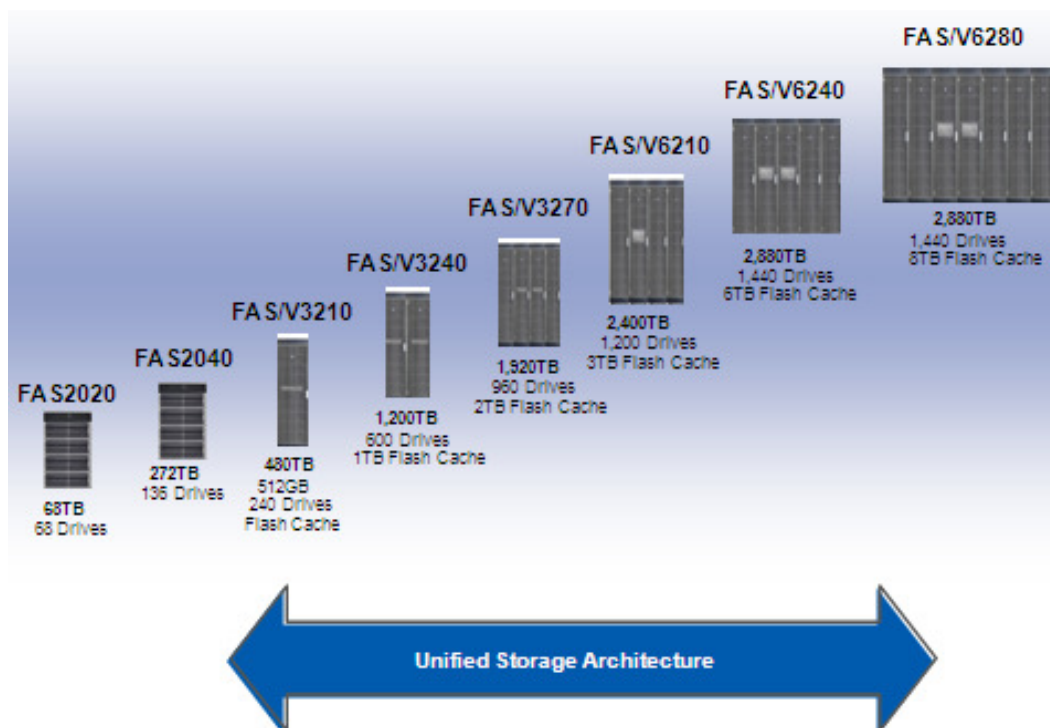
NetApp FAS systems offer:

- Both high-performance and high-density disk drives, in either homogeneous or mixed storage configurations, to give application owners a choice of tiered storage options

- Support for both SAN and NAS environments to address both primary and secondary storage needs

- The ability to quickly upgrade to newer controllers or models while keeping data intact

- Nondisruptive capacity expansion



3.1.4 High Availability Architecture

NetApp technology is specifically designed to reduce costly downtime and maximize access to mission-critical data. A combination of standard features and optional software capabilities allows NetApp systems to deliver 99.999% field-measured availability.

NetApp's dual controller (clustered) systems have no single point of failure. The disk shelves are connected via paths allowing either controller to communicate with any disk. NetApp's cluster failover technology allows either controller to automatically takeover the identity and all functions of the failed controller. The two controllers communicate over a private Infiniband (2.5 Gb/sec) cluster interconnect and each keeps a copy of the other's non-volatile cache contents. During normal operation, both controllers are active and provide data services. The Clustered Failover Software constantly monitors the health of the both controllers. If it detects a catastrophic hardware failure on one controller, it automatically initiates a failover operation to transfer the data service to its partner controller. Data integrity is ensured during the transfer. Once the failover operation completes, the takeover controller will automatically resume data service for the failed controller. The data service of the takeover controller is never impacted and is fully available during the entire failover operation. The takeover controller maintains this dual data-serving mode until an administrator initiates action to restore data service to its original state. The entire failover process is automatic, with no manual intervention required at any point, and will typically be completed in less than one minute.

Additionally, each controller includes redundant hot swappable cooling fans and power supplies. The system may also be configured with one or more hot swappable, spare disk drives that will automatically take over for any failed drive. Multiple fibre channel or Ethernet interface cards may be configured so that I/O will automatically continue via a secondary path in the event of a

failed I/O card. The system also supports secondary power sources (such as a backup generator or UPS) that will automatically and nondisruptively switch over to the backup power source.

3.1.5 Non-Disruptive Storage Capacity Expansion

Because NetApp efficiently integrates RAID, disk optimization, and volume management, data volumes may be enlarged or shrunk dynamically without down time or any re-alignment of data as would be necessary in typical RAID environments. As storage requirements evolve, additional capacity (shelves and/or disk drives) can be added and deployed non-disruptively. This is true for both SAN & NAS environments.

3.1.6 Controller Upgrades

As performance and capacity requirements change over time, NetApp storage systems offers the flexibility to quickly upgrade between all models without expensive and disruptive “forklift” upgrades or data migration. As customer storage requirements grow beyond the capacity and performance limits of one controller model, an upgrade to any other controller model (even to our largest system) does not require any data migration and could be accomplished in less than 30 minutes. This type of upgrade simply swaps out one model system controller for any other model. All data, including the Data ONTAP operating system, will remain on the existing disk drives.

3.1.7 RAID-DP (Dual Parity RAID)

NetApp storage systems all use dual parity RAID called RAID-DP (NetApp’s implementation of RAID 6), which provides higher availability than RAID 1 (mirroring), RAID 0+1 (striping + mirroring), and RAID 5 at the cost of only one additional parity drive and incurs no performance penalty. Additionally, compared to RAID 1 and RAID 5, RAID-DP (combined with NetApp’s unique file system) offers much higher performance.

RAID-DP provides protection against the possibility of any two drive failures in the same RAID group. With normal single parity RAID (RAID 3, 4, or 5) or even RAID 1 (mirroring), the entire volume and all its data would be lost if a second drive failed (or had an uncorrectable bit error) while another drive in the RAID group is being rebuilt. As disk drive sizes increase, so do the rebuild times for failed drives, creating ever larger “at risk” windows. Even technologies such as RAID 0+1 (disk striping & mirroring all disk) are not as available as RAID-DP because RAID 0+1 protects against any two drives failing at the same time except the same two drives on each side of the mirror. NetApp’s RAID-DP not only allows any two drives to fail, it does so with only one additional parity disk in the RAID Group, therefore greatly reducing storage cost compared with RAID 0+1. No other RAID protection level offers high availability, high performance, and low cost simultaneously.

3.1.8 Integrated with UNIX & Windows Cluster Software

NetApp storage systems fully support the major cluster technology (Microsoft’s MSCS, IBM’s HACMP, HP’s MC Service Guard, Sun’s SunCluster, and Veritas Cluster Server) to support server (“front-end”) clustering and multi-pathing. Server clusters, combined with NetApp’s controller (“back-end”) clustering for the storage subsystem, provide the greatest level of reliability for an application environment.

