



Protecting Workloads

NetApp Solutions

NetApp
September 06, 2022

Table of Contents

- Protecting Workloads 1
 - Disaster Recovery with ANF and JetStream 1
 - Disaster Recovery with CVO and AVS (guest-connected storage) 16

Protecting Workloads

Disaster Recovery with ANF and JetStream

Disaster recovery to cloud is a resilient and cost-effective way of protecting the workloads against site outages and data corruption events (for example, ransomware). Using the VMware VAI framework, on-premises VMware workloads can be replicated to Azure Blob storage and recovered, enabling minimal or close to no data loss and near-zero RTO.

JetStream DR can be used to seamlessly recover the workloads replicated from on-premises to AVS and specifically to Azure NetApp Files. It enables cost-effective disaster recovery by using minimal resources at the DR site and cost-effective cloud storage. JetStream DR automates recovery to ANF datastores via Azure Blob Storage. JetStream DR recovers independent VMs or groups of related VMs into recovery site infrastructure according to network mapping and provides point-in-time recovery for ransomware protection.

This document provides an understanding of the JetStream DR principles of operations and its main components.

Solution deployment overview

1. Install JetStream DR software in the on-premises data center.
 - a. Download the JetStream DR software bundle from Azure Marketplace (ZIP) and deploy the JetStream DR MSA (OVA) in the designated cluster.
 - b. Configure the cluster with the I/O filter package (install JetStream VIB).
 - c. Provision Azure Blob (Azure Storage Account) in the same region as the DR AVS cluster.
 - d. Deploy DRVA appliances and assign replication log volumes (VMDK from existing datastore or shared iSCSI storage).
 - e. Create protected domains (groups of related VMs) and assign DRVAs and Azure Blob Storage/ANF.
 - f. Start protection.
2. Install JetStream DR software in the Azure VMware Solution private cloud.
 - a. Use the Run command to install and configure JetStream DR.
 - b. Add the same Azure Blob container and discover domains using the Scan Domains option.
 - c. Deploy required DRVA appliances.
 - d. Create replication log volumes using available vSAN or ANF datastores.
 - e. Import protected domains and configure RocVA (recovery VA) to use ANF datastore for VM placements.
 - f. Select the appropriate failover option and start continuous rehydration for near-zero RTO domains or VMs.
3. During a disaster event, trigger failover to Azure NetApp Files datastores in the designated AVS DR site.
4. Invoke failback to the protected site after the protected site has been recovered. Before starting, make sure that the prerequisites are met as indicated in this [link](#) and also run the Bandwidth Testing Tool (BWT) provided by JetStream Software to evaluate the potential performance of Azure Blob storage and its replication bandwidth when used with JetStream DR software. After the pre-requisites, including connectivity, are in place, set up and subscribe to JetStream DR for AVS from the [Azure Marketplace](#). After the software bundle is downloaded, proceed with the installation process described above.

When planning and starting protection for a large number of VMs (for example, 100+), use the Capacity Planning Tool (CPT) from the JetStream DR Automation Toolkit. Provide a list of VMs to be protected together with their RTO and recovery group preferences, and then run CPT.

CPT performs the following functions:

- Combining VMs into protection domains according to their RTO.
- Defining the optimal number of DRVAs and their resources.
- Estimating required replication bandwidth.
- Identifying replication log volume characteristics (capacity, bandwidth, and so on).
- Estimating required object storage capacity, and more.



The number and content of domains prescribed depend upon various VM characteristics such as average IOPS, total capacity, priority (which defines failover order), RTO, and others.

Install JetStream DR in On-Premises Datacenter

JetStream DR software consists of three major components: JetStream DR Management Server Virtual Appliance (MSA), DR Virtual Appliance (DRVA), and host components (I/O Filter packages). MSA is used to install and configure host components on the compute cluster and then to administer JetStream DR software. The following list provides a high-level description of the installation process:

Details

1. Check prerequisites.
2. Run the Capacity Planning Tool for resource and configuration recommendations (optional but recommended for proof-of-concept trials).
3. Deploy the JetStream DR MSA to a vSphere host in the designated cluster.
4. Launch the MSA using its DNS name in a browser.
5. Register the vCenter server with the MSA. To perform the installation, complete the following detailed steps:
6. After JetStream DR MSA has been deployed and the vCenter Server has been registered, access the JetStream DR plug-in using the vSphere Web Client. This can be done by navigating to Datacenter > Configure > JetStream DR.



7. From the JetStream DR interface, select the appropriate cluster.



8. Configure the cluster with the I/O filter package.

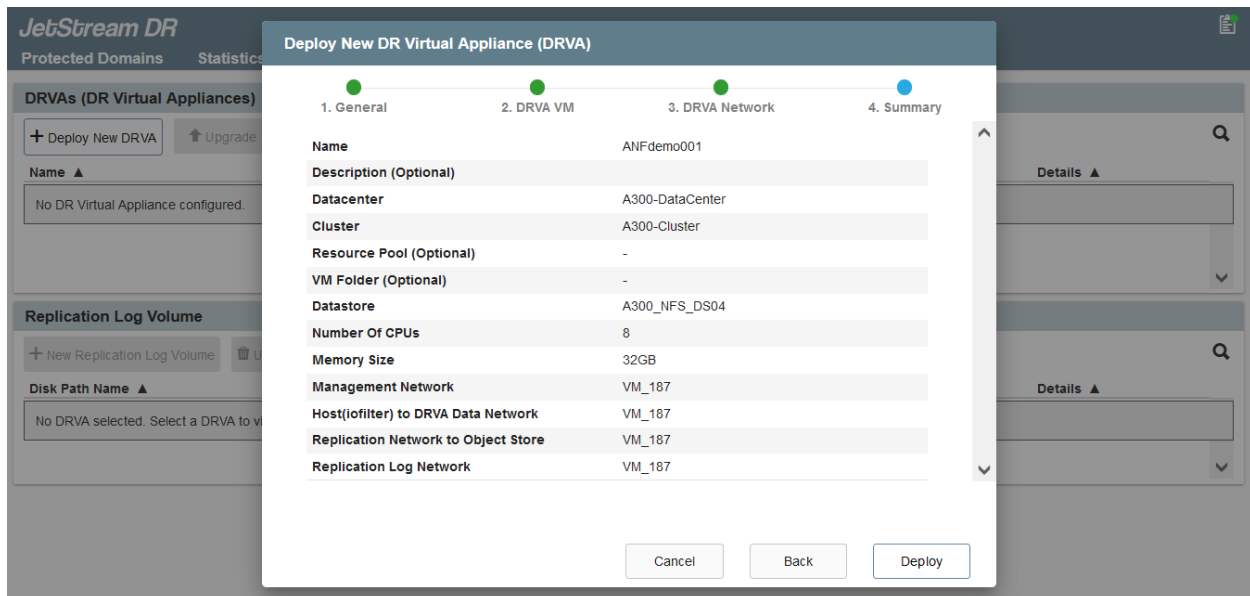


9. Add Azure Blob Storage located at the recovery site.
10. Deploy a DR Virtual Appliance (DRVA) from the Appliances tab.



DRVAs can be automatically created by CPT, but for POC trials we recommend configuring and running the DR cycle manually (start protection > failover > failback).

The JetStream DRVA is a virtual appliance that facilitates key functions in the data replication process. A protected cluster must contain at least one DRVA, and typically one DRVA is configured per host. Each DRVA can manage multiple protected domains.



In this example, four DRVA's were created for 80 virtual machines.

1. Create replication log volumes for each DRVA using VMDK from the datastores available or independent shared iSCSI storage pools.
2. From the Protected Domains tab, create the required number of protected domains using information about the Azure Blob Storage site, DRVA instance, and replication log. A protected domain defines a specific VM or set of VMs within the cluster that are protected together and

assigned a priority order for failover/failback operations.

JetStream DR

Protected Domains Statistics Storage Sites Appliances Configurations Task Log

Select Protected Domain:

Create Protected Domain

1. General 2. Primary Site 3. Summary

Protected Domain Name ANFPD001

Priority Level (Optional) 1

Total estimated data size to be protected 1000GB

DR Virtual Appliance ANFdemo001

Compression Yes

Compression Level Default

Normal GC Storage Overhead 50%

Maximum GC Storage Overhead 300%

Replication Log Storage /dev/sdb

Replication Log Size 94.31GB

Metadata Size 31.56GB

Cancel Back Create

3. Select VMs you want to protect and start VM protection of the protected domain. This begins data replication to the designated Blob Store.



