



# **TR-4894: NetApp ONTAP 9.9.1 Feature Overview**

## **ONTAP What's New**

NetApp  
July 29, 2021

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# TR-4894: NetApp ONTAP 9.9.1 Feature Overview

Justin Parisi, NetApp

NetApp ONTAP is the industry-leading flagship data-management software that enables you to seamlessly manage and protect your data wherever it lives, whether on-premises, at the edge, or in the cloud.

NetApp ONTAP offers support for the following features, all on the same platform:

- NAS protocols (NFS and SMB)
- SAN protocols (iSCSI, FCP, and NVMe)
- S3 data access
- Data protection (NetApp Snapshot copy, NetApp SnapMirror, and SnapVault technologies)
- Storage efficiencies (deduplication, compaction, and compression)
- High Availability (HA) failovers (including fast failovers for Tier-1 SAN with the All-SAN Array)
- Support for all-flash, spinning drive, and hybrid disk configurations
- Security features (multifactor authentication, NetApp Volume Encryption, and Secure Purge)

This is not a comprehensive list; if we included every feature offered by ONTAP, this document would be hundreds of pages long!

For more detailed information about NetApp ONTAP, see the [ONTAP 9 data management software data sheet](#) and the product documentation.

## System Manager enhancements

With the revamped GUI experience for ONTAP introduced in ONTAP 9.8, you might have noticed that some things moved or were no longer available. In ONTAP 9.9.1, we have collected customer feedback and addressed some of the concerns around the GUI and have added some of the missing functionality back in, as well as adding new and improved features. The following section covers some of these changes and new additions. You can also find information about System Manager in the [System Manager docs](#).

### Functionality restored/usability enhancements

You asked for it, and we listened. In ONTAP 9.9.1, some of the functionality that was no longer available in ONTAP 9.8 System Manager was added back into the product. Additionally, new usability enhancements were included.

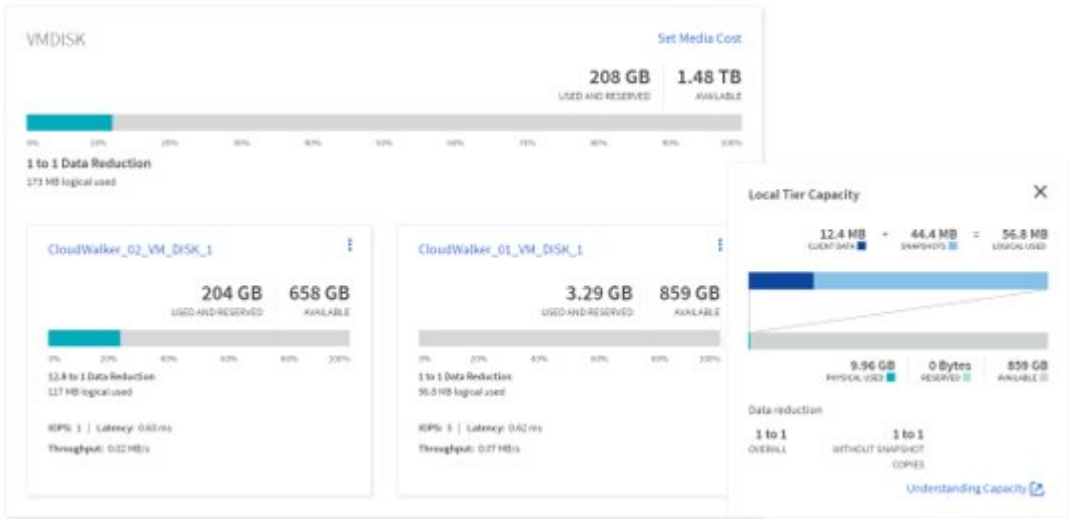
#### Manual selection of a local tiers/aggregates during volume provisioning

System Manager 9.9.1 allows you to manually select the physical storage tier you want to use when provisioning new volumes, including the ability to specify aggregates during FlexGroup volume creation. Optionally, you can still allow ONTAP and System Manager make selections based on balanced placement logic.

#### Capacity display enhancements

Now you can view the logical used space by Snapshot copies in ONTAP, as well as seeing what your storage efficiency ratios look like with and without Snapshot copies.

The following figure depicts the ONTAP System Manager 9.9.1 capacity view.



NVMe over Fibre Channel – LIF creation

With System Manager, you can now create and view LIFs used with NVMe over Fibre Channel namespaces, including port statuses, asymmetrical port selection, and the ability to see the number of LIFs created per port to help avoid overloading a physical network interface.

EMS Event Viewer – Dashboard

For a faster view of what issues might be present in your ONTAP cluster, System Manager 9.9.1 adds EMS events on the dashboard when you first log in. This includes errors in the past 24 hours, such as broken disks, network links down, license issues, and shelf or node errors.

You also get warnings from the past 24 hours, including failed volume moves and health monitor alerts.

Snapshot sizes and SnapMirror labels

From the snapshot views in System Manager, you can see snapshot sizes and labels (such as daily, weekly, and so on) on SnapMirror snapshot copies.

+ Add

🗑 Delete

🔍 Search

👁 Show / Hide ▾

⌵ Filter

<input checked="" type="checkbox"/>	Name	Snapshot Copy Creation Time	Snapshot Restore Size ⓘ
<input checked="" type="checkbox"/>	base	Apr/8/2021 4:56 PM	324 KB

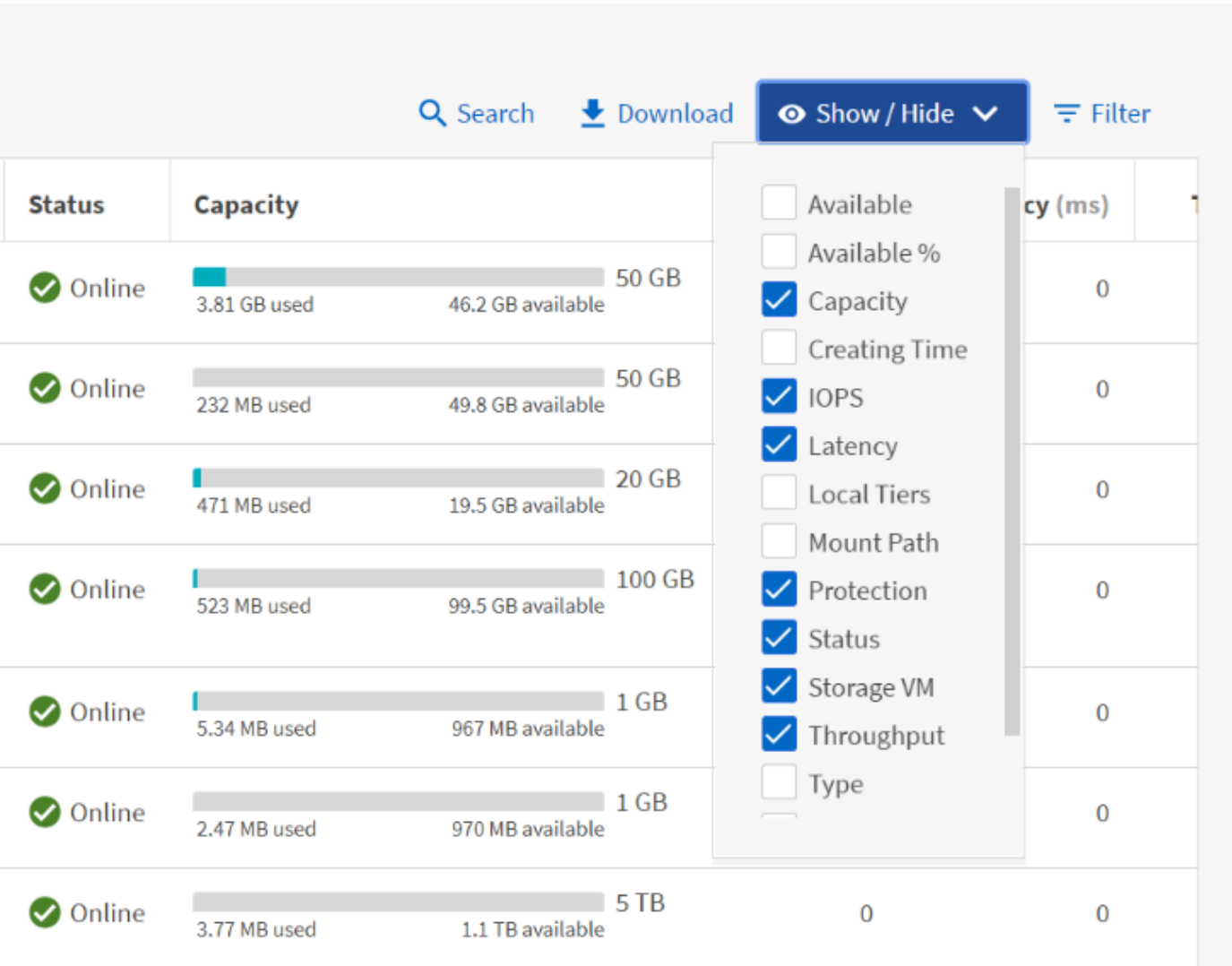
Re-home data LIFs

During failovers or after network outages have been resolved, data LIFs often remain on the failover port, which can create potential performance and resiliency concerns. If you need a simple way to send those data LIFs back home, System Manager 9.9.1 now offers a single-click method to send all data LIFs back to their intended home ports.

**New volume fields to show/hide**

There are additional ways to view volume information in System Manager 9.9.1 via the Show/Hide button, including local tiers and available/used information.

The following figure depict the new volume views in ONTAP System Manager 9.9. 1.



**Bulk operations**

If you need to perform multiple volume moves or deletions, map multiple LUNs to an initiator group, or add multiple volumes to a cloud tier, you can now select multiple objects and perform tasks. Volume deletions also come with a way to be able to unmount, offline and confirm deletions in a single window.

The following figure depicts simplified volume deletions in ONTAP System Manager 9.9.1.

# Delete Volumes



Deletes the associated data, Snapshot copies, and objects in the volumes, such as LUNs, qtrees, exports, and namespaces. This operation stops the replication of data but does not remove the Snapshot copies from the replicas.

SELECTED VOLUMES

FGNFS, XCPdest

- ☒ Unmount the volume disrupting clients accessing the data
- ☒ Take the volume offline
- ☒ Delete 256 GB of data

Cancel

Delete

## Active IQ Integration

In the interest of giving ONTAP users a single access point for multiple information sources, System Manager 9.9.1 provides integration with the NetApp Active IQ solution. This delivers firmware recommendations as well as a method to download the images directly from the NetApp support site and easy to access support case views for when you want to see what's going on with your cluster. Simply navigate to the Support link under Cluster in the left-hand menu and register the cluster with Active IQ to begin.

The following figure depicts Active IQ views in ONTAP System Manager 9.9.1.

Support

[Go to NetappSupport](#) [View My Cases](#) [View Cluster Details](#)

Open Support Cases

Case Number	Status	Priority	Symptoms	Node	Node S	
<a href="#">202012120020332</a>	Active	1	details of the case goes here	Node1	J82893	
<a href="#">202012120020331</a>	Active	2	details of the case goes here	Node1	J82893	
<a href="#">202012120020330</a>	Active	3	details of the case goes here	Node1	J82893	
<a href="#">202012120020329</a>	Active	3	details of the case goes here	Node2	J82893	
<a href="#">202012120020328</a>	Active	3	details of the case goes here	Node2	J82893gggfs2u72826	17th Sep 2020
<a href="#">202012120020327</a> <a href="#">🔗</a>	Unassigned	3	details of the case goes here	Node2	J82893gggfs2u72827	17th Sep 2020

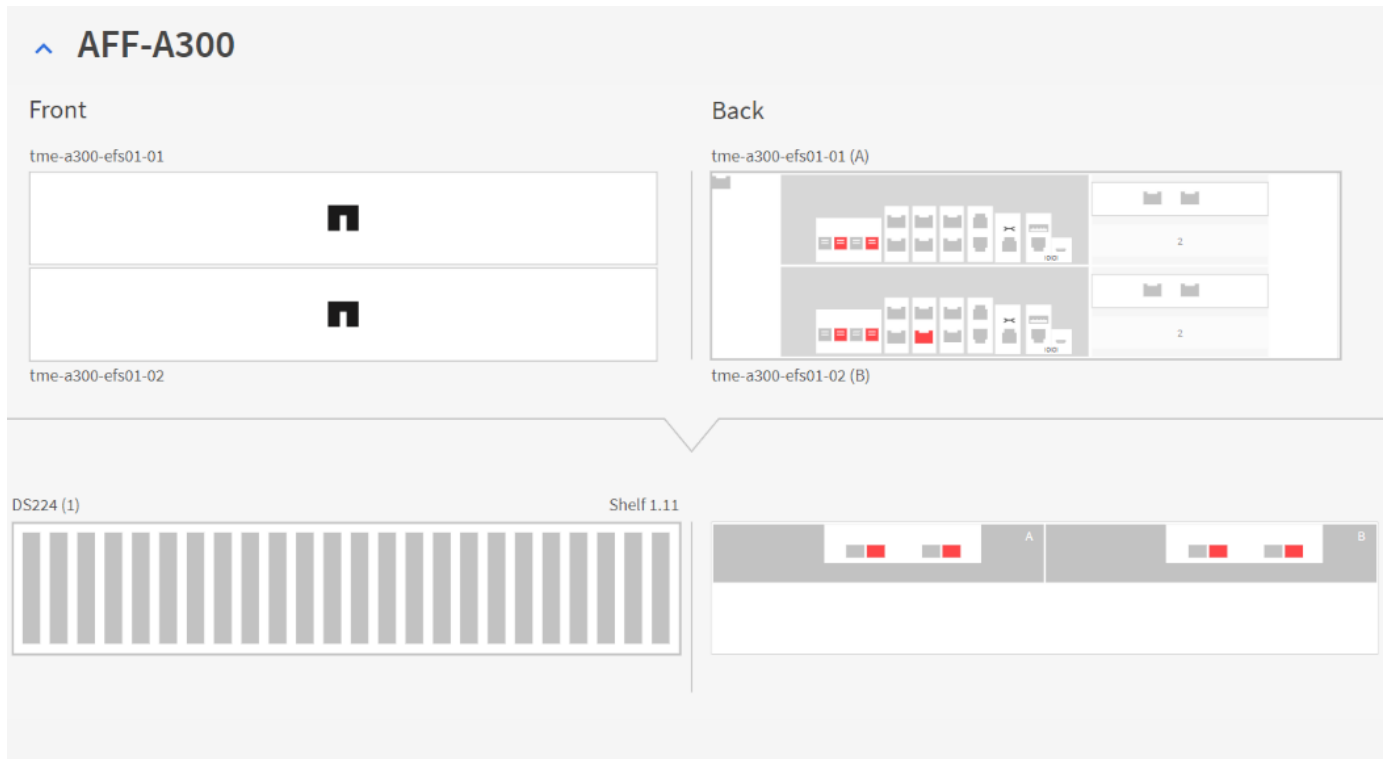
Active IQ  
Registration

STATUS

Registered

## Hardware visualization platform expansion

Hardware visualization includes information such as platform models, serial numbers, takeover/giveback status, disk status, port information and much more. ONTAP 9.9.1 brings added platform support for hardware visualization to include all current AFF platforms.



The following components are supported in ONTAP 9.9.1:

- **Platforms.** C190 / A220 / A250 / A300 / A400 / A700 / A700s / A800 / A320 / FAS500f
- **Disk Shelves.** DS4243 / DS4486 / DS212C / DS2246 / DS224C / NS224
- **Network Switches.** Cisco Nexus 3232C / Cisco Nexus 9336C-FX2

## Ansible Playbook workflows

More and more enterprises are turning to automation of day-to-day tasks using applications like Ansible to provide repeatable, error-free workflows. NetApp has an entire library of Ansible playbooks available, and you can find those and more information at the [Ansible for NetApp page](#).

System Manager 9.9.1 adds additional avenues to use Ansible with a new way to generate playbooks with a single click. To use these playbooks, install Ansible and the NetApp Collection from [Ansible Galaxy](#), but you can start creating playbooks by clicking the Save to Ansible Playbook link on select storage provisioning tasks in System Manager.

## Protection

- ☒ Enable Snapshot Copies (Local)
- ☐ Enable SnapMirror (Local or Remote)



Clicking that button creates a .zip file with the necessary .yaml files needed for Ansible.

Name	Size	Packed Si...	Modified	Created
 volumeAdd.yaml	11 740	11 740	2021-05-...	
 volumeAdd_variable.yaml	2 940	2 940	2021-05-...	

## File system analytics enhancements

In high file-count environments, trying to find information about folder capacity, data age, and file counts usually requires time-intensive commands or scripts that run serial operations over NAS protocols, such as `ls`, `du`, `find`, and `stat`.

ONTAP System Manager 9.8 introduced a way for admins to find out file system information in any NAS storage volume quickly and easily by enabling a low-impact scanner for each volume. This scanner crawls the ONTAP file system in the background with a low priority job and delivers a wealth of information that is available as soon as you navigate to a volume that has it enabled.

Enabling [File System Analytics](#) is as easy as navigating to the volume you want to scan. Go to Storage > Volumes and then use the search to find your desired volume. Click the volume, and then the Explorer tab.

From here, you see the Enable Analytics link on the right side of the page.



After you click enable, the scanner starts. The time of completion depends on the number of objects in the volume as well as the system load. After it is finished, you see the entire directory structure populated in the System Manager view. This view can be navigated down the directory tree, and it provides access for history information, directory size information, and file sizes.

ONTAP 9.9.1 brings some additional enhancements to the feature, such as filtering by file or directory name and performing [fast directory deletes](#).



## Other System Manager 9.9.1 enhancements

ONTAP 9. 9.1 also brings the following enhancements to System Manager:

<ul style="list-style-type: none"><li>• Nested igroups</li><li>• SnapMirror Cloud - backups and restores (ONTAP S3 and StorageGrid only)</li><li>• All SAN Array expansion</li><li>• FlexCache pre-populate, DR, view bandwidth savings</li></ul>	<ul style="list-style-type: none"><li>• SVM-DR for FlexGroup volumes</li><li>• SnapMirror cascade and fan-out support for FlexGroup volumes</li><li>• FabricPool: Adjust or change minimum cooling days</li></ul>
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## SAN enhancements

ONTAP 9.9.1 delivers some important SAN-related enhancements. This section covers those features and includes links to documentations that go over those in further detail.

### All SAN Array enhancements

ONTAP 9.8 introduced the [All SAN Array](#) (ASA) to the NetApp product portfolio. In ONTAP 9.9.1, the ASA gets some highly coveted additions.

#### Scale-out from two nodes to 12 nodes

Prior to ONTAP 9.9.1, the ASA could only be a two-node cluster. However, SAN clusters in ONTAP can scale up to 12 nodes, which provides additional scale-out for performance and capacity in enterprise SAN environments. Now, the ASA can scale up to 12 nodes in a single cluster, provided all nodes in the cluster have the ASA personality. ASA models can be mixed in the same cluster (for instance, a two-node A400 HA pair with a two-node A800 HA pair).

#### NVMe/FC support

The ASA can now take advantage of ultra-low latency NVMe over Fibre Channel in ONTAP 9.9.1. All that is required is a license for NVMe/FC and 32Gb FC target adapters.

#### In-place conversion from AFF SAN to ASA

With the assistance of a script and NetApp TME or Professional Services resources, you can convert existing AFF SAN clusters to ASA personalities without needing to migrate data. The only prerequisite is that if the cluster is serving any NAS or S3 data, those protocols and datasets should be removed prior to conversion.

### Single LUN performance

Both ASA platforms and AFF SAN clusters gain the benefits of changes in ONTAP 9.9.1 that greatly improve single-LUN performance at peak workloads by way of parallelization of the SCSI stack to the LUN.

In the following table, tests on an A800 platform and an A300 platform compare performance for a single LUN workload, with nearly 4x performance for reads and 75% better performance for writes on the AFF A800 in ONTAP 9.9.1 against the same workload in ONTAP 9.8.

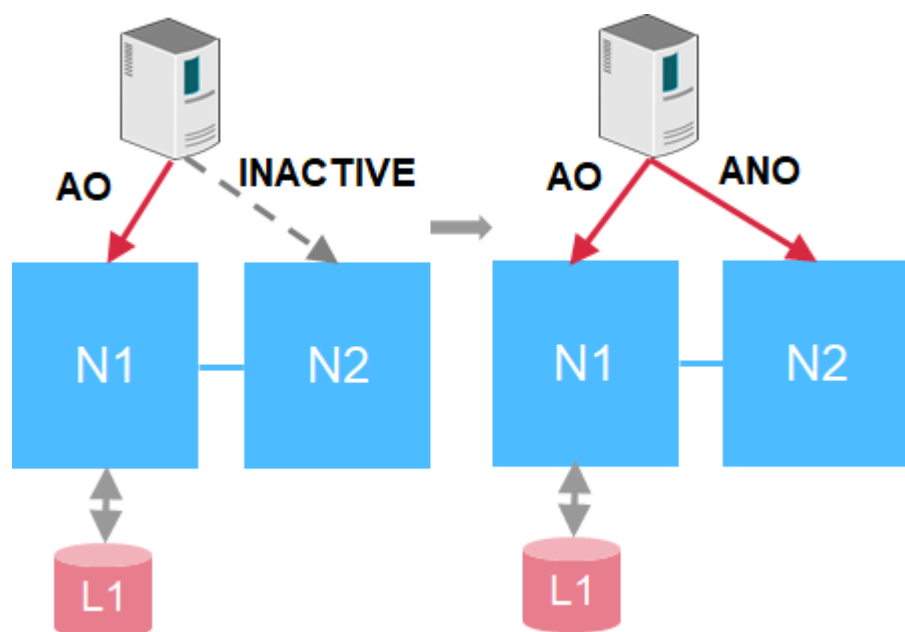
Platform	Random read peak IOPS	Random write peak IOPS
A800	+393%	+75%
A300	+245%	+3.5%



These improvements do not affect multi-LUN applications (such as Logical Volume Manager).

## NVMe over Fibre Channel enhancements

In ONTAP 9.9.1, NVMe over Fibre Channel namespaces can now failover by way of an inactive remote path, providing greater overall resiliency for NVMe/FC applications.



In addition, ONTAP 9.9.1 introduces support for NVMe/FC with VMware virtualization workloads by providing vVol support and provisioning of namespaces through vCenter.

## Data protection enhancements

Data protection in the context of this document refers to both the notion of off-site replication of data, as well as automated site infrastructure failovers. This section covers the latest data protection enhancements for ONTAP 9.9.1.

### Transparent application failover for SAN with SnapMirror Business Continuity

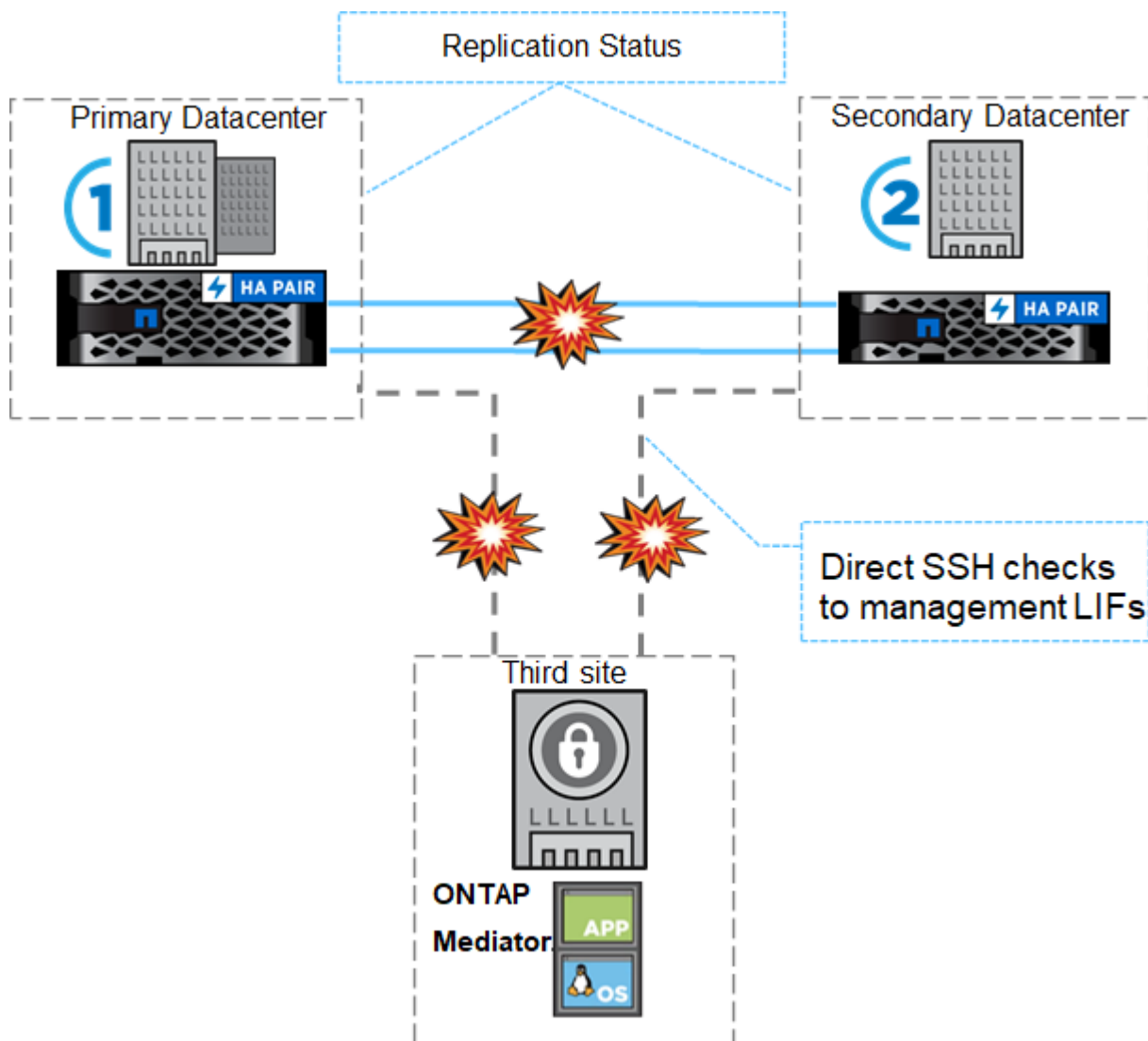
NetApp SnapMirror is an industry-leading replication technology that can be leveraged for a variety of use cases, including the following:

- Disaster recovery for quick site failovers during an outage and fast resyncs back to primary
- Synchronous replication for up-to-the-second copies of data on a remote site
- Backup and archive use cases (with more Snapshot copies on the destination than on the source)

[SnapMirror Business Continuity in ONTAP](#) extends what SnapMirror offers and provides fast, easy automated

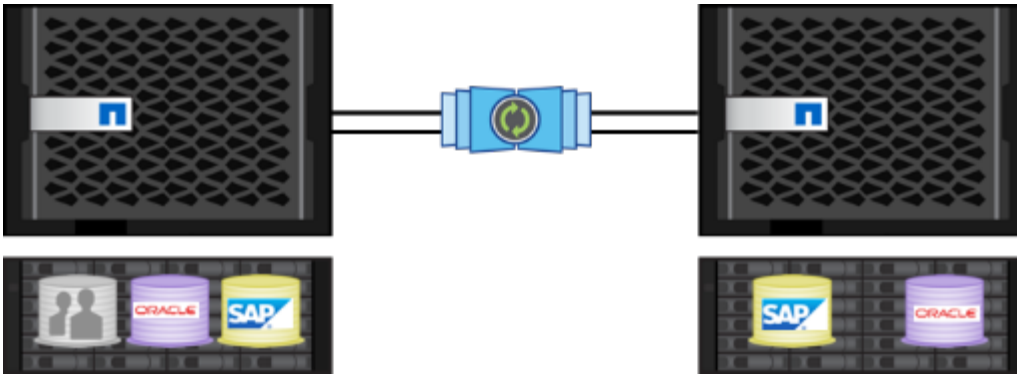
failover of synchronous SnapMirror relationships for application-level, granular data protection.

SnapMirror Business Continuity makes use of a mediator to maintain quorum between sites and avoid split-brain scenarios in the event of a site failure. A new ONTAP Mediator software version (1.2) is now available and supports up to 10 ONTAP systems and automates switchovers of applications between sites within 120 seconds of failure.



## MetroCluster over IP

NetApp MetroCluster (MC) software is a solution that combines array-based clustering with synchronous replication to deliver continuous availability and zero data loss at the lowest cost. Administration of the array-based cluster is simpler because the dependencies and complexity normally associated with host-based clustering are eliminated.



MetroCluster immediately duplicates all your mission-critical data on a transaction-by-transaction basis, providing uninterrupted access to your applications and data. Unlike standard data replication solutions, MetroCluster works seamlessly with your host environment to provide continuous data availability while eliminating the need to create and maintain complicated failover scripts.

With MetroCluster, you can perform the following tasks:

- Protect against hardware, network, or site failure with transparent switchover
- Eliminate planned and unplanned downtime and change management
- Upgrade hardware and software without disrupting operations
- Deploy without complex scripting, application, or operating system dependencies
- Achieve continuous availability for VMware, Microsoft, Oracle, SAP, or any critical application

NetApp MetroCluster traditionally was implemented with a Fibre Channel backend, but more recent versions of ONTAP support the use of IP networks for the backend. This not only reduces cost and complexity for site failover infrastructure, but it also extends the range of MetroCluster to approximately 700km (or 300mi).

ONTAP 9.9.1 brings the following advancements to MetroCluster.

- Increased volume counts to 1600 per HA pair
- Shared layer-3 networks
  - No longer dependent on dedicated layer- 2 networks
  - ONTAP must be directly connected to router
  - No dynamic routing support
- Increased nodes per site (four per site, eight per cluster)

### **When to choose MetroCluster versus SnapMirror Business Continuity**

Since MetroCluster and SnapMirror Business Continuity share some of the same feature sets (ability to leverage existing IP networks, automated failovers, synchronous replication), the question of “when should I use each” becomes more relevant.

The answer depends on the following questions.

- What are your service level objectives?
- How granular do you want failovers to be?

MetroCluster provides automated infrastructure failovers for HA pairs and physical aggregates and supports SAN and NAS workloads, while SnapMirror Business Continuity offers application-level granularity for SAN

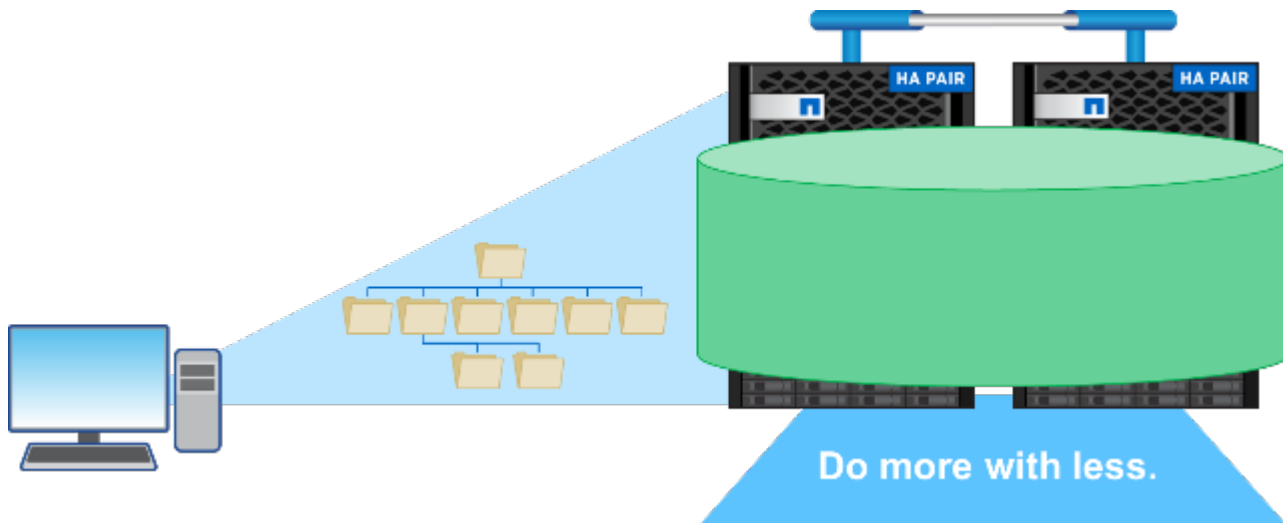
workloads only.

For more information on MetroCluster over IP, see [MetroCluster IP Solution Architecture and Design](#).

For more information on SnapMirror Business Continuity, see [SnapMirror Business Continuity in ONTAP](#).

## FlexGroup volume data protection

FlexGroup volumes are the NetApp ONTAP scale-out NAS solution, providing up to 20PB and 400 billion files in a single namespace, while offering automatically load-balanced parallel processing of high ingest workloads for a blend of capacity, performance, and simplicity.

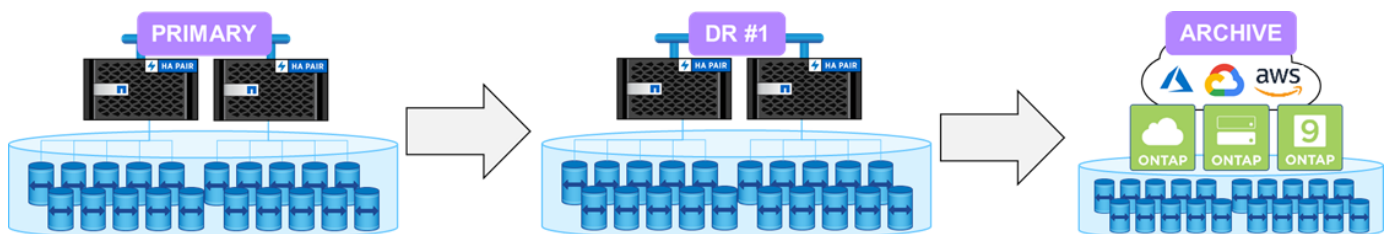


For more information about FlexGroup volumes, see [TR-4571: NetApp FlexGroup Volumes Best Practices](#).

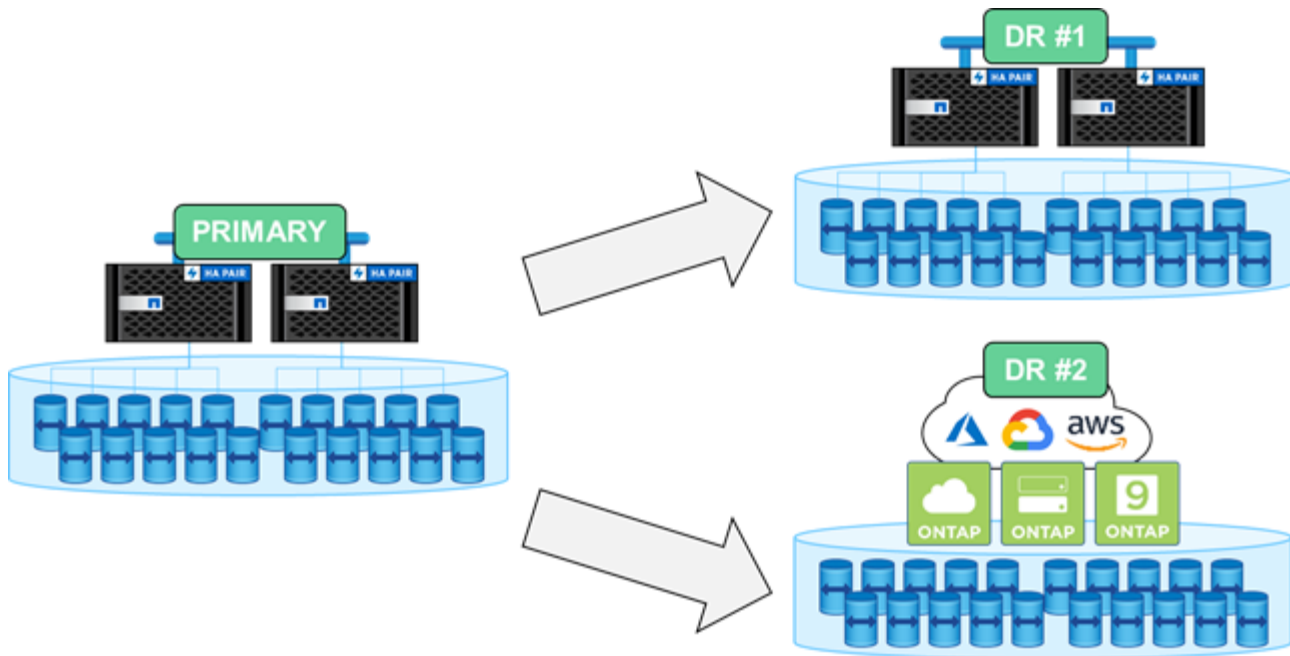
In ONTAP 9.9.1, FlexGroup volumes support a variety of data protection configurations.

## Cascading and fan-out SnapMirror

A SnapMirror cascade allows a storage administrator to replicate to multiple sites in serial. For example, site A can replicate to site B (on-prem or cloud) and site B can then replicate that same volume to site C (on-prem or cloud).

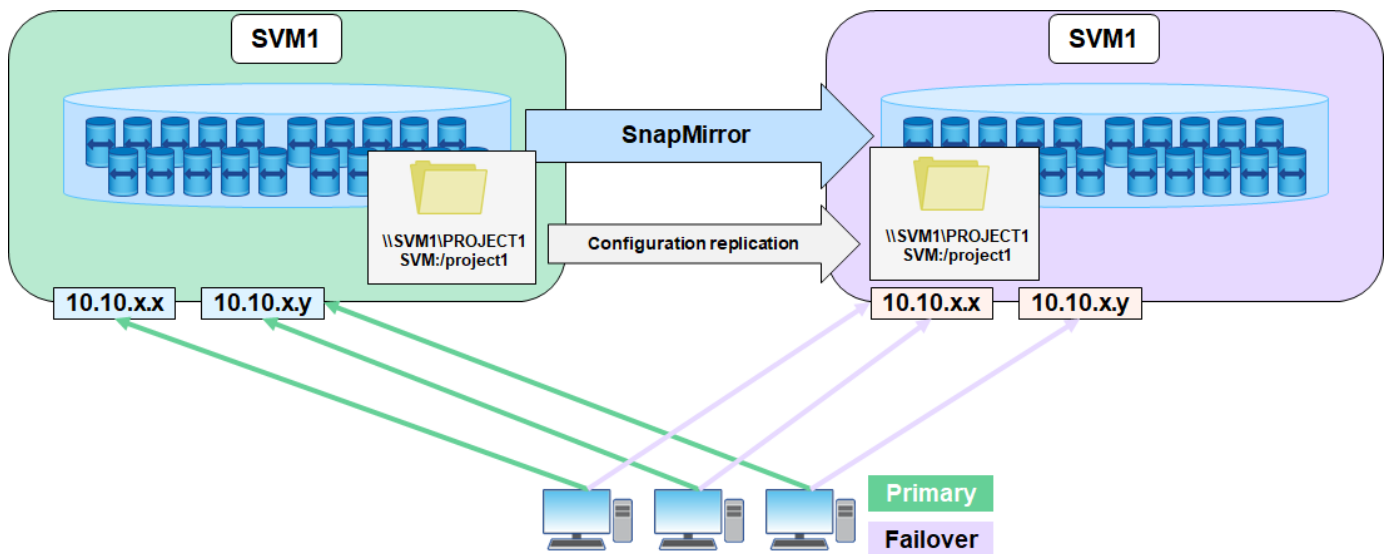


SnapMirror fan-out can replicate from a source volume to multiple destination volumes. So site A can replicate a source FlexGroup to sites B and C (on-prem or cloud). This offers more flexibility and resiliency in data protection configurations.



### Storage virtual machine disaster recovery (SVM-DR)

SVM-DR is an ONTAP feature that allows you to replicate not just data volumes to a remote site, but also the SVM configuration details, such as CIFS shares, NFS exports, data LIFs, and even the NFS file handles to avoid remounts when failing over to the DR site.



ONTAP 9.9.1 brings support for SVM-DR to FlexGroup volumes with the following limitations.

- No FabricPool support
- No FlexClone
- No SnapMirror fan-out
- No FlexVol convert without rebaseline

## SnapLock enhancements

[NetApp SnapLock](#) is the WORM compliance replication solution from NetApp. It provides integrated data protection for workloads that need to adhere to regulatory guidelines such as HIPAA, SEC 17a-4(f) rule, FINRA, and CFTC as well as national requirements for German-speaking countries (DACH).

Snaplock helps provide data integrity and retention, enabling electronic records to be both unalterable and rapidly accessible. SnapLock retention features are certified to meet strict records retention requirements as well as addressing an expanded set of retention requirements, including Legal Hold, Event-Based Retention, and Volume Append Mode.

ONTAP 9.9.1 brings the following improvements to NetApp SnapLock:

- [Storage efficiency](#) support on WORM volumes. Support for data compaction, cross-volume/aggregate-level deduplication (AFF only), continuous segment cleaning, and Temperature Sensitive Storage Efficiency.
- Ransomware protection for SnapLock volumes containing snapshot copies of LUNs. For more information on SnapLock, see [Compliant WORM Storage Using NetApp SnapLock](#).

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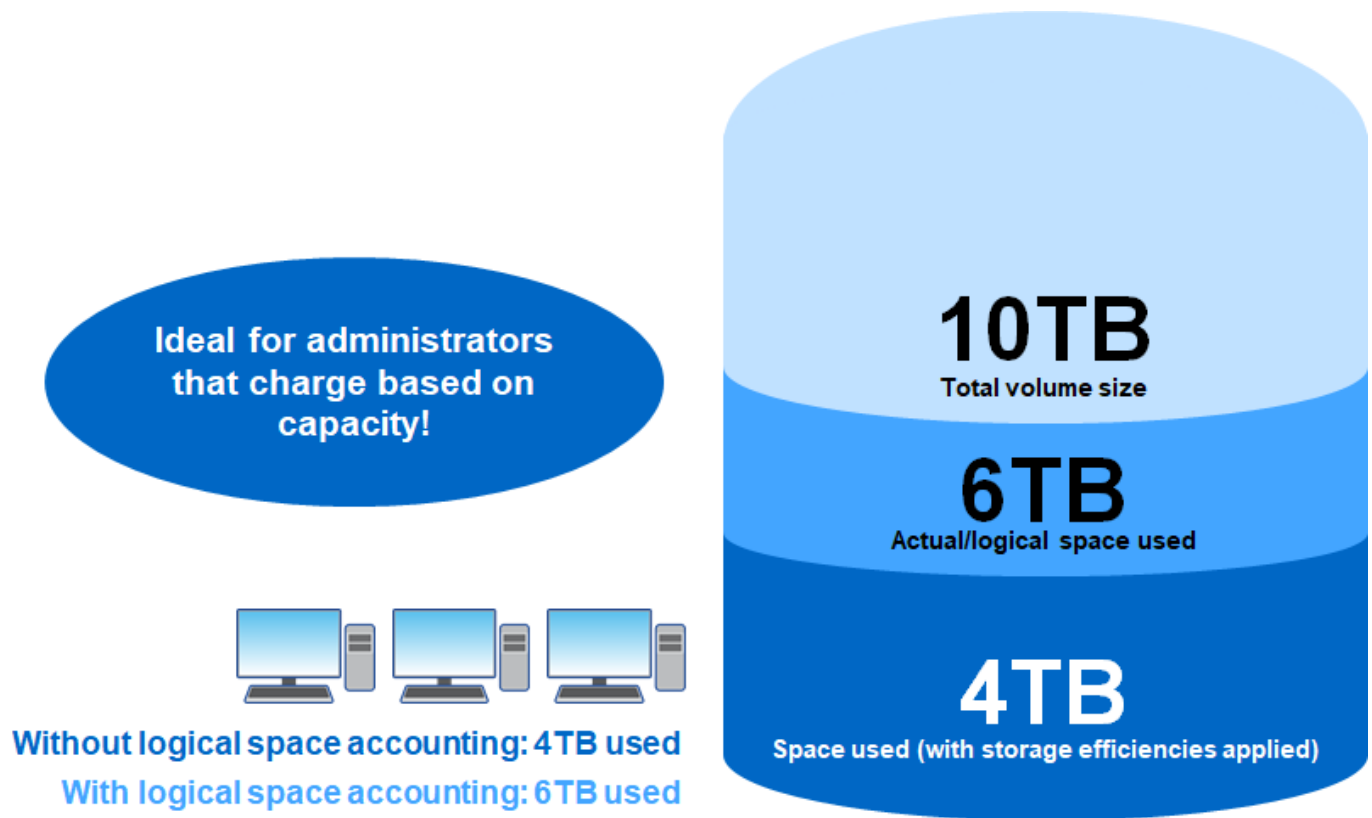
## Other major additions

In addition to the System Manager enhancements, SAN enhancements, and data protection enhancements, there are a few other big additions to ONTAP 9.9.1.

### Logical space accounting/enforcement – FlexGroup volumes

Logical space accounting was introduced for FlexVol volumes in ONTAP 9.4. It enables storage administrators to mask storage efficiency savings so that end users avoid overallocating their designated storage quotas.

For example, if a user writes 6TB to a 10TB volume and storage efficiencies save 2TB, logical space accounting can control whether the user sees 6TB or 4TB.



ONTAP 9.5 enhanced this feature and added quota enforcement support for FlexVols to give more control to storage administrators by preventing new writes according to the logical space thresholds set. However, FlexGroup volumes were missing this functionality until ONTAP 9.9.1.

## ONTAP S3 user-defined metadata tags

ONTAP 9.8 introduced support for the S3 protocol for basic object storage functionality.

Support for S3 in ONTAP 9.8 included the following:

- Basic PUT/GET object access (does not include access to both S3 and NAS from the same bucket)
  - No object tagging or ILM support; for feature-rich, globally dispersed S3, use [NetApp StorageGRID](#).
- TLS 1.2 encryption
- Multi-part uploads
- Adjustable ports
- Multiple buckets per volume
- Bucket access policies
- S3 as a NetApp FabricPool target

ONTAP 9.9.1 and later offers support for metadata tagging of objects when using `ObjectCreate` and `MultiPartUpload` calls. When `HEAD` or `GET` is performed on an object, the user-defined metadata and count of the number of tags is returned as part of the HTTP header in the response. These tags allow you to better categorize your objects within ONTAP buckets for more robust data management and are compatible with applications that require the ability to create metadata and tags.

For more information, see the following resources:



- [Tech ONTAP Podcast: Episode 268 - NetApp FabricPool and S3 in ONTAP 9.8](#)
- [ONTAP S3](#)

## NFSv4.2 security labels

ONTAP 9.9.1 introduces support for the NFSv4.2 feature called Labeled NFS, which is a way to manage granular file and folder access by using SELinux labels and Mandatory Access Control (MAC). These MAC labels are stored with files and folders and works in conjunction with UNIX permissions and NFSv4.x ACLs. Support for labeled NFS means that ONTAP now recognizes and understands the NFS client's SELinux label settings. Labeled NFS is covered in [RFC-7204](#).

Use cases include the following:

- MAC labeling of virtual machine images
- Data security classification for the public sector (secret, top secret, and so on)
- Security compliance
- Diskless Linux

In this release, ONTAP supports the following enforcement modes:

- [Limited Server Mode](#). ONTAP cannot enforce the labels, but it can store and transmit them.
  - The ability to change MAC labels is also up to the client to enforce.
- [Guest Mode](#). If the client is not labeled NFS-aware (v4.1 or lower), MAC labels are not transmitted.

ONTAP does not currently support [Full Mode](#) (storing and enforcing MAC labels).

## Technical Resources

This section covers the technical resources available that detail the features mentioned in this document.

### Technical Reports

- TR-4067: NetApp ONTAP NFS Best Practices and Implementation Guide  
<https://www.netapp.com/us/media/tr-4067.pdf>
- TR-4515: ONTAP AFF All SAN Array Systems  
<https://www.netapp.com/pdf.html?item=/media/10379-tr4515pdf.pdf>
- TR-4526: Compliant WORM Storage Using NetApp SnapLock  
<https://www.netapp.com/pdf.html?item=/media/6158-tr4526pdf.pdf>
- TR-4569: Security Hardening Guide for ONTAP 9  
<https://www.netapp.com/pdf.html?item=/media/10674-tr4569pdf.pdf>
- TR-4571: NetApp FlexGroup Volumes Best Practices  
<https://www.netapp.com/us/media/tr-4571.pdf>

- TR-4597: VMware vSphere with ONTAP  
<https://www.netapp.com/us/media/tr-4597.pdf>
- TR-4598: FabricPool Best Practices  
<https://www.netapp.com/us/media/tr-4598.pdf>
- TR-4684: Implementing and Configuring Modern SANs with NVMe/FC  
<https://www.netapp.com/pdf.html?item=/media/10681-tr4684.pdf>
- TR-4678: Data Protection and Backup - FlexGroup Volumes  
<https://www.netapp.com/us/media/tr-4678.pdf>
- TR-4689: MetroCluster IP Solution Architecture and Design  
<https://www.netapp.com/us/media/tr-4689.pdf>
- TR-4705: NetApp MetroCluster Solution Architecture and Design  
<https://www.netapp.com/pdf.html?item=/media/13480-tr4705pdf.pdf>
- TR-4743: FlexCache in ONTAP  
<https://www.netapp.com/pdf.html?item=/media/7336-tr4743pdf.pdf>
- TR-4814: S3 in ONTAP Best Practices  
<https://www.netapp.com/pdf.html?item=/media/17219-tr4814pdf.pdf>

## Podcasts

- Tech ONTAP Podcast Episode 288: ONTAP System Manager 9.9.1  
[https://soundcloud.com/techontap\\_podcast/episode-288-ontap-system-manager-991](https://soundcloud.com/techontap_podcast/episode-288-ontap-system-manager-991)

# TR-4872: NetApp ONTAP 9.8 Feature Overview

Justin Parisi, NetApp

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- Support for all-flash, spinning drive, and hybrid disk configurations
- Security features (multifactor authentication, NetApp Volume Encryption, and Secure Purge)

This is not a comprehensive list; if we included every feature offered by ONTAP, this document would be hundreds of pages long.

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Check out this [video](#) from NetApp Insight 2020 for a broader tour of noteworthy advances in NetApp ONTAP.

[Next: Simplicity Enhancements](#)

## Simplicity Enhancements

This section covers ONTAP 9.8 enhancements that improve simplicity. This includes the following:

- ONTAP System Manager updates
- ONTAP upgrade and tech refresh improvements
- REST API enhancements

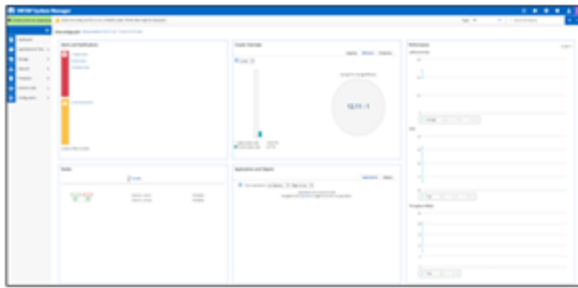
### System Manager Enhancements

ONTAP 9.7 introduced a revamp of the System Manager GUI, with the intention of simplifying the way admins manage ONTAP basic operations, such as storage provisioning and day-to-day operations. The new GUI also leverages REST APIs, which were added in ONTAP 9.6. In ONTAP 9.8, the System Manager classic view has been removed.

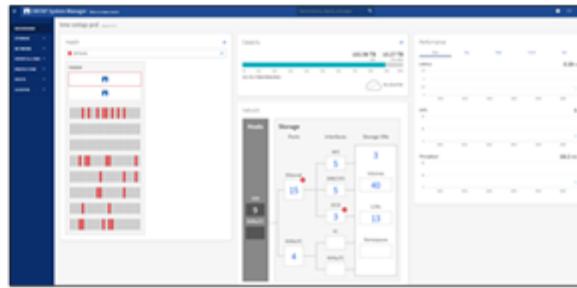
One of the major differences between the interfaces is the dashboard, which is the first page you reach when you first log in to NetApp ONTAP System Manager.

The following graphics show a side-by-side comparison of the classic and new versions of the System Manager dashboard.

## ONTAP System Manager Classic



## ONTAP System Manager 9.8

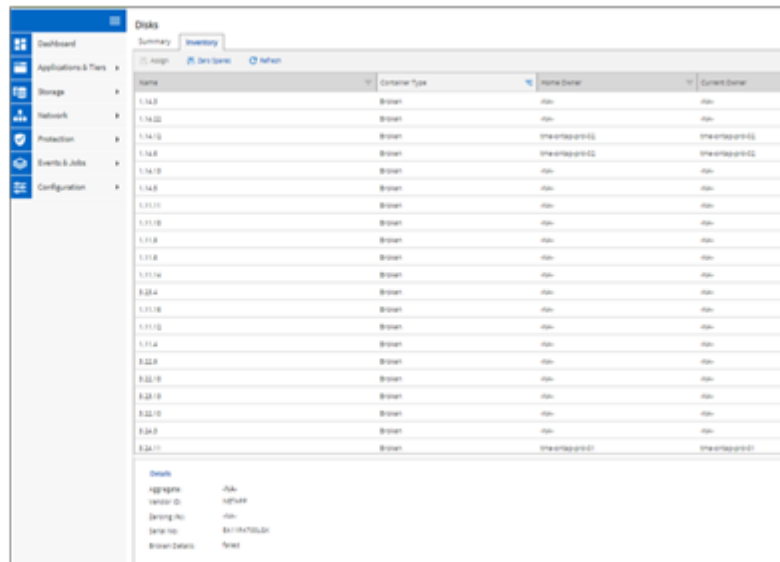


When we look closer, we can see a few major differences.

### Health/Alerts

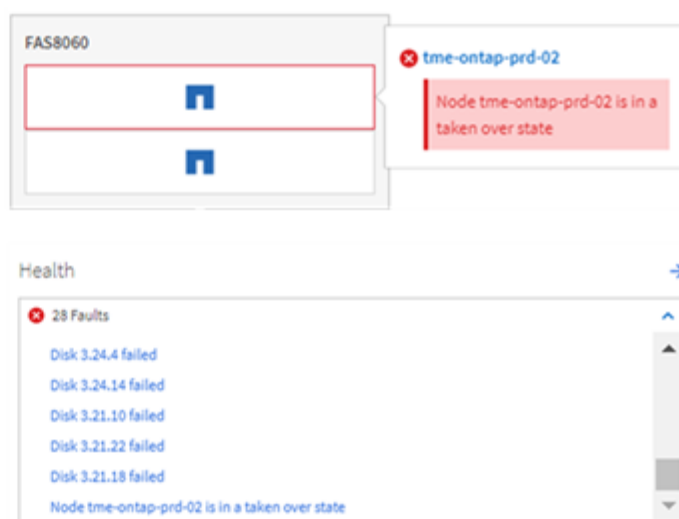
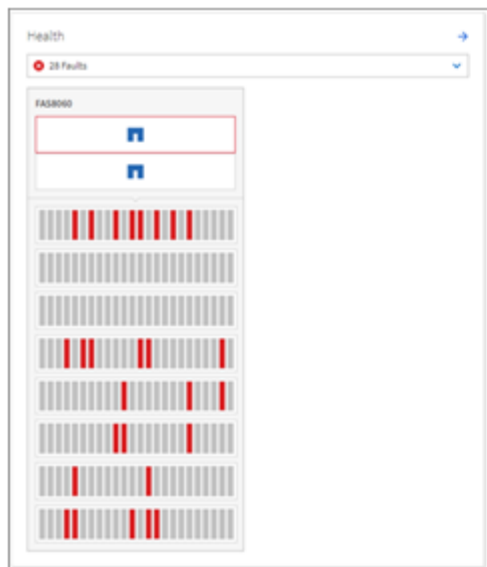
When you first log into Classic System Manager, the top left corner has a list of cluster and node faults. These are summarized into clickable links. When you click one of the links, you get redirected to another page in System Manager.

You also had a separate area that shows the cluster HA state to see whether a node has failed over. In the following images, we see the dashboard view and what we see when we click on one of the links—in this case, our failed disks.



To see other alerts, you must navigate back to the dashboard, which takes time and extra clicks. One of the goals of the new System Manager view is to simplify this process.

The following figure shows the new System Manager dashboard. The two main differences for the health and alert views are that we now have the node HA state and alerts in the same window, and, rather than clicking away from the main dashboard, the alerts are now in a drop-down box.



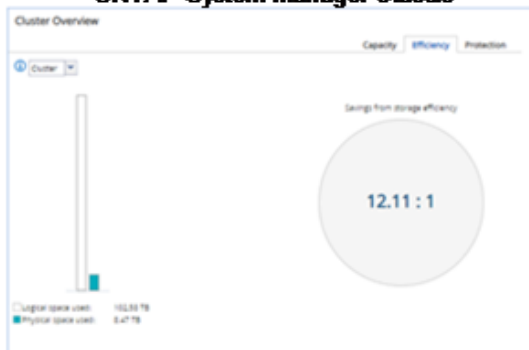
## Capacity Views

Extra clicks are also reduced for capacity views. In classic ONTAP System Manager, the capacity and storage efficiency ratios were found under Cluster Overview and had tabs to click around to find information. The new System Manager view consolidates the storage efficiency ratios and capacity views into a single graphic.

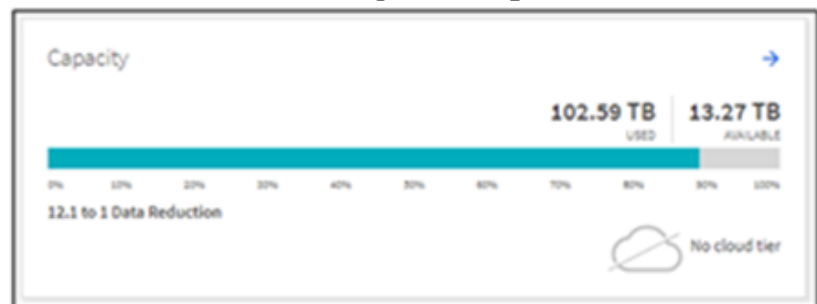


The new UI leverages logical used space and physical available space.

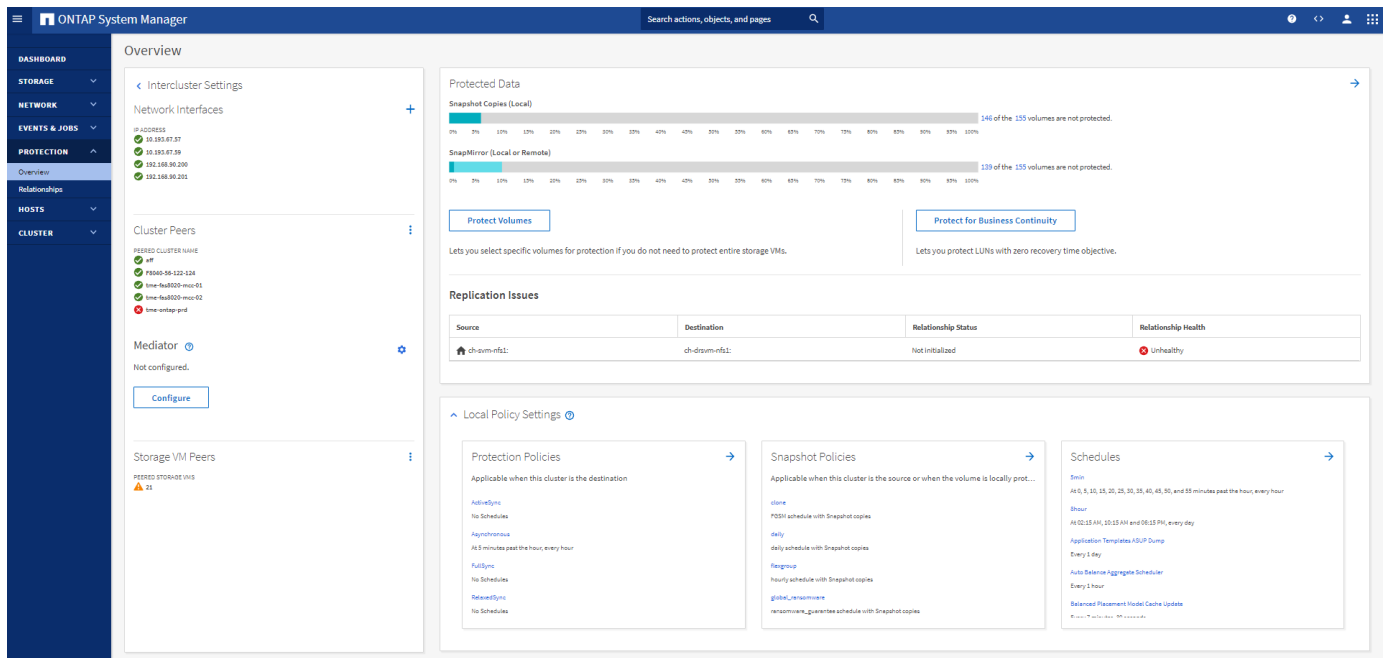
### ONTAP System Manager Classic



### ONTAP System Manager 9.8

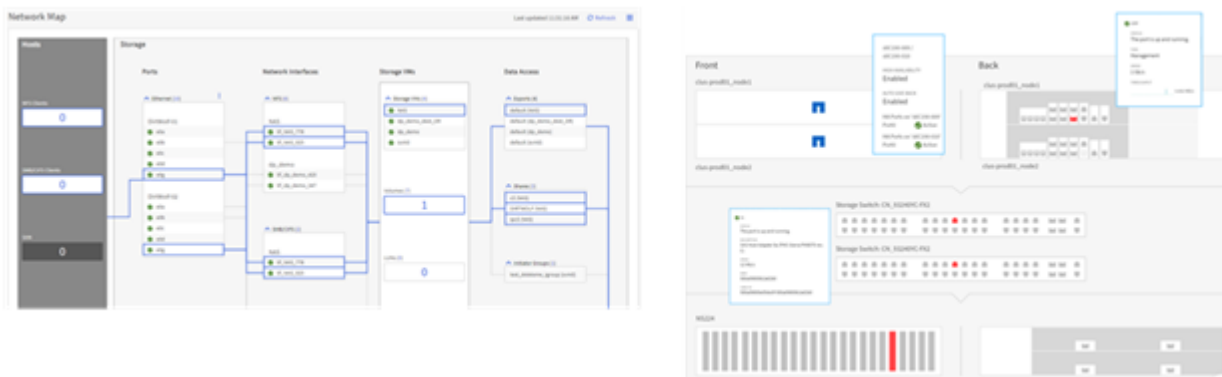


The data protection views have been moved to their own dashboard under Protection. This page provides deeper, more granular looks at the data protection in the cluster and also provides a location to leverage the new SnapMirror Business Continuity (SM-BC).



## Network Visualization

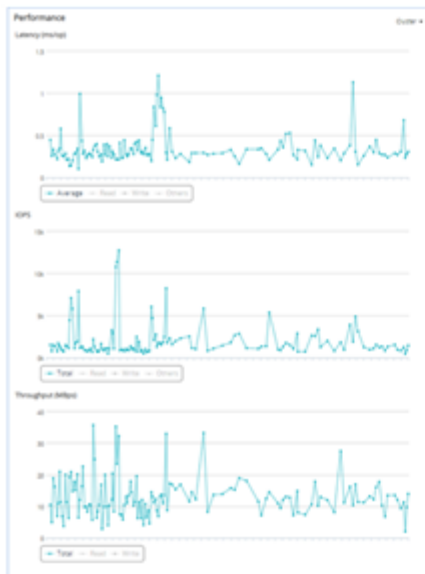
ONTAP System Manager 9.8 also removes the Application and Objects view in favor of a new Network Visualization view that shows network topology for the cluster, as well as red X's when a port is down.



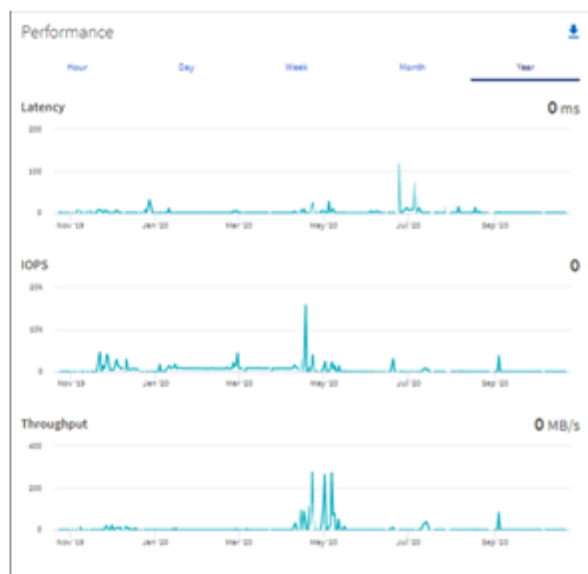
## Performance Views

Performance data graphs in System Manager now retain data for the cluster up to 1 year, rather than having classic System Manager performance data only be available while you are logged in. In ONTAP System Manager 9.8, you can now click on the hour, day, week, month, or year. There is also a way to download performance data to a CSV.

## ONTAP System Manager Classic



## ONTAP System Manager 9.8



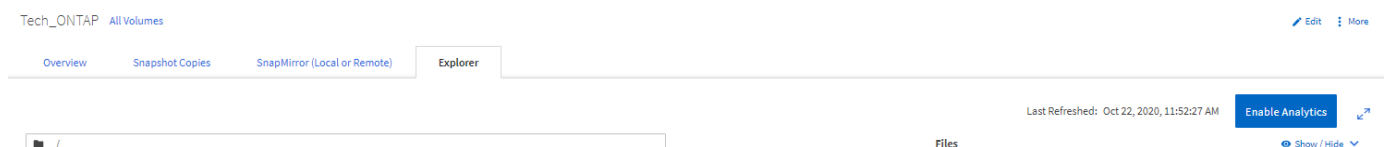
## File System Analytics

In high file- count environments, trying to find information about folder capacity, data age, and file counts usually requires time-intensive commands or scripts that run serial operations over NAS protocols, such as `ls`, `du`, `find`, and `stat`.

ONTAP System Manager 9.8 provides a way for admins to find out file system information in any NAS storage volume quickly and easily by enabling a low-impact scanner for each volume. This scanner crawls the ONTAP file system in the background with a low priority job and delivers a wealth of information that is available as soon as you navigate to a volume in System Manager 9.8 or later.


Enabling File Systems Analytics is as easy as navigating to the volume you want to scan. Go to Storage > Volumes and then use the search to find your desired volume. Click the volume, and then the Explorer tab.


From here, you see the Enable Analytics link on the right side of the page.




























After you click enable, the scanner starts. The time of completion depends on the number of objects in the volume as well as the system load. After it is finished, you see the entire directory structure populated in the System Manager view. This view can be navigated down the directory tree, and it provides access for history information, directory size information, and file sizes.


The following figure shows views from the Tech\_ONTAP volume in my cluster, which I use as an archive for [NetApp Tech ONTAP Podcast episodes](#).


 / > Episodes


 Graphical View






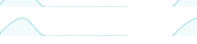




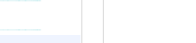


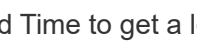





Directory Name	Used 	Modify History	Access History
▼ Episodes	30.4 GB		
> Insight 2016 - EMEA	4.1 GB		
> Episode 64 - Barcelona Recap	2.62 GB		
> Episode 65 - DevOps with the DevOpsFather Gene Kim	2.16 GB		
> Episode 66 - VCDX236	1.87 GB		
> Episode 1	1.71 GB		
> Episode 105 - CSA	1.1 GB		
> Episode 4	815 MB		
> Episode 170 - Active IQ	658 MB		
Episode 62 - Hardware Refresh	655 MB		
Episode 63 - Fabric Pools	649 MB		
> Episode 71 - SPC-1 A700s	624 MB		


When you click a folder, a file list appears on the right side of the page.

 / > Episodes > Episode 170 - Active IQ

 Graphical View

Files 

Directory Name	Used 	Modify History	Access History
▼ Episodes	30.4 GB		
> Insight 2016 - EMEA	4.1 GB		
> Episode 64 - Barcelona Recap	2.62 GB		
> Episode 65 - DevOps with the DevOpsFather Gene Kim	2.16 GB		
> Episode 66 - VCDX236	1.87 GB		
> Episode 1	1.71 GB		
> Episode 105 - CSA	1.1 GB		
> Episode 4	815 MB		
> Episode 170 - Active IQ	658 MB		

Name	Size 
ep170-meet-combined.output.mp3	57.7 MB
ep170-outro.output.mp3	195 KB
ep170-intro.output.mp3	103 KB
.DS_Store	6 KB
._DS_Store	4 KB

If you choose, you can enable Show Accessed Time to get a look at the last time a file was accessed.



Last Refreshed: Oct 22, 2020, 11:57:09 AM

Disable Analytics



## Files

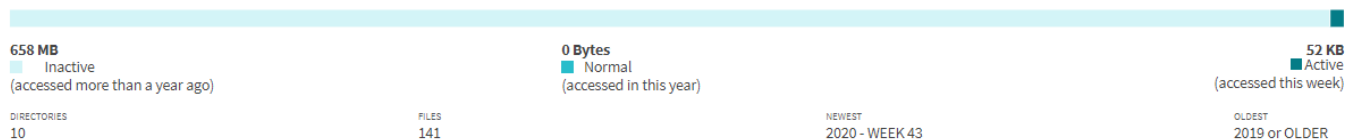
Name	Size	
ep170-meat-combined.output.mp3	57.7 MB	Wednesday, M...
ep170-outro.output.mp3	195 KB	Wednesday, M...
ep170-intro.output.mp3	103 KB	Wednesday, M...
.DS_Store	6 KB	Wednesday, M...
._DS_Store	4 KB	Wednesday, M...

Show / Hide

- ☒ Accessed Time
- ☒ Size

At the bottom of the page, you can see how much data hasn't been accessed in a year, as well as the directory and file counts in that folder.

Episode 170 - Active IQ (658 MB)



In addition to being able to quickly find file sizes and directory information, this feature also provides information that can help you decide whether NetApp FabricPool technology would be effective in reducing the amount of cold data that is taking up space on your aggregates.

## Active NFS Clients

ONTAP 9.7 introduced a way to see which NFS clients were accessing specific volumes in a cluster, as well as which data LIF IP addresses were in use with the `nfs connected-clients` command. This command is covered in detail in [TR-4067: NetApp ONTAP NFS Best Practices and Implementation Guide](#). This command is useful for scenarios where you need to find out what clients are attached to the storage system, such as upgrades, tech refreshes, or simple reporting.

ONTAP System Manager 9.8 offers a way to see these clients with the GUI, as well as a way to export the list to a .csv file. Navigate to Hosts > NFS Clients and you see a list of NFS clients that were active in the past 48 hours.

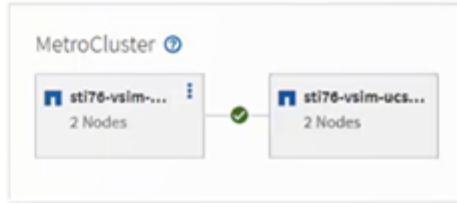
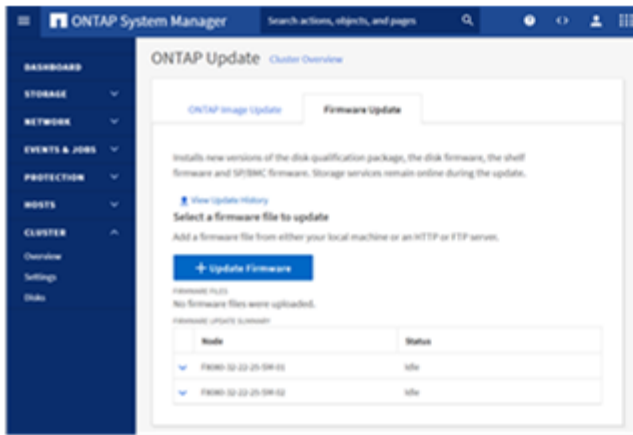
ONTAP System Manager		Search actions, objects, and pages			
NFS Clients (active in the past 48 hours)				Show / Hide Download Filter	
Client IP Address	Last Access	Storage VM	NFS Version	Data Network Interface	Volume
10.193.67.205	1 day 11 hour 16 minutes 25 seconds	DEMO	nfs3	10.193.67.219	ldbtestdata
10.193.67.205	1 day 11 hour 16 minutes 25 seconds	DEMO	nfs3	10.193.67.219	postgres012_fg
10.193.67.205	1 day 11 hour 16 minutes 25 seconds	DEMO	nfs3	10.193.67.219	postgres01_fg
10.193.67.205	1 day 11 hour 16 minutes 25 seconds	DEMO	nfs3	10.193.67.219	testdata
10.193.67.205	1 day 11 hour 16 minutes 25 seconds	DEMO	nfs3	10.193.67.219	testdata_export
10.193.67.225	1 day 19 hour 29 minutes 22 seconds	DEMO	nfs3	10.193.67.219	filegroup05
10.193.67.225	1 day 19 hour 29 minutes 1 seconds	DEMO	nfs3	10.193.67.219	netappcp_harbenos
10.193.67.225	1 day 19 hour 28 minutes 59 seconds	DEMO	nfs3	10.193.67.219	netgroup1
10.193.67.225	1 day 19 hour 28 minutes 59 seconds	DEMO	nfs3	10.193.67.219	vsroot
10.193.67.178	8 hour 35 minutes 43 seconds	DEMO	nfs3	10.193.67.237	scripts
10.193.67.196	8 hour 33 minutes 43 seconds	DEMO	nfs3	10.193.67.237	scripts
10.193.67.205	1 day 11 hour 13 minutes 5 seconds	DEMO	nfs3	10.193.67.237	postgres012_fg
10.193.67.225	1 day 19 hour 28 minutes 18 seconds	DEMO	nfs3	10.193.67.237	filegroup05
10.193.67.225	1 day 19 hour 28 minutes 34 seconds	DEMO	nfs3	10.193.67.237	home
10.193.67.240	21 seconds	DEMO	nfs3	10.193.67.237	postgres01_fg
10.193.67.178	8 hour 35 minutes 43 seconds	NFS	nfs3	10.193.67.214	netappcp_testdata
10.193.67.176	59 minutes 2 seconds	ch-qum-mixed1	nfs4.1	10.193.67.112	vol_fc_origin
10.193.67.176	59 minutes 2 seconds	ch-qum-mixed1	nfs4.1	10.193.67.112	vol_unix

Other System Manager 9.8 Enhancements

ONTAP 9.8 also brings the following enhancements to System Manager:

<ul style="list-style-type: none"> <li>NAS file security tracing (trace file access to troubleshoot permissions)</li> <li>Login banner configuration (banner that shows when you log in)</li> <li>MetroCluster configuration</li> <li>Logging level (adjust the level of logging done on the cluster)</li> <li>SAML configuration</li> <li>Onboard Key Manager</li> <li>NVMe subsystem</li> <li>Automatic aggregate provisioning and capacity expansion</li> <li>REST API support for ONTAP image upload</li> <li>Automatic port placement</li> <li>SnapMirror restore and reverse resync</li> </ul>	<ul style="list-style-type: none"> <li>Disk assignment</li> <li>FabricPool enhancements (tiering policies and object tagging)</li> <li>Adding nodes to the cluster</li> <li>Direct nondisruptive upgrade to n+2 ONTAP releases (2-year window)</li> <li>Performance views per protocol</li> <li>S3 protocol management</li> <li>Multiple LUNs in the same volume</li> <li>Multiple LUN moves</li> <li>Single-click firmware updates</li> <li>SnapMirror Business Continuity support</li> <li>Storage efficiency policies</li> <li>Volume management enhancements</li> </ul>
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The following figure shows MetroCluster and single-click firmware updates.



## REST API Enhancements

REST API support, added in ONTAP 9.6, enables storage admins to leverage industry standard API calls to ONTAP storage in their automation scripts without needing to interact with the CLI or GUI.

REST API documentation and samples are available with System Manager. Simply navigate to the cluster management interface from a web browser and add `docs/api` to the address (using HTTPS).

For example:

<https://cluster/docs/api>

This page provides an interactive glossary of available REST APIs, as well as a method to generate your own REST API queries.

# ONTAP REST API <sup>v1</sup>

[ Base URL: /api ]  
<https://ontap9-tme-8040.ntap2016.local/docs/api/swagger.yaml>

ONTAP adds support for an expansive RESTful API. The documentation below provides information about the types of API calls available to you, as well as details about using each API endpoint. You can learn more about the ONTAP REST API and ONTAP in the ONTAP 9 Documentation Center: <http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-rest-api/home.html>. NetApp welcomes your comments and suggestions about the ONTAP REST API and the documentation for its use.

## Using the ONTAP REST API online documentation

Each API method includes usage examples, as well as a model that displays all the required and optional properties supported by the method. Click the *Model* link, available with each API method, to see all the required and optional properties supported by each method.

## Features for all ONTAP APIs

### ▼ Getting started with the ONTAP REST API

#### Overview

Let's review some key things about RESTful APIs and how they're implemented in ONTAP:

- REST API URLs identify the resources that you'll be working with, including clusters, SVMs, and storage.
- REST APIs use HTTP methods GET, POST, PATCH, DELETE, and OPTIONS to indicate their actions.
- REST APIs return common HTTP status codes to indicate the results of each call. Additional error details can be included in the results body.
- REST APIs request and response bodies are encoded using JSON.
- REST APIs support hyperlinking among resources using the Content-Type "application/hal+json".
- GET calls on collections usually return only name and UUID by default. If you want to retrieve additional properties, you need to specify them using the "fields" query parameter.
- ONTAP supports query-based DELETE or PATCH for all collection endpoints.
- If you're already familiar with the ONTAPI API (also known as ZAPI), there are some similarities between ONTAP REST APIs and ONTAPI. For example:
  - Both support the same transport and security mechanisms.
  - Both paginate results based on either number of seconds or number of records.
  - Both support filtering the returned records based on property values.
  - Both support limiting the returned properties.
  - Both support concurrent requests. If ONTAP temporarily can't handle additional calls, it will respond with an HTTP error status code of 503.
- However, there are important differences between REST APIs and the ONTAP CLI and ONTAPI that you should understand as well:
  - In many cases, ONTAP REST APIs use different names for fields and features.
  - REST APIs do not expose infrequently used CLI parameters.
  - REST APIs do not treat the cluster or nodes as an SVM (aka Vserver).
  - REST GET APIs support specifying a maximum time before paginating results. However, the default time is 15 seconds for REST (instead of 90 seconds for ONTAPI).
  - REST APIs are generally ordered by UUID or ID, so a rename operation using the PATCH method doesn't change the path keys.
  - REST APIs use one or more of the following properties to identify a resource: "name", "uuid", "id".
  - REST APIs often execute the equivalent of multiple CLI commands in a single request.
  - REST API properties use underscores instead of hyphens between words.
  - REST API dates are always in ISO-8601 format.
  - REST API comparisons between enum values (for <, >, ranges, and order\_by) are done alphabetically. (In CLI and ONTAPI, enum comparisons are done based on an internal value for the enum.)
  - REST API field '<' queries exclude records where the specified field is not set. You can add "null" (eg: limit=<10|null) to also return records where the specified field is not set.

#### ► HAL linking

#### ► Query parameters

#### ► Query-based PATCH and DELETE

#### ► Record filtering

#### ► Requesting specific fields

In ONTAP 9.8, REST APIs are now annotated with which version they were added, which helps simplify life when you are trying to keep your scripts working across multiple ONTAP versions.

## cluster Manages clusters, nodes, jobs, and cluster software

DOC cluster

DOC /cluster

GET /cluster

Introduced in 9.6

POST /cluster

Introduced in 9.6

PATCH /cluster

Introduced in 9.6

DOC /cluster/chassis

GET /cluster/chassis

Introduced in 9.6

GET /cluster/chassis/{id}

Introduced in 9.6

DOC /cluster/firmware/history

GET /cluster/firmware/history

New in 9.8

The following table provides a list of new REST APIs in ONTAP 9.8.

<b>Cluster</b> * Firmware history * Cluster licensing – capacity pools * Cluster licensing – license managers * Node metrics * Software image upload <b>MetroCluster</b> * Mediator * Diagnostics * Management/creation * DR groups * Interconnects * Nodes * Operations <b>Networking</b> * Ethernet port metrics * Switch port information * Switch information * FC interface metrics * BGP peer groups * IP interface metrics * LIF service policies <b>SAN</b> * NVMe metrics	<b>Security</b> * FIPS mode enable/disable * Data encryption enable/disable * Azure Key Vaults * Google GCP-KMS * IP Sec <b>Storage</b> * File copy/move * NetApp FlexCache® PATCH/modify * Monitored files * Snapshot policies * Storage efficiency policies * File and directory management (Async delete, QoS and File Systems Analytics) <b>NAS</b> * Audit log redirect * CIFS sessions * File access tracing/Security trace <b>Manage</b> * Event remediation <b>Object Store/S3</b> * S3 bucket management * S3 groups * S3 policies
---	---

For more information on System Manager updates in ONTAP 9.8 see the [Tech ONTAP Podcast Episode 266: NetApp ONTAP System Manager 9.8](#).

## Upgrade and Tech Refresh Enhancements – ONTAP 9.8

Traditionally, ONTAP upgrades have had to happen within one or two major releases to work non-disruptively. For storage administrators who don't upgrade frequently, this becomes a major headache and logistical nightmare when it's finally time to upgrade ONTAP. Who wants to upgrade and reboot multiple times in a maintenance window?

ONTAP 9.8 now supports upgrades to ONTAP releases within a two-year window. This means if you want to upgrade from 9.6 to 9.8, you can do that directly without needing to go to ONTAP 9.7.

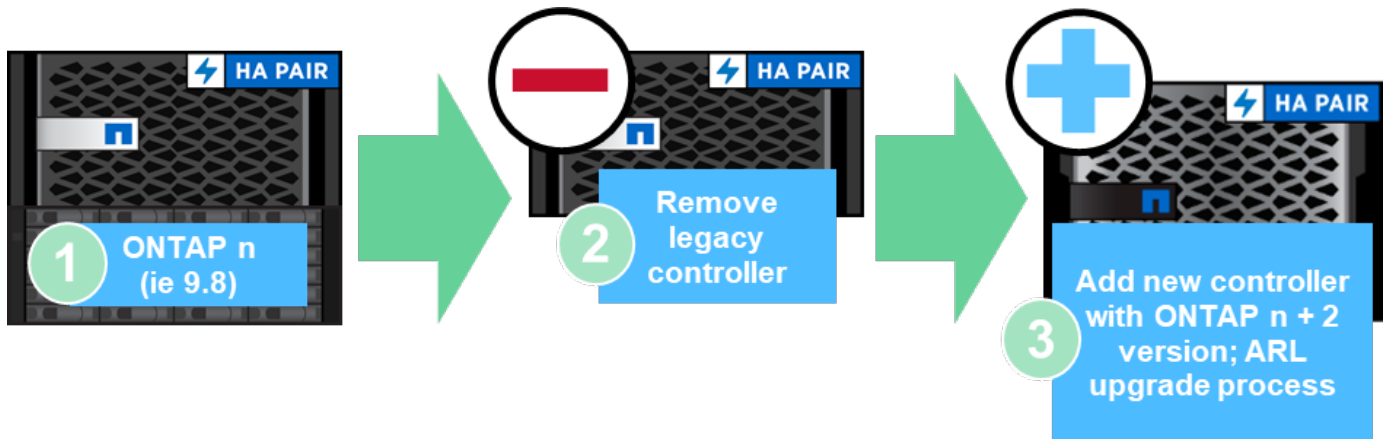
The following table provides a matrix of NetApp ONTAP version upgrades.

Starting Point	Direct Upgrade to:
ONTAP 9.6	ONTAP 9.7, ONTAP 9.8
ONTAP 9.7	ONTAP 9.8, ONTAP 9.n+2
ONTAP 9.8	ONTAP 9.n+1, ONTAP 9.n+2

This simplified upgrade process also provides a way for streamlined head upgrades. When a new hardware node is shipped, it has the latest ONTAP release installed. Previously, if your existing cluster was running an older ONTAP release, you had to either upgrade the existing nodes to the same ONTAP version as the new

node or you had to downgrade the new node to the older ONTAP release. And, as a further complication, if the newer hardware could not be downgraded, you were forced to take a maintenance window to upgrade the existing cluster.

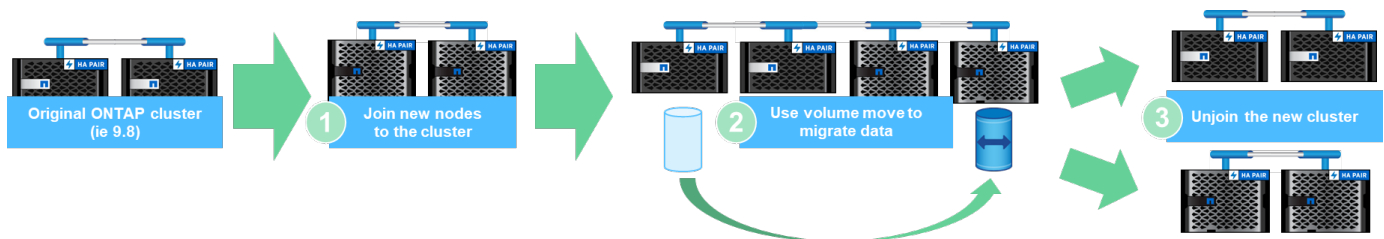
With ONTAP 9.8's 2-year revision window, now you can add new nodes into a cluster that have ONTAP versions within that range and the old nodes automatically upgrade to the new ONTAP release in the background, using the nondisruptive aggregate relocation upgrade process.



This process also extends into cluster upgrades, where you want to swap out an entire HA pair from a cluster. With the ONTAP 9.8 2-year revision window and nondisruptive volume moves, this is now possible.

The basic steps are as follows:

1. Connect the new systems to an existing cluster, with ONTAP versions within a 2-year window.
2. Use nondisruptive volume move to evacuate the nodes.
3. Unjoin the old nodes from the cluster.



Next: Data Protocols

## Data Protocols

Data protocols refer to the methods in which clients and end users interact with the NetApp ONTAP storage system for data access. NetApp ONTAP provides multiple officially supported interfaces for data access in the same storage platform, including the following:

- NAS
- SAN
- S3

ONTAP 9.8 delivers a slew of enhancements to ONTAP data protocols.

## NAS Protocol Enhancements

Network Attached Storage (NAS) protocols refer to file-based transfer methods such as NFS and SMB/CIFS. The following enhancements were added to ONTAP 9.8 for NAS protocol support, as well as features that apply specifically to NAS, such as NetApp FlexGroup and FlexCache volumes.

### NFS Enhancements

ONTAP 9.8 offers the following NFS enhancements:

- **NFSv4.2.** Offers basic NFSv4.2 protocol support and does not include NFSv4.2 features such as labeling. NFSv4.2 is enabled when NFSv4.1 is enabled.
- **Qtree Quality of Service (QoS).** Provides a way for storage administrators to apply QoS maximums and minimums to qtrees in ONTAP. This is currently only available with REST APIs and the command line, does not include adaptive QoS support, and is NFS only.

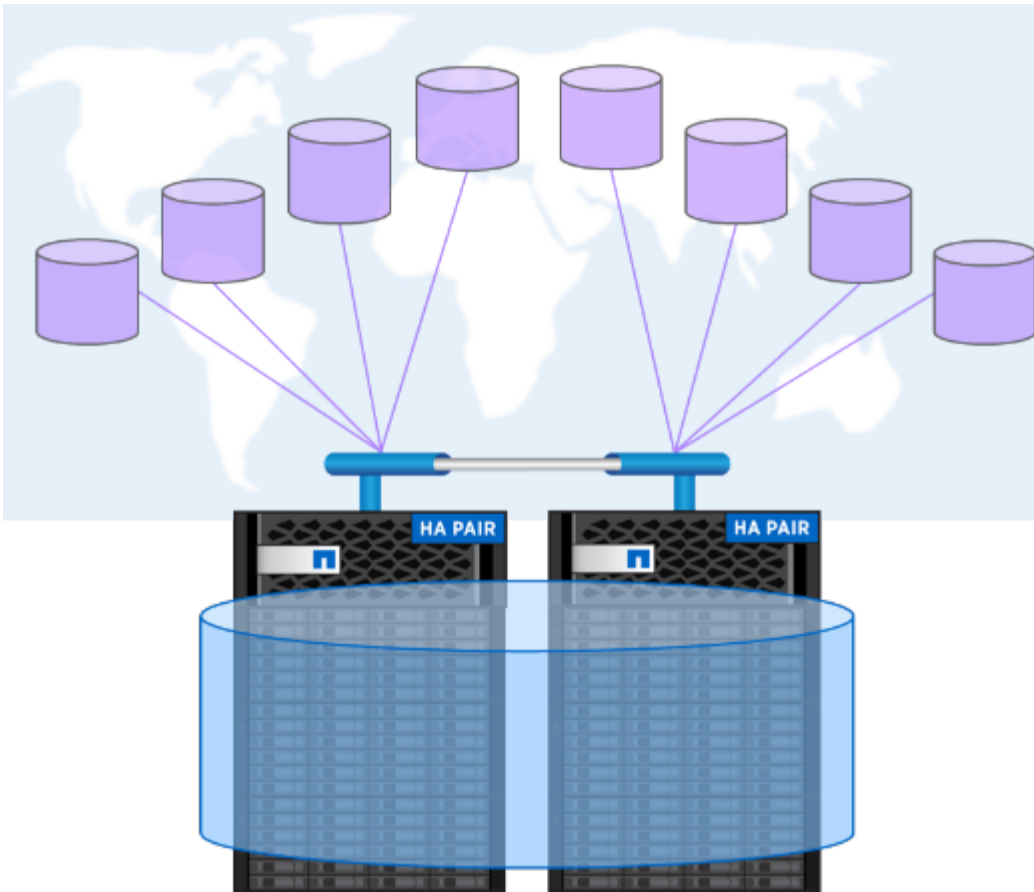
### SMB/CIFS Enhancements

ONTAP 9.8 offers the following SMB/CIFS enhancements:

- **SMB3-encrypted DC connections.** Encryption over the wire for SMB DC connections.
- **Map SID to UID on Set Owner (-map-sid-to-uid-on-set-owner).** This option controls whether ONTAP maps the Windows SID to a UNIX UID when setting ownership on files and folders. The option was added to improve the data migration experience for customers that experienced increased load on their Active Directory Servers. The default is `true`. (Fix for bug [1153207](#).)
- **Set Modebits when NFSv4\_acl are inherited (-is-inherit-modebits-with-nfsv4acl-enabled).** Provides support for multiprotocol NAS interaction when SMB files are created in directories where NFSv4 ACLs have removed the default `OWNER@`, `GROUP@`, and `EVERYONE@` ACLs, or those ACLs don't have inherit flags set. Default is `false`. (Fix for bug [820848](#).)

### FlexCache Volume Enhancements

NetApp FlexCache volumes are sparse, virtual caches comprised of NetApp FlexGroup volumes. These caches point back to an origin volume and populate data into the cache as it is requested from clients to provide fast, localized access anywhere you run ONTAP—whether in the cloud, at the edge, or in the datacenter—to provide a truly global namespace.



For more information about FlexCache volumes, see [TR-4743: FlexCache in ONTAP](#).

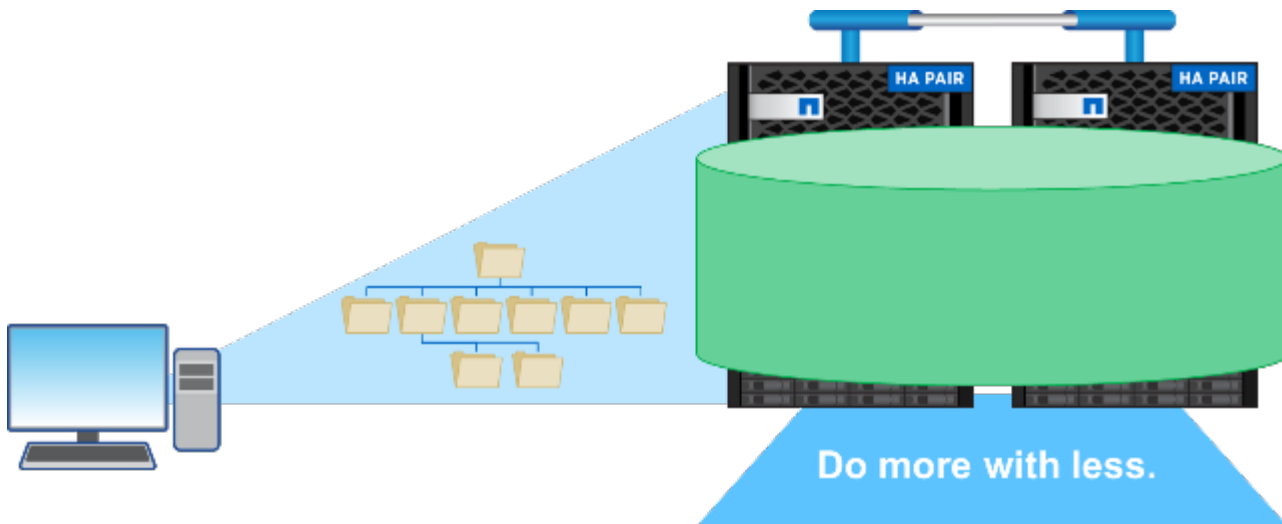
ONTAP 9.8 offers the following FlexCache volume enhancements:

- **SMB/CIFS support.** NetApp FlexCache now supports cache access to NFSv3 and SMB clients, as well as multiprotocol NAS data access. FlexCache can be used for multi-site distributed localized file locking for workloads that are read-heavy.
- **Increased FlexCache fan-out ratio.** ONTAP 9.8 provides a 100:1 fan-out ratio. Previously, the ratio was 10:1.
- **FlexCache volumes with a SnapMirror secondary origin.** FlexCache volumes can now be attached to SnapMirror secondary volumes, which provides a way to offload read operations from the primary storage systems, as well as offering a more geographically localized origin volume.
- **Block-level cache invalidation.** Rather than invalidating entire files when evicting changed data from the cache, now only the blocks that have changed are evicted. This saves capacity and WAN traffic load.
- **Pre-populating caches.** If you have a directory in a volume that you know will be accessed frequently, you can now pre-populate the cache with the contents of that directory to eliminate the latency from initial client access.

### FlexGroup Volume Enhancements

FlexGroup volumes are the NetApp ONTAP scale-out NAS solution, providing up to 20PB and 400 billion files in a single namespace, while offering automatically load-balanced parallel processing of high ingest workloads for a blend of capacity, performance, and simplicity.





For more information about FlexGroup volumes, see [TR-4571: NetApp FlexGroup Volumes Best Practices](#).

ONTAP 9.8 offers the following FlexGroup volume enhancements:

- **1,023 Snapshot support.** NetApp FlexGroup volumes now can have up to 1,023 Snapshot copies per volume. With additional Snapshot copies, FlexGroup volumes can become more viable as archival destinations, can keep a larger number of frequent snapshots, and can now support FlexVol conversions that have Snapshot copy IDs greater than 255.
- **NDMP enhancements.** NDMP support for FlexGroup volumes was added in ONTAP 9.7 but was missing the following functionality options:
  - ONTAP 9.8 adds support for NDMP
  - EXCLUDE
  - Restartable Backup Extensions (RBE)
  - MULTI\_SUBTREE\_NAMES
  - Performance enhancements

For more information on FlexGroup volumes and NDMP, see [TR-4678: Data Protection and Backup - FlexGroup Volumes](#).

- **FlexGroup convert support for 7MTT volumes.** Prior to ONTAP 9.8, you could not convert a FlexVol that had been transitioned from 7-Mode to a FlexGroup volume. ONTAP 9.8 lifts that restriction.
- **Proactive resizing.** Proactive resizing is a capacity management feature that maintains a free space buffer in FlexGroup member volumes to encourage consistent performance and capacity distribution.
- **File cloning.** You can now clone files in a FlexGroup volume using VMware vSphere through VAAI copy offload support. File cloning with REST APIs or the CLI is not currently supported, however.
- **VMware datastore support.** ONTAP 9.8 now has official support for FlexGroup volumes as scalable VMware datastores. This means the following:
  - Validated performance and placement
  - Interop qualification
  - Virtual Storage Console support
  - NetApp SnapCenter backup support

## Async Delete

Async delete enables storage administrators to bypass the latency of the network by deleting directories from the CLI.

If you have ever tried to delete a directory with many files in it over NFS or SMB, you know how painful that can be. Each operation must travel over the network via the NAS protocol that you are using, and then ONTAP must process those requests and respond. Depending on the network bandwidth available, client specs, or storage system, that process can take a long time. Async delete saves significant time and allows clients to get back to work quicker.

For more information on async delete, see [TR-4751: NetApp FlexGroup Volumes Best Practices](#).

## SAN Enhancements

Storage Area Network (SAN) protocols refer to block-based data transfer methods such as FCP, iSCSI, and NVMe over Fibre Channel. The following enhancements were added to ONTAP 9.8 for SAN protocol support.

### All-SAN Array (ASA)

ONTAP 9.7 introduced a new dedicated SAN platform called [ASA](#), with the goal of simplifying Tier-1 SAN deployments while drastically reducing the failover times in SAN environments by offering an active/active approach to SAN connectivity.

You can find out more about the ASA at [All-SAN Array documentation resources](#).

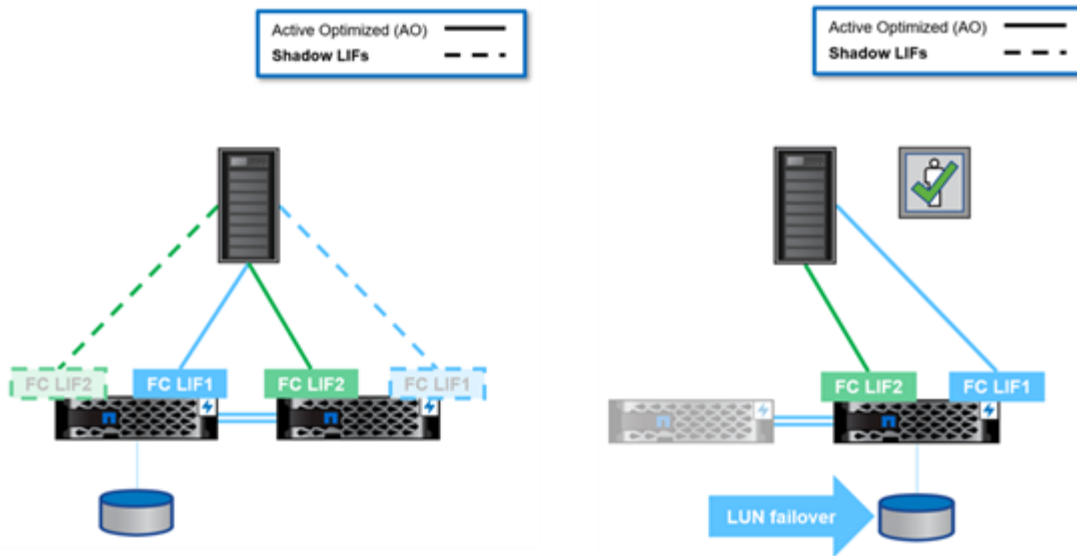
ONTAP 9.8 brings some enhancements to the ASA, including the following:

- **Larger LUN and FlexVol volume sizes.** LUNs on the ASA can now be provisioned at 128TB; FlexVol volumes can be 300TB.
- **MetroCluster over IP support.** ASA can now be used for site failovers over IP networks.
- **SnapMirror Business Continuity (SM-BC) support.** ASA can be used with SnapMirror Business Continuity. [xref](#)
- **Host ecosystem expansion.** HP-UX, Solaris, and AIX support. See the [Interoperability Matrix](#) for details.
- **Support for the A800 and A250 platforms.**
- **Simplified Provisioning in System Manager.**

### Persistent Ports

ASA adds an enhancement called Persistent Ports to improve failover times. Persistent ports in ONTAP offer much more resiliency and continuous data access for SAN hosts connecting to an ASA. Each node on the ASA maintains shadow fiber channel LIFs. This functionality is key to how ONTAP 9.8 reduces SAN failover time even more for the ASA. These LIFs maintain the same IDs of the partner LIFs, but they remain in standby mode. If there is a failover and an FC LIF must migrate to the partner node, then, rather than changing the IDs (which can increase failover times while the host negotiates that change), the shadow LIF becomes the new path. The host continues I/O on the same path, on the same ID, without a link-down notification and without any additional configuration required.

The following figure provides a failover example for persistent ports.



## NVMe/FC

NVMe is a new SAN protocol that helps improve latency and performance with block workloads over traditional FCP and iSCSI.

This blog covers it nicely: [When You're Implementing NVMe Over Fabrics, the Fabric Really Matters](#).

NetApp introduced support for NVMe over Fibre Channel in ONTAP 9.4 and has been adding feature enhancements in each release. ONTAP 9.8 adds the following:

- **NVMe/FC on the same SVM with FCP and iSCSI.** Now, you can use NVMe/FC on the same SVMs as your other SAN protocols, which simplifies management of your SAN environments.
- **Gen 7 SAN switch fabric support.** This feature adds support for the newer Gen-7 SAN switches.

## S3 Enhancements

Object storage with the S3 protocol is the newest addition to the ONTAP protocol family. Added as a public preview in ONTAP 9.7, S3 is now a fully supported protocol in ONTAP 9.8.

Support for S3 includes the following:

- Basic PUT/GET object access (does not include access to both S3 and NAS from the same bucket)
    - No object tagging or ILM support; for feature-rich, globally dispersed S3, use [NetApp StorageGRID](#).
  - TLS 1.2 encryption
  - Multi-part uploads
  - Adjustable ports
  - Multiple buckets per volume
  - Bucket access policies
  - S3 as a NetApp FabricPool target
- For more information, see the following resources:
- [Tech ONTAP Podcast: Episode 268 - NetApp FabricPool and S3 in ONTAP 9.8](#)
  - [ONTAP S3](#)

## Storage Efficiencies

Storage efficiencies include any features that reduce the amount of physical capacity taken up by data in a storage system. In ONTAP, these include the following:

- Data compression
- Data compaction
- Data deduplication
- NetApp FabricPool

Sometimes, these definitions can be stretched to include:

- NetApp FlexClone technology
- NetApp Snapshot copies

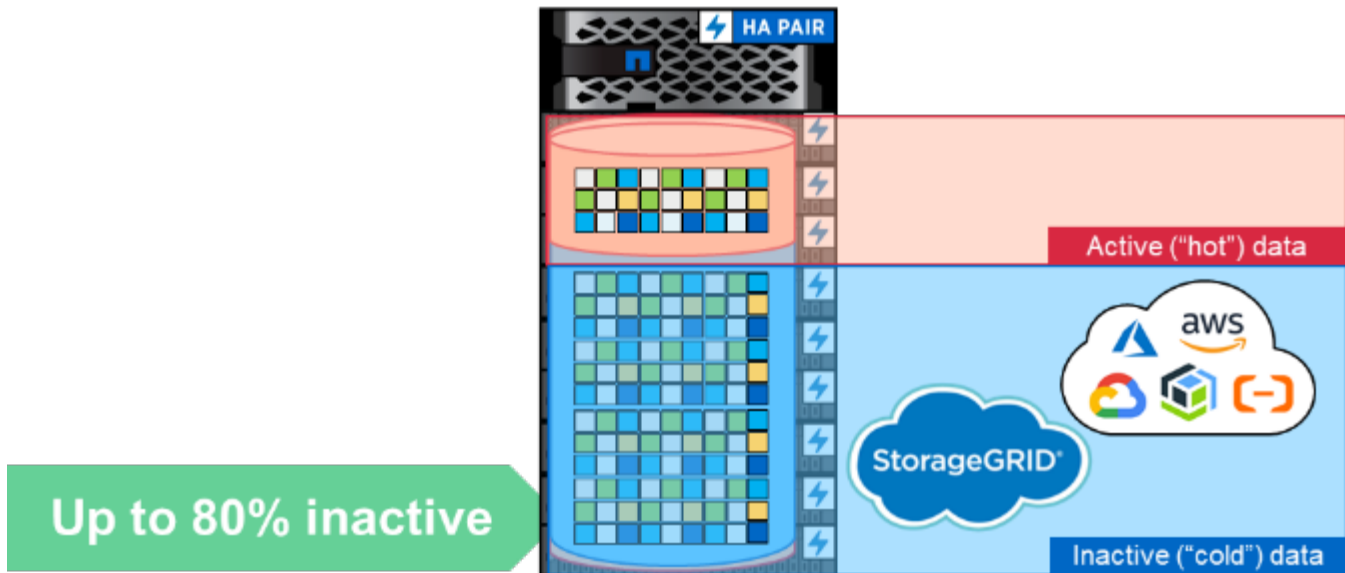
Storage efficiencies are vital for keeping storage costs low by reducing the amount of physical hardware that you need to purchase. ONTAP can perform data reduction on systems inline (AFF systems) or post-process (all systems), with minimal effects on the system's performance.

In ONTAP 9.8, there are a number of enhancements available for storage efficiencies.

### FabricPool

FabricPool is the NetApp data tiering technology that takes blocks marked as cold in a filesystem and bundles them into 4MB objects to be shipped off to cloud or S3 buckets. The idea is that cold data can use up to 80% of the total capacity in a storage system, so, rather than keep all of that on the performance tier, it's better to move it to a lower cost storage solution.

This all happens automatically in ONTAP via tiering policies that you can set, and you can find out how much cold data you have in your storage system today with Inactive Data Reporting. That way, you can evaluate whether FabricPool would actually save you money.



When a client accesses a file that has been tiered to the cloud, only the requested blocks (not the entire file) are brought back to the performance tier for access.

For more information on FabricPool, see [TR-4598: FabricPool Best Practices](#) and [TR-4598: FabricPool Best Practices and Tech ONTAP Podcast Episode 268: NetApp FabricPool and S3 in ONTAP 9.8](#).

ONTAP 9.8 supports the following FabricPool features:

- **Tiering from HDD aggregates.** Prior to ONTAP 9.8, FabricPool tiering to cloud from ONTAP was only possible on SSD aggregates. ONTAP 9.8 now allows you to tier using FabricPool from HDD aggregates.
- **Tiering to ONTAP S3.** Since ONTAP S3 is now generally available, it's now possible to tier from an ONTAP system using FabricPool to an ONTAP S3 bucket. This provides a way to repurpose aging capacity storage by using it as a FabricPool tier. And, by tiering to the same cluster, you get faster retrieval times than traversing a cloud network connection.
- **Increased Cooling Period.** Prior to ONTAP 9.8, data would be marked as cold after a cooling period, with a maximum of 63 days. ONTAP 9.8 allows you to configure that maximum to be as high as 183 days. This is useful for data that might be accessed sporadically, such as data that gets accessed on a quarterly basis, such as financial reports.
- **Object tagging.** When you tier to an S3 provider that offers Information Lifecycle Policies that manage data based on object tags, ONTAP 9.8 can tag objects tiered using FabricPool to incorporate into those policies.
- **Cloud retrieval.** In some cases, you might need to pull all tiered data back from the cloud. Rather than having to access all the data, you can now run a job that retrieves the data from the cloud in ONTAP 9.8.

## Compression

ONTAP 9.8 introduced some data compression changes that help improve performance, as well as improving data reduction ratios on compressible datasets.

The main change for compression was to differentiate data into cold and hot classifications. Cold data is data that has not been accessed for a long time, and hot data is data that is frequently accessed. That means we want to less aggressively compress hot data and more aggressively compress cold data.

In ONTAP 9.8, hot data is compressed inline using 8K compression groups. Additionally, data deduplication happens before compression to add even more efficiency to the datasets.

Cold data is then compressed again in the background using a more aggressive 32K compression group. These changes mean better performance for hot data and better data reduction ratios for all data.

[Next: Data Protection](#)

## Data Protection

Data protection in the context of this document refers to both the notion of off-site replication of data, as well as securing that data in-flight and at-rest. This section covers the latest data protection enhancements for ONTAP 9.8.

### Security

Each ONTAP release builds in new security features and enhancements, and ONTAP 9.8 is no different in that regard. For more information on ONTAP security features, see [TR-4569: Security Hardening Guide for ONTAP 9](#).

#### Secure Purge

In environments with classified or sensitive data, having a file mistakenly written to a volume that is accessible to people who should not have access to that file creates what is known as a data spill. This creates a scenario in which entire volumes must be deleted and disks scrubbed to clean up the spill.

NetApp Volume Encryption and Secure Purge provided a way to mitigate those potential disasters by offering a way to cryptographically shred individual files by deleting the security encryption key associated with the file. After that key is gone, that data is no longer recoverable from disk. This process has been externally validated by a data recovery company using NIST SP 800-88 guidelines for media sanitation.

But even secure purge had its limits; for example, if you must purge a file, you would need to perform a volume move, which requires available space in the system. If you have SnapMirror in place, you would need to re-baseline after a secure purge operation.

Secure Purge in ONTAP 9.8 removes those limitations by:

- Providing a simple, in-place procedure for cryptoshredding files.
- Allowing you to keep your existing SnapMirror mirrors in place with no need to re-baseline.

#### IPSec

IPSec is a standard mechanism for performing application-agnostic encryption over the wire. With IPSec, you can encrypt network traffic regardless of the protocol in use. That provides opportunities for simplification, particularly with NFS, where Kerberos encryption is difficult to set up and use, as well as providing the only way

to encrypt iSCSI traffic over the wire.

ONTAP 9.8 now adds support for IPSec. The ONTAP implementation of IPSec leverages a pre-shared secret or key (PSK) with the connecting client. Those clients include any recent OS that leverages IKEv2 with PSK. Note that the Windows OS does not support IKEv2 with PSK.

## Trusted Platform Module

With the new Trusted Platform Module (TPM) in ONTAP 9.8, the encryption keys for the onboard key manager (OKM) are no longer stored in the boot device but instead are stored in the physical TPM for systems so equipped, offering greater security and protection. Moving to the TPM is a nondisruptive process.

## NetApp Volume Encryption

NetApp Volume Encryption (NVE) is a software solution that enables encryption of any data volume on any drive type where it is enabled, with a unique key for each volume. This feature has been available since ONTAP 9.1.

ONTAP 9.8 brings NVE support to the node root volumes, which contain log files, cluster configuration backups, core files and other system-related information that you may want to secure with FIPS-140-2 compliant encryption.

## SnapMirror Cloud

SnapMirror is industry-leading replication technology in ONTAP that provides a way for storage administrators to create exact copies of datasets across a WAN connection and only replicating the changed blocks for reduced network utilization.

Over the past few ONTAP releases, SnapMirror support has been expanded to include non-ONTAP systems, such as the [SolidFire Element OS](#). ONTAP 9.8 now provides a way to leverage SnapMirror to replicate to cloud or on-premises S3 object buckets.



By leveraging the new [SnapDiff 3.0 engine](#), SnapMirror can securely and efficiently replicate data from ONTAP NAS volumes to object storage buckets. This provides hybrid-cloud mobility across the ONTAP data fabric.

- Space-efficient backups of snapshots to cloud object storage preserve storage efficiency.
- Supports full-volume and single-file restore

In ONTAP 9.8, SnapMirror Cloud requires orchestration by one of the following two methods. It is not supported in System Manager or directly through APIs or the CLI.

- Through a licensed ISV partner application which creates and manage the backup and restore workflows. A SnapMirror Cloud license is required.
- Through the Cloud Backup Service. A SnapMirror Cloud license is not required.



For more information on SnapDiff and SnapMirror Cloud, see the following resources:

- [Tech ONTAP Podcast Episode 264: NetApp ONTAP SnapDiff](#)
- [Tech ONTAP Podcast Episode 265: NetApp SnapMirror Cloud featuring ProLion](#)
- [NetApp Blog: A new backup architecture with SnapDiff/SnapMirror Cloud-v3](#)

## SnapMirror Business Continuity (SM-BC)

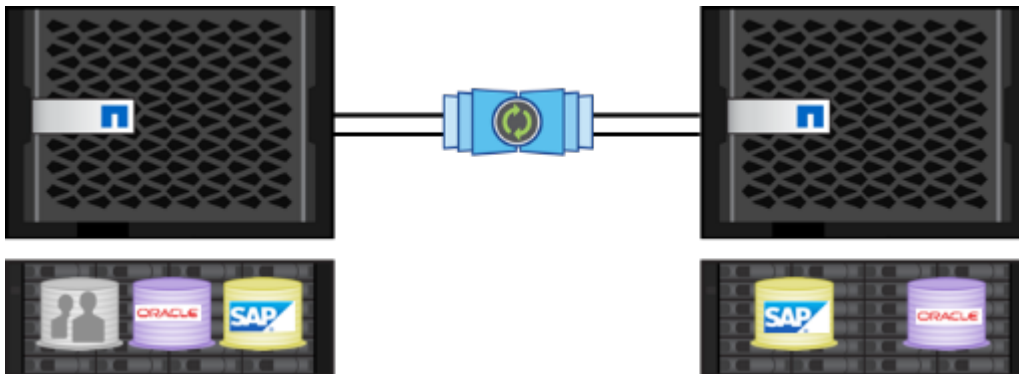
[SnapMirror Synchronous](#) (SM-S) was introduced in ONTAP 9.5 and provides volume- granular and storage-efficient synchronous data replication that enterprises depend on for backup, disaster recovery, and data mobility. SM-S replicates data on NetApp FlexVol volumes between fully redundant ONTAP storage systems located across data centers or metro regions with a round trip time (RTT) less than 10ms to achieve a zero recovery point objective and a near-zero recovery time objective.

ONTAP 9.8 takes the concept of SnapMirror Synchronous in SAN environments and brings an automated failover capability for applications at the Consistency Group, using System Manager to configure and the ONTAP Mediator to manage and maintain business continuity in the event of an outage. Because the relationship is synchronous, applications won't miss a beat when failing over. The initial release of SnapMirror Business Continuity only supports SAN (iSCSI and FCP) workloads.

For more information on SnapMirror Business Continuity, see the [Tech ONTAP Podcast Episode 267: SnapMirror Business Continuity](#).

## MetroCluster

NetApp MetroCluster (MC) software is a solution that combines array-based clustering with synchronous replication to deliver continuous availability and zero data loss at the lowest cost. Administration of the array-based cluster is simpler because the dependencies and complexity normally associated with host-based clustering are eliminated.



MetroCluster immediately duplicates all your mission-critical data on a transaction-by-transaction basis, providing uninterrupted access to your applications and data. Unlike standard data replication solutions, MetroCluster works seamlessly with your host environment to provide continuous data availability while eliminating the need to create and maintain complicated failover scripts.

With MetroCluster, you can perform the following tasks:

- Protect against hardware, network, or site failure with transparent switchover
- Eliminate planned and unplanned downtime and change management
- Upgrade hardware and software without disrupting operations



- Deploy without complex scripting, application, or operating system dependencies
- Achieve continuous availability for VMware, Microsoft, Oracle, SAP, or any critical application

ONTAP 9.8 provides the following feature enhancements for MetroCluster.

- **New entry-level and midrange platform support.** NetApp AFF A250, FAS500f, FAS8300, FAS 8700 hybrid, and A400. For new installations of A220, FAS2750, and FAS500f, a VLAN can now be specified to be greater than 100 and less than 4096.
- **Non-disruptive transition from MC-FC to MC-IP.** Four-node clusters only; two-node MCC require downtime. Simple to move to MC IP in your upcoming tech refresh.
- **Unmirrored aggregates now supported for MC IP.** Replicate only desired aggregates to the failover site for more application granularity.
- Support for the Cisco 9336C-FX2 switch and for A400, FAS 8300, and FAS 8700 on the BES-53248 switch with an additional 100G port license.

For more information about MetroCluster, see the following resources:

- [TR-4375: MetroCluster FC for ONTAP 9.7](#)
- [TR-4689: MetroCluster IP Solution Architecture and Design](#)
- [TR-4705: NetApp MetroCluster Solution Architecture and Design](#)

[Next: VMware Virtualization](#)

## VMware Virtualization

VMware integration and support in ONTAP 9.8 gets a boost with a number of new features including FlexGroup datastore support. ONTAP 9.8 allows you to provision a FlexGroup volume as a VMware NFS datastore, simplifying datastore management with a single, scalable datastore that provides the power of a full ONTAP cluster. Many of these new features are coming with the ONTAP tools for VMware vSphere 9.8 release.

This means the following applies:

- Validated performance and placement
- Interop qualification
- Enhanced VAAI copy offload that is faster and completes in the background
- Virtual Storage Console support, including FlexGroup provisioning, resize and deletion, setting QoS on individual VMs, and displaying performance metrics (latency, IOPS, and throughput) for VMs
- NetApp SnapCenter primary storage backup and recovery support
- Support for a maximum of 64TB VMFS LUNs. With support for 128TB LUNs/300TB FlexVol volumes with the NetApp All-SAN Array, you can provision the maximum 64TB VMFS datastore using the Virtual Storage Console in the ONTAP tools for VMware vSphere 9.8 release.
- Increased [Site Recovery Manager \(SRM\)](#) scale. The Storage Replication Adapter in the ONTAP tools for VMware vSphere 9.8 release increases the scale of datastores and protection groups supported up to 512.
- VMware vSphere vVols file metrics with REST APIs. REST API support for vVols file metrics is added to ONTAP 9.8, which allows the Virtual Storage Console to display ONTAP storage performance metrics for vVols in the dashboard and reports.
- [Storage Replication Adapter \(SRA\)](#) support for SnapMirror Synchronous

- Support for [VMware Tanzu](#) storage
- Improved support for vVols, including an enhanced SAN vVol rebalancing command and enhancements to Storage Capability Profiles. For more information on the latest VMware virtualization support, see the following resources:
- [Tech ONTAP Podcast Episode 263: Virtualization in ONTAP – Fall 2020](#)
- [TR-4597: VMware vSphere with ONTAP](#)

## Technical Resources

This section covers the technical resources available that detail the features mentioned in this document.

### Technical Reports

- TR-4067: NetApp ONTAP NFS Best Practices and Implementation Guide  
<https://www.netapp.com/us/media/tr-4067.pdf>
- TR-4375: MetroCluster FC for ONTAP 9.7  
<https://www.netapp.com/us/media/tr-4375.pdf>
- TR-4569: Security Hardening Guide for ONTAP 9  
<https://www.netapp.com/pdf.html?item=/media/10674-tr4569pdf.pdf>
- TR-4571: NetApp FlexGroup Volumes Best Practices  
<https://www.netapp.com/us/media/tr-4571.pdf>
- TR-4597: VMware vSphere with ONTAP  
<https://www.netapp.com/us/media/tr-4597.pdf>
- TR-4598: FabricPool Best Practices  
<https://www.netapp.com/us/media/tr-4598.pdf>
- TR-4678: Data Protection and Backup - FlexGroup Volumes  
<https://www.netapp.com/us/media/tr-4678.pdf>
- TR-4689: MetroCluster IP Solution Architecture and Design  
<https://www.netapp.com/us/media/tr-4689.pdf>
- TR-4705: NetApp MetroCluster Solution Architecture and Design  
<https://www.netapp.com/pdf.html?item=/media/13480-tr4705pdf.pdf>
- TR-4743: FlexCache in ONTAP  
<https://www.netapp.com/pdf.html?item=/media/7336-tr4743pdf.pdf>

## Podcasts

- Tech ONTAP Podcast Episode 263: Virtualization in ONTAP – Fall 2020

[https://soundcloud.com/techontap\\_podcast/episode-263-virtualization-in-ontap-fall-2020-update](https://soundcloud.com/techontap_podcast/episode-263-virtualization-in-ontap-fall-2020-update)

- Tech ONTAP Podcast Episode 264: NetApp ONTAP SnapDiff

[https://soundcloud.com/techontap\\_podcast/episode-264-netapp-ontap-snapdiff](https://soundcloud.com/techontap_podcast/episode-264-netapp-ontap-snapdiff)

- Tech ONTAP Podcast Episode 265: NetApp SnapMirror Cloud featuring ProLion

[https://soundcloud.com/techontap\\_podcast/episode-265-netapp-snapmirror-cloud-featuring-prolion](https://soundcloud.com/techontap_podcast/episode-265-netapp-snapmirror-cloud-featuring-prolion)

- Tech ONTAP Podcast Episode 266: NetApp ONTAP System Manager 9.8

[https://soundcloud.com/techontap\\_podcast/episode-266-netapp-system-manager-98](https://soundcloud.com/techontap_podcast/episode-266-netapp-system-manager-98)

- Tech ONTAP Podcast Episode 267: SnapMirror Business Continuity

[https://soundcloud.com/techontap\\_podcast/episode-267-snapmirror-business-continuity-sm-bc-for-ontap-98](https://soundcloud.com/techontap_podcast/episode-267-snapmirror-business-continuity-sm-bc-for-ontap-98)

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