3.1.9 Proactive Problem Notification (AutoSupport)

Every NetApp storage system includes AutoSupport. AutoSupport is a sophisticated, event driven logging agent inside each NetApp system which continuously monitors the system. The AutoSupport feature triggers the automatic sending of email messages to one or more customer-specified email addresses and to NetApp Technical Support, alerting recipients to potential problems with the storage system. If necessary, Technical Support will contact customers at the email address and/or telephone number specified in the AutoSupport Setup screen to help resolve potential system problems. AutoSupport makes sure that your storage environment is working at top efficiency.

3.1.10 Automatic Power Adjustment

NetApp systems are regularly deployed around the world. The systems have an auto-sensing power supply that accepts 90VAC to 250VAC / 48Hz to 62Hz power. If the controllers are mounted in NetApp's 19" rack mount cabinet, the cabinet power supply is also auto-sensing and accepts 200VAC to 250VAC / 48Hz to 62Hz power. The only difference between systems shipped anywhere in the world are the detachable power cords which are matched to each country's power connection requirements.

3.1.11 V-Series

The NetApp V-Series product line is the first and only storage virtualization solution on the market that unifies block and file (NAS, FC SAN, and IP SAN) storage networking paradigms under a common architecture. NetApp is the only company with a solution that can virtualize a customer's entire storage infrastructure under one interface. The family of V-Series systems includes the GF270c, GF980, V3020, V3040, V3070, V3140, V3170, V6040 and V6080 models. Both dual and single controller configurations are supported. Storage arrays from HDS, HP, EMC, IBM, Fujitsu and 3PAR are supported behind the V-Series controller. This unique solution allows customers to transform existing heterogeneous multi-vendor storage systems into a single storage pool. This result in simplified storage provisioning and management, increased storage utilization, dramatically lower backup times and reduced costs.

3.1.12 Data ONTAP GX System

Data ONTAP GX systems are highly scalable, multi-node solutions that meet the requirements of the high performance computing (HPC) and digital media content (DMC) markets. The primary HPC markets include energy (for example, seismic processing), EDA (for example, chip design, verification, and layout), and research labs (for example, intelligence, defense, and genomic research). The primary digital media content markets include digital media archive, rendering, and Internet content storage.

Data ONTAP GX systems are based on the Data ONTAP GX operating system and up to 24 FAS (FAS3040, FAS3070 or FAS6080) nodes within a single, easy-to-manage global namespace. Each system consists of two or more FAS building blocks, and each FAS building block is a pair of controllers (nodes) that are configured for high availability. Gigabit Ethernet connections are used for client connections and for interconnecting FAS controllers into a single, scalable Data ONTAP GX system. Both Fibre Channel and SATA disks are supported. .

- Single system image for 2 to 24 nodes
- Linearly scale to multi-GB/sec throughput
- Scale to 6PB capacity
- High Performance NFS and CIFS
- High performance volume striping across multiple nodes
- Built for continuous operation
- Online load balancing and scaling
- Transparent data movement
- Robust functionality for HPC
- Fully integrated, single-vendor solution

3.2 Data ONTAP Operating System

All NetApp primary storage systems use the same operating system, Data ONTAP, so there is no retraining needed if administrators support small, single-shelf systems or enterprise data center class systems with capacities of over 1000 TB. At the heart of NetApp's unified storage architecture is a robust operating system - Data ONTAP. The Data ONTAP OS combines a unique, patented file system (Write Anywhere File Layout (WAFL)), non-volatile cache, a RAID system, Volume Manager, and a powerful microkernel-based design dedicated to high performance data access. Data ONTAP's architecture increases overall system performance by eliminating all functions not associated with data service or data protection. The microkernel design produces fast response times and high throughput without requiring complex hardware configurations or manual performance tuning. The power of the Data ONTAP operating system is its ability to scale from entry level systems of less than 1 TB to high end enterprise systems containing more than 1000 TBs and support SAN & NAS interfaces to both primary & secondary disk drives simultaneously.

3.2.1 WAFL (Write Anywhere File Layout)

WAFL is the Write Anywhere File Layout, an approach to writing data to disk locations that minimizes the historic RAID write penalty. By keeping file system metadata (inodes, block maps, and inode maps) in files, WAFL is able to write file system metadata blocks anywhere on the disk. This approach in turn allows multiple writes to be "gathered" and scheduled to the same RAID stripe, eliminating the traditional read-modify-write penalty prevalent in parity-based RAID schemes. In the case of WAFL, this stripe-at-a-time write approach makes RAID 4 a viable (and even preferred) parity scheme. At the time of its design, the common wisdom was that RAID 4 (which uses a dedicated parity drive) presented a bottleneck for write operations because writes that would otherwise be spread across the data drives would all have to update the single parity drive in the RAID group. WAFL and full-stripe writes, however, eliminate the potential bottleneck and, in fact, provide a highly optimized write path. This stripe-at-a-time approach to writes also required that the system provide a means of reliably buffering write requests before they are written (en masse) to disk. Nonvolatile RAM (NVRAM) allows the system to reliably log writes and quickly acknowledge those writes back to clients.

3.2.2 Flexible Provisioning (FlexVol)

NetApp FlexVol technology delivers true storage virtualization solutions that can lower overhead and capital expenses, reduce disruption and risk, and provide the flexibility to adapt quickly and easily to the dynamic needs of the enterprise. FlexVol technology pools storage resources automatically and enables creation of multiple flexible volumes on a large pool of disks. This flexibility means that customers can focus on managing data, not hardware, and make changes quickly and seamlessly. The result is that customers can add storage when and where it is needed without disruption and at the lowest incremental cost.

Data ONTAP enables higher storage utilization with flexible volumes which do not require physical pre-partitioning and can be dynamically re-sized (increased or decreased) without the need to rebuild RAID groups. These capabilities enable customers to tailor data management to the requirements of each data set, respond quickly to the changing needs of the enterprise, and reduce implementation and management overhead, while driving storage capacity utilization higher. Storage capacity may be allocated or reallocated as needed non-disruptively between data volumes. NetApp's FlexVol technology allows volumes to grow or shrink on-the-fly, even while serving LUNs via fibre channel or iSCSI and NAS via NFS or CIFS. Storage can be "re-purposed" at any time, to allow for flexible deployment both now and in the future.

Customers may also change the connectivity option used to access the data without migrating or copying the data. For example, a file system may be changed from fibre channel access to iSCSI access. Only a simple dismount of the fibre channel LUN and a mount of the same LUN using iSCSI would be required. On the NAS side, a single version of the data may be accessed via CIFS (Windows) or NFS (UNIX).

3.2.3 Instant Backup (Snapshot™ Technology)

A standard feature of all NetApp systems is the ability to instantly make a copy (called a Snapshot™) of an entire data volume. Up to 255 read-only snapshots may be taken of each volume. Snapshots may be taken on demand, regularly scheduled, or integrated with third party applications (such as Veritas NetBackup, Exchange, and Oracle & SQL databases) and each data volume may have its own snapshot schedule. Single files or entire directories may be recovered from any snapshot via a single command or a simple "drag & drop" operation. The Snapshot function requires minimal disk space, causes no disruption of service, and does not affect performance of the system. Additionally, there is absolutely no performance impact regardless of how many snapshots are taken.

