



# **Protecting Workloads on Azure / AVS**

## NetApp Solutions

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# **Protecting Workloads on Azure / AVS**

## **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 VAAI 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 fallback 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:

## How to install JetStream DR for on-premises

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.

The screenshot shows the vSphere Client interface with the title bar "vSphere Client" and "A300-DataCenter". The left sidebar shows a tree view of hosts and clusters under "a300-vcsa.ehcde.com". The main content area is titled "JetStream DR" and contains tabs for Protected Domains, Statistics, Storage Sites, Appliances, Configurations, and Task Log. The "Configurations" tab is selected. On the right, there is a "Site Details" section with fields for vCenter Server Hostname (172.21.253.160), Management Appliance Hostname (ANFJSDR-msa), Software Version (4.0.0.443), Subscription ID (00000000-0000-0000-0000-000000000001), Tenant ID / Application ID (Configure), and Application Secret (Configure). A link to "Alarm Settings" is also present.

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

The screenshot shows the JetStream DR interface with the "Configurations" tab selected. In the background, the "Site Details" section is visible with the same configuration details as the previous screenshot. In the foreground, a modal dialog titled "Configure Clusters" is open. It lists two clusters: "Cluster Name" (checked) and "A300-Cluster" (checked). There are "Select All" and "Clear All" buttons at the top of the list. At the bottom of the dialog are "Cancel" and "Configure" buttons. The background interface also includes sections for "Protected Domains", "Statistics", "Storage Sites", "Appliances", "Task Log", and "Host Details".

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

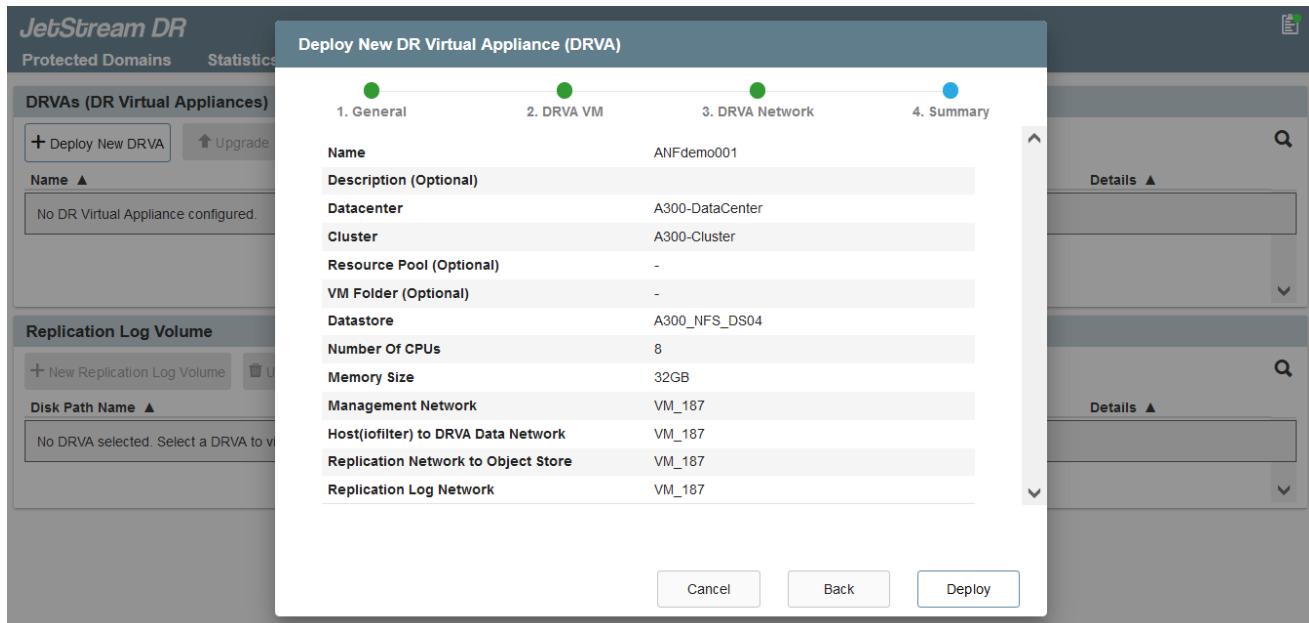


9. Add Azure Blob Storage located at the recovery site.
10. Deploy a DR Virtual Appliance (DRVA) from the Appliances tab.



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

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.