Verify that the same protection mode is used for all VMs in a protected domain.



Write- Back(VMDK) mode can offer higher performance.

JetStream DR

Protected Domains Statistics Storage Sites Appliances Configurations Task Log

Select Protected Domain: ANFPD001

Recoverable / Total VMs

Replication Status

Remaining Background Data

Current RPO

Protected VMs Settings Alerts

+ Start Protection Stop Protection

VM Name ▲

No VM is protected.

Start Protection

Protection Mode for selected VMs

Write-Back(VMDK)

VM Name ▲	# of Disks...	Protection Mode
1		
<input checked="" type="checkbox"/> AuctionAppA1	1	Write-Back(VMDK)
<input checked="" type="checkbox"/> AuctionAppB1	1	Write-Back(VMDK)
<input checked="" type="checkbox"/> AuctionDB1	2	Write-Back(VMDK)
<input checked="" type="checkbox"/> AuctionLB1	1	Write-Back(VMDK)
<input checked="" type="checkbox"/> AuctionMSQ1	1	Write-Back(VMDK)
<input checked="" type="checkbox"/> AuctionNoSQL1	2	Write-Back(VMDK)
<input checked="" type="checkbox"/> AuctionWebA1	1	Write-Back(VMDK)
<input checked="" type="checkbox"/> AuctionWebB1	1	Write-Back(VMDK)
<input checked="" type="checkbox"/> Client1	1	Write-Back(VMDK)
<input checked="" type="checkbox"/> D32DB1	2	Write-Back(VMDK)

Cancel Start Protection

Verify that replication log volumes are placed on high performance storage.



Failover run books can be configured to group the VMs (called Recovery Group), set boot order sequence, and modify the CPU/memory settings along with IP configurations.

Install JetStream DR for AVS in an Azure VMware Solution private cloud using the Run command

A best practice for a recovery site (AVS) is to create a three-node pilot-light cluster in advance. This allows the recovery site infrastructure to be preconfigured, including the following items:

- Destination networking segments, firewalls, services like DHCP and DNS, and so on.
- Installation of JetStream DR for AVS
- Configuration of ANF volumes as datastores, and moreJetStream DR supports near-zero RTO mode for mission- critical domains. For these domains, destination storage should be preinstalled. ANF is a recommended storage type in this case.



Network configuration including segment creation should be configured on the AVS cluster to match on-premises requirements.

Depending on the SLA and RTO requirements, continuous failover or regular (standard) failover mode can be used. For near-zero RTO, continuous rehydration should be started at the recovery site.



Details

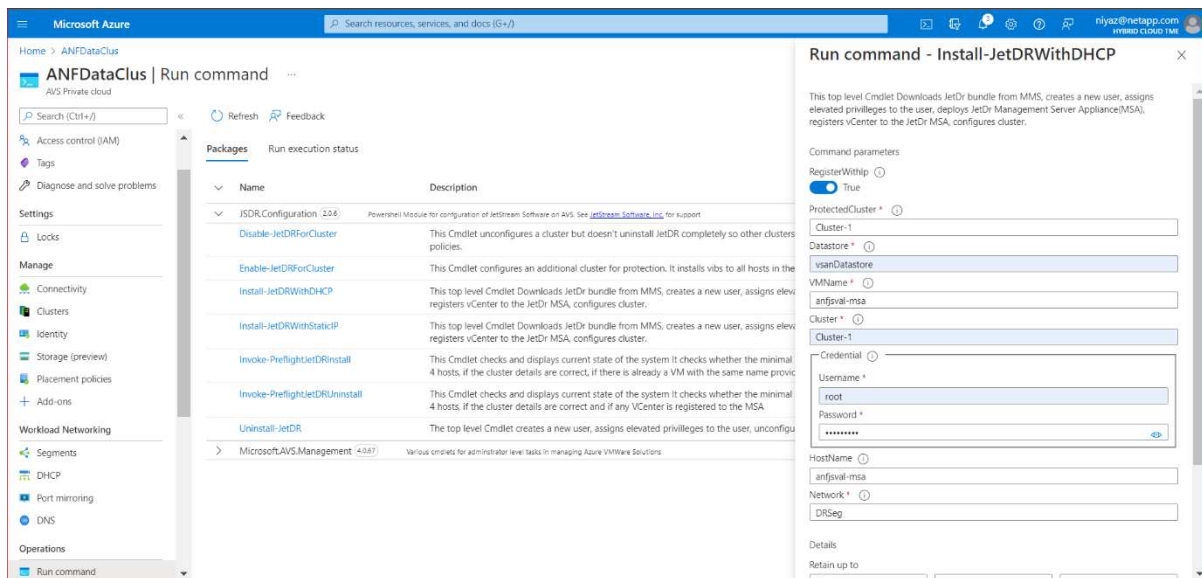
To install JetStream DR for AVS on an Azure VMware Solution private cloud, complete the following steps:

1. From the Azure portal, go to the Azure VMware solution, select the private cloud, and select Run command > Packages > JSDR.Configuration.



The default CloudAdmin user in Azure VMware Solution doesn't have sufficient privileges to install JetStream DR for AVS. Azure VMware Solution enables simplified and automated installation of JetStream DR by invoking the Azure VMware Solution Run command for JetStream DR.

The following screenshot shows installation using a DHCP-based IP address.



2. After JetStream DR for AVS installation is complete, refresh the browser. To access the JetStream DR UI, go to SDDC Datacenter > Configure > JetStream DR.

JetStream DR

Protected DomainsStatisticsStorage SitesAppliancesConfigurationsTask Log

Site Details[Alarm Settings](#)

vCenter Server Hostname	172.30.156.2
Management Appliance Hostname	anfjsval-msa
Software Version	4.0.2.450
Subscription ID	- Configure
Tenant ID / Application ID	- Configure
Application Secret	- Configure

Configure Cluster

Upgrade

Unconfigure

Resolve Configure Issue

☐ **Cluster Name** ▲

☐ Cluster-1

Datacenter Name ▲

SDDC-Datacenter

Status ▲

OK

Software Version ▲

4.0.2.132

Host Details ▲

[Details](#)

- From the JetStream DR interface, add the Azure Blob Storage account that was used to protect the on-premises cluster as a storage site and then run the Scan Domains option.



- After the protected domains are imported, deploy DRVA appliances. In this example, continuous rehydration is started manually from the recovery site using the JetStream DR UI.



These steps can also be automated using CPT created plans.

- Create replication log volumes using available vSAN or ANF datastores.
- Import the protected domains and configure the Recovery VA to use the ANF datastore for VM placements.



Make sure that DHCP is enabled on the selected segment and enough IPs are available. Dynamic IPs are temporarily used while domains are recovering. Each recovering VM (including continuous rehydration) requires an individual dynamic IP. After recovery is complete, the IP is released and can be reused.

7. Select the appropriate failover option (continuous failover or failover). In this example, continuous rehydration (continuous failover) is selected.

The screenshot shows the JetStream DR console interface. At the top, there's a header with the logo and navigation tabs: Protected Domains, Statistics, Storage Sites, Appliances, Configurations, and Task Log. Below the header, a dropdown menu shows 'Select Protected Domain: ANFPD000' with a 'View all' link. To the right are buttons for '+ Create', 'Delete', and 'More'. A table on the left shows the 'Mode' as 'Imported' and 'Recoverable / Total VMs' as '20 / 20'. A 'Configurations' panel is open, showing 'Storage Site' and 'Owner Site' with a 'RE' icon. A context menu is open over the 'Owner Site', showing options: 'Restore', 'Failover', 'Continuous Failover' (highlighted), and 'Test Failover'. Below this, there's a 'Protected VMs' section with tabs for 'Protected VMs', 'Settings', and 'Alarms'. A table lists two VMs: 'AuctionAppA0' and 'AuctionAppB0', both with a 'Recoverable' status and 'Write-Back(VMDK)' protection mode. Each row has a 'Details' link.