The benefits of NetApp's Snapshot technology include:

- **Automated, near-instantaneous backups (with no impact to users)** - NetApp's Snapshot technology allows customers to take more frequent backups (typically several per day, with no performance impact to users), offer more recovery points in the event of data corruption or virus infection, and reduce the backup window to seconds. In the event of a recovery, more frequent backups will reduce data lost since the last backup was taken. For applications such as Oracle, frequent backup (such as hourly) enables a much shorter log replay time (1 hour vs. 24 hours of logs for tape) after the database is restored to a previous point-in-time. Snapshots are integrated with many applications, such as Exchange, SQL, and Oracle, and are done without the need for application downtime. Up to 255 snapshots per volume are supported.

- **More recovery points** - Tape backup is usually done only once per day. With Snapshot technology, “backups” may be done as often as needed, even hourly. In the event of a recovery, more frequent backups will reduce data lost since the last backup was taken.
- **Data recovery in seconds** - Data recovery for a single file, directory, or an entire volume (no matter how large) is decreased to just seconds.
- **Verifiable Backups (with no impact to users)** - Any Snapshot may be used as a read-only image of the data. The data may be verified with the normal application utilities. For example, a database may be started as a read-only instance from a snapshot and then a database consistency check can be performed. This ensures that the “backup” was done correctly and validates that no corruption exists in the Snapshot image. Additionally, the validated data may then be used for archiving to tape or for secondary applications, such as reporting or testing.
- **Improved Productivity with Parallel applications** - Any Snapshot may be used as a read-only copy of the data volume. Read-only applications such as backup, test/development, a reporting database, or data mining may be done with the read only Snapshot copy while read/write operations continue with the normal data volume.
- **Minimal additional storage required** - With Snapshot™ technology, multiple point-in-time copies (up to 255) of a data volume require only a small amount (typically 10-20%) of additional disk space. This is a huge difference from our competitors who require 100% additional storage for each copy.
- **Eliminate tape for backup** - Data volumes may be instantly “backed up” in seconds, using Snapshot™, via an automated process with no need for slow transfer to tape. For offsite copies, NetApp’s SnapMirror data replication software is available. Other advantages of using Snapshots instead of tape include:
 - **Backup Performance** - Disk based backups are non-disruptive and take just seconds versus many hours required for traditional tape systems.
 - **Reliability of the Backups**-- Snapshots are RAID protected unlike tape based backup. With many tape backup applications, if a section of tape is unreadable, the data restore fails and your data is lost.

3.2.4 Instant Recovery (SnapRestore)

SnapRestore is a Data ONTAP feature that provides administrators with the means to revert an entire data volume back to a previous point-in-time within seconds. SnapRestore is based on Snapshot functionality and provides instant, full volume level recovery. SnapRestore works in just seconds (regardless of the volume size) and does not require a massive read/write operation that many other vendor systems require. Full file system recoveries can potentially take hours if completed using traditional tape restoration methods. It is also possible that this data will not be up to date as possible, i.e., only as up to date as the previous physical tape backup. The combined downtime due to slow tape restoration and the interval between tape backups can lead to loss of data access for multiple days.

SnapRestore uses previously taken Snapshots as the recovery point. Critical databases or important project data may be given a higher frequency Snapshot schedule that would provide a more granular set of Snapshots. More frequent Snapshots provide a smaller data loss window from which to recover from. An example would be for an administrator to create a Snapshot schedule that would occur as often as every 30 minutes. Should there be a database corruption, the system administrator may select any of the (up to) 255 existing Snapshots from

which to revert the volume back to its previous state. Reverting to a volume, whether it is 50 Gigabytes or 10 Terabytes takes only seconds.

3.2.5 Flexible Cloning (FlexClone)

NetApp's flexible cloning (FlexClone) technology enables true cloning -- instant replication of data volumes and data sets without requiring additional storage space at the time of creation. Each cloned volume is a transparent virtual copy that can be used for essential enterprise operations, such as testing and bug fixing, platform and upgrade checks, multiple simulations against large data sets, remote office testing and staging, or market-specific product variations. Together FlexVols and FlexClones help customers deploy new capabilities faster, with less risk, less effort, and less cost.

3.2.6 Thin Provisioning

The first step in the implementation of any storage system is the allocation of capacity to servers and applications. Thin provisioning separates the logical representation of storage from the underlying physical disk arrays, making it possible to allocate more storage capacity to applications than is physically installed. With traditional storage provisioning, disk capacity is allocated to applications regardless of how much data is actually being written. The problem is that early in a deployment, space requirements are often not known. To make sure that their applications will have adequate capacity, users often present overly high estimates of capacity requirements, and as a result, administrators are forced to overprovision the larger storage infrastructure. With the ability to do thin provisioning, NetApp storage systems make it possible to oversubscribe free space and adapt rapidly to the changing needs of the enterprise. This is essentially an allocate-on-demand model that allows allocation of storage to application needs, whether or not all of the provisioned capacity is actually installed up front. Because you can present more storage space to the hosts or servers connecting to the storage system than is actually available, storage purchases can be deferred until real application capacity thresholds are realized. Because disk storage prices decline significantly over time, this can result in dramatic cost savings. It also allows customers to take advantage of the latest disk technology.

3.2.7 Quality of Service for Storage (FlexShare)

NetApp's unified storage facilitates the deployment of a single integrated storage solution. NetApp's FlexShare is a powerful workload management tool that enables quality of service (QoS) for all NetApp storage systems. With FlexShare, customers can host multiple workloads on a single NetApp system and assign individual priorities to each one. FlexShare gives storage administrators the ability to leverage the existing infrastructure and increase processing utilization, without sacrificing the performance allocated to mission-critical tasks. Using FlexShare, administrators can confidently consolidate disparate applications, prioritize specific data sets, and dynamically adjust priorities as program needs change.

3.2.8 NetApp Deduplication for FAS

Most storage solutions (including NetApp) offer some type of space reduction functionality. This is often referred to as deduplication and/or single instance storage. NetApp's approach differs in that we use Advanced Single Instance Storage (A-SIS) at the block-level. Since NetApp's storage solution is block aware, we are able to eliminate duplicated blocks of data. For example, if a user adds their name to a PowerPoint presentation, NetApp will only save the

blocks of data that make up that presentation once, plus a few extra blocks to capture the addition of the user's name. This can contribute to a significant reduction in the amount of disk storage required. When NetApp deduplication for FAS is enabled on a volume, it computes a database of fingerprints for all of the in-use blocks in the volume (a process known as "gathering"). Once this initial setup is finished, the volume is ready for deduplication. NetApp deduplication leverages the unique characteristics of WAFL to conserve disk space while keeping system overhead low. In many environments, the space savings can be substantial. Even in primary storage applications, such as a home directory environment, NetApp deduplication can often produce significant savings.

3.2.9 Integration with VMware

While customers experience dramatic improvements in server utilization and management by using VMware, the market leader in virtualization, these benefits place a much higher demand on storage subsystems to support higher I/O rates, greater capacity, faster provisioning, and backups and restores. Selection of a server virtualization solution requires careful consideration of many variables including operational requirements, performance needs, and cost objectives. A complete virtualization solution or consolidation strategy should consider not only servers, but storage. NetApp storage, when deployed as part of a VMware solution, has a lower total cost compared to competing solutions.

NetApp and VMware are mutual Global Technology Alliance Partners with thousands of joint customers. Our companies continue working very closely together providing the Government highly complementary solutions, which deliver:

- Scalable and consistent I/O performance for all ESX protocols (NFS, iSCSI, and FCP)
- Flexible, rapid, simple, and cost-efficient provisioning and data management solutions
- Superior virtualized storage for thin provisioning of heterogeneous storage environments
- Quickly and easily protect and archive virtual machines (VM) with Snapshot, SnapMirror and SnapVault without impacting production
- Grid or Utility Computing type functionality including data center space and energy efficiencies, higher utilization rates, and overall IT agility

3.2.10 Increased Energy Efficiency

Power and cooling are concerns in computer environments and the problem is magnified with growing data retention requirements. Many competitive offerings are limited to disk mirroring technology for data protection. Mirroring doubles the amount of spinning disks, thus doubling power consumption and heat. NetApp's integrated RAID-DP technology provides significant cost, power, cooling, and space savings for our Government customers.

Competitive offerings often require an increase in the amount of storage nodes as you increase the amount of disk drives, since each node manages a finite number of drives. This direct relationship of drives per node requires customers to increase their CPU count as data growth occurs. Unfortunately, the increase in CPUs does not always improve performance; it may only enable the capacity to grow. Like disks, CPUs are one of the leading contributors to heat generation and power consumption. NetApp's modular scalability allows customers to scale with far fewer disks and less CPUs while having superior performance as a result of our core software technology and unified architecture.

3.2.11 File Virus Protection & File Type Management

Using integrated 3rd party virus protection and file type filtering software, you may ensure that only non-infected files and allowed file types may be stored on the storage system.

3.2.12 Impervious to Virus Attacks

Unlike Windows or UNIX based systems, Data ONTAP is a microkernel storage operating system that is not based on a Windows or UNIX operating system. Data ONTAP cannot run third party applications including operating system virus or worms. Since there are no “hooks” into the OS, Data ONTAP is impervious to harmful software that could corrupt or destroy data on Windows or UNIX systems.

3.2.13 Always Consistent File System with Zero Data Loss

A huge benefit that sets NetApp technology apart is that Data ONTAP and WAFL, NetApp’s file system, are always consistent. In the event of an unexpected shutdown or power failure, a lengthy file system consistency check is not required. Imagine if the power failed to a 10 TB storage system and how long it might take to do a consistency check such as Scandisk (for Windows systems) or fsck (for UNIX systems). It could be many hours or days before the system is able to resume normal I/O operations.

Data that has been sent to the NetApp system but not yet written to the disk is contained in the NVRAM. The NVRAM is used as a write journal, similar to a database log. If the system power is lost during operations, upon restart, the journal in the NVRAM is replayed and all data is sent to the correct data volume. With the file system already in a consistent state, recovery is extremely rapid and file system checks are unnecessary. When the power is restored to a NetApp system, normal I/O operations will resume after the usual two minute boot up.

3.2.14 Windows & UNIX Data Sharing

All NetApp storage systems support the sharing of a single copy of data to multiple heterogeneous servers. This differs from competing products that require a separate copy for each operating system. This ability allows NetApp systems to share a single copy of data seamlessly between UNIX and Windows environments. Each server may access the data using its native network protocol (NFS or CIFS) and permission types. Additionally, multiple servers may access the same data simultaneously.

3.2.15 FilerView

Each NetApp system includes FilerView, a powerful, web based administration tool. The FilerView tool enables administrators to use standard web browsers to access a consistent, easy-to-use graphical user interface (GUI) for everyday administration tasks.

Administrators can set up and control any NetApp system remotely, from virtually anywhere and from any computing platform. After the system is operational, administrators can efficiently monitor status, satisfy requests for additional storage capacity, make changes to file system configurations, and keep up with other administration tasks as they arise.

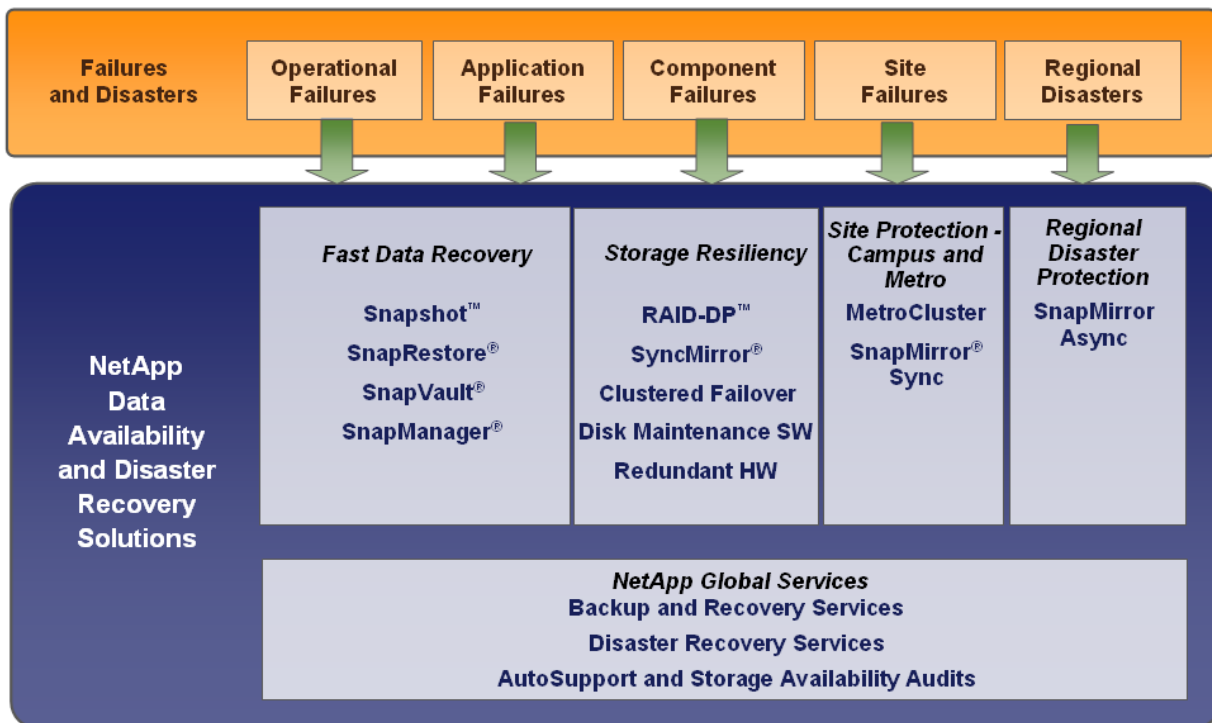
A simplified command line interface is also available. Most of commands will be familiar to any UNIX system administrator. The command line interface can be accessed either locally from the console or remotely via telnet, rsh or ssh.

3.2.16 Simple Network Management Protocol (SNMP)

All NetApp storage systems come with a built-in SNMP Agent and Management Information Base (MIB). The Simple Network Management Protocol (SNMP) is a standard Internet protocol that facilitates communications between a system being managed and the management console or framework, including HP's OpenView and IBM's Tivoli. This can provide administrators additional insight into Filer health through customizable alerts. Alerts can be dynamically adjusted based on any number of factors, including growth, information flow, and configuration changes. Alerts can be configured to be forwarded to many locations including administrative Email, SNMP enabled hosts, or a centralized management location.

3.3 Availability, Data Protection and Archiving Solutions

NetApp technology offers many standard and optional features that ensure data is protected, backed up, mirrored and/or replicated, depending upon the high availability requirements of a customer site.



3.3.1 Flexible Mirroring (SnapMirror)

NetApp's SnapMirror delivers a disaster recovery and data distribution solution by replicating data at high speeds over an IP-based LAN or a WAN. SnapMirror replicates data directly between NetApp systems (no 3rd party device or converter needed), and deploys easily into any networking infrastructure. It updates the replicated data, making it available for disaster recovery, COOP, offloading tape backup, read-only data distribution, testing on non-production systems, online data migration, and more.

SnapMirror uses special Snapshot copies at the source and destination, essentially checkpointing the state of the storage at both ends and guaranteeing consistency. If the data replication is interrupted or halted, the transfer restarts from the most recent checkpoint. SnapMirror also performs intelligent resynchronization, which eliminates the need for full transfers when recovering from DR testing, application testing, etc. Administrators can set up SnapMirror in minutes and handle administration and operations through an easy-to-use graphical user interface.

Synchronous SnapMirror



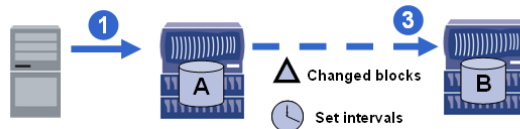
- ▶ Zero data loss
- ▶ Distance limited
- ▶ Performance impact

Semi-Synchronous SnapMirror



- ▶ Small data loss
- ▶ No distance limit
- ▶ No performance impact

Asynchronous SnapMirror



- ▶ Data loss > 1 minute
- ▶ No distance limit
- ▶ No performance impact

3.3.2 Flexible Backup (SnapVault)

In terms of backup efficiency, NetApp SnapVault software provides a fast, centralized, and cost-effective disk-to-disk backup solution by replicating NetApp Snapshot copies to inexpensive secondary storage. Leveraging NetApp Snapshot technology, the SnapVault software is able to move and store data efficiently by eliminating redundant data across each backup. In fact, each full backup consumes only the disk space necessary to store changes from the previous backup, reducing capacity requirements 90% or more. While NetApp Snapshot and SnapVault copies represent a full copy of a data set, deduplication of data blocks can mean that copies often consume as little as 1% of the storage. As a result, users can store up to 250 stable online backups with minimal storage consumption.

3.3.3 Heterogeneous Flexible Backup (Open Systems SnapVault)

Open Systems SnapVault (OSSV) provides the advantages of NetApp SnapVault advanced backup and recovery technology to heterogeneous storage environments. OSSV enables automated backups, rapid snapshots, low bandwidth utilization and reduced storage requirements making it particularly useful for remote office environments.

3.3.4 Heterogeneous Replication (SnapMirror for Open Systems)

SnapMirror for Open Systems is enterprise class software for data replication, recovery and continuous data sharing across a range of locations, platforms and storage systems. SnapMirror for Open Systems can be used by customers for Disaster Recovery (DR), SAN Data Migration, and for non-disruptive replication of data to support cloning for production support applications like development and testing. With SnapMirror for Open Systems, customers can near-synchronously replicate block data over any distance and across heterogeneous infrastructures, without the operational disruption incurred through traditional alternatives. Customers can then rapidly recover an up-to-the-second image of data that is 100% consistent. This results in a unified DR infrastructure for mixed storage environments yielding management simplicity and reduced costs when consolidating a number of diverse data centers.

3.3.5 NetApp Virtualization Solutions for the Data Center

While customers experience dramatic improvements in server utilization and management by using VMware, the market leader in virtualization, these benefits place a much higher demand on storage subsystems to support higher I/O rates, greater capacity, faster provisioning, and backups and restores. Selection of a server virtualization solution requires careful consideration of many variables including operational requirements, performance needs, and cost objectives. A complete virtualization solution or consolidation strategy should consider not only servers, but storage. NetApp storage, when deployed as part of a VMware solution, has a lower total cost compared to competing solutions.

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- Superior virtualized storage for thin provisioning of heterogeneous storage environments
- Quickly and easily protect and archive virtual machines (VM) with Snapshot, SnapMirror and SnapVault without impacting production
- Grid or Utility Computing type functionality including data center space and energy efficiencies, higher utilization rates, and overall IT agility

3.3.6 MetroCluster

MetroCluster is a cost-effective, integrated high availability and disaster recovery solution that protects against site failures resulting from terrorist attacks, human error, HVAC failures, power failures, building fire, architectural failures, and planned maintenance downtime. Stretch MetroCluster provides site protection within a campus, and supports replication up to 500m. Fabric MetroCluster provides site protection within a metro, and supports replication up to 100 km using FC switches. MetroCluster provides for simple and fast recovery of systems by providing for automatic recovery of any single component failure with minimal interruption to transactions and One-button recovery even for major catastrophic site failures resulting in reduced downtime. It is a cost-effective, integrated HA clustering with DR mirroring solution resulting in cost savings and simplicity with zero data loss in the event of site disasters (Synchronous Replication).

3.3.7 Regulatory Compliance (SnapLock)

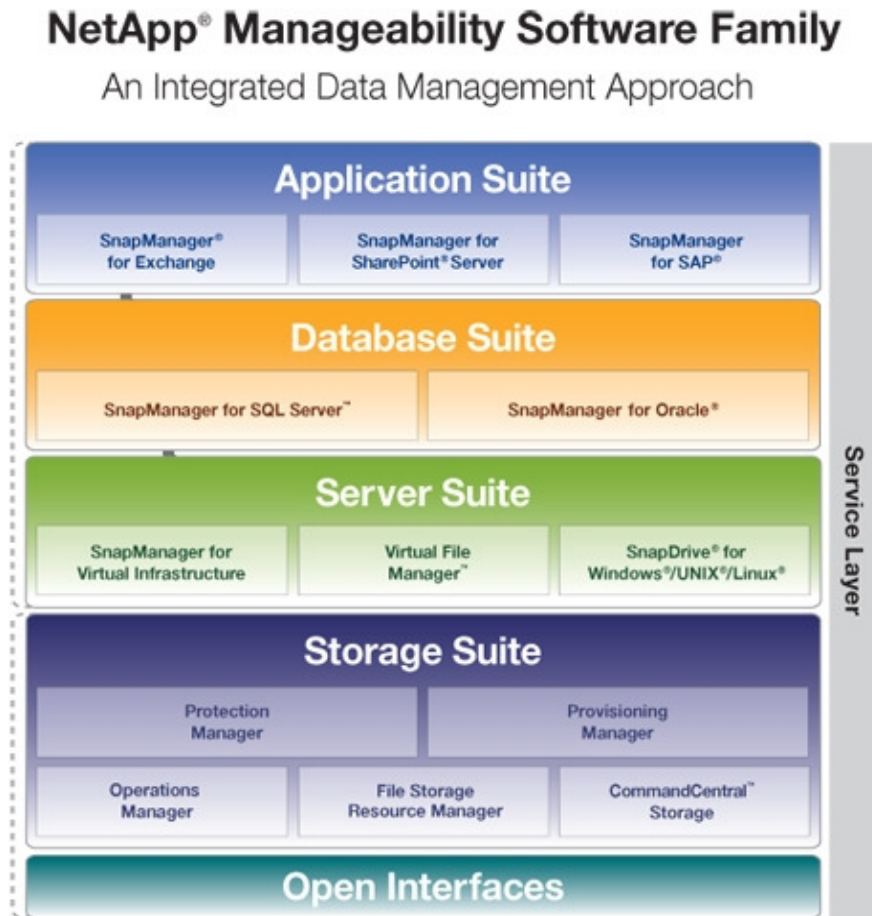
NetApp SnapLock® enables you to comply with regulatory and best-practices records-retention requirements by allowing the creation of non-rewritable, non-erasable WORM volumes on NetApp NearStore® and FAS storage systems, thereby preventing critical files from being altered or deleted until a specified retention date. This is an open solution that utilizes standard protocols to allow for seamless integration with ISV Archival Applications and/or custom applications

3.3.8 Regulatory Compliance for Unstructured Data (LockVault)

NetApp LockVault software delivers a high performance, storage-efficient, disk-based regulatory compliance solution for unstructured data. Our solution mitigates compliance risk by making backups compliant and by delivering fast data access and recovery. Available on both NetApp FAS and NearStore systems, LockVault leverages SnapLock and SnapVault technologies to provide compliant versions of enterprise data along with a Compliance Journal which tracks changes between versions. With the introduction of LockVault, a single NetApp system now allows customers to meet all regulatory requirements across all data classes (structured, semi-structured, and unstructured).

3.4 Manageability Software Family

With the NetApp integrated data management (IDM) approach, users go from an environment with limited productivity and limited flexibility to one that offers dramatically improved efficiency, utilization and availability.



3.4.1 SnapManager for Microsoft Exchange

SnapManager for Microsoft Exchange speeds and simplifies application data management. It empowers Exchange administrators to utilize the capabilities of NetApp storage systems from an Exchange-centric approach. SnapManager automates and simplifies the complex, manual and time-consuming processes associated with the backup, recovery and verification of Exchange databases. It is integrated with native Microsoft technology and frameworks. Using SnapManager with FC or IP SANs, customers can scale their storage infrastructure, meet their SLA commitments and improve the productivity of storage and Email administrators.

3.4.2 SnapManager for Microsoft SharePoint Server

SnapManager for Microsoft Office SharePoint Server 2007 automates and simplifies the complex, manual and time-consuming processes associated with the backup and recovery of business-critical SharePoint data. Testing and integration with Microsoft Office SharePoint Server 2007, and with Microsoft SQL Server 2005, provides customers with the assurance that they can rely on NetApp for their business critical data center needs. NetApp brings availability, speed and quick retrieval to Microsoft SharePoint environments which increases productivity and minimizes the risk of downtime and data loss.

3.4.3 SnapManager for SAP

SnapManager for SAP automates and simplifies the complex, manual and time-consuming processes associated with the backup, recovery, and cloning of databases in a variety of SAP environments based on SAP's Backup Tools for Oracle. Testing and certification with the SAP's BR*Tools provides customers with the assurance they require to use NetApp for their most critical data center needs. NetApp brings cloning services, speed and reduced cost to SAP environments.

For SAP on Microsoft SQL Server, SnapManager for Microsoft® SQL Server (SMSQL) is the recommended and fully supported Solution. SAP does not provide Backup tools for Microsoft SQL Server. SMSQL Simplifies the SAP Backup/Restore and Cloning Processes.

3.4.4 SnapManager for SQL Server

NetApp SnapManager for SQL Server is a data management solution that streamlines database storage while simplifying configuration, backup, and restore operations for SQL Server databases. SnapManager dramatically reduces SQL Server backup times from hours to seconds and makes every backup a full backup. Backups are based on NetApp Snapshot™ copies, allowing multiple databases of any size to be backed up simultaneously in seconds and requiring minimal disk space for each additional full backup. SnapManager allows organizations to recover from SQL Server outages in minutes – not hours or days – making it one of the fastest backup and recovery solutions available and delivering an industry-leading combination of availability, scalability, and reliability for SQL Server environments.

3.4.5 SnapManager for Oracle

SnapManager for Oracle speeds and simplifies Oracle data management. It empowers Oracle DBAs to utilize the capabilities of NetApp storage systems from an Oracle-centric approach.

SnapManager automates and simplifies the complex, manual and time-consuming processes associated with the backup, recovery, and cloning of Oracle databases. It leverages the NetApp technology stack to create fast and space-efficient snapshot copies. The ability to create, use and delete clone databases for use by non-production teams is a key capability. SnapManager also integrates with native Oracle technology (such as RAC, RMAN and ASM) and across FC, iSCSI and NFS protocols. It enables customers to:

- Scale their Oracle infrastructure
- Meet their Tier1 SLA commitments
- Improve the productivity of both database and storage administrators

3.4.6 SnapManager for Virtual Infrastructure

SnapManager® for Virtual Infrastructure provides storage and virtual infrastructure administrators with an automated solution for data protection and recovery of virtual machines in a VMware® ESX environment. In addition to simplifying and automating storage administration, SnapManager for Virtual Infrastructure empowers virtual infrastructure administrators to perform backup, recovery and replication of virtual machines without assistance, within the policies set by the storage administrator. Key benefits include:

- Automated policy-based data protection of datastores through Snapshots
- Virtual machine-consistent backup through hot-backup mode enablement
- Granular recovery of virtual machine(s) through SnapRestore
- Increased server utilization for application workloads by eliminating interruptions and performance impact caused by traditional backups/restores
- Replication of datastores to secondary sites through SnapMirror, enabling cost-effective disaster recovery
- Eliminates development and maintenance costs of customized scripts for backups, restores and replications
- Easy-to-use interface

3.4.7 Virtual File Manager

Virtual File Manager — Enterprise Edition is a comprehensive and integrated solution that uniquely provides non-disruptive storage consolidation, remote office data management, disaster recovery and data lifecycle management for file data through policy based management leveraging a global namespace. Virtual File Manager directly addresses current needs of both administrators and users by increasing data availability, minimizing user downtime, optimizing storage capacity, and dramatically simplifying storage management. This leads to a significant reduction in the total cost of ownership of enterprise data infrastructures. Virtual File Manager takes advantage of deep integration with NetApp SnapMirror®, SnapLock®, and Snapshot™ to provide its rich set of data management capabilities.

Virtual File Manager - Migration Edition is a migration product for file data. It includes Simplified Namespace Management and facilitates customers to migrate data non-disruptively from other storage to NetApp storage.

3.4.8 SnapDrive Technology for Windows and UNIX

SnapDrive for Windows is an enterprise-class storage and data management solution for the Microsoft® Windows® environments. It simplifies management and increases availability and reliability of the application data. Key SnapDrive functionality includes error free application-storage provisioning, consistent data snapshots, rapid application recovery, and the ability to easily manage data. SnapDrive runs on Windows hosts, complements the native NTFS Filesystem, and integrates seamlessly with Microsoft Cluster Server (MSCS).

With SnapDrive for Windows, server and storage administrators can quickly and easily use a wizard-based approach to map, manage, and migrate data between new and existing NetApp

storage resources from a host-consistent perspective. SnapDrive for Windows eliminates the need to maintain manual scripts normally used to backup and restore data to specific drives or mount points being used by various downstream applications and databases without extensive downtime. It can also be used to easily add additional storage as needed, eliminating the need to pre-allocate large amounts of storage resources based only on forecasted demand.

SnapDrive for UNIX is an Enterprise class storage and data management solution for the Linux and UNIX (AIX, HP-UX, Solaris) environments. It simplifies mapping and managing of NetApp storage to server data across both IP and FC SAN infrastructure, as well as NFS. Key SnapDrive functionality includes error free application storage provisioning, consistent data snapshots, rapid application recovery and the ability to easily manage data with its server-centric approach. SnapDrive runs on Linux and UNIX hosts, complements the native Filesystem and provides the capability to easily navigate the host storage stack. It enables server and system administrators to quickly and easily perform the right tasks required for streamlined data management.

3.4.9 Protection Manager

Protection Manager is an intuitive and innovative backup and replication management software for NetApp disk based data protection environment. Protection Manager delivers greater assurance of data protection and higher productivity by providing policy based management including automated data protection set-up.

3.4.10 Provisioning Manager

Provisioning Manager is automated, policy-based provisioning software for NetApp NAS and SAN environments. The software automates manual and repetitive provisioning processes, increasing the productivity of administrators and improving the availability of data by ensuring that provisioned storage complies with policies. Provisioning Manager improves the productivity of storage administrators by automating repetitive provisioning processes and allowing delegation of provisioning activity to others. It also improves capacity utilization by leveraging flexible volumes and intelligently provisioning storage from resource pools.

3.4.11 Operations Manager

To manage large numbers of systems spread across an enterprise, NetApp offers Operations Manager (OPTS MGR). Operations Manager is a simple, yet powerful application for managing a distributed storage infrastructure. OPTS MGR's support for logical group formation enables administrators to effectively manage large numbers of distributed devices through one centralized interface. Common tasks such as device configuration, software upgrades, provisioning, backup, and monitoring are simplified through device and file system consolidation. Group-based management and monitoring not only alleviate the need for a large IT staff but also provide administrators with a global view of how their network and storage infrastructure is performing on a real-time basis. OPTS MGR also helps ensure data availability and business continuance by allowing administrators to proactively predict and protect against increased demand for storage and data resources through the use of quotas, threshold settings, and the repositioning of data.

In addition to NetApp's management tools, NetApp also offers "plug-ins" for management framework software such as HP's Openview and IBM's Tivoli.

3.4.12 File Storage Resource Manager

The File Storage Resource Manager is an enabling tool to make efficient storage management decisions, such as how much storage is used and what kind of data is consuming the space. File Storage Resource Manager gives insights into the storage by file size, type, age, ownership, least recently accessed files, and most recently modified.

3.4.13 CommandCentral Storage

NetApp CommandCentral Storage (CCStorage) provides a centralized operational console for delivering storage management services in large-scale, heterogeneous, SAN environments. It complements NetApp's native storage management technology and integrates storage resource management, performance and policy management, provisioning and management capabilities. The efficient management of heterogeneous SAN storage resources drives service level agreements, ensuring improved performance and availability. In addition, CCStorage offers customizable policy-based management to automate notification, recovery, and other user-definable actions.

3.5 Security Solutions

3.5.1 Common Criteria Certified

NetApp believes that security starts with a secure operating system that is not prone to attack. NetApp's Data ONTAP is first storage system OS to be Common Criteria Certified to EAL-2 by the National Security Agency (NSA) and National Institute of Standards and Technology (NIST). This will ensure that customer's mission critical Exchange data is stored on a storage system in full compliance with the Federal standards of operating system security.

Additionally, NetApp systems are also able to interface with existing security mechanisms such as Window's Active Directory (AD), UNIX Access Control List (ACL), NIS, IPsec, and VPN. Data from different servers and user groups may be segregated such that data may be accessed only from its proper owner. Only properly authorized users and/or servers may access data that is stored on the NetApp system.

3.5.2 Secure Administration

Storage administration privileges may be protected from unauthorized use and access with NetApp's SecureAdmin software. This software enables authenticated, command-based & GUI based administrative sessions between an administrative user and storage system over an intranet or the Internet using Secure Socket Layer (SSL) and Secure Shell (SSH) protocols. For environments with many administrators, internal security concerns, or the need to implement specific security policies, SecureAdmin authenticates both the administrative user and the server, creating a secure, direct communication link to the storage system. It protects administrative logins, passwords, and session commands from "cleartext" snooping by replacing rsh and telnet with the strongly encrypted SSH protocol. SSH is considered the de facto industry standard for secure command-based administrative sessions. Users are authenticated to the storage system via encrypted passwords once the secure session is initialized. On the storage system, host authentication is accomplished through RSA public key encryption.

Data encryption is supported for transporting encrypted passwords, commands, arguments, and results to and from administrative clients through a secure authenticated channel. SecureAdmin export is subject to the U.S. encryption export regulations.

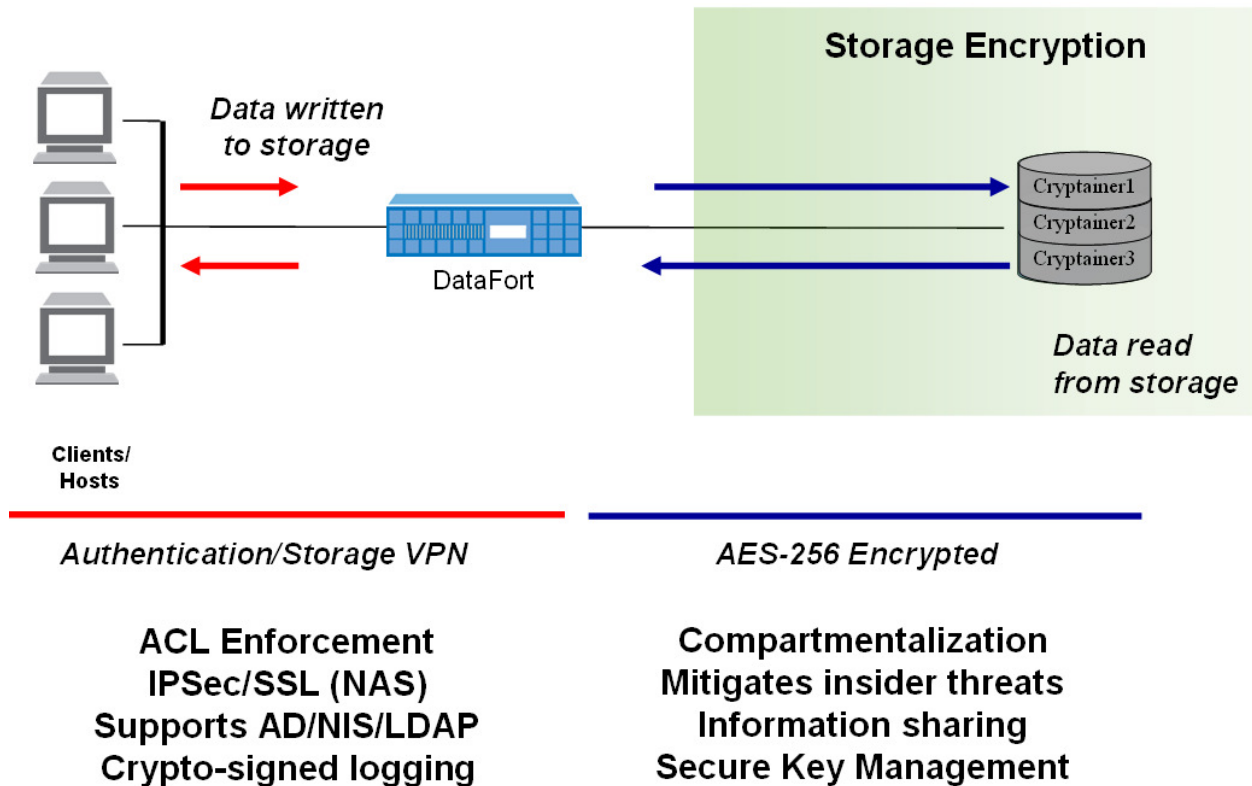
3.5.3 Data Encryption (Disk or Tape)

NetApp offers the DataFort line of encryption appliances. The DataFort appliance provides AES-256 level encryption and FIPS compliance. Data entering the DataFort on one interface is encrypted on-the-fly and exits on a corresponding interface at wire speed. The net result, when placed in front of the storage appliance or tape system, is that all data stored on the devices is encrypted and stays encrypted, regardless of where it is replicated or physically stored. The DataFort does not significantly impact performance of the disk or tape system.

DataFort devices use automated symmetric key management, with keys backed up to a Lifetime Key Management (LKM) server. The keys are also encrypted and never exposed in the clear to the outside world. Each device has its own randomly generated master key at initialization. In remote replication scenarios (for DR), the LKM servers translate from one system's master key to another to allow data to be accessed by authenticated systems at the remote site.

In the event of inadvertent "spillage" from one security domain to another, DataFort has the ability to "cryptoshred" data in place by deleting all the keys in the affected volume, copy and rekey the good data in a new location and permanently destroy the keys for the suspect data.

DataFort Storage Encryption



4. NetApp Software Overview

Software/Feature	Function	Benefit
Data ONTAP	NetApp storage operating system providing full-featured and unified data management for both block and file-serving environments	Single architecture and user interface simplify data management and reduce costs for SAN and NAS deployment
FlexCache	Caches NFS volumes for accelerated file access in remote offices and for server compute farms	Improves performance, response times, and data availability
FlexClone	Instantaneously creates LUN and volume clones without requiring additional storage	Accelerated test and development and storage capacity savings
FlexShare	Prioritizes storage resource allocation to highest value workloads on a heavily loaded system	Ensures that best performance is provided to designated high-priority applications
FlexVol	Creates flexibly sized LUNs and volumes across a large pool of disks and one or more RAID groups	Fast, simple, and flexible storage provisioning and high-capacity utilization
LockVault	Creates WORM-protected archives for unstructured files by combining SnapLock® and SnapVault	Regulatory compliance solution for spreadsheets, presentations, and other unstructured application data
MetroCluster	An integrated high-availability/disaster recovery solution for campus and metro-area deployments	Ensures high data availability when a site failure occurs
MultiStore	Securely partitions a storage system into multiple virtual storage appliances	Enables secure consolidation of multiple domains and file servers
NetApp CommandCentral Storage	A Symantec® product that provides a centralized operational console for delivering storage management services in large-scale, heterogeneous SAN environments	Efficient management of heterogeneous SAN storage resources with improved performance and availability
Operations Manager (formerly DFM)	Manages multiple NetApp systems from a single administrative console	Faster deployment and consolidated management of multiple NetApp systems
Protection Manager	Backup and replication management software for NetApp disk-to-disk environment	Improves productivity through automation of data protection tasks; delivers higher assurance of data protection than with manual execution of tasks by reducing human errors
SnapDrive	Provides host-based data management of NetApp storage from Windows, UNIX, and Linux servers	Simplifies host-consistent Snapshot copy creation and automates error-free restores
SnapLock	Write-protects structured application data files within a volume to provide WORM disk storage	Provides storage enabling compliance with government records retention regulations
SnapManager	Provides host-based data management of NetApp storage for databases and business applications	Simplifies application-consistent Snapshot copies, automates error-free data restores, and enables application-aware disaster recovery
SnapMirror	Enables automatic, incremental data replication between systems: synchronous or asynchronous	Provides flexible, space- and network-efficient site-to-site mirroring for disaster recovery and data distribution
SnapMover	Enables rapid reassignment of disks between controllers within a system without disruption	Enables fast, nondisruptive load balancing within an active-active controller system
SnapRestore	Rapidly restores single files, directories, or entire LUNs and volumes from any Snapshot backup	Enables near-instantaneous recovery of files, databases, and complete volumes
Snapshot	Makes incremental, data-in-place, point-in-time copies of a LUN or volume with minimal performance impact	Enables frequent, nondisruptive, space-efficient, and quickly restorable backups
SnapValidator	Maximizes data integrity for Oracle® Databases	Enhances Oracle Database resiliency in compliance with Oracle HARD initiative
SnapVault	Exports Snapshot copies to another NetApp system, providing an incremental block-level backup solution	Enables cost-effective, long-term retention of rapidly restorable disk-based backups
SyncMirror	Maintains two online copies of data with RAID-DP protection on each side of the mirror	Protects against all types of hardware outages, including triple disk failure
VFM® (Virtual File Manager)	Virtualizes multiple Windows and UNIX file servers into a single logical pool of storage (namespace)	Provides automated, nondisruptive capacity expansion, data replication, and data management across heterogeneous file server environments



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