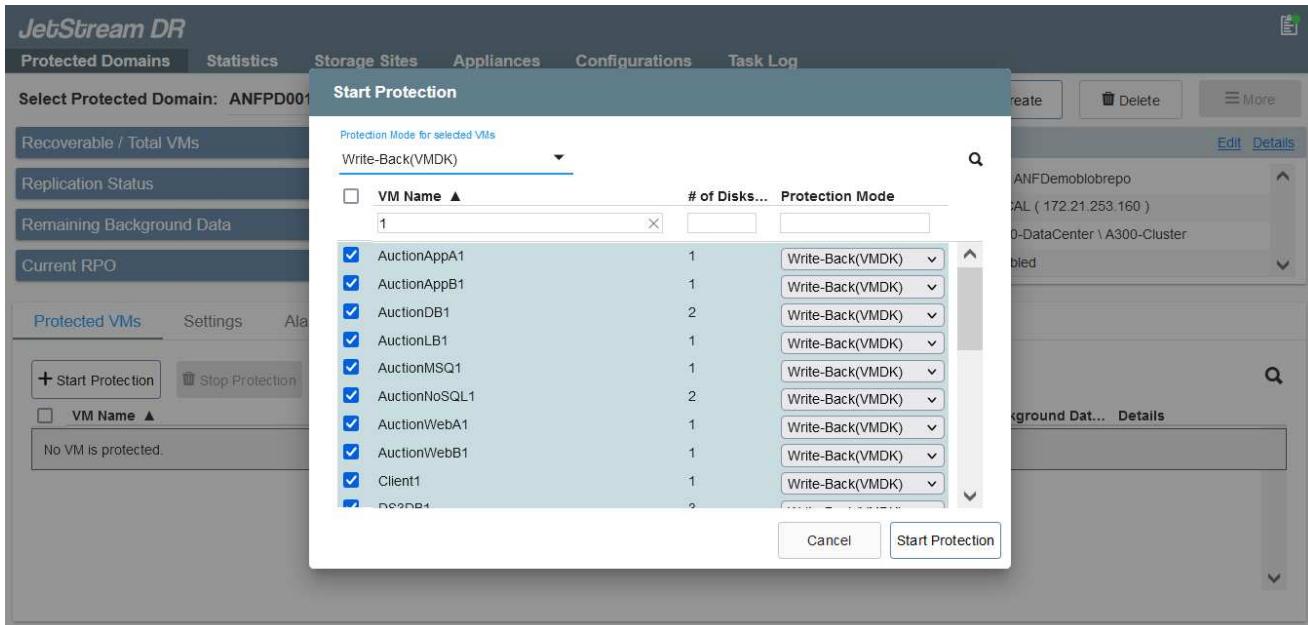
3. Select VMs you want to protect and start VM protection of the protected domain. This begins data replication to the designated Blob Store.



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



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



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.

## How to install JetStream DR for AVS in a private cloud

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.

The screenshot shows the Microsoft Azure portal interface for running commands on an Azure VMware Solution private cloud named 'ANFDataClus'. The left sidebar shows various management options like Access control, Tags, and Diagnose and solve problems. The main area is titled 'Run command' and shows a list of packages under 'JSDR.Configuration'. The 'Install-JetDRWithDHCP' command is selected, and its details are shown on the right. The command parameters include 'RegisterWithIsp' set to 'True', 'ProtectedCluster' set to 'Cluster-1', 'Datastore' set to 'vsanDatastore', 'VMName' set to 'anfjpsval-msa', 'Cluster' set to 'Cluster-1', and 'Credential' with 'Username' 'root' and 'Password' '\*\*\*\*\*'. Other fields like 'HostName' (set to 'anfjpsval-msa'), 'Network' (set to 'DRSeg'), and 'Details' (set to 'Retain up to 1 day') are also visible.

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 anfjsval-msa

Software Version 4.0.2.450

Subscription ID - [Configure](#)

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

- [Configure](#)

#### Application Secret

[Configure Cluster](#)

[Upgrade](#)

[Unconfigure](#)

[Resolve Configure Issue](#)



Cluster Name ▲

Datacenter Name ▲

Status ▲

Software Version ▲

Host Details ▲

Cluster-1

SDDC-Datacenter

Ok

4.0.2.132

[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.

Available Protected Domain(s) For Import

Protected Domain ...	Description	Recoverable V...	VMs ...	Import
ANFPD000	Protected Domain Tile0	20	20	<a href="#">Import</a>
ANFPD001	-	20	20	<a href="#">Import</a>
ANFPD002	Protected Domain 02	20	20	<a href="#">Import</a>
ANFPD003	Protected Domain Tile 03	20	20	<a href="#">Import</a>

[Close](#)

- 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.