VM Name ▲	Protection Status ▲	Protection Mode ▲	Details
AuctionAppA0	✓ Recoverable	Write-Back(VMDK)	Details ^
AuctionAppB0	✓ Recoverable	Write-Back(VMDK)	Details

Performing Failover / Failback



Details

1. After a disaster occurs in the protected cluster of the on-premises environment (partial or full failure), trigger the failover.



CPT can be used to execute the failover plan to recover the VMs from Azure Blob Storage into the AVS cluster recovery site.



After failover (for continuous or standard rehydration) when the protected VMs have been started in AVS, protection is automatically resumed and JetStream DR continues to replicate their data into the appropriate/original containers in Azure Blob Storage.



The task bar shows progress of failover activities.

2. When the task is complete, access the recovered VMs and business continues as normal.



After the primary site is up and running again, failback can be performed. VM protection is resumed and data consistency should be checked.

3. Restore the on-premises environment. Depending upon the type of disaster incident, it might be necessary to restore and/or verify the configuration of the protected cluster. If necessary, JetStream DR software might need to be reinstalled.



Note: The `recovery_utility_prepare_failback` script provided in the Automation Toolkit can be used to help clean the original protected site of any obsolete VMs, domain information, and so on.

4. Access the restored on-premises environment, go to the Jetstream DR UI, and select the appropriate protected domain. After the protected site is ready for failback, select the Failback option in the UI.





The CPT generated failback plan can also be used to initiate the return of the VMs and their data from the object store back to the original VMware environment.



Specify the maximum delay after pausing VMs in the recovery site and restarting in the protected site. This time includes completing replication after stopping failover VMs, the time to clean recovery site, and the time to recreate VMs in protected site. The NetApp recommended value is 10 minutes.

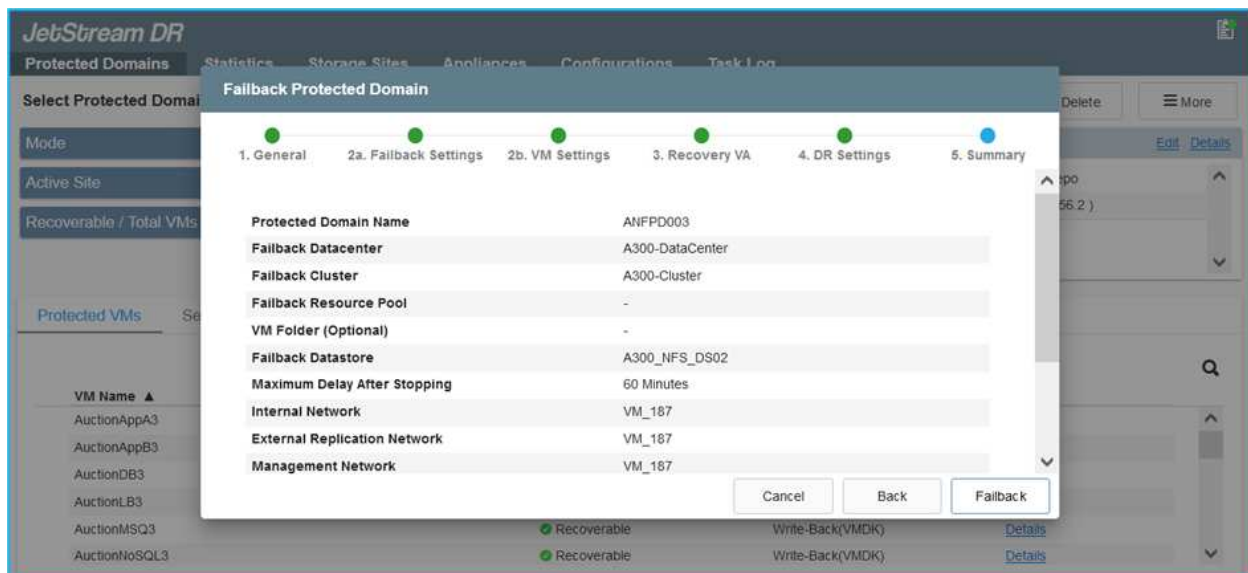
Complete the failback process, and then confirm the resumption of VM protection and data consistency.

Ransomware Recovery

Recovering from ransomware can be a daunting task. Specifically, it can be hard for IT organizations to determine the safe point of return and, once determined, how to ensure that recovered workloads are safeguarded from the attacks reoccurring (from sleeping malware or through vulnerable applications).

Details

JetStream DR for AVS together with Azure NetApp Files datastores can address these concerns by allowing organizations to recover from available points in time, so that workloads are recovered to a functional, isolated network if required. Recovery allows applications to function and communicate with each other while not exposing them to north-south traffic, thereby giving security teams a safe place to perform forensics and other necessary remediation.



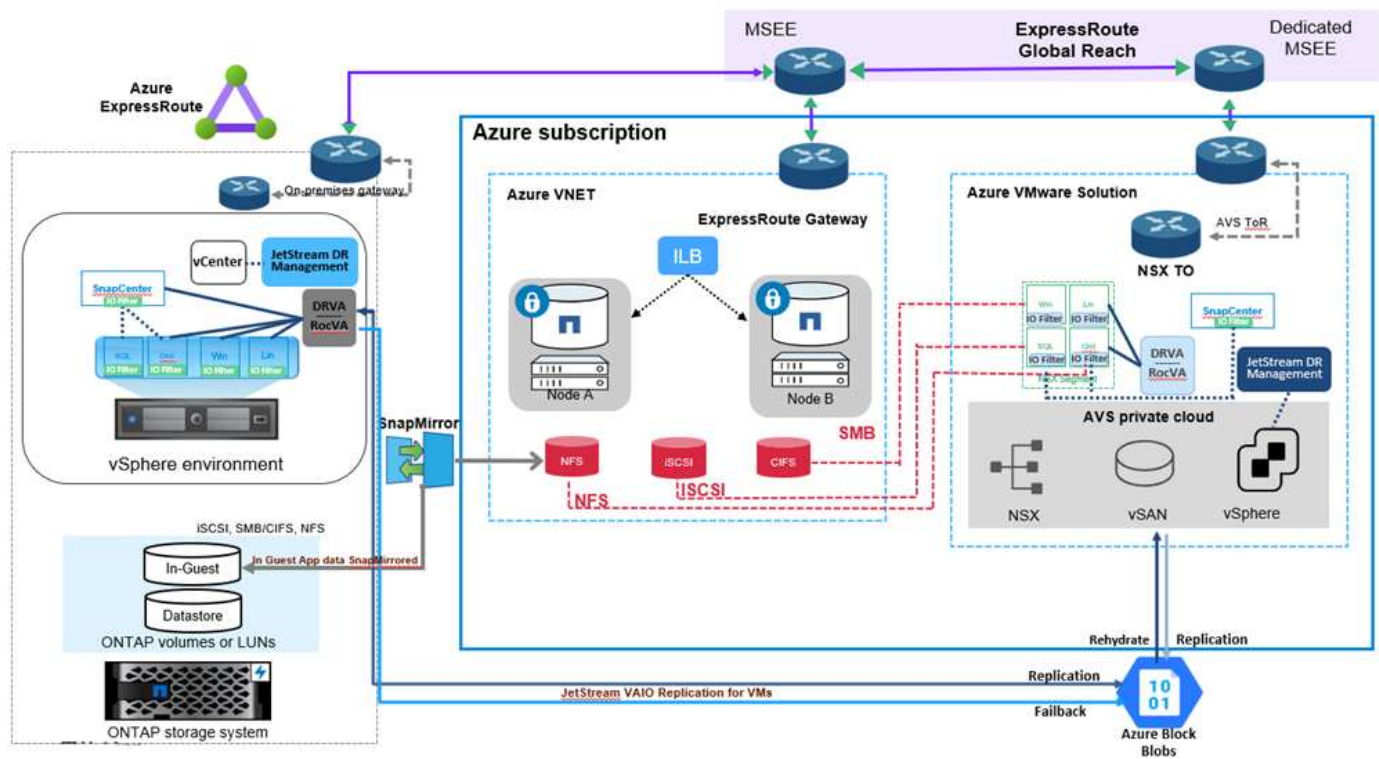
Disaster Recovery with CVO and AVS (guest-connected storage)

Overview

Authors: Ravi BCB and Niyaz Mohamed, NetApp

Disaster recovery to cloud is a resilient and cost-effective way of protecting workloads against site outages and data corruption events such as ransomware. With NetApp SnapMirror, on-premises VMware workloads that use guest-connected storage can be replicated to NetApp Cloud Volumes ONTAP running in Azure. This covers application data; however, what about the actual VMs themselves. Disaster recovery should cover all dependent components, including virtual machines, VMDKs, application data, and more. To accomplish this, SnapMirror along with Jetstream can be used to seamlessly recover workloads replicated from on-premises to Cloud Volumes ONTAP while using vSAN storage for VM VMDKs.

This document provides a step-by-step approach for setting up and performing disaster recovery that uses NetApp SnapMirror, JetStream, and the Azure VMware Solution (AVS).



Assumptions

This document focuses on in-guest storage for application data (also known as guest connected), and we assume that the on-premises environment is using SnapCenter for application-consistent backups.



This document applies to any third-party backup or recovery solution. Depending on the solution used in the environment, follow best practices to create backup policies that meet organizational SLAs.

For connectivity between the on-premises environment and the Azure virtual network, use the express route global reach or a virtual WAN with a VPN gateway. Segments should be created based on the on-premises vLAN design.



There are multiple options for connecting on-premises datacenters to Azure, which prevents us from outlining a specific workflow in this document. Refer to the Azure documentation for the appropriate on-premises-to-Azure connectivity method.

Deploying the DR Solution

Solution Deployment Overview

1. Make sure that application data is backed up using SnapCenter with the necessary RPO requirements.
2. Provision Cloud Volumes ONTAP with the correct instance size using Cloud manager within the appropriate subscription and virtual network.
 - a. Configure SnapMirror for the relevant application volumes.
 - b. Update the backup policies in SnapCenter to trigger SnapMirror updates after the scheduled jobs.
3. Install the JetStream DR software in the on-premises data center and start protection for virtual machines.
4. Install JetStream DR software in the Azure VMware Solution private cloud.
5. During a disaster event, break the SnapMirror relationship using Cloud Manager and trigger failover of virtual machines to Azure NetApp Files or to vSAN datastores in the designated AVS DR site.
 - a. Reconnect the iSCSI LUNs and NFS mounts for the application VMs.
6. Invoke failback to the protected site by reverse resyncing SnapMirror after the primary site has been recovered.

Deployment Details

Configure CVO on Azure and replicate volumes to CVO

The first step is to configure Cloud Volumes ONTAP on Azure ([Link](#)) and replicate the desired volumes to Cloud Volumes ONTAP with the desired frequencies and snapshot retentions.

Health Status	Source Volume	Target Volume	Total Transfer Time	Status	Mirror State	Last Successful Transfer
✓	gcsdrsqldb_sc46 ntaphci-a300e9u25	gcsdrsqldb_sc46_copy ANFCVODRDemo	17 seconds	idle	snapmirrored	May 6, 2022, 11:43:18 AM 105.06 KiB
✓	gcsdrsqlhd_sc46_copy ANFCVODRDemo	gcsdrsqlhd_sc46 ntaphci-a300e9u25	7 seconds	idle	snapmirrored	May 6, 2022, 11:42:20 AM 7.22 MiB
✓	gcsdrsqllog_sc46 ntaphci-a300e9u25	gcsdrsqllog_sc46_copy ANFCVODRDemo	16 seconds	idle	snapmirrored	May 6, 2022, 11:43:52 AM 130.69 KiB

Configure AVS hosts and CVO data access

Two important factors to consider when deploying the SDDC are the size of the SDDC cluster in the Azure VMware solution and how long to keep the SDDC in service. These two key considerations for a disaster recovery solution help reduce the overall operational costs. The SDDC can be as small as three hosts, all the way up to a multi-host cluster in a full-scale deployment.

The decision to deploy an AVS cluster is primarily based on the RPO/RTO requirements. With the Azure VMware solution, the SDDC can be provisioned just in time in preparation for either testing or an actual disaster event. An SDDC deployed just in time saves on ESXi host costs when you are not dealing with a disaster. However, this form of deployment affects the RTO by a few of hours while SDDC is being provisioned.

The most common deployed option is to have SDDC running in an always-on, pilot-light mode of operation. This option provides a small footprint of three hosts that are always available, and it also speeds up recovery operations by providing a running baseline for simulation activities and compliance checks, thus avoiding the risk of operational drift between the production and DR sites. The pilot-light cluster can be scaled up quickly to the desired level when needed to handle an actual DR event.

To configure AVS SDDC (be it on-demand or in pilot-light mode), see [Deploy and configure the Virtualization Environment on Azure](#). As a prerequisite, verify that the guest VMs residing on the AVS hosts are able to consume data from Cloud Volumes ONTAP after connectivity has been established.

After Cloud Volumes ONTAP and AVS have been configured properly, begin configuring Jetstream to automate the recovery of on-premises workloads to AVS (VMs with application VMDKs and VMs with in-guest storage) by using the VAIO mechanism and by leveraging SnapMirror for application volumes copies to Cloud Volumes ONTAP.

Install JetStream DR in on-premises datacenter

JetStream DR software consists of three major components: the JetStream DR Management Server Virtual Appliance (MSA), the DR Virtual Appliance (DRVA), and host components (I/O filter packages). The MSA is used to install and configure host components on the compute cluster and then to administer JetStream DR software. The installation process is as follows:

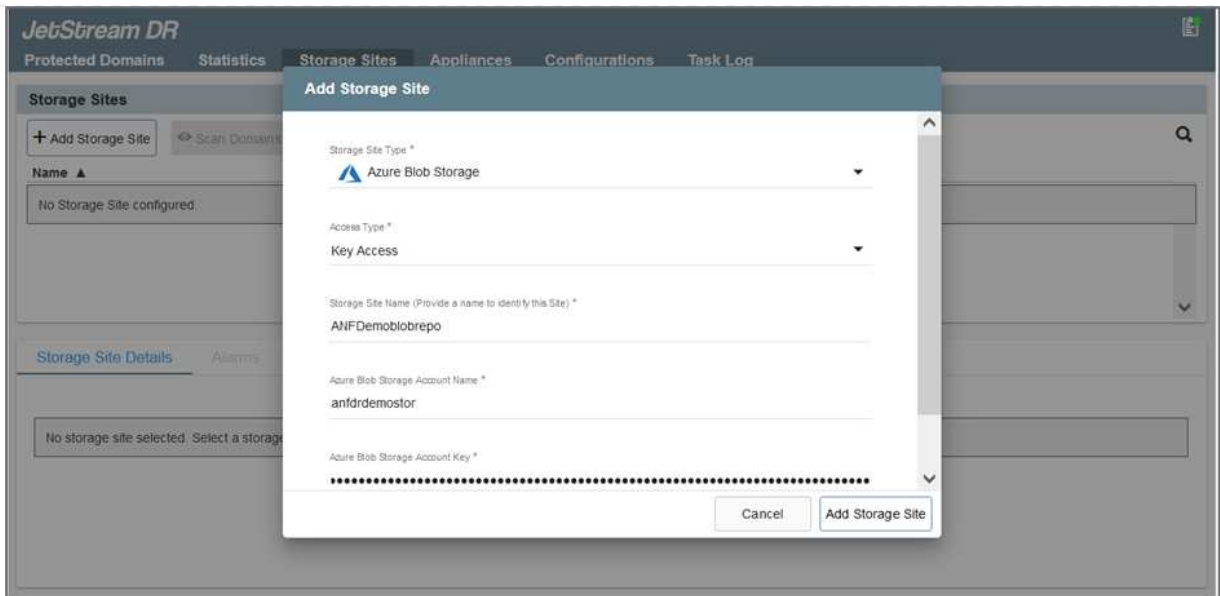
1. Check the prerequisites.
2. Run the Capacity Planning Tool for resource and configuration recommendations.
3. Deploy the JetStream DR MSA to each vSphere host in the designated cluster.
4. Launch the MSA using its DNS name in a browser.
5. Register the vCenter server with the MSA.
6. After JetStream DR MSA has been deployed and the vCenter Server has been registered, navigate to the JetStream DR plug-in with the vSphere Web Client. This can be done by navigating to Datacenter > Configure > JetStream DR.



7. From the JetStream DR interface, complete the following tasks:
 - a. Configure the cluster with the I/O filter package.



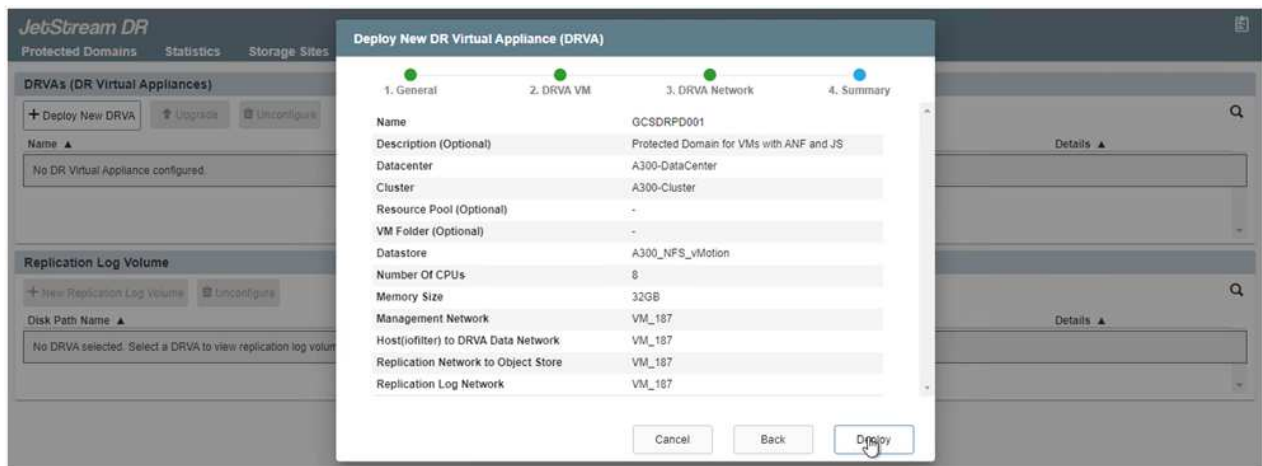
- b. Add the Azure Blob storage located at the recovery site.



8. Deploy the required number of DR Virtual Appliances (DRVAs) from the Appliances tab.



Use the capacity planning tool to estimate the number of DRVAs required.



9. Create replication log volumes for each DRVA using the VMDK from the datastores available or the independent shared iSCSI storage pool.



- From the Protected Domains tab, create the required number of protected domains using information about the Azure Blob Storage site, the DRVA instance, and the replication log. A protected domain defines a specific VM or set of application VMs within the cluster that are protected together and assigned a priority order for failover/failback operations.



- Select the VMs to be protected and group the VMs into applications groups based on dependency. Application definitions allow you to group sets of VMs into logical groups that contain their boot orders, boot delays, and optional application validations that can be executed upon recovery.



Make sure that the same protection mode is used for all VMs in a protected domain.



Write-Back(VMDK) mode offers higher performance.



12. Make sure that replication log volumes are placed on high- performance storage.



13. After you are done, click Start Protection for the protected domain. This starts data replication for the selected VMs to the designated Blob store.

JetStream DR

Protected Domains | Statistics | Storage Sites | Appliances | Configurations | Task Log

Select Protected Domain: GCSDRPD_Demo01 [View all](#)

Recoverable / Total VMs: 0 / 5

Replication Status: OK

Remaining Background Data: 0 B

Current RPO: -

Configurations

- Storage Site: ANFDRD
- Owner Site: LOCAL (172.2)
- Datacenter \ Cluster: A300-DataCen
- Point-in-time Recovery: Disabled

Running Tasks

- Start Protection (GCS-DR-SCA) 50%
- Start Protection (GCS-DR-Win...) 50%
- Start Protection (GCS-DR-Lin...) 50%
- Start Protection (GCS-DR-DC) 50%
- Start Protection (GCS-DR-SQ...) 50%
- Configure VMDK Re... Completed

Protected VMs | Settings | Alarms

+ Start Protection | Stop Protection

VM Name	Protection Status	Replication Status	Protection Mode	Background Data	Details
GCS-DR-DC	Initializing	-	Write-Back(VMDK)	-	Details
GCS-DR-LinVM01	Initializing	-	Write-Back(VMDK)	-	Details
GCS-DR-SCA	Initializing	-	Write-Back(VMDK)	-	Details
GCS-DR-SQL01	Initializing	-	Write-Back(VMDK)	-	Details
GCS-DR-WinVM01	Initializing	-	Write-Back(VMDK)	-	Details

14. After replication is completed, the VM protection status is marked as Recoverable.

JetStream DR

Protected Domains | Statistics | Storage Sites | Appliances | Configurations | Task Log

Select Protected Domain: GCSDRPD_Demo01 [View all](#)

Recoverable / Total VMs: 5 / 5

Replication Status: OK

Remaining Background Data: 0 B

Current RPO: 0s

Configurations

- Storage Site: ANFDRDdemoFailoverSite
- Owner Site: LOCAL (172.21.253.160)
- Datacenter \ Cluster: A300-DataCenter \ A300-Cluster
- Point-in-time Recovery: Disabled

Protected VMs | Settings | Alarms

+ Start Protection | Stop Protection

VM Name	Protection Status	Replication Status	Protection Mode	Background Data	Details
GCS-DR-DC	Recoverable	OK	Write-Back(VMDK)	0 B	Details
GCS-DR-LinVM01	Recoverable	OK	Write-Back(VMDK)	0 B	Details
GCS-DR-SCA	Recoverable	OK	Write-Back(VMDK)	0 B	Details
GCS-DR-SQL01	Recoverable	OK	Write-Back(VMDK)	0 B	Details
GCS-DR-WinVM01	Recoverable	OK	Write-Back(VMDK)	0 B	Details



Failover runbooks can be configured to group the VMs (called a recovery group), set the boot order sequence, and modify the CPU/memory settings along with the IP configurations.

15. Click Settings and then click the runbook Configure link to configure the runbook group.

JetStream DR

Protected Domains | Statistics | Storage Sites | Appliances | Configurations | Task Log

Select Protected Domain: GCSDRPD_Demo01 [View all](#)

Recoverable / Total VMs: 5 / 5

Replication Status: OK

Remaining Background Data: 0 B

Current RPO: 0s

Configurations

- Storage Site: ANFDRDdemoFailoverSite
- Owner Site: LOCAL (172.21.253.160)
- Datacenter \ Cluster: A300-DataCenter \ A300-Cluster
- Point-in-time Recovery: Disabled

Protected VMs | **Settings** | Alarms

+ Create | Delete | More

Failover Runbook	Not Configured	Configure
Test Failover Runbook	Not Configured	Configure
Failback Runbook	Not Configured	Configure
Memory Setting	Not Configured	Configure
GC Settings	Configured	Configure
Concurrency Settings	Not Configured	Configure

16. Click the Create Group button to begin creating a new runbook group.



If needed, in the lower portion of the screen, apply custom pre-scripts and post-scripts to automatically run prior to and following operation of the runbook group. Make sure that the Runbook scripts are residing on the management server.



17. Edit the VM settings as required. Specify the parameters for recovering the VMs, including the boot sequence, the boot delay (specified in seconds), the number of CPUs, and the amount of memory to allocate. Change the boot sequence of the VMs by clicking the up or down arrows. Options are also provided to Retain MAC.



18. Static IP addresses can be manually configured for the individual VMs of the group. Click the NIC View link of a VM to manually configure its IP address settings.



19. Click the Configure button to save NIC settings for the respective VMs.



The status of both the failover and failback runbooks is now listed as Configured. Failover and failback runbook groups are created in pairs using the same initial group of VMs and settings. If necessary, the settings of any runbook group can be individually customized by clicking its respective Details link and making changes.

Install JetStream DR for AVS in private cloud

A best practice for a recovery site (AVS) is to create a three-node pilot-light cluster in advance. This allows the recovery site infrastructure to be preconfigured, including the following:

- Destination networking segments, firewalls, services like DHCP and DNS, and so on
- Installation of JetStream DR for AVS
- Configuration of ANF volumes as datastores and more

JetStream DR supports a near-zero RTO mode for mission-critical domains. For these domains, destination storage should be preinstalled. ANF is a recommended storage type in this case.



Network configuration including segment creation should be configured on the AVS cluster to match on-premises requirements.



Depending on the SLA and RTO requirements, you can use continuous failover or regular (standard) failover mode. For near-zero RTO, you should start continuous rehydration at the recovery site.

1. To install JetStream DR for AVS on an Azure VMware Solution private cloud, use the Run command. From the Azure portal, go to Azure VMware solution, select the private cloud, and select Run command > Packages > JSDR.Configuration.



The default CloudAdmin user of the Azure VMware Solution doesn't have sufficient privileges to install JetStream DR for AVS. The Azure VMware Solution enables simplified and automated installation of JetStream DR by invoking the Azure VMware Solution Run command for JetStream DR.

The following screenshot shows installation using a DHCP-based IP address.



2. After JetStream DR for AVS installation is complete, refresh the browser. To access the JetStream DR UI, go to SDDC Datacenter > Configure > JetStream DR.

JetStream DR

Protected Domains Statistics Storage Sites Appliances **Configurations** Task Log

Site Details [Alarm Settings](#)

vCenter Server Hostname: 172.30.156.2

Management Appliance Hostname: anjfsval-msa

Software Version: 4.0.2.450

Subscription ID: - [Configure](#)

Tenant ID / Application ID: - [Configure](#)

Application Secret: - [Configure](#)

[Configure Cluster](#) [Upgrade](#) [Unconfigure](#) [Resolve Configure Issue](#)

<input type="checkbox"/> Cluster Name ▲	Datacenter Name ▲	Status ▲	Software Version ▲	Host Details ▲
<input type="checkbox"/> Cluster-1	SDDC-Datacenter	Ok	4.0.2.132	Details

3. From the JetStream DR interface, complete the following tasks:
 - a. Add the Azure Blob Storage account that was used to protect the on-premises cluster as a storage site and then run the Scan Domains option.
 - b. In the pop-up dialog window that appears, select the protected domain to import and then click its Import link.

JetStream DR

Protected Domains Statistics **Storage Sites**

[Add Storage Site](#) [Scan Domains](#) [Remove](#)

Name ▲: ANJFDemo01blobreporec

Available Protected Domain(s) For Import

Protected Domain ...	Description	Recoverable V...	VMs ...	Import
GCSDRPD_Demo01	Protection domain ANF	5	5	Import

4. The domain is imported for recovery. Go to the Protected Domains tab and verify that the intended domain has been selected or choose the desired one from the Select Protected Domain menu. A list of the recoverable VMs in the protected domain is displayed.

JetStream DR

Protected Domains Statistics Storage Sites Appliances Configurations Task Log

Select Protected Domain: GCSDRPD_Demo01 [View all](#)

[+ Create](#) [Delete](#) [More](#)

Mode Imported

Recoverable / Total VMs 5 / 5

Configurations [Details](#)

Storage Site: ANJFDemo01blobreporec

Owner Site: -

Protected VMs Settings Alarms

VM Name ▲	Protection Status ▲	Protection Mode ▲	Details
GCS-DR-DC	Recoverable	Write-Back(VMDK)	Details
GCS-DR-LinVM01	Recoverable	Write-Back(VMDK)	Details
GCS-DR-SCA	Recoverable	Write-Back(VMDK)	Details
GCS-DR-SQL01	Recoverable	Write-Back(VMDK)	Details
GCS-DR-WinVM01	Recoverable	Write-Back(VMDK)	Details

5. After the protected domains are imported, deploy DRVA appliances.



These steps can also be automated using CPT- created plans.

6. Create replication log volumes using available vSAN or ANF datastores.
7. Import the protected domains and configure the recovery VA to use an ANF datastore for VM placements.



Make sure that DHCP is enabled on the selected segment and that enough IPs are available. Dynamic IPs are temporarily used while domains are recovering. Each recovering VM (including continuous rehydration) requires an individual dynamic IP. After recovery is complete, the IP is released and can be reused.

8. Select the appropriate failover option (continuous failover or failover). In this example, continuous rehydration (continuous failover) is selected.



Although Continuous Failover and Failover modes differ on when configuration is performed, both failover modes are configured using the same steps. Failover steps are configured and performed together in response to a disaster event. Continuous failover can be configured at any time and then allowed to run in the background during normal system operation. After a disaster event has occurred, continuous failover is completed to immediately transfer ownership of the protected VMs to the recovery site (near-zero RTO).

JetStream DR

Protected Domains | Statistics | Storage Sites | Appliances | Configurations | Task Log

Select Protected Domain: GCDRDP_Demo01 [View all](#)

Mode: Imported Recoverable / Total VMs: 5 / 5

Configurations

Storage Site: ANFDemoblobrepor
Owner Site: REMOTE (172.21.253.11)

Actions: + Create, Delete, More

More Actions: Restore, Failover, Continuous Failover, Test Failover

Protected VMs | Settings | Alarms

VM Name ▲	Protection Status ▲	Protection Mode ▲	Details
GCS-DR-DC	Recoverable	Write-Back(VMDK)	Details
GCS-DR-LinVM01	Recoverable	Write-Back(VMDK)	Details
GCS-DR-SCA	Recoverable	Write-Back(VMDK)	Details
GCS-DR-SQL01	Recoverable	Write-Back(VMDK)	Details
GCS-DR-WinVM01	Recoverable	Write-Back(VMDK)	Details

The continuous failover process begins, and its progress can be monitored from the UI. Clicking the blue icon in the Current Step section exposes a pop-up window showing details of the current step of the failover process.

Failover and Failback

1. After a disaster occurs in the protected cluster of the on-premises environment (partial or complete failure), you can trigger the failover for VMs using Jetstream after breaking the SnapMirror relationship for the respective application volumes.

The screenshot displays the 'Replication' section of a management console. At the top, a summary bar shows: 3 Volume Relationships, 4.78 GiB Replicated Capacity, 0 Currently Transferring, 3 Healthy, and 0 Failed. Below this is a table titled '3 Volume Relationships' with columns: Health Status, Source Volume, Target Volume, Total Transfer Time, Status, Mirror State, and Last Successful Transfer. The table lists three relationships, all with a 'snapmirrored' mirror state. A context menu is open for the first relationship, showing options: Information, Break, Reverse Resync, Edit Schedule, Edit Max Transfer Rate, Update, and Delete. The 'Break' option is highlighted. Below the table, a 'Break Relationship' dialog box is shown, asking: 'Are you sure that you want to break the relationship between "gcsdrsqldb_sc46" and "gcsdrsqldb_sc46_copy"?' with 'Break' and 'Cancel' buttons.

Health Status	Source Volume	Target Volume	Total Transfer Time	Status	Mirror State	Last Successful Transfer
✓	gcsdrsqldb_sc46 ntaphci-a300e9u25	gcsdrsqldb_sc46_copy ANFCVODRDemo	6 minutes 41 seconds	idle	snapmirrored	May 5, 2022, 12:08:34 PM 33.66 KiB
✓	gcsdrsqhld_sc46 ntaphci-a300e9u25	gcsdrsqhld_sc46_copy ANFCVODRDemo	4 minutes 56 seconds	idle	snapmirrored	May 5, 2022, 12:09:15 PM 69.84 KiB
✓	gcsdrsqlog_sc46 ntaphci-a300e9u25	gcsdrsqlog_sc46_copy ANFCVODRDemo	10 minutes 18 seconds	idle	snapmirrored	May 5, 2022, 12:08:34 PM 104.34 KiB



This step can easily be automated to facilitate the recovery process.

2. Access the Jetstream UI on AVS SDDC (destination side) and trigger the failover option to complete failover. The task bar shows progress for failover activities.

In the dialog window that appears when completing failover, the failover task can be specified as planned or assumed to be forced.

JetStream DR

Protected Domains | Statistics | Storage Sites | Appliances | Configurations | Task Log

Select Protected Domain: **GCSDRPD_Demo01** [View all](#)

Mode: Continuous Rehydration in Progress

Recoverable / Total VMs: 4 / 4

Data (Processed/Known Remaining): 329.01 GB / 6.19 GB

Current Step: Recover VMs' data from Storage Site

Configurations

Storage Site	ANFDemo01breporec
Owner Site	REMOTE (172.21.253.160)
Datacenter \ Cluster	SDDC-Datacenter \ Cluster-1
Point-in-time Recovery	Disabled

Protected VMs | Settings | Alarms

VM Name	Protection Status	Protection Mode	Details
GCS-DR-DC	Recoverable	Write-Back(VMDK)	Details
GCS-DR-LinVM01	Recoverable	Write-Back(VMDK)	Details
GCS-DR-SCA	Recoverable	Write-Back(VMDK)	Details
GCS-DR-SQL01	Recoverable	Write-Back(VMDK)	Details
GCS-DR-WinVM01	Recoverable	Write-Back(VMDK)	Details

Complete Continuous Failover for Protected Domain

VM Network Mapping

Protected VM Network	Recovery VM Network
VM_3510	DRStretchSeg

Other Settings

☐ Planned Failover
☒ Force Failover

Some VM's guest credential are required because of network configuration: [Configure](#)

[Cancel](#)
[Complete Failover](#)

Forced failover assumes the primary site is no longer accessible and ownership of the protected domain should be directly assumed by the recovery site.

Force Failover


Force Failover of Protected Domain requested. Administrator consent is required!
 Complete ownership of this Protected Domain will be taken over by this Site.
 Are you sure you want to continue?

[Cancel](#)
[Confirm](#)

Complete Continuous Failover for Protected Domain

VM Network Mapping

Protected VM Network ▲	Recovery VM Network
VM_3510	DRStretchSeg

☐ ☐

Other Settings

☐ Planned Failover
 ☒ Force Failover

Some VM's guest credential are required because of network configuration:
 Configure

Cancel

Complete Failover

- After continuous failover is complete, a message appears confirming completion of the task. When the task is complete, access the recovered VMs to configure iSCSI or NFS sessions.



The failover mode changes to Running in Failover and the VM status is Recoverable. All the VMs of the protected domain are now running at the recovery site in the state specified by the failover runbook settings.



To verify the failover configuration and infrastructure, JetStream DR can be operated in test mode (Test Failover option) to observe the recovery of virtual machines and their data from the object store into a test recovery environment. When a failover procedure is executed in test mode, its operation resembles an actual failover process.

JetStream DR

- Protected Domains
- Statistics
- Storage

Select Protected Domain: GCSDRPD002

Mode
 Recoverable / Total VMs
 Replication Status
 Remaining Background Data
 Current RPO

Protected VMs
 Settings
 Alarms

+ Start Protection
 Stop Protection

☐ VM Name ▲

- ☐ GCS-DR-SC46
- ☐ GCS-DR-SQL03
- ☐ GCS-DR-W2K16-01
- ☐ UbuntuSn001

Task Completed Successfully with warnings

Protected Domain	GCSDRPD002
VMs Recovery Status	Success with warnings
Total VMs Recovered	4
VM(s) with warning	2 View
GCSRecovery03 Status:	
Pre-script Execution Status	Not defined
Runbook Execution Status	Success
Post-script Execution Status	Not defined

+ Create
 Delete
 More

ANFCVODR
 OCAL (172.30.156.2)
 DDC-Datacenter \ Cluster-1
 Disabled

Background Data
 Details
 Details
 Details
 Details
 Details

4. After the virtual machines are recovered, use storage disaster recovery for in-guest storage. To demonstrate this process, SQL server is used in this example.
5. Log into the recovered SnapCenter VM on AVS SDDC and enable DR mode.
 - a. Access the SnapCenter UI using the browserN.



- b. In the Settings page, navigate to Settings > Global Settings > Disaster Recovery.
- c. Select Enable Disaster Recovery.
- d. Click Apply.



- e. Verify whether the DR job is enabled by clicking Monitor > Jobs.



NetApp SnapCenter 4.6 or later should be used for storage disaster recovery. For previous versions, application-consistent snapshots (replicated using SnapMirror) should be used and manual recovery should be executed in case previous backups must be recovered in the disaster recovery site.

6. Make sure that the SnapMirror relationship is broken.

The screenshot shows the NetApp SnapCenter Replication dashboard. At the top, there are tabs for Canvas, Replication, Backup & Restore, Data Sense, File Cache, Compute, Sync, and All Services (+9). The Replication tab is active. Below the tabs, there are five summary cards: 3 Volume Relationships, 4.78 GiB Replicated Capacity, 0 Currently Transferring, 3 Healthy, and 0 Failed. Below these cards, there is a section titled '3 Volume Relationships' with a table showing the details of the replication relationships.

Health Status	Source Volume	Target Volume	Total Transfer Time	Status	Mirror State	Last Successful Transfer
✓	gcsdrsqldb_sc46 ntaphci-a300e9u25	gcsdrsqldb_sc46_copy ANFCVODRDemo	6 minutes 41 seconds	idle	broken-off	May 5, 2022, 12:08:34 PM 33.66 KiB
✓	gcsdrsqhld_sc46 ntaphci-a300e9u25	gcsdrsqhld_sc46_copy ANFCVODRDemo	4 minutes 56 seconds	idle	broken-off	May 5, 2022, 12:09:15 PM 69.84 KiB
✓	gcsdrsqlog_sc46 ntaphci-a300e9u25	gcsdrsqlog_sc46_copy ANFCVODRDemo	10 minutes 18 seconds	idle	broken-off	May 5, 2022, 12:08:34 PM 104.34 KiB

7. Attach the LUN from Cloud Volumes ONTAP to the recovered SQL guest VM with same drive letters.

The screenshot shows the Windows Disk Management window. The window title is 'Disk Management'. It has a menu bar with File, Action, View, and Help. Below the menu bar is a toolbar with icons for disk operations. The main area displays a table of disks and volumes.

Volume	Layout	Type	File System	Status	Capacity	Free Spa...	% Free
Simple	Simple	Basic		Healthy (R...	450 MB	450 MB	100 %
Simple	Simple	Basic		Healthy (E...	99 MB	99 MB	100 %
(C:)	Simple	Basic	NTFS	Healthy (B...	89.45 GB	67.03 GB	75 %
BACKUP (G:)	Simple	Basic	NTFS	Healthy (P...	9.97 GB	9.92 GB	99 %
DATA (E:)	Simple	Basic	NTFS	Healthy (P...	24.88 GB	24.57 GB	99 %
LOG (F:)	Simple	Basic	NTFS	Healthy (P...	9.97 GB	8.93 GB	90 %

8. Open iSCSI Initiator, clear the previous disconnected session and add the new target along with multipath for the replicated Cloud Volumes ONTAP volumes.



9. Make sure that all the disks are connected using the same drive letters that were used prior to DR.



10. Restart the MSSQL server service.



11. Make sure that the SQL resources are back online.



In the case of NFS, attach the volumes using the mount command and update the /etc/fstab entries.

At this point, operations can be run and business continues normally.



On the NSX-T end, a separate dedicated tier-1 gateway can be created for simulating failover scenarios. This ensures that all workloads can communicate with each other but that no traffic can route in or out of the environment, so that any triage, containment, or hardening tasks can be performed without risk of cross-contamination. This operation is outside of the scope of this document, but it can easily be achieved for simulating isolation.

After the primary site is up and running again, you can perform failback. VM protection is resumed by Jetstream and the SnapMirror relationship must be reversed.

1. Restore the on-premises environment. Depending on the type of disaster incident, it might be necessary to restore and/or verify the configuration of the protected cluster. If necessary, JetStream DR software might need to be reinstalled.
2. Access the restored on-premises environment, go to the Jetstream DR UI, and select the appropriate protected domain. After the protected site is ready for failback, select the Failback option in the UI.



The CPT-generated failback plan can also be used to initiate the return of the VMs and their data from the object store back to the original VMware environment.

The screenshot shows the JetStream DR web interface. At the top, there's a navigation bar with tabs: Protected Domains, Statistics, Storage Sites, Appliances, Configurations, and Task Log. Below this, a dropdown menu shows 'Select Protected Domain: GCSDRPD_Demo01' with a 'View all' link. To the right are buttons for '+ Create', 'Delete', and 'More'. A 'Configurations' panel on the right shows 'Storage Site: ANFCVODR' and 'Owner Site: REMOTE (172.3)'. A 'More' menu is open, showing options: 'Restore', 'Resume Continuous Rehydration', and 'Failback' (which is highlighted with a mouse cursor). Below the configurations, there's a 'Protected VMs' section with a table listing VMs and their protection status.

VM Name ▲	Protection Status ▲	Protection Mode ▲	Details
GCS-DR-DC	Recoverable	Write-Back(VMDK)	Details
GCS-DR-LinVM01	Recoverable	Write-Back(VMDK)	Details
GCS-DR-SCA	Recoverable	Write-Back(VMDK)	Details
GCS-DR-SQL01	Recoverable	Write-Back(VMDK)	Details
GCS-DR-WinVM01	Recoverable	Write-Back(VMDK)	Details



Specify the maximum delay after pausing the VMs in the recovery site and restarting them in the protected site. The time need to complete this process includes the completion of replication after stopping failover VMs, the time needed to clean the recovery site, and the time needed to recreate VMs in the protected site. NetApp recommends 10 minutes.

Failback Protected Domain

1. General 2a. Failback Settings 2b. VM Settings 3. Recovery VA 4. DR Settings 5. Summary

Failback Datacenter	A300-DataCenter
Failback Cluster	A300-Cluster
Failback Resource Pool	-
VM Folder (Optional)	-
Failback Datastore	A300_NFS_vMotion
Maximum Delay After Stopping	10 Minutes
Internal Network	VM_187
External Replication Network	VM_187
Management Network	VM_187
Storage Site	ANFCVODR
DR Virtual Appliance	GCSDRVA002
Replication Log Storage	/dev/sdb

Cancel Back Failback

- Complete the failback process and then confirm the resumption of VM protection and data consistency.

JetStream DR

Protected Domains Statistics Storage S...

Select Protected Domain: GCSDRPD002

Recoverable / Total VMs

Replication Status

Remaining Background Data

Current RPO

Protected VMs Settings Alarms

Failback Task Result

Task Completed Successfully

Protected Domain	GCSDRPD002
VMs Recovery Status	Success
Total VMs Recovered	4
GCSRecovery03 Status:	
Pre-script Execution Status	Not defined
Runbook Execution Status	Success
Post-script Execution Status	Not defined

- After the VMs are recovered, disconnect the secondary storage from the host and connect to the primary storage.

Health Status	Source Volume	Target Volume	Total Transfer Time	Status	Mirror State	Last Successful Transfer
✓	gcsdrsqlldb_sc46 ntaphci-a300e9u25	gcsdrsqlldb_sc46_copy ANFCVODRDemo	6 minutes 41 seconds	idle	broken-off	May 5, 2022, 12:08:34 PM 33.66 KiB
✓	gcsdrsqlihd_sc46 ntaphci-a300e9u25	gcsdrsqlihd_sc46_copy ANFCVODRDemo	4 minutes 56 seconds	idle	broken-off	
✓	gcsdrsqliog_sc46 ntaphci-a300e9u25	gcsdrsqliog_sc46_copy ANFCVODRDemo	10 minutes 18 seconds	idle	broken-off	

Information

Resync

Reverse Resync

Edit Schedule

Edit Max Transfer Rate

Delete

3

Volume Relationships

6.54 GiB

Replicated Capacity

0

Currently Transferring

3

Healthy

0

Failed

3 Volume Relationships

Health Status	Source Volume	Target Volume	Total Transfer Time	Status	Mirror State	Last Successful Transfer	
<div></div>	gcsdrsqldb_sc46 ntaphci-a300e9u25	gcsdrsqldb_sc46_copy ANFCVODRDemo	19 seconds	idle	snapmirrored	May 6, 2022, 11:03:09 AM 5.73 MiB	<div></div>
<div></div>	gcsdrsqhld_sc46_copy ANFCVODRDemo	gcsdrsqhld_sc46 ntaphci-a300e9u25	1 minute 46 seconds	idle	snapmirrored	May 6, 2022, 11:01:39 AM 800.76 MiB	<div></div>
<div></div>	gcsdrsqlog_sc46 ntaphci-a300e9u25	gcsdrsqlog_sc46_copy ANFCVODRDemo	51 seconds	idle	snapmirrored	May 6, 2022, 11:03:15 AM 785.8 MiB	<div></div>

- Restart the MSSQL server service.
- Verify that the SQL resources are back online.

SQLQuery1.sql - GCS-DR-SQL03.CarDB (GCSDC\adminnimo (66)) - Microsoft SQL Server Management Studio (Administrator)

File Edit View Query Project Tools Window Help

CarDB

Execute

Object Explorer

- Connect
- System Databases
- Database Snapshots
- CarDB
 - Database Diagrams
 - Tables
 - System Tables
 - FileTables
 - External Tables
 - Graph Tables
 - dbo.Cars
 - Views
 - External Resources
 - Synonyms
 - Programmability
 - Service Broker
 - Storage
 - Security

SQLQuery1.sql - G...DC\adminnimo (66))

```

/***** Script for SelectTopNRows command from SSMS *****/
SELECT TOP (1000) [Id]
, [Name]
, [Price]
FROM [CarDB].[dbo].[Cars]

```

Results

	Id	Name	Price
1	1	Car-1	1000
2	2	Car-2	2000
3	3	Car-3	3000
4	4	Car-4	4000
5	5	Car-5	5000

Messages

Query executed successfully.

Ready Ln 1 Col 1 Ch 1



To failback to the primary storage, make sure that the relationship direction remains the same as it was before the failover by performing a reverse resync operation.



To retain the roles of primary and secondary storage after the reverse resync operation, perform the reverse resync operation again.

This process is applicable to other applications like Oracle, similar database flavors, and any other applications using guest-connected storage.

As always, test the steps involved for recovering the critical workloads before porting them into production.

Benefits of this solution

- Uses the efficient and resilient replication of SnapMirror.
- Recovers to any available points in time with ONTAP snapshot retention.
- Full automation is available for all required steps to recover hundreds to thousands of VMs, from the storage, compute, network, and application validation steps.
- SnapCenter uses cloning mechanisms that do not change the replicated volume.
 - This avoids the risk of data corruption for volumes and snapshots.
 - Avoids replication interruptions during DR test workflows.
 - Leverages the DR data for workflows beyond DR, such as dev/test, security testing, patch and upgrade testing, and remediation testing.
- CPU and RAM optimization can help lower cloud costs by enabling recovery to smaller compute clusters.

Copyright Information

Copyright © 2022 NetApp, Inc. All rights reserved. Printed in the U.S. No part of this document covered by copyright may be reproduced in any form or by any means-graphic, electronic, or mechanical, including photocopying, recording, taping, or storage in an electronic retrieval system-without prior written permission of the copyright owner.

Software derived from copyrighted NetApp material is subject to the following license and disclaimer:

THIS SOFTWARE IS PROVIDED BY NETAPP "AS IS" AND WITHOUT ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY DISCLAIMED. IN NO EVENT SHALL NETAPP BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

NetApp reserves the right to change any products described herein at any time, and without notice. NetApp assumes no responsibility or liability arising from the use of products described herein, except as expressly agreed to in writing by NetApp. The use or purchase of this product does not convey a license under any patent rights, trademark rights, or any other intellectual property rights of NetApp.

The product described in this manual may be protected by one or more U.S. patents, foreign patents, or pending applications.

RESTRICTED RIGHTS LEGEND: Use, duplication, or disclosure by the government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.277-7103 (October 1988) and FAR 52-227-19 (June 1987).

Trademark Information

NETAPP, the NETAPP logo, and the marks listed at <http://www.netapp.com/TM> are trademarks of NetApp, Inc. Other company and product names may be trademarks of their respective owners.