Technical Report

NetApp HCI Data Protection

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Abstract

This document introduces data protection with NetApp® HCI.
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1 Introduction

NetApp HCI is designed on the foundation of SolidFire® all-flash storage hardware and software to deliver enterprise-class performance. A self-healing design and robust integrated data services make sure that you reach availability SLAs and can sustain multiple failures and restore full resilience quickly without administrator intervention and without affecting application performance. Built for the next-generation data center, NetApp HCI Element® OS was designed to meet the high-availability standards and data assurance that are expected from enterprise-class arrays. It was also designed to be ready for tomorrow's applications and data demands. As protecting data becomes ever more important, the native data protection features of Element OS are essential to all infrastructures.

NetApp HCI is an enterprise-scale hyper converged infrastructure solution ideally suited for customers who are looking to break free from first-generation HCI limitations.

NetApp HCI customers can run multiple applications with guaranteed performance to confidently deploy resources across the entire data center. The architecture allows you to deploy your infrastructure by simplifying management and independently scale both compute and storage resources. NetApp HCI is Data Fabric ready out of the box for easy access to all your data across any public, private, or hybrid cloud. By moving to NetApp HCI, IT organizations can transform their data center, driving operational efficiencies and reducing costs.

Data Fabric is a software-defined approach from NetApp for data management that enables businesses to connect disparate data management and storage resources. NetApp HCI can streamline data management between on-premises and cloud storage for enhanced data portability, visibility, and protection.

Figure 1) NetApp HCI architecture overview.

1.1 Performance Guarantee

A common challenge for a data center is delivering predictable performance, complicated even more by running multiple applications sharing the same infrastructure. One application interfering with other applications creates performance degradations, causing IT admins to spend valuable time troubleshooting the environment. Mainstream applications, such as virtual desktop infrastructure (VDI) and database applications, have unique I/O patterns that can change during the day and affect one another when deployed in a shared environment. The NetApp HCI quality of service (QoS) feature allows fine-grained control of performance for every application, eliminating noisy neighbors, meeting unique performance needs, and satisfying performance SLAs. The storage architecture, which is part of the NetApp HCI solution, eliminates performance variance in the context of data locality because the data is distributed across all the nodes in the HCI cluster.
1.2 Enterprise Scale

The ability to scale compute and storage independently is critical in any environment. First-generation HCI solutions have done a good job of delivering initial configurations but have limited capability when things start to change. Running on innovative NetApp HCI technology and delivered on an architecture designed by NetApp, NetApp HCI is an enterprise-scale hyper converged infrastructure solution. NetApp HCI comes in 2RU x 4-node building blocks (chassis) with compute and storage nodes available in small, medium, and large sizes. NetApp HCI scales compute and storage resources independently and avoids costly and inefficient overprovisioning, thus simplifying capacity and performance planning. Scaling is as easy as adding additional nodes for compute, storage, or both.

1.3 Streamline Operation

A common goal of IT organizations is to automate all routine tasks, eliminating the risk of user error associated with manual operations and allowing valuable resources to be focused on higher value priorities that drive business efficiencies. NetApp HCI allows IT departments to become more agile and responsive by simplifying day-zero deployment and ongoing management tasks. The NetApp Deployment Engine (NDE) eliminates many manual steps it takes to deploy infrastructure, while vCenter with the NetApp HCI management plug-in provides a single interface to manage both compute and storage resources. Additionally, a robust suite of APIs enables seamless integration into higher-level management, orchestration, backup, and disaster recovery tools.

Data Protection in vSphere

Figure 2) NetApp HCI data protection in the vSphere management plug-in.

2 Native Integrated Data Protection Features

2.1 Enterprise Reliability and High Availability

NetApp HCI Helix data protection is a RAID-less data protection solution designed to maintain both data availability and performance regardless of failure condition. Helix data protection is a distributed replication algorithm that spreads at least two redundant copies of data across all drives in the system. Our approach allows the system to absorb multiple failures across all levels of the storage solution while maintaining data redundancy and QoS settings.

Failure Prevention

- **Shared-nothing storage architecture.** NetApp HCI shared nothing storage architecture has no single point of failure and completely eliminates common failure scenarios where loss of availability of data might occur.
- **Fully redundant storage architecture.** NetApp HCI automatically rebuilds redundant data across remaining storage nodes in minutes to maintain high availability with minimal impact to performance degradation upon disk or controller failures.
**Data Protection**

- **Nondisruptive software and hardware upgrades.** NetApp HCI clustered architecture allows nondisruptive software upgrades on a rolling node-by-node basis. Upgrades can be done during production hours with little to no workload impact.

- **Self-healing architecture.** The NetApp HCI system can recover from failures in minutes and is fully automated. Failure recovery requires no operator intervention, eliminating the fire drills common with traditional RAID-based architectures:
  - NetApp HCI automatically rebuilds redundant data across remaining nodes in minutes to maintain high availability with minimal impact to performance. RAID-based systems suffer significant performance degradation upon disk or controller failures, taking hours or days to restore redundancy and equally long to replace failed hardware.
  - With NetApp HCI, recovering from failures takes minutes and is fully automated. In a failure event, each drive in the system redistributes a small percentage of its data (usually 1% to 2%) in parallel to the free space on all remaining drives. Failure recovery requires no operator intervention, eliminating the fire drills common with traditional RAID-based architectures.

  No matter the failure mode—drive, node, backplane, network failure, or software failure—the recovery process is the same. Because the recovery workload is distributed across all nodes in the cluster, redundancy is restored quickly, and no single node (or application workload) takes a performance hit. The more nodes in the cluster, the faster the activity occurs and the lower the overall impact.
  - Secure assist
  - 24/7/365 worldwide availability
  - Expert tier 3 support engineers only
  - Active IQ® monitoring

Table 1 shows various events that do not cause downtime and their associated effects on the NetApp HCI cluster.

**Table 1) High-availability event impact.**

<table>
<thead>
<tr>
<th>Event</th>
<th>Causes Downtime</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSD failure</td>
<td>No</td>
<td>Fully automated</td>
</tr>
<tr>
<td>Node failure</td>
<td>No</td>
<td>Fully automated</td>
</tr>
<tr>
<td>HW upgrades/replacement</td>
<td>No</td>
<td>Seamless</td>
</tr>
<tr>
<td>Hardware expansion</td>
<td>No</td>
<td>Instant resource availability</td>
</tr>
<tr>
<td>Software upgrades</td>
<td>No</td>
<td>Rolling/online</td>
</tr>
</tbody>
</table>

**2.2 Data Reduction**

**Global Efficiency**

- Inline and postcompression
- Distribute data automatically (no hot spots) with always-on deduplication
- Global thin provisioning
Deduplication
• Cluster-wide, across all volumes
• Garbage collection cleans up blocks that are no longer referenced by any metadata (including Snapshot™ copies)

Compression
• Compression is completely inline, with no performance impact
• During a write, a block is compressed, and during the recycling process blocks are recompressed to provide even greater efficiency

Thin Provisioning
• Data thin provisioning is always on and requires no capacity reservations.
• Has no negative performance impact.
• Thin provisioning automatically reclaims unused space and stays thin by reclaiming zeroed data and data released by the operating system.
• Saves capacity and makes the effective capacity of the system higher without any extra cost.
• Makes the system recover from faults faster too because unwritten data does not need to be rebuilt or rebalance. It reduces the I/O required to do the same tasks and reduces network bandwidth required to transmit data between nodes.
• Another benefit that comes from the increased efficiency is power/cooling/space. It takes less of those if the excess capacity is not provisioned where it is not needed.

2.3 Real-Time Replication
With the built-in synchronous and asynchronous replication of NetApp HCI, you can quickly copy data between multiple sites, regardless of where your clusters sit. Synchronous replication confirms data synchronization for your mission-critical data in near real time. Asynchronous replication protects against hardware failure and natural disaster incidents over long distances through bidirectional replication, allowing each replication partner to fail over or fail back, respectively. And with no additional licenses or support needed, costs are reduced. Plus, by finding additional uses for your remote copies, you can drive more revenue from your data. The simplified management of NetApp HCI facilitates flexible replication to multiple locations from a single cluster.

Replication use cases:
• Programmatic replication control
  – Initiate replication
  – Pause/unpause
  – Change replication mode
• Disaster recovery (DR), backup, and dev/test
• Combine replication with Snapshot copies, clones, copyvolume to create robust workflows

2.4 Snapshot Copies and Clones
NetApp HCI enables you to get the most out of the storage layer by allowing for the creation of instant replication-ready copies, zero-RTO Snapshot backups and restores, and massively efficient poly-use clones. When combined with native NetApp HCI features such as per-volume QoS controls, this enables advanced topologies with the economics of shared infrastructure, unlocking architectural patterns and flexibilities that no other storage architecture can provide.

Using NetApp HCI volume Snapshot copies is an exceedingly simple process and can drastically reduce TCO for backups due to simplification of maintenance tasks and minimization of storage overhead.
Backups on NetApp HCI can be accompanied with no system impact or maintenance window and automated using the NetApp HCI API.

Similarly, spinning off a clone on NetApp HCI is as easy as taking a Snapshot backup. By using the clone from Snapshot functionality to copy the volume metadata to a different account, you can then mount the volume to another instance mount point. Because NetApp HCI deduplicates system wide, the majority of the initial data does not require additional capacity utilization. The ability to clone from Snapshot copies reduces both capital (storage) and operational (administration) outlays, driving TCO from both sides.

Snapshot copies:
- There is no performance impact from the Snapshot operation.
- Snapshot copies are crash-consistent, point-in-time references of a volume. If you want to make a Snapshot copy of a live file system, consider suspending writes on the client beforehand.
- You can replicate Snapshot copies to a remote NetApp HCI cluster and use them as a backup copy for the volume. This enables you to roll back a volume to a specific point in time by using the replicated Snapshot copy; you can also create a clone of a volume from a replicated Snapshot copy.
- You can create a new volume from a Snapshot copy of a volume. When you create a volume that way, the system uses the Snapshot information to clone a new volume by using the data that is contained on the volume at the time that the Snapshot copy was created. This process also stores information about other Snapshot copies of the volume in the newly created volume.
- You can use the integrated backup feature to back up a volume Snapshot copy. You can back up Snapshot copies from a NetApp HCI cluster to an external object store or to another NetApp HCI cluster. When you back up a Snapshot copy to an external object store, you must have a connection to the object store that allows read/write operations.

Snapshot backup operations:
- Backing up a volume Snapshot copy to an Amazon S3 object store
- Backing up a volume Snapshot copy to an OpenStack Swift object store
- Backing up a volume Snapshot copy to a NetApp HCI cluster

Clones:
- There is no performance impact from the cloning operation.
- Clones have the same QoS level as the parent volume.
- Cloned volumes have no explicit link to their parent, so you are free to delete the parent volume at any time without affecting any clones.
- Volumes can be resized (grown or shrunk) during the cloning process. NetApp recommends not shrinking a volume. It is a best practice to create a smaller volume, copy the data over from the file system, and then delete the original volume.
- Cloned volumes are crash-consistent, point-in-time copies of a volume. If you want to make a NetApp Snapshot copy of a live file system, consider first suspending writes on the client before making the copy.
- Only two active clone requests can be running at one time for a single volume. All subsequent clone requests are queued for later processing.
- Only a total of eight active volumes can be cloned at one time. All subsequent clone requests are queued for later processing.
- A clone is a readable and writable full copy of the original data but often takes little space due to deduplication. Clones are point-in-time copies also.
- Cloned volumes can be changed from read/write to read-only or can be set as locked.
2.5 Integrated Backup and Restore

The native data protection in NetApp HCI extends past the cluster to any Amazon S3 or Swift-compatible system with integrated backup and restore. The API-driven backup makes it easy to manage at scale, and it automatically resumes backup after an interruption. The incremental backup approach reduces network traffic, and the host impact is also reduced through direct transfer of data. The system maintains data efficiencies during backup, reducing network traffic, shortening backup windows, and using less target storage.

Figure 3) NetApp HCI integrated backup and restore.

Volume backup and restore operations:

- You can configure the system to back up and restore the contents of a volume to and from an object store container that is external to NetApp HCI storage using Amazon S3 or OpenStack Swift. You can also back up and restore data to and from remote NetApp HCI storage systems.
- Data format:
  - **Native.** A compressed format readable only by NetApp HCI storage systems.
  - **Uncompressed.** An uncompressed format compatible with other systems.
- Automate:
  - Automatically resume backup after interruption
  - API-driven backup makes it easy to manage at scale
- Economical:
  - Allows for data protection without requiring third-party tools
  - Easily incorporate object storage into your data protection strategy
  - Offload infrequently used point-in-time copies of data from SSD
- Efficient:
  - Uses incremental backup approach to reduce network traffic
  - Reduce host impact with direct transfer of data
  - Maintains data efficiencies during backup, reducing network traffic, shortening backup windows, and using less target storage
Note: You can run a maximum of two backup or restore processes at a time on a volume.

3 Data Fabric

Enterprises are under tremendous pressure to harness today's wealth of data and apply it to create new value and competitive advantage, all with limited time, skills, and budget. The Data Fabric is the NetApp vision for the future of data management. NetApp HCI is NetApp Data-Fabric ready out of the box, making sure that you can leverage the full potential of your data to be unleashed, whether on the premises or in a public or hybrid cloud.

Figure 4) NetApp HCI Data Fabric integration points.

NetApp HCI Data Fabric Integration Points
Robust integrations provide additional services through the Data Fabric and third parties, including:
- File services out of the box using ONTAP® Select
- Object services using StorageGRID®
- Replication with NetApp SnapMirror®
- Backup and recovery using AltaVault™ and/or Commvault/Veeam
- Orchestration and disaster recovery using VMware vRealize and Site Recovery Manager

4 ONTAP Select
- Leverage single HCI platform for block storage access and NAS file services
- Provide basic infrastructure NAS file services to support a VDI or private cloud deployment
- Dynamically add capacity on the fly in increments as small as 1TB
- Utilize the industry's #1 storage operating system for proven file services: NetApp ONTAP is the world's #1 open networked branded storage OS (source: IDC, Worldwide Quarterly Enterprise Storage Systems Tracker - 2017Q2, Sept 14, 2017)
5 SnapMirror

With the release of ONTAP 9.3 and Element OS 10.1, SnapMirror will be native between NetApp HCI and FAS storage systems. For the initial release, replication from NetApp HCI to FAS will be supported as well as recovery from FAS to HCI.

If your organization is ready to add NetApp HCI to your environment, you can still leverage your existing investments in NetApp All Flash FAS (AFF) and FAS systems as secondary storage for multiple use cases. You can use AFF or FAS systems to protect against storage outages, with easy DR relationship setups. The storage-efficient transport mechanism transfers only changed data to the secondary site, which reduces recovery time and enables more frequent replication. Because SnapMirror stores data in its native format, it maximizes your investment in DR infrastructure, while your DR site copies can help accelerate development. Further leverage your data protection copies by creating zero-impact copies of the replicated data for development and testing. Data that is replicated from a SolidFire system to AFF or FAS can benefit from the rich data management capabilities of ONTAP. NetApp SnapMirror technology provides an agile, flexible, and secure way to transport data between storage systems, protecting your data and improving accessibility across the Data Fabric.

The primary use case is DR of NetApp HCI systems to FAS. The procedure for replication and recovery of volumes is a four-step process as shown in Figure 5.

Figure 5) NetApp HCI SnapMirror to ONTAP.

1. Establish link and replicate.
2. Promote FAS volumes.
3. Replicate back to NetApp HCI.
4. Fail back to NetApp HCI volumes.

6 StorageGRID Webscale

Object storage backup:

- Direct from NetApp HCI, managed by NetApp HCI
- S3 to webscale
- Format options:
  - Native. Deduped, compressed, readable only by NetApp HCI.
  - Uncompressed. Open format.

Figure 5) NetApp HCI to StorageGRID.

7 AltaVault

AltaVault storage enables customers to securely back up data to any cloud at up to 90% less cost compared to that of on-premises solutions. AltaVault gives customers the power to tap into cloud economics while preserving investments in existing backup infrastructure and meeting backup and recovery SLAs. This feature allows a flexible infrastructure in which one or more applications can move the data to a single AltaVault appliance.

AltaVault is designed to allow the most recent backup data to remain locally cached. All data is replicated to cloud storage. Cloud storage can consist of a private object storage solution for replication between sites of data that cannot be stored in a public cloud. In Figure 7, NetApp HCI communicates with a backup server connected to AltaVault, providing connectivity options to both the public cloud and private cloud in the form of StorageGRID.
8 Partnered Solutions

8.1 VMware vCenter Site Recovery Manager (SRM)

VMware vCenter Site Recovery Manager (SRM) simplifies DR by automating data protection and failover/failback processes.

Integrated Disaster Recovery for Your VMware Environment

- NetApp HCI integrates seamlessly with VMware’s SRM, making sure of availability and performance control for disaster recovery.
- VMware’s site recovery manager pairs extremely well with NetApp HCI’s QoS architecture and integrated remote replication functionality, providing superior performance control for disaster recovery.
- Only NetApp HCI with VMware enables IT management to set and enforce fine-grained QoS policies to each virtual disk in the NetApp HCI system and available at the disaster recovery site.
The Commvault data platform allows you to maximize your investment from NetApp HCI by extending the value of hardware Snapshot copies through Commvault IntelliSnap, providing for faster data management and recovery and comprehensive data protection across the entire NetApp portfolio.

**Benefits of Commvault IntelliSnap Technology**
NetApp HCI includes hardware-based Snapshot copies, which allow for the creation and deletion of point-in-time views of data, with scheduling and retention. IntelliSnap technology significantly extends the value of hardware Snapshot copies. IntelliSnap technology adds application awareness and consistency to automate and orchestrate the creation, retention, and access of NetApp HCI Snapshot copies. IntelliSnap software maintains source application context to provide simple, granular recovery.

The Commvault platform provides centralized management to manage protection, retention, search, and reporting for multiple applications, heterogeneous storage platforms, locations, and environments from a single, web-based console.
IntelliSnap Operation Workflow

1. vCenter integration for autodiscovery of new virtual machines for protection.
2. Virtual Server Agent (VSA) contacts vCenter and creates a consistent VMware snapshot for all VMs being protected.
3. IntelliSnap software communicates with NetApp HCI to take Snapshot copies.
4. Mount Snapshot copy to ESXi proxy for indexing and LiveBrowse operations; VSA performs indexing operations.
5. Optionally, data can be streamed off array to create a long-term retention copy.

8.3 Veeam

With Veeam backup and replication, Veeam and NetApp HCI offer the right solution for performance, flexibility, and reliability, providing an impressive, modern disaster recovery solution for your vSphere environment.

Veeam backup and replication provide the following advantages:

- Granular recovery of virtual machines (VMs) and files, including Microsoft Exchange and SharePoint application items
- The ability to automatically verify every backup, VM, and replica
- Self-service recovery of VMs and guest files without a direct network connection to the VM, user permissions, or the need to deploy costly agents
- Instant VM recovery in as little as two minutes
• A choice to back up and recover what you need, where you need it, and when you need it, whether it is on site, on tape, or in the cloud

Figure 9) NetApp HCI with Veeam.

8.4 Datos IO

Datos IO has developed an industry-first data protection software platform built from ground up for applications and databases of the Next Generation Data Center. Datos IO RecoverX delivers application-aware data management that allows massive storage efficiency and subtable-level recovery/mobility solutions at scale.

The combination of NetApp HCI and Datos IO RecoverX offers fully orchestrated, any point-in-time recovery and increased storage efficiency. Figure 11 shows Datos IO RecoverX protecting MongoDB clusters and Cassandra databases running on NetApp HCI.

Figure 10) NetApp HCI architecture with Datos IO.
## 9 NetApp HCI Plug-In for VMware vCenter

### 9.1 NetApp HCI Plug-In for VMware vCenter

The NetApp HCI plug-in for VMware vCenter is a VMware vCenter Server plug-in that provides integrated management of NetApp HCI storage arrays from within a VMware vSphere Web Client. The vSphere Web Client is a single management interface that you can use to manage the VMware infrastructure and all your day-to-day storage needs:

- Manage NetApp HCI in vCenter
- Discover and manage multiple NetApp HCI clusters
- vSphere datastore create, extend, clone, share, and delete
- NetApp HCI account create, edit, and delete
- NetApp HCI volume create, edit, clone, delete, and access group add and remove
- NetApp HCI access group create, edit, delete


## 10 NetApp HCI VSS Hardware Provider

### 10.1 NetApp HCI VSS Provider Introduction

The NetApp HCI VSS hardware provider integrates VSS shadow copies with NetApp HCI Snapshot copies and clones. The provider runs on Microsoft Windows 2008 R2 and 2012 R2 editions and supports shadow copies created using DiskShadow and other VSS requesters. A GUI-based configuration utility is provided to add, modify, and remove cluster information used by the NetApp HCI VSS hardware provider.

Utilizing VSS Snapshot capabilities with the NetApp HCI VSS hardware provider makes sure that Snapshot copies are application consistent with business applications that use NetApp HCI volumes on a system. A coordinated effort between VSS components provides this functionality. NetApp HCI Snapshot copies and clones minimize recovery time without affecting stability and performance and provide instant volume recovery.

### 10.2 NetApp HCI VSS Provider Overview

There are three major components of the Microsoft Windows Volume Shadow Copy Service (VSS): VSS providers, VSS writers, and VSS requesters. A VSS provider is a storage-level component that offers functionality to create a shadow copy of one or more volumes. A VSS writer is application-specific software that makes sure that application data is ready for shadow copy creation. The application that initiates the creation of a shadow copy is a VSS requester.

The backup application DiskShadow is a VSS requester for creating shadow copies of volumes. When DiskShadow executes a backup, VSS orchestrates the interaction between the VSS requester, VSS writers, and VSS providers. VSS maintains application consistency while creating a volume shadow copy. There are several VSS writers installed on a system, such as the Microsoft SQL Server VSS writer. The NetApp HCI VSS hardware provider manages the shadow copies created by a VSS requester at the hardware level using NetApp HCI Snapshot copies and clones.

The NetApp HCI provider uses Snapshot copies and clones to make shadow copies available to the VSS requester. Shadow copy volumes allow for immediate read-only access to the data from the MS Windows host.

The Microsoft Windows host must have access to both storage and the management network so that the VSS provider can work correctly. Administrators must add one or more clusters to the NetApp HCI VSS
hardware provider configuration. This allows the provider to connect to NetApp HCI clusters and interact with the NetApp HCI API to create Snapshot copies and clones during the backup process.

10.3 NetApp HCI VSS Provider Requirements

Hardware Prerequisites
Table 2 describes the hardware prerequisites.

Table 2) Hardware prerequisites.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>System processor</td>
<td>1.5GHz (dual core recommended), Intel compatible 64-bit</td>
</tr>
<tr>
<td>System memory</td>
<td>Minimum 4GB recommended</td>
</tr>
<tr>
<td>Free disk space required for installation</td>
<td>Minimum 5MB required and recommended 100MB</td>
</tr>
<tr>
<td>Networking</td>
<td>Ethernet ports for cluster communication and Ethernet ports for iSCSI</td>
</tr>
<tr>
<td>NetApp HCI cluster</td>
<td>A cluster of NetApp HCI nodes</td>
</tr>
</tbody>
</table>

Software Prerequisites
Table 3 describes the software prerequisites.

Table 3) Software prerequisites.

<table>
<thead>
<tr>
<th>Component</th>
<th>Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating system</td>
<td>Microsoft Windows Server</td>
<td>Windows Server 2008 R2 64-bit</td>
</tr>
<tr>
<td>.NET framework</td>
<td></td>
<td>Windows Server 2012 R2 64-bit</td>
</tr>
<tr>
<td>NetApp HCI cluster</td>
<td></td>
<td>Element OS version 10.0 and later</td>
</tr>
</tbody>
</table>

Supported Configurations
Table 4 describes the supported configurations. VSS hardware provider configurations leverage directly connected NetApp HCI iSCSI volumes. Only the configurations described in the preceding tables are supported.

Table 4) Supported configurations.

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
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<td>Standalone</td>
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<td>Shared Storage Cluster</td>
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<tr>
<td>AlwaysOn Cluster</td>
<td></td>
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</table>
Summary

As data centers migrate away from dedicated/siloed platforms and consolidate environments, the need to scale granular components and control the performance of the applications is critical. Data centers are moving away from dedicated platforms and are trying to avoid overprovisioning to increase efficiency and cost. NetApp HCI solution provides a unique solution with QoS limits, allowing the granular control of every application, eliminating noisy neighbors, and enabling administrators to set and satisfy all performance SLAs. As environments change, administrators can easily add compute and/or storage without overprovisioning any element of the solution.

Your enterprise needs a data protection solution that is reliable, flexible, and easy to use. NetApp HCI Element OS delivers self-healing resiliency, continuously accessible data, and a range of backup and restore and disaster recovery options to best fit your environment’s needs. NetApp HCI’s Element OS provides native protection, SnapMirror replication across the Data Fabric, and third-party trusted integrations to keep your dynamic data protected and safe. NetApp HCI makes it easy to protect your data and your protected data remains reliable, flexible, and easy to use on the infrastructure that makes the most sense for your business needs.

Version History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Document Version History</th>
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<td>Version 1.0</td>
<td>October 2017</td>
<td>Initial release</td>
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