## Performing Failover / Fallback

## How to perform a Failover / Failback

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

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

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

**Protected Domains**   **Statistics**

**Continuous Rehydration Task Result**

**Select Protected Domain:** ANFPD003

**Mode**

**Recoverable / Total VMs**

**Replication Status**

**Remaining Background Data**

**Current RPO**

**Protected VMs**   **Settings**

**+ Start Protection**   **Stop Protection**

Protected Domain	
Protected Domain	ANFPD003
VMs Recovery Status	Success
Total VMs Recovered	20
testFGP0 Status:	
Pre-script Execution Status	Not defined
Runbook Execution Status	Success
Post-script Execution Status	Not defined

**Protected VMs**

- VM Name ▲
- AuctionAppA3
- AuctionAppB3
- AuctionDB3
- AuctionLB3
- AuctionMSQ3
- AuctionNoSQL3

**RECOVERABLE**   **ON**   **VMIC-DISK(VMDK)**   **CD**

**Dismiss**

**Details**

**Details**

**Details**

**Details**

**Details**

**Details**

**Details**

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

- 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.

- 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.

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

**Select Protected Domain:** ANFPD003   [View all](#)

**Mode**   **Running in Failover**

**Active Site**   **172.30.156.2**

**Recoverable / Total VMs**   **20 / 20**

**Protected VMs**   **Settings**   **Alarms**

**Configurations**

**Storage Site**   **ANF**

**Owner Site**   **REMOT**

**+ Create**   **>Delete**   **More**

**Restore**

**Resume Continuous Rehydration**

**Failback**

VM Name ▲	Protection Status ▲	Protection Mode ▲	Details
AuctionAppA3	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>
AuctionAppB3	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>
AuctionDB3	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>
AuctionLB3	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>
AuctionMSQ3	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>
AuctionNoSQL3	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>



The CPT generated fallback 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 fallback 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).

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.

Protected Domain Name: ANFPD003  
Fallback Datacenter: A300-DataCenter  
Fallback Cluster: A300-Cluster  
Fallback Resource Pool: -  
VM Folder (Optional): -  
Fallback Datastore: A300\_NFS\_DS02  
Maximum Delay After Stopping: 60 Minutes  
Internal Network: VM\_187  
External Replication Network: VM\_187  
Management Network: VM\_187

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

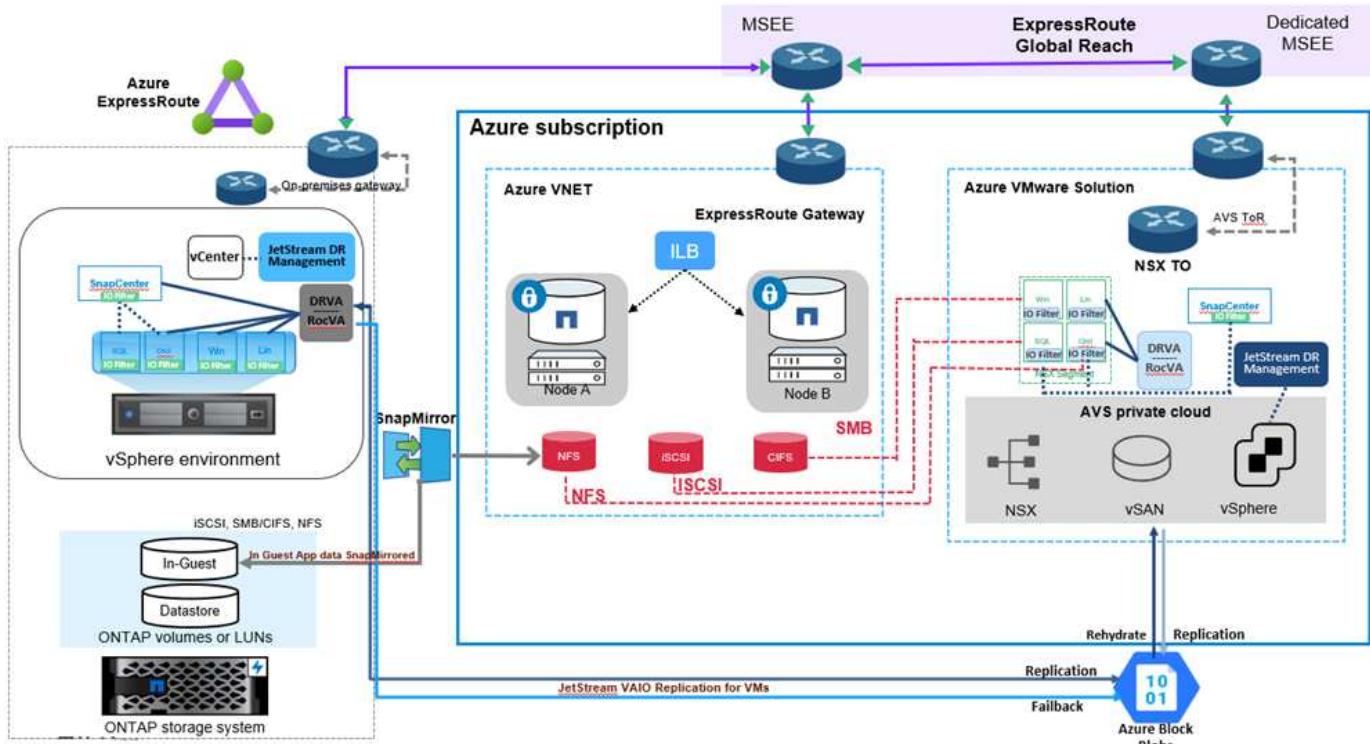
### Overview

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.

**i** 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.

**i** 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 fallback 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	...
✓	gcsdrsqlhld_sc46_copy_ANFCVODRDemo	gcsdrsqlhld_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.

The screenshot shows the vSphere Client interface with the title bar "vSphere Client" and "Administrator@EHCDC.COM". The main navigation bar includes "Menu", "Search in all environments", and "Actions". Below the navigation bar, the left sidebar shows a tree structure with "a300-vcsa.ehcdc.com" expanded, revealing "A300-DataCenter" which further expands to "A300-Cluster" containing "a300-esxi02.eh...", "a300-esxi03.eh...", "a300-esxi04.eh...", "a300-esxi05.eh...", "ANFJSDR-MSA", "AuctionAppA0", "AuctionAppA2", "AuctionAppA3", and "AuctionAppB0". The main content area is titled "JetStream DR" and contains tabs for "Protected Domains", "Statistics", "Storage Sites", "Appliances", "Configurations", and "Task Log". The "Configurations" tab is selected. Under "Site Details", there are fields for "vCenter Server Hostname" (172.21.253.160), "Management Appliance Hostname" (ANFJSDR-msa), "Software Version" (4.0.0.443), "Subscription ID" (00000000-0000-0000-0000-000000000001), "Tenant ID / Application ID" (Configure), and "Application Secret" (Configure). An "Alarm Settings" link is also present.

7. From the JetStream DR interface, complete the following tasks:

- a. Configure the cluster with the I/O filter package.

The screenshot shows the JetStream DR Configuration interface with the "Configurations" tab selected. The main panel displays "Site Details" with the same information as the previous screenshot. Below it, the "Configured Clusters" section shows a table with one row: "Cluster Name" (A300-Cluster) and "Datacenter Name" (A300-DataCenter). A "Configure" button is visible at the bottom right of this section. A modal dialog box titled "Configure Clusters" is open over the main interface. It contains a table with two rows: "Cluster Name" (A300-Cluster) and "Datacenter Name" (A300-DataCenter). Both rows have checkboxes next to them, and the first row's checkbox is checked. At the bottom of the dialog are "Cancel" and "Configure" buttons.

- 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.

The screenshot shows the JetStream DR interface with two main sections visible:

- DRVAs (DR Virtual Appliances):** A table listing one entry: GCSDRPD001. Columns include Name, Status (Running), Child Alarm (0), Software Version (4.0.0.134), and Details.
- Replication Log Volume:** A table listing one entry: /dev/sdb. Columns include Disk Path Name, Status (Ok), Child Alarm (0), Size (available/total) (179.88 GB / 200 GB), and Details.

- 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.

The screenshot shows the "Create Protected Domain" dialog box in Step 1: General. The form fields are as follows:

Protected Domain Name	GCSDRPD_Demo01
Priority Level (Optional)	-
Description	Protection domain ANF
Total estimated data size to be protected	1000GB
DR Virtual Appliance	GCSDRPD001
Compression	Yes
Compression Level	Default
Normal GC Storage Overhead	50%
Maximum GC Storage Overhead	300%
Replication Log Storage	/dev/sdb
Replication Log Size	4KB/R

The screenshot shows the "Create Protected Domain" dialog box in Step 2: Primary Site. The form fields are as follows:

Compression	Yes
Compression Level	Default
Normal GC Storage Overhead	50%
Maximum GC Storage Overhead	300%
Replication Log Storage	/dev/sdb
Replication Log Size	50GB
Metadata Size	31.56GB
Primary Site Datacenter	A300-DataCenter
Primary Site Cluster	A300-Cluster
Storage Site	ANFDRDemoFailoverSite
Enable PITR	No

- 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.

The screenshot shows the 'Start Protection' dialog box from the JetStream DR interface. The 'Protection Mode for selected VMs' dropdown is set to 'Write-Through'. A list of VMs is shown with their protection modes: GCS-DR-DC, GCS-DR-LinVM01, GCS-DR-SCA, GCS-DR-SQL01, and GCS-DR-WinVM01 are all set to 'Write-Through'. Other VMs like ElasticWebA2, ElasticWebA3, etc., have 'Write-Through' as the default. The 'Start Protection' button at the bottom right is highlighted.

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

The screenshot shows the 'Start Protection' dialog box from the JetStream DR interface. The 'Protection Mode for selected VMs' dropdown is set to 'Write-Back(VMDK)'. A list of VMs is shown with their protection modes: GCS-DR-DC, GCS-DR-LinVM01, GCS-DR-SCA, GCS-DR-SQL01, and GCS-DR-WinVM01 are all set to 'Write-Back(VMDK)'. Other VMs like ElasticWebA2, ElasticWebA3, etc., have 'Write-Through' as the default. The 'Start Protection' button at the bottom right is highlighted.

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.

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



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.

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.

The screenshot shows the 'Failover Runbook Settings' page. On the left, there's a sidebar with 'Protected Domains' set to 'GCSDRDPD\_Demo01'. The main area displays a table for 'Failover Runbook Settings' with two rows: 'Group Name' (with a plus icon) and 'Independent VMs' (with a minus icon). A tooltip 'Group Name' is visible over the first row. To the right, there's a separate window titled 'ANFDRDemoFailoverSite' showing replication status: LOCAL (172.21.253.160) and A300-DataCenter \A300-Cluster, with a status of 'Disabled'.

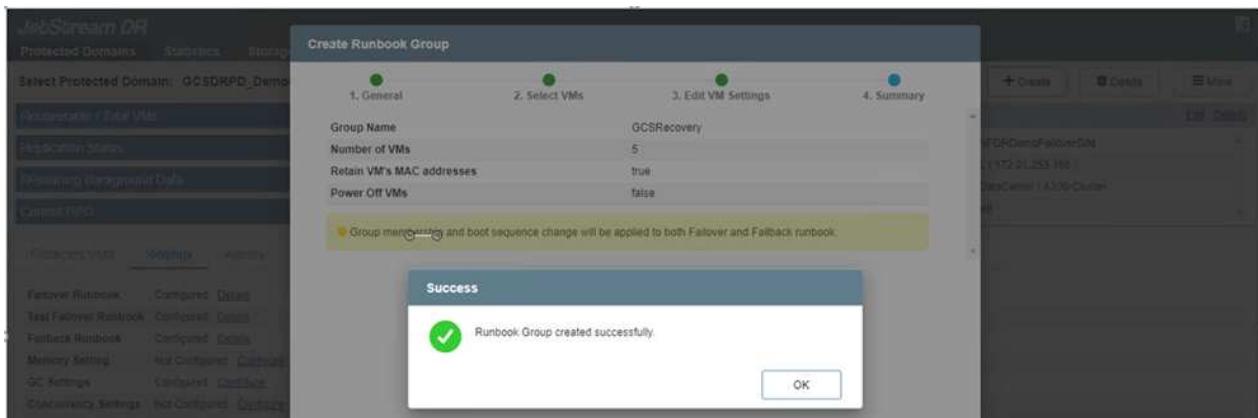
17. Edit the VM settings as required. Specify the parameters for recovering the VMs, including the boot sequence, the boot delay (specified in seconds), the number of CPUs, and the amount of memory to allocate. Change the boot sequence of the VMs by clicking the up or down arrows. Options are also provided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

The screenshot shows the 'Create Runbook Group' wizard, step 3: 'Edit VM Settings'. It has tabs for 'General', 'Select VMs', 'Edit VM Settings' (which is active), and 'Summary'. Under 'Edit VM Settings', there are checkboxes for 'Retain MAC' and 'Power Off VMs'. Below is a table with columns: VM Name, Boot Sequence..., Boot Delay, CPU, Memory, Script, and NIC... (with a dropdown arrow). The table lists several VMs: GCS-DR-WinVM01, GCS-DR-SCA, GCS-DR-DC, GCS-DR-LinVM01, and GCS-DR-SQL01. A tooltip 'Double click on the cell or click on the up/down icon to change value.' is shown. At the bottom are 'Cancel', 'Back', and 'Next' buttons.

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 fallback runbooks is now listed as Configured. Failover and fallback 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

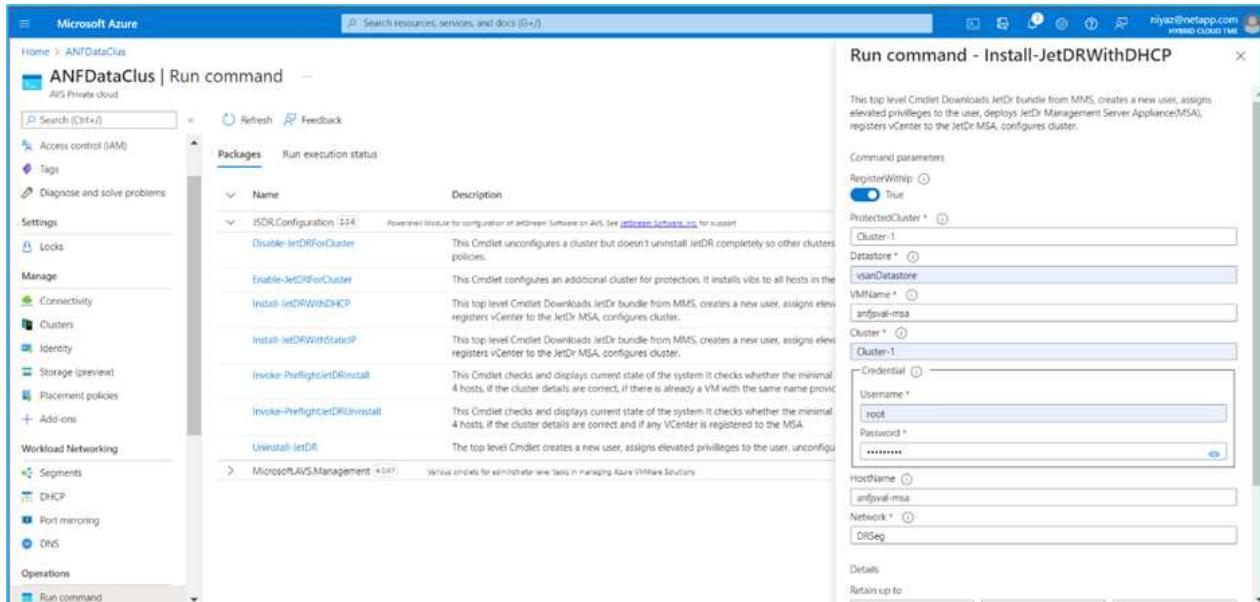
JetStream DR supports a near-zero RTO mode for mission-critical domains. For these domains, destination storage should be preinstalled. ANF is a recommended storage type in this case.

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

- i 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 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 ▲

Datacenter Name ▲

Status ▲

Software Version ▲

Host Details ▲

Cluster-1

SDDC-Datacenter

Ok

4.0.2.132

[Details](#)

- From the JetStream DR interface, complete the following tasks:

- 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.
- In the pop-up dialog window that appears, select the protected domain to import and then click its Import link.

Protected Domain ...	Description	Recoverable V...	VMs ...	Import
GCSDRPD_Demo01	Protection domain ANF	5	5	<a href="#">Import</a>

- 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.

VM Name ▲	Protection Status ▲	Protection Mode ▲	Details
GCS-DR-DC	Recoverable	Write-Back(VMDDK)	<a href="#">Details</a>
GCS-DR-LinVM01	Recoverable	Write-Back(VMDDK)	<a href="#">Details</a>
GCS-DR-SCA	Recoverable	Write-Back(VMDDK)	<a href="#">Details</a>
GCS-DR-SQL01	Recoverable	Write-Back(VMDDK)	<a href="#">Details</a>
GCS-DR-WinVM01	Recoverable	Write-Back(VMDDK)	<a href="#">Details</a>

- 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: GCSDRPD\_Demo01 View all

Mode Imported

Recoverable / Total VMs 5 / 5

Configurations

Storage Site ANFDemoblobrepor  
Owner Site REMOTE ( 172.21.253.10 )

+ Create Delete More

Restore → Failover → Continuous Failover → Test Failover

Protected VMs Settings Alarms

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

- 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 shows the Jetstream UI for managing volume relationships. At the top, there are summary statistics: 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. Three rows are listed, all in a healthy state. The first row has a context menu open, showing options: Break (which is highlighted with a cursor), Reverse Resync, Edit Schedule, Edit Max Transfer Rate, Update, and Delete.

The screenshot shows the Jetstream UI with a "Break Relationship" dialog box. The dialog asks, "Are you sure that you want to break the relationship between "gcsdrsqldb\_sc46" and "gcsdrsqldb\_sc46\_copy"?". There are two buttons: "Break" (highlighted with a cursor) and "Cancel". In the background, the main interface shows the same volume relationships table as the previous screenshot, with the first row selected.



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

- 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 4 / 4

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	ANFDemotlobreporec
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\MDK	<a href="#">Details</a>
GCS-DR-LinVM01	Recoverable	Write-Back\MDK	<a href="#">Details</a>
GCS-DR-SCA	Recoverable	Write-Back\MDK	<a href="#">Details</a>
GCS-DR-SQL01	Recoverable	Write-Back\MDK	<a href="#">Details</a>
GCS-DR-WinVM01	Recoverable	Write-Back\MDK	<a href="#">Details</a>

### 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](#)

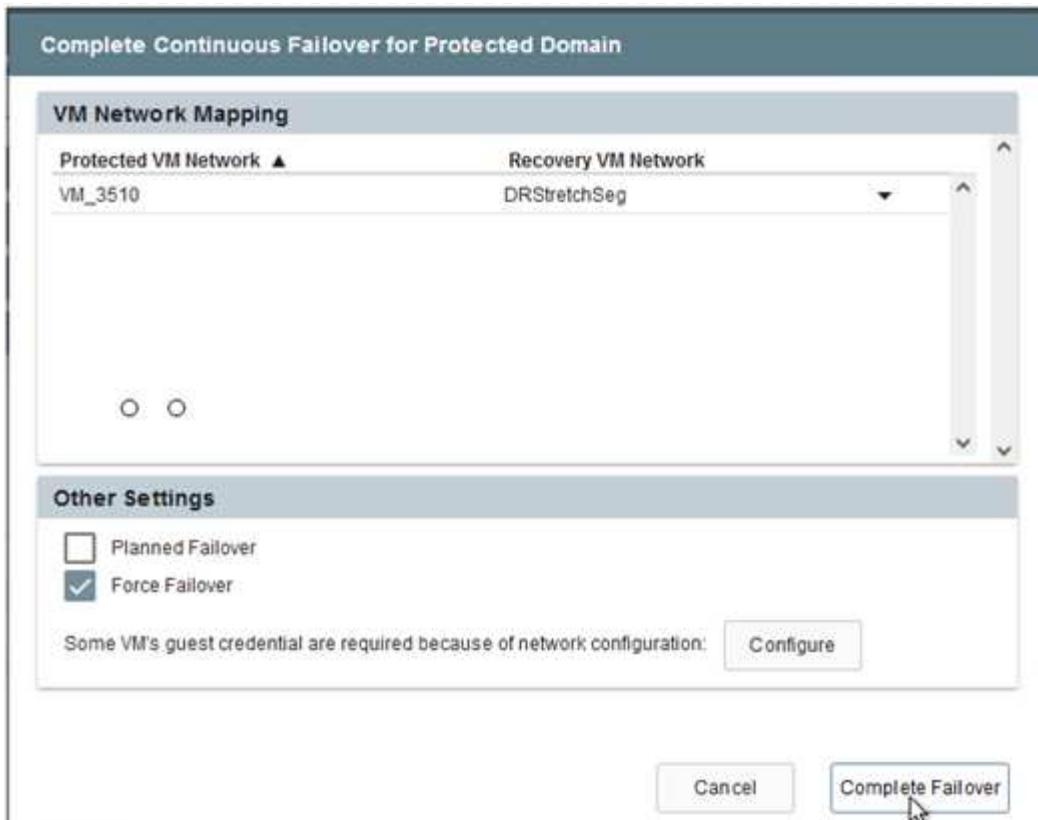
[Cancel](#) [Complete Failover](#)

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](#)



3. 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.

- i 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.
- i 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.

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 browser.



- 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 interface with the 'Replication' tab selected. At the top, there are summary statistics: 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 the following data:

Health Status	Source Volume	Target Volume	Total Transfer Time	Status	Mirror State	Last Successful Transfer
✓	gcsdrsqldb_sc46_ntaphci-a300e9u25	gcsdrsql ldb_sc46_copy ANFCVODRDemo	6 minutes 41 seconds	idle	broken-off	May 5, 2022, 12:08:34 PM 33.66 kB
✓	gcsdrsqlhld_sc46_ntaphci-a300e9u25	gcsdrsql hld_sc46_copy ANFCVODRDemo	4 minutes 56 seconds	idle	broken-off	May 5, 2022, 12:09:15 PM 69.84 kB
✓	gcsdrsqllog_sc46_ntaphci-a300e9u25	gcsdrsql log_sc46_copy ANFCVODRDemo	10 minutes 18 seconds	idle	broken-off	May 5, 2022, 12:08:34 PM 104.34 kB

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 tool. The table below lists the volumes and their properties:

Volume	Layout	Type	File System	Status	Capacity	Free Spa...	% Free
---	Simple	Basic		Healthy (R...)	450 MB	450 MB	100 %
---	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.

## iSCSI Initiator Properties

X

Targets Discovery Favorite Targets Volumes and Devices RADIUS Configuration

### Quick Connect

To discover and log on to a target using a basic connection, type the IP address or DNS name of the target and then click Quick Connect.

Target:

Quick Connect...

### Discovered targets

Refresh

Name

Status

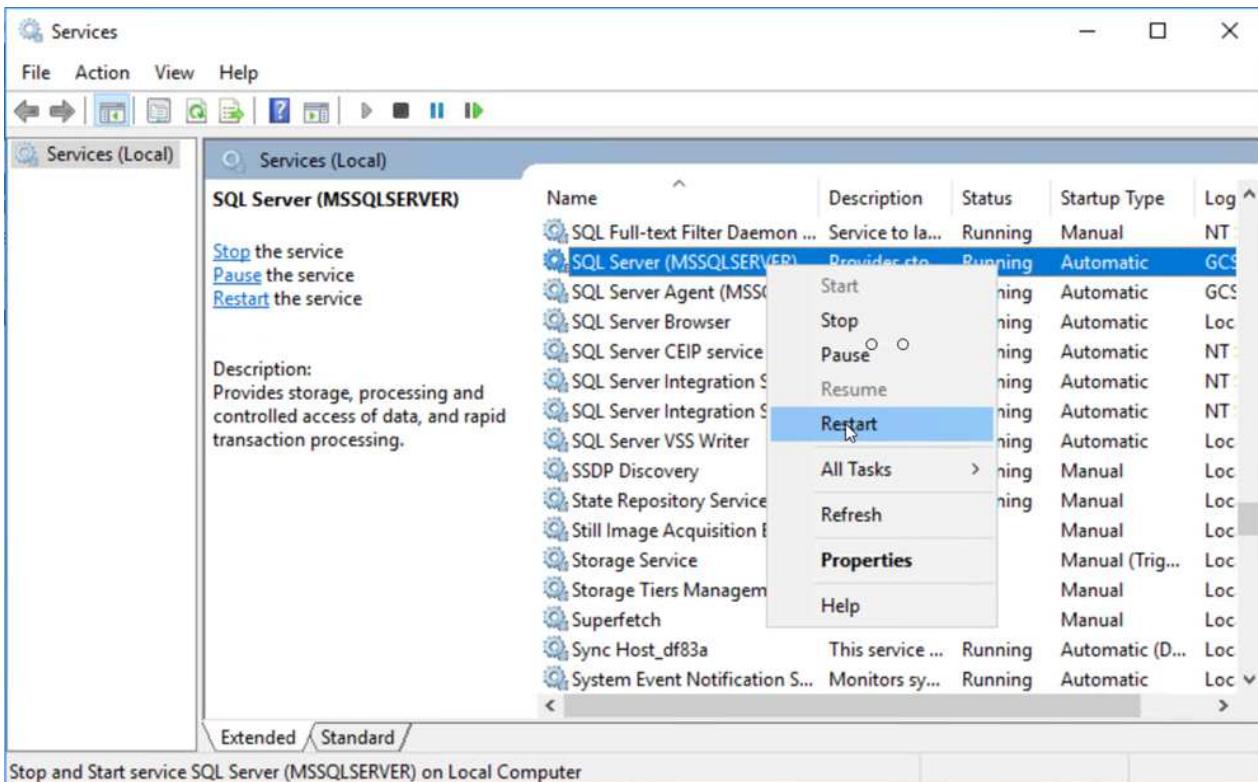
iqn.1992-08.com.netapp:sn.547772ccc47811ecbb62000... Connected

iqn.1992-08.com.netapp:sn.aeab78ab720011ec939800... Reconnecting...

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.

The screenshot shows the Microsoft SQL Server Management Studio (SSMS) interface. The title bar reads 'SQLQuery1.sql - GCS-DR-SQL03.CarDB (GCSDC\adminnimo (66)) - Microsoft SQL Server Management Studio (Administrator)'. The main area consists of several panes: 'Object Explorer' on the left showing database structures like 'System Databases', 'Database Snapshots', 'CarDB' (selected), 'Tables', 'dbo.Cars' (selected), and its sub-objects; a 'Script' pane at the top right containing a script for 'Select Top N Rows'; a 'Results' pane below it displaying the query results for 'dbo.Cars' with columns 'Id', 'Name', and 'Price', showing rows from 1 to 5; and a 'Messages' pane at the bottom right indicating 'Query executed successfully.'



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.

VM Name	Protection Status	Protection Mode	Details
GCS-DR-DC	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>
GCS-DR-Lin\MO1	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>
GCS-DR-SCA	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>
GCS-DR-SQL01	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>
GCS-DR-Win\MO1	Recoverable	Write-Back(VMDK)	<a href="#">Details</a>



Specify the maximum delay after pausing the VMs in the recovery site and restarting them in the protected site. The time needed 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.

## Fallback Protected Domain

1. General	2a. Fallback Settings	2b. VM Settings	3. Recovery VA	4. DR Settings	5. Summary
Fallback Datacenter			A300-DataCenter		
Fallback Cluster			A300-Cluster		
Fallback Resource Pool			-		
VM Folder (Optional)			-		
Fallback 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

Fallback

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

Protected Domain:		GCSDRPD002
Protected Domain	GCSDRPD002	
VMs Recovery Status	Success	
Total VMs Recovered	4	
GCSR03 Status:		
Pre-script Execution Status	Not defined	
Runbook Execution Status	Success	
Post-script Execution Status	Not defined	

4. 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	More Options
✓	gcsdrsqldb_sc46_ntaphcl-a300e9u25	gcsdrsqldb_sc46_copy_ANFCVODRDemo	6 minutes 41 seconds	idle	broken-off	May 5, 2022, 12:08:34 PM 33.66 kB	...
✓	gcsdrsqlhