Technical Report

NetApp Deployment Guidelines and Storage Best Practices for Windows Server 2012 R2

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1 Overview

Windows Server® 2012 R2 is an enterprise-class server operating system that addresses various use cases such as virtualization, private cloud, hybrid cloud, virtual desktop infrastructure, business application hosting, and much more. Windows Server 2012 R2 along with the System Center 2012 R2 offers a comprehensive solution to deploy, manage, protect, and monitor the data center. With Windows Server 2012 R2, there is a deeper integration with storage. NetApp® Data ONTAP® 8.2.1 and its host-side products such as SnapDrive® for Windows® and SnapManager® products offer an end-to-end storage management solution in a Windows Server 2012 environment.

2 Purpose and Scope

This document provides best practices and implementation guidance for NetApp storage in Windows Server 2012 R2 environments. We will discuss important features that NetApp offers to complement Windows Server 2012 R2.

3 Clustered Data ONTAP 8.2.1 and Windows Server 2012 R2

Table 1 lists the scalability numbers for Windows Server 2012 R2

Table 1) Scalability numbers for Windows Server 2012 R2.

Parameter	Scale
Nodes in the cluster	64
VMs per cluster	8,000
VMs per node	1,024
Virtual hard disk capacity	64TB

Table 2 lists the scalability numbers for clustered Data ONTAP 8.2.1.

Table 2) Scalability numbers for clustered Data ONTAP 8.2.1.

Parameter	SAN	SMB
Nodes in the storage cluster	8	24
Storage virtual machines per cluster	1,024	1,024
Maximum size of a 64-bit aggregate	400TB	400TB
Maximum size of a 64 bit volume	100TB	100TB
Maximum Snapshot™ copies per HA pair	510,000	510,000
Maximum LUN size	16TB	NA
Maximum file size	NA	16TB

Considering Table 1 and Table 2, it is clear that both Windows Server 2012 R2 and clustered Data ONTAP 8.2.1 are capable of operating in large environments and can bring immense value in data center consolidations efforts or private cloud and public cloud deployments.

Clustered Data ONTAP 8.2 is a truly unified architecture, in that it supports both file and block protocols: CIFS, iSCSI, FC, FCoE, NFS, and other protocols. This means that a pair of NetApp FAS systems running clustered Data ONTAP 8.2 can support running any or all of the following workloads in a Windows Server 2012 R2 environment simultaneously:

- VMs hosted on continuously available SMB 3.0 shares
- VMs hosted on CSV LUNs running on iSCSI or FC
- SQL Server® databases on SMB 3.0 shares
- SQL Server databases on iSCSI or FC
- Other application workloads

In addition, NetApp's storage efficiency features such as deduplication, SIS clones, thin provisioning, thin replication, compression, and storage tiering provide significant value for workloads running on Windows Server 2012 R2.

4 Networking Best Practices

Ethernet networks in Windows Server 2012 R2 can be broadly segregated into the following:

- Client network for the virtual machines
- Storage network (iSCSI or SMB 3.0 connecting to the storage systems)
- Cluster communication network (heartbeat and other communication between the nodes of the cluster)
- Management network (to monitor and troubleshoot the system)
- Migration network (host live migration)
- Virtual machine replication (Hyper-V® replica): optional if using NetApp SnapMirror® technologies

NetApp recommends having dedicated physical ports for each of the preceding functionalities for network isolation and performance. For each of the preceding network requirements, except for the storage requirements, multiple physical network ports can be aggregated to distribute load or have fault tolerance. The following sections describe major networking features with Windows Server 2012 and things to remember when configuring them.

4.1 Hyper-V Switch

A Hyper-V virtual switch is an extensible switch, which provides communication between the Hyper-V host, virtual machine, and external networks. This enables some essential features for cloud deployments such as secure multi-tenancy, quality of service, and security. Multiple physical ports can be aggregated, and a virtual switch can be created on top of them. This virtual switch can be further used to create virtual network adapters for specific purposes such as cluster communication, management, live migration, replication, and so on.

4.2 Network Virtualization (Software-Defined Networking)

Network virtualization with Windows Server 2012 helps in decoupling virtual networks from the physical network. This is especially helpful in deploying private cloud for organizations or hosters that provide public cloud infrastructure services. Virtual machines can be grouped and isolated securely in a multi-tenant infrastructure having overlapping VM IP addresses.

Best Practices for Configuring Storage Networks in Windows Server 2012 R2

- NetApp recommends having a dedicated virtual switch created on the host for guest storage connection within the virtual machine.
- Confirm that the host and guest iSCSI data paths use different physical ports and virtual switches for secure isolation between the guest and the host.
- NetApp recommends avoiding NIC teaming and using Data ONTAP MPIO configured on the host for storage purposes. For more information, refer to TR-3441: Windows Multipathing Options with Data ONTAP: Fibre Channel and iSCSI.
- NetApp recommends using MPIO within a guest VM if using guest iSCSI initiators. MPIO usage must be avoided within the guest if using pass-through disks. In this case, installing MPIO on the host should suffice.
- When using third-party extensible switch plug-ins, such as Cisco® 1000V in Windows Server 2012, refer to best practices from Cisco to configure IP storage traffic.

It is recommended to avoid applying QoS policies to the virtual switch assigned for the storage network.

Things to Remember

Data ONTAP 8.2.1 does not support RDMA and SMB multichannel.

5 Provisioning in SAN Environments

5.1 Planning for a SAN Environment

When designing the volume and aggregate layouts for your SAN infrastructure, verify that other important factors such as data security, data protection, and meeting service-level agreements are considered. For example, workloads belonging to a business unit within an organization can be isolated into an independent storage virtual machine mapped to multiple aggregates that address specific performance requirements. Identical workloads can have a common data protection policy.

When designing a SAN storage solution, here are some of the key aspects that need to be addressed:

- How many storage controllers are required?
- How many hosts are required in the environment?
- How many host clusters are required in the environment?
- For FC, should the hosts have a single FC HBA or a dual FC HBA?
- For iSCSI, how many ports should be used for storage communication?
- How many network FC switches are required in the environment?

For Fibre Channel SAN best practices, refer to TR-4017: Fibre Channel SAN Best Practices.

5.2 Provisioning Guidelines

For provisioning SAN storage in Windows Server 2012 environments, NetApp recommends installing the following:

- Data ONTAP DSM 4.1 for multipathing
- SnapDrive 7.0.2 for Windows for storage management on the host

5.3 Multipathing

Data ONTAP DSM 4.1 enables users to manage multiple data paths from the host to the storage system. NetApp also supports the native DSM that is available as part of Windows Server 2012 R2 OS.

5.4 Provisioning

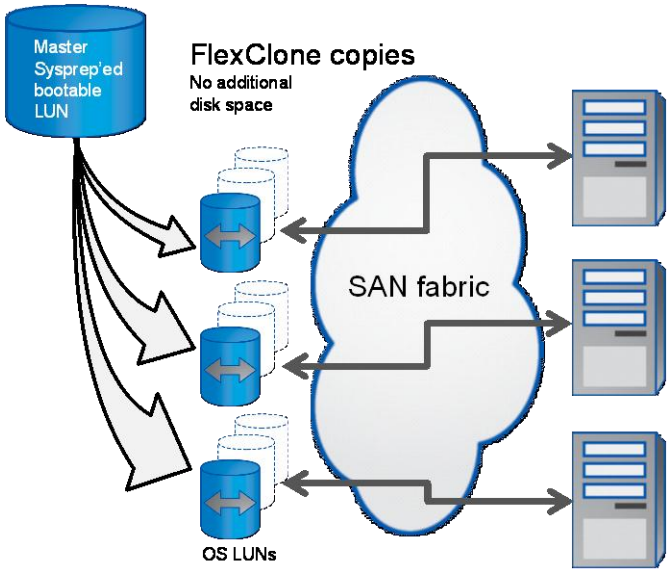
SnapDrive for Windows includes storage management capabilities both for SAN and SMB 3.0. It also contains the VSS hardware provider that enables hardware Snapshot copies. The VSS hardware provider facilitates in backing up the applications by integrating with the SnapManager product suite.

Following sections discuss various use cases that were SAN solutions and can be deployed in Windows Server 2012 R2 environments.

Provisioning for Boot from SAN

A SAN array can hold a set of clean boot LUNs on which Sysprep has been run or LUNs containing boot virtual hard disk (VHD) with the OS ready for minisetup to be run. Using NetApp FlexClone® and SAN boot technologies, such LUNs, or even volumes holding multiple LUNs, can be cloned instantly, and multiple LUN clones can be attached to physical or virtual machines, making clean machines available for the build or test process in a matter of minutes or even seconds. Figure 1 illustrates the LUN cloning process that takes place in the physical machine.

Figure 1) Boot from SAN.



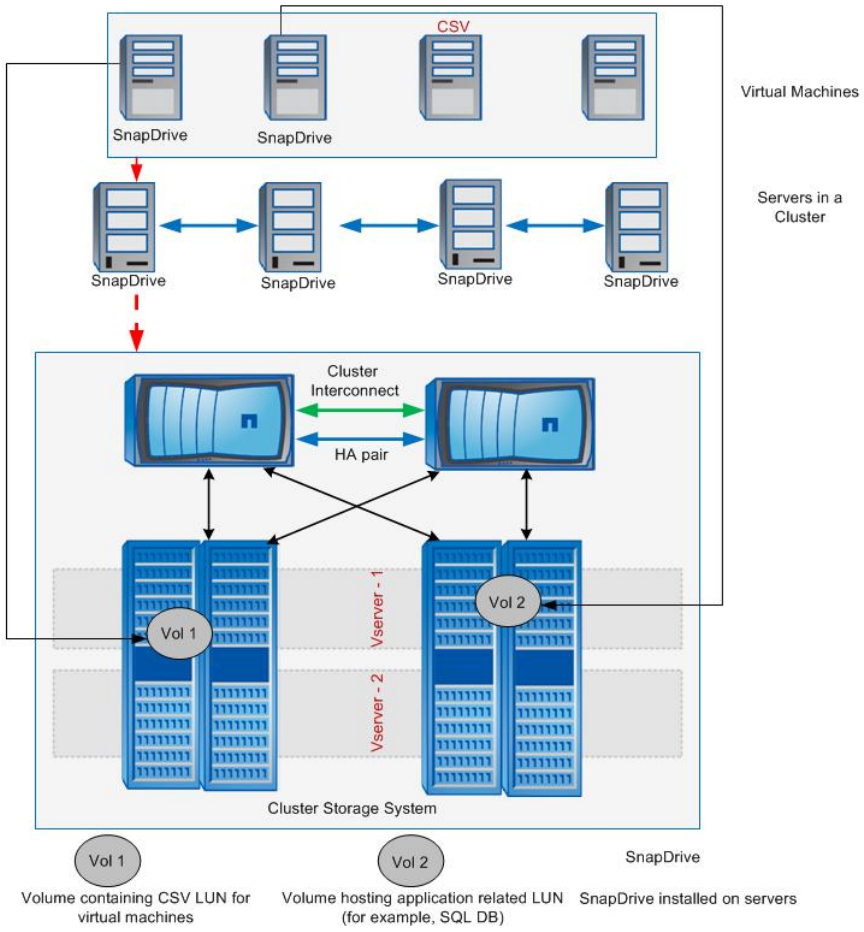
For more information, refer to TR-3922: NetApp and Microsoft Hyper-V in Software Development and Testing Environments.

Provisioning CSV LUNs

SnapDrive 7.0.2 for Windows can be used to provision CSV LUNs in Windows Server 2012 R2 cluster environments. SnapDrive 7.0.2 for Windows supports up to 16 Windows cluster nodes in SAN environments. Each CSV LUN can be of maximum size of 16TB. For more information, refer to SnapDrive 7.0 for Windows for Clustered Data ONTAP 8.2: Best Practices and Implementation Guide.

Figure 2 illustrates provisioning CSV LUNs.

Figure 2) Provisioning CSV LUNs.



Provisioning Virtual Machines

NetApp SAN copy offload feature (virtual machine management section) can help decrease virtual machine provisioning time in a SAN LUN significantly. A golden virtual machine can be first created with all the required software and patches installed in it. Several copies of this VHD file can then be made by initiating a simple iterative copy process. Because the entire copy process is offloaded to the storage system, the host network is not utilized. SAN copy offload feature uses the SIS cloning feature available in clustered Data ONTAP.

NetApp SAN copy offload is supported with Data ONTAP SMI-S provider with System Center Virtual Machine Manager 2012 R2. Large number of VMs can be provisioned using SMI-S and SCVMM, which internally leverages copy offload feature in clustered Data ONTAP.

For more information, refer to https://communities.netapp.com/community/netapp-blogs/msenviro/blog/2014/02/21/leverage-scvmm-2012-r2-offload-data-transfer-odx-for-vm-provisioning-using-data-ontap-smi-s-agent-51.

Methods to Provision Storage to a Virtual Machine

- Adding storage LUN through Virtual Fibre Channel initiator within the VM.
- Adding pass-through physical disk to a VM.
- Adding storage LUN through the iSCSI initiator within the VM.

- Adding VHD/VHDx to a VM from the host.

Adding LUN Through a Virtual Fibre Channel initiator Within the VM: Virtual Fibre Channel Support

Windows Server 2012 supports the provisioning of storage to guest virtual machine through virtual Fibre Channel. Also, features such as live migration and MPIO are supported. Virtual Fibre Channel requires a NPIV-enabled Fibre Channel HBA. At most, four Fibre Channel ports are supported. If the host system is configured with multiple FC ports and presented to the VM, then MPIO must be installed in the VM to enable multipathing. Also, pass-through disks cannot be provisioned to the host if MPIO is being used on the host. This is because pass-through disks do not support MPIO.

Best Practice

If you are using multiple FC initiators on the host, NetApp recommends installing Data ONTAP DSM in the guest virtual machines and also the host to enable multipathing.

SnapDrive supports provisioning of storage through virtual Fibre Channel using Windows Server 2008 R2 SP1 and Windows Server 2012 guest virtual machines. After installing SnapDrive in the VM, SnapDrive recognizes the virtual Fibre Channel initiator and enables storage provisioning. Up to 256 LUNs can be provisioned per vFC port presented to the VM. All the SnapDrive features such as Snapshot copies and restore are supported on a vFC LUN.

Note: For information about FC HBAs, refer to the NetApp Interoperability Matrix.

For more information on virtual Fibre Channel, refer to http://technet.microsoft.com/en-us/library/hh831413.aspx. Also, for more information on how to use virtual Fibre Channel on NetApp storage systems, you can refer to the appendix in this guide.

Best Practices for Provisioning SAN in Windows Server 2012 R2

- Verify that the volumes hosting the LUNs have thin provisioning enabled.
- Verify that ODX is enabled on the storage system. This would significantly increase the copy and provisioning performance in Windows Server 2012 environments.
- Use the latest version of SnapDrive for Windows to establish iSCSI session from the Windows Server 2012 R2 host to the NetApp storage and provision SAN storage.
- To avoid multipathing problems with iSCSI sessions, use either all 10Gb sessions or all 1Gb sessions to a given LUN.
- Confirm that ALUA is enabled on the storage system. ALUA is enabled by default with clustered Data ONTAP systems but needs to be enabled manually for the Fibre Channel–based igroups on 7-Mode systems.
- In case of virtual environments, NetApp recommends hosting the virtual machines and workloads it serves in different aggregates.
- In the storage system, NetApp recommends at least four LIFs per SVM: two data LIFs, one management LIF, and one intercluster LIF (for intercluster replication) per node.
- In Windows Server 2012 R2 environments, it is recommended to use storage features provided by clustered Data ONTAP such as hardware Snapshot copies, HW RAID, cloning, ODX, replication, and so on. Because all these activities are performed by the storage system, this would thereby reduce CPU memory overhead on the host.
- NetApp recommends running NetApp deduplication at the volume level at regular intervals. NetApp provides significant space savings when identical VMs are hosted on a CSV or SMB share. Because the deduplication is running in the storage controller, it does not affect the host system and VM performance.

Things to Remember

- NetApp does not support Windows Server 2012 R2 storage spaces. Storage spaces are used only for JBOD and cannot work with any type of RAID (DAS or SAN). Clustered Data ONTAP implements RAID-DP® or RAID 4. Also, storage spaces does not support boot volumes and cannot replicate data. SnapDrive for Windows integrates with NetApp SnapMirror to replicate data.
- Clustered storage pools in Windows Server 2012 and Windows Server 2012 R2 are not supported by Data ONTAP.
- NetApp supports shared VHDx for guest clustering in Windows SAN environments.

6 Provisioning in SMB Environments

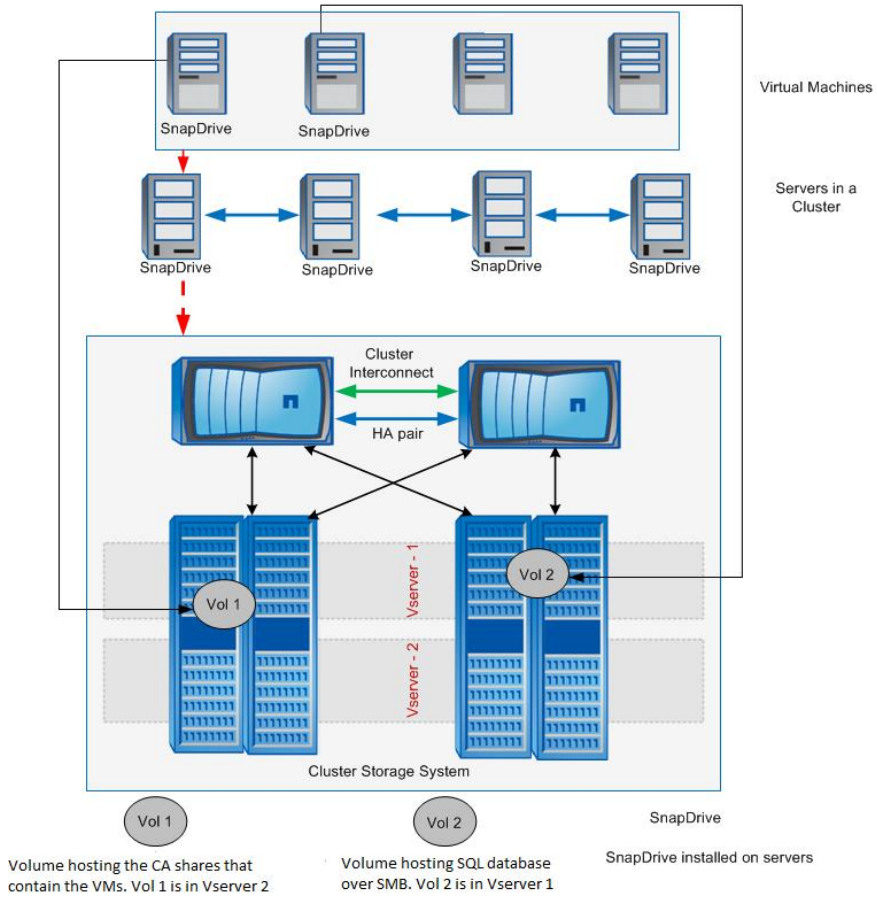
One of the major components added to clustered Data ONTAP 8.2 is support for the SMB 3.0 NAS protocol, which enables NetApp customers to utilize the SMB 3.0 features introduced with Windows Server 2012. With these new features, clustered Data ONTAP can be used to host VM virtual disks and configuration settings on a CIFS file share. In addition to supporting VMs for Hyper-V over SMB 3.0, SQL Server over SMB 3.0 workloads are also supported.

Some of the SMB 3.0 features implemented in clustered Data ONTAP 8.2 to support continuously available file shares and Hyper-V storage are:

- Persistent handles (continuously available file shares for VMs)
- Witness protocol
- Clustered client failover
- Scale-out awareness
- Offloaded data transfer (ODX)
- Remote VSS

Figure 3 illustrates Hyper-V over SMB on NetApp storage.

Figure 3) Hyper-V over SMB on NetApp storage.



6.1 Provisioning Shares for SMB Environments

SnapDrive for Windows can be used to provision SMB 3.0 shares from the host system. SMB shares in Windows Server 2012 R2 can be used to host virtual machines and SQL Server databases. Currently, SnapDrive for Windows supports up to 32 nodes in a Windows failover cluster environment.

SnapDrive 7.0 for Windows also introduced Windows PowerShell® templates that can instantly provision SMB environments depending on the workload on which the user intends to host them. The template is configured per the best practices for the workload that will be deployed on the SMB environment. The Windows PowerShell templates are installed at the following location:

```
C:\Program Files\NetApp\SnapDrive\templates
```

The following templates are available:

- Home directory
- SQL Server over SMB
- Hyper-V over SMB

Note: The preceding templates can be customized depending on the environment.

6.2 Rapidly Provisioning Virtual Machines in Hyper-V over SMB Environments

To confirm faster provisioning of virtual machines in SMB shares hosted on NetApp storage, the CIFS copy offload feature available in clustered Data ONTAP 8.2 can be used. Similar to the SAN copy offload feature, CIFS copy offload enables faster copy of files within a share, between two shares, or to a

different SAN LUN. Because the copy activity is offloaded to the controller, VM provisioning time can be considerably reduced. Several copies of VHD files can be created from a golden VM within seconds.

Things to Remember

- Storage spaces are not supported with SMB 3.0 hosted on NetApp.
- While provisioning volumes for SMB environments, the volumes must be created as NTFS security-style volumes.
- Persistent handles work only between nodes in an HA pair.
- Witness protocol works only between nodes in an HA pair.
- Continuously available file shares are only supported for Hyper-V workloads.
- ODX is supported with clustered Data ONTAP 8.2 and works across protocols. Copying data between a file share and iSCSI or an FCP-attached LUN utilizes ODX.
- CIFS and FlexClone (required by remote VSS of SMHV) licenses should be installed.
- Time settings on nodes in the cluster should be set up accordingly. Network Time Protocol (NTP) should be used if the NetApp CIFS server has to participate in the Windows Active Directory® (AD) domain.
- SMB3 features multichannel, SMB direct, and SMB encryption are not supported.
- RDMA is not supported.
- REFS is not supported.

Best Practices for Hyper-V over SMB on NetApp Storage in Windows Server 2012 R2 Environments

- To confirm there is no downtime when a volume is moved from one node to another or in case of a node failure, enable the continuous availability option on the file share.
- When provisioning VMs for Hyper-V over SMB environment, verify that the copy offload is enabled on the storage system. This will reduce the provisioning time of the VMs.
- If the storage cluster hosts multiple SMB workloads such as SQL Server, Hyper-V, and CIFS servers, check different SMB workloads are hosted on separate storage virtual machines (SVMs; formerly Vservers) on separate aggregates. This is because each of these workloads warrants unique storage networking and volume layouts.
- Connectivity between Hyper-V hosts and the NetApp array is recommended on a 10GB network if one is available. In case of 1GB network connectivity, NetApp recommends creating an interface group consisting of multiple 1GB ports.
- For noncritical SMB 3.0 deployments use SVMs that have aggregates created using SATA drives. This is not possible with storage spaces that depend on shared SAS drives.
- When migrating VMs from one SMB 3.0 share to another, remember to enable the CIFS copy offload functionality on the storage system so that the migration is faster.

Refer to the following:

- https://library.netapp.com/ecmdocs/ECMP1196891/html/GUID-22CB5323-1BBD-4099-BC7F-BA78BA76E12F.html
- https://fieldportal.netapp.com/Core/DownloadDoc.aspx?documentID=95293&contentID=131268
- https://fieldportal.netapp.com/Core/DownloadDoc.aspx?documentID=95480&contentID=131759
- SnapDrive 7.0 for Windows SMB 3.0: Best Practices and Implementation Guide.

For best practices protecting SQL Server workloads in SMB environments using SnapManager for SQL Server, refer to TR-4225: SnapManager for SQL 7.0 Best Practices Guide for Clustered Data ONTAP.

7 Storage Efficiency

7.1 NetApp Deduplication

NetApp deduplication works by removing duplicate blocks at the storage volume level, thereby storing only one physical copy regardless of how many logical copies are present and creating the illusion that there are numerous copies of that block. Deduplication automatically removes duplicate data blocks on a 4KB block level across an entire volume, reclaiming storage to achieve space and potential performance savings by reducing the amount of physical writes to the disk. Deduplication can provide more than 70% space savings in Hyper-V environments.

NetApp recommends enabling NetApp deduplication at the time of volume creation. Using the native deduplication feature with Windows Server 2012 R2 on NetApp storage might result in issues with NetApp cloning capabilities.

7.2 Thin Provisioning

Thin provisioning is an efficient way to provision storage, because the storage is not preallocated up front. In other words, when a volume or LUN is created using thin provisioning, the space on the storage system is unused. The space remains unused until the data is written to the LUN or volume, and only the necessary space to store the data is used. NetApp recommends enabling thin provisioning on the volume and disabling LUN reservation.

7.3 Quality of Service

Storage QoS in clustered Data ONTAP 8.2 provides the ability to group storage objects and set throughput limits on the group. With this ability, a storage administrator can separate workloads by organization, application, business unit, or production or development environments.

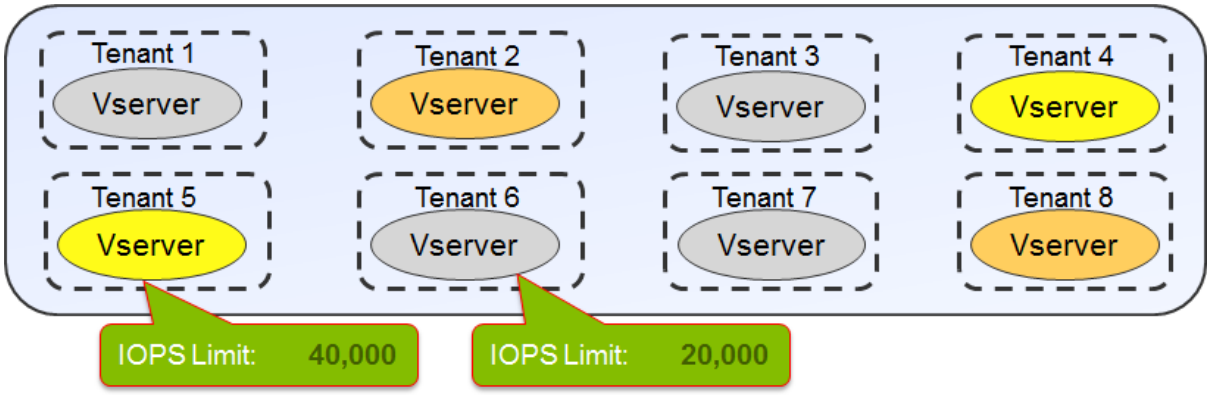
In enterprise environments, storage QoS helps to achieve the following:

- Prevents user workloads from affecting each other
- Protects critical applications that have specific response times that must be met in IT as a service (ITaaS) environments, storage QoS
- Prevents tenants from affecting each other
- Avoids performance degradation with the addition of each new tenant

QoS allows you to limit the amount of I/O sent to a storage virtual machine, a flexible volume, a LUN, or a file. I/O can be limited by the number of operations or the raw throughput.

Figure 4 illustrates SVM with its own QoS policy.

Figure 4) SVM with its own QoS policy.



After configuring SVMs or volumes for QoS, SnapDrive 7.0 for Windows can be used to provision storage from these SVMs onto the host system or the guest virtual machines after adding details of these SVMs on the host. For Microsoft® application-specific QoS best practices, refer to the respective SnapManager best practice guides.

8 VM Backup and Recovery

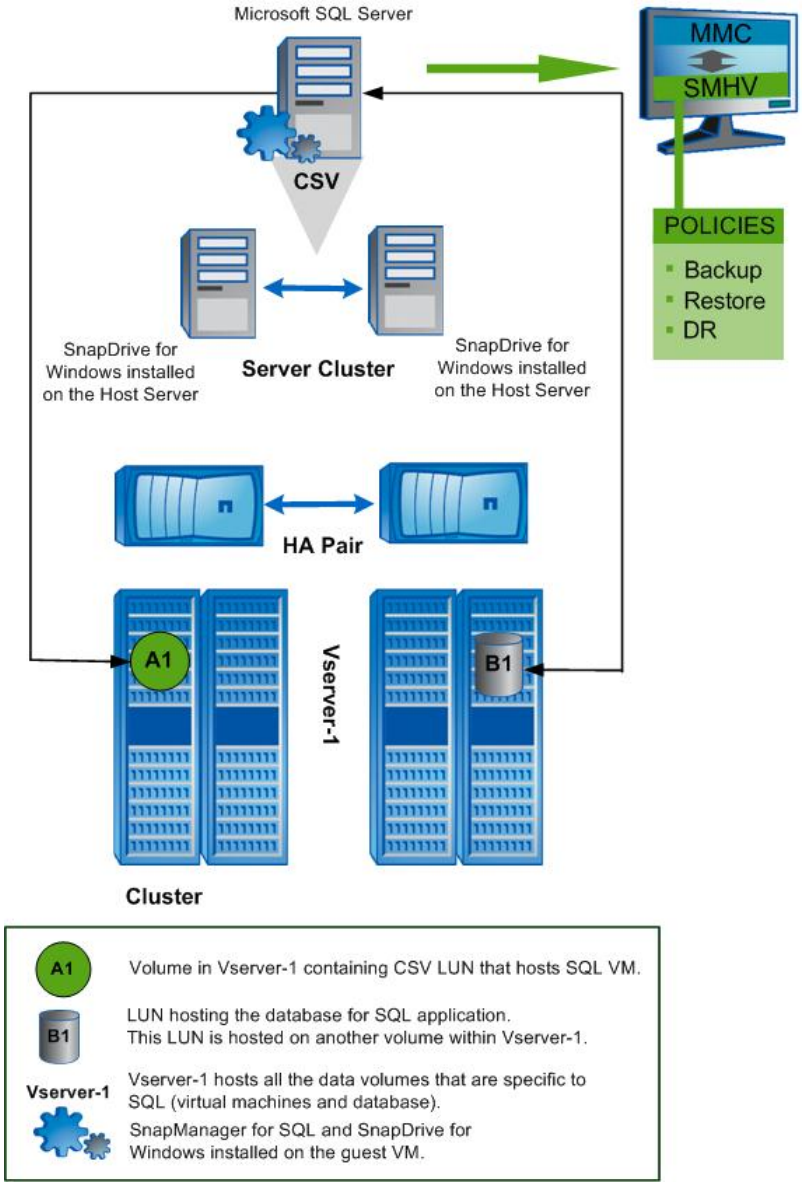
Virtual machines in Windows Server 2012 R2 can be protected using SnapManager for Hyper-V. Backups, restores, and disaster recovery (DR) can place a huge overhead on the Hyper-V virtual infrastructure. NetApp SMHV simplifies and automates the backup process by leveraging the underlying NetApp Snapshot and SnapRestore® technologies to provide fast, space-efficient, disk-based backups and rapid, granular restore and recovery of VMs and the associated datasets.

NetApp SnapManager for Hyper-V protects virtual machines hosted on CSVs and SMB 3.0 shares by integrating with the VSS framework. In case of VMs hosted on CSVs, SnapManager for Hyper-V integrates with SnapDrive for Windows, which contains the VSS hardware provider to transfer Snapshot copies to the NetApp storage system. In case of VMs hosted on SMB 3.0 shares, clustered Data ONTAP 8.2 implements the remote VSS framework on the storage controller, which performs Snapshot copy operations on SMB 3.0 shares.

NetApp SnapManager for Hyper-V integrates with SnapMirror for replication and SnapVault® for creating a secondary copy of VM data. This means virtual machines can backed up, replicated to a SnapMirror destination volume for disaster recovery, and also vaulted to a SnapVault system in a single workflow. This confirms end-to-end data protection of Hyper-V environments.

Figure 5 illustrates VM backup and recovery.

Figure 5) VM backup and recovery.



For best practices on data protection with SnapManager for Hyper-V, refer to the SnapManager for Hyper-V best practice guide available at http://www.netapp.com/us/media/tr-4226.pdf.

For best practice guidance on protection for applications such as SQL Server, SharePoint®, and Exchange, refer to the respective best practice guides available at fieldportal.netapp.com.

9 VM Disaster Recovery

SnapManager for Hyper-V integrates with SnapMirror to provide disaster recovery solutions for VMs hosted on Windows Server 2012 R2. Virtual machines can be backed up and replicated to a secondary site using SnapManager for Hyper-V. SnapManager for Hyper-V can also create a secondary copy by integrating with SnapVault. Because the replication is performed at the storage level, there is no overhead on the host CPU, memory, and network.

Note: Hyper-V replica does not support storage-level replication and hence is not supported by NetApp.

Figure 6 illustrates VM disaster recovery.

Figure 6) VM disaster recovery.

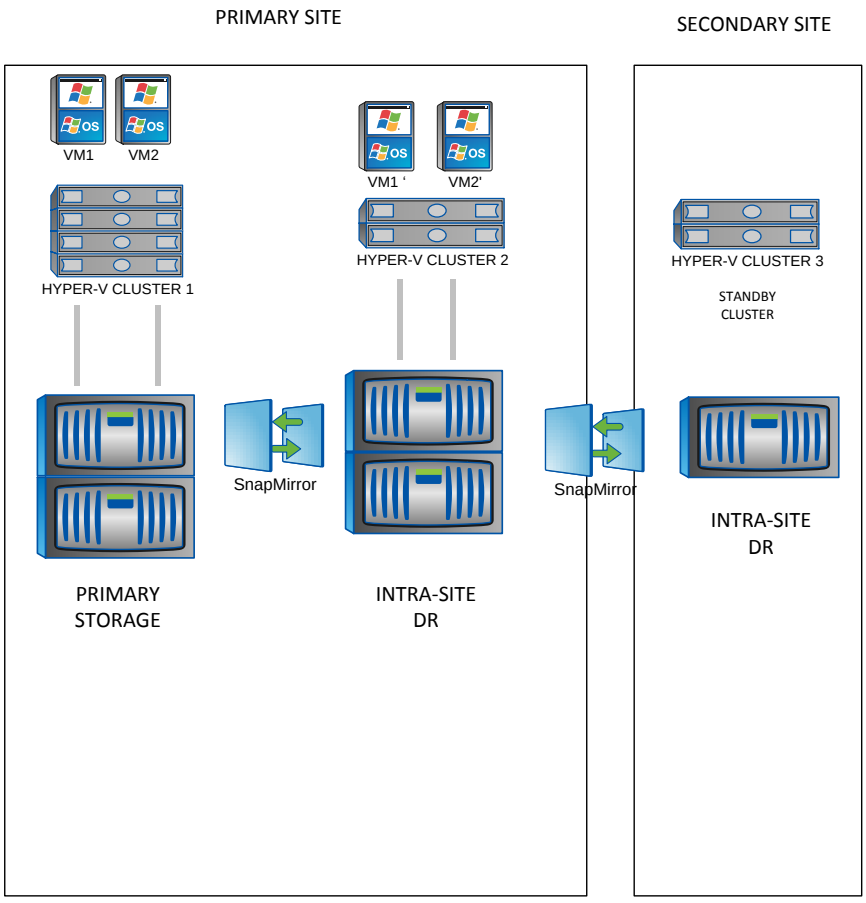


Figure 6 represents a comprehensive DR solution for a Hyper-V environment in which data is protected through a cascading SnapMirror to SnapMirror to SnapMirror relationship. Here the primary site consists of the primary storage hosting the VMs of "HYPER-V CLUSTER 1." The primary storage is mirrored to a second storage cluster within the primary site. In the event of the partial site outage due to a power failure, the virtual machines can be brought online by mounting the LUNs in the SnapMirror destination volume onto "HYPER-V CLUSTER 2." From the second storage cluster, data is mirrored using SnapMirror to a storage system in the disaster recovery site.

10 Monitoring

Hyper-V storage infrastructure hosted on NetApp storage systems can be monitored by System Center Operations Manager. This can be achieved after importing the SCOM management pack, which is part of the OnCommand® Plug-In for Microsoft suite of products, into the SCOM console. The SCOM management pack can be used to monitor Data ONTAP 8.2 clusters and storage virtual machines. It also monitors the VMs in SMB shares and CSV LUNs. Also, the SCOM management pack can detect misaligned VHDs.

In addition to providing the storage layout of the infrastructure, the SCOM management pack also provides users with performance counters for measuring CPU utilization per volume and LUN-level latency. For more details, refer to [NetApp OnCommand Plug-in for Microsoft.]

11 Virtual Machine Management

During the lifetime of the virtual machines, they are sometimes required to move to a different host on the Windows cluster. This might be required if the host is running out of system resources or if the host is required to reboot for maintenance reasons. Similarly, the VM might sometimes be required to move to a different LUN or an SMB share. This might be required if the present LUN or share is running out of space or yielding lesser than expected performance. Following are the different cases of virtual machine migration and their best practices.

11.1 Host-Level Live Migration

The virtual machine is moved from one node of the Hyper-V cluster to another node. Moving VMs from one node to another node of the cluster does not affect the backup policies of the cluster. Backup and restore operations will continue to operate successfully.

Best Practice
Have a dedicated host live migration network to avoid network-related issues during migration.

11.2 Storage Live Migration Using NetApp ODX in Windows Server 2012 R2

Copy offload, or ODX, provides a mechanism to perform full-file or subfile copies between two directories residing on remote servers, where the server can be the same or different. Here, the copy is created by copying data between the servers (or same server if both source and destination files are on the same server) without the client reading the data from source and writing to the destination. This reduces the client/server processor/memory utilization and minimizes network I/O bandwidth.

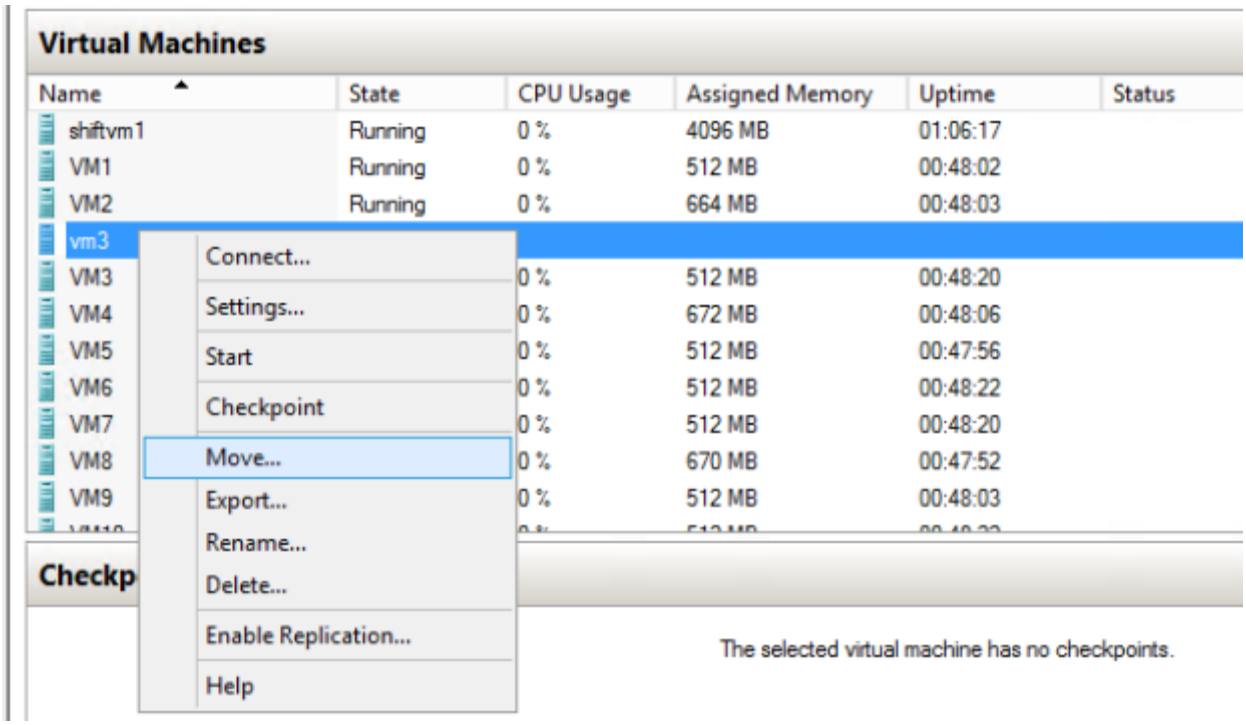
When the LUN or the share that currently hosts the VM runs out of space, is being repurposed, or is not providing expected performance, the virtual machine can be moved to another LUN or share on a different volume, aggregate, or cluster. This can be achieved without downtime. This process is faster if the storage system has copy offload capabilities. NetApp storage systems are copy offload enabled by default for CIFS and SAN environments. Before proceeding with copy operation on the host, confirm that the copy offload settings are configured on the storage system. Host-side products such as SnapDrive 7.0.2 for Windows do not enable copy offload settings on the storage system directly. After provisioning LUNs/shares using SnapDrive, activities such as storage live migration and file copy are offloaded to the storage system, and SnapDrive does not participate in these operations.

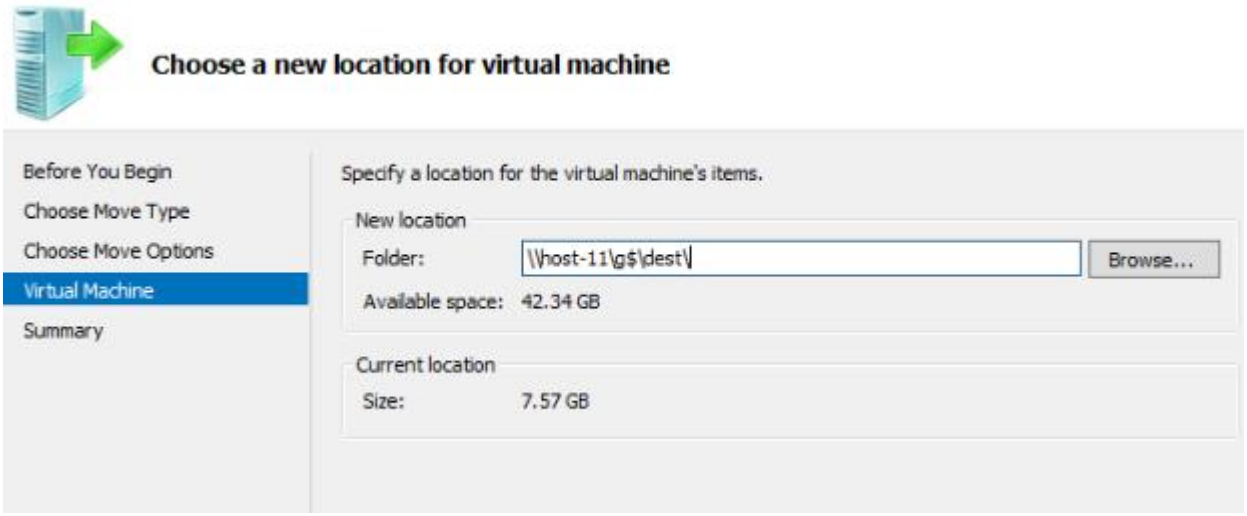
When a VM storage live migration is initiated from a host, the source and the destination are identified, and the copy activity is offloaded to the storage system. Because the activity is performed by the storage system, there is negligible utilization of the host CPU, memory, or network.

After the migration is complete, the backup and replication policies must be reconfigured to reflect the new volume holding the VMs. Any previous backups that were taken cannot be utilized.

11.3 Shared Nothing Live Migration

In case of shared nothing live migration, the entire virtual machine can be moved to a different cluster or a standalone host. Because shared nothing live migration can work with just a TCP/IP connection between the source and the destination, the network is often a bottleneck, and migration takes a significant amount of time. Shared nothing live migration can leverage copy offload technology if the source and the destination volumes are in the same NetApp storage cluster. Therefore, in a case in which a VM would take 20 to 30 minutes to copy over the network, it could be accelerated to just under 2 minutes.



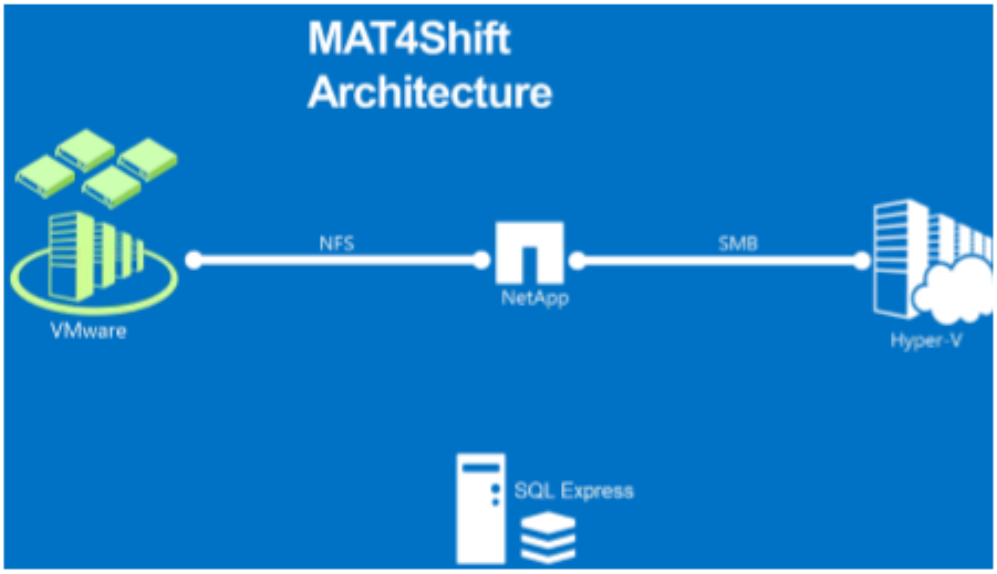


11.4 Node Draining

Node draining is a Windows Server 2012 feature in which a node of a cluster can be paused, and its resources such as virtual machines can be moved to another healthy node in the cluster. During node draining, NetApp recommends performing quick migration if the VM can afford a downtime. This is because quick migration usually consumes less network bandwidth and is quicker than live migration. Setting the priorities so that VMs of higher priority are started first after migration and can start serving clients is recommended. Also, VMs with higher priorities can be set to be live migrated, and VMs with lower priority can be set for quick migration.

In case of Windows Server 2012 R2, if a node in a cluster is shut down, the cluster automatically live migrates all running virtual machines before shutdown.

11.5 Migration from VMware to Hyper-V Environments



Large-scale virtual machine conversion from VMware® to Hyper-V environments can cause a considerable amount of downtime and is not acceptable for large enterprises. NetApp and Microsoft have developed a tool to make this conversion faster and reduce downtime. The conversion is faster because the conversion operation is offloaded to the storage system, where Data ONTAP cloning technology is utilized.

Virtual machines residing on NFS datastores can be converted to VHDs and placed in SMB shares.

For more information, refer to https://kb.netapp.com/support/index?page=content&id=S:3013969.

12 Security

Bitlocker is data protection software that is available with Windows Server 2012. In addition to protection of physical disks, bitlocker can also protect clustered shared volumes and SMB shares. Bitlocker can be enabled using server manager or Windows PowerShell cmdlets. SnapDrive for Windows supports management of CSV disks that are encrypted with bitlocker.

Best Practice
Before enabling bitlocker, the clustered shared volume needs to be put into maintenance mode. Therefore it is recommended that before creating VMs on the CSV, decisions pertaining to bitlocker-based security must be made to avoid downtime.

13 Windows PowerShell

NetApp host-side products such as SnapDrive 7.0 for Windows, SnapManager 2.0 for Hyper-V, and other SnapManager products offer Windows PowerShell cmdlets as an alternative to the GUI. Most GUI operations can be executed by running the Windows PowerShell cmdlets that are packaged with the product. Windows PowerShell cmdlets can be utilized to implement a scripted custom workflow.

In addition to these host-side products offering Windows PowerShell cmdlets, NetApp offers the Data ONTAP PowerShell toolkit, which enables most storage operations to be executed using Windows PowerShell on the host. After the toolkit is installed on the host, common storage management operations can be executed using the Data ONTAP PowerShell toolkit.

For more information, refer to TR-4161: Data ONTAP PowerShell Toolkit Primer (First-Steps Guide for Data ONTAP Automated Management Using PowerShell).

Appendix

Sequence of Deployment of Storage System in SAN Environments

1. Set up the cluster environment. Refer to the Data ONTAP 8.2 Installation and Administration Guide, available on the NetApp Support site.
2. Create an aggregate.
3. Create an SVM.
4. Create iSCSI service or FC service to set up an iSCSI or FC target node.
5. Configure the network for the SVM:
   a. The data LIFs, which enable SVMs to serve data to the clients (iSCSI and FCP)
   b. The management LIF, which allows SnapDrive to communicate with the other LIFs to serve data
6. Create data volumes of the required size. SnapDrive uses these volumes to create and manage LUNs.
7. For data protection within the cluster, perform the following additional steps:
   a. Create a volume in the SVM of the secondary SVM. Make sure that the property of that volume is of the DP type.
   b. Establish a SnapMirror relationship between the primary and the secondary for intercluster SnapMirror replication. Make sure that at least one intercluster management LIF is present in each node on both primary and secondary storage systems.

   For more information about data protection, refer to:
   - Data ONTAP 8.2 Cluster-Mode Data Protection Guide
   - SnapMirror FAQ

Note: SnapDrive does not support single sign-on when connected to clustered Data ONTAP.

Note: Unlike earlier version of SnapDrive, SnapDrive 7.0 for Windows does not require providing cluster VSM credentials for updating SnapMirror using SnapDrive.

Version History

Version	Date	Document Version History
Version 1.0	May 2014	Initial release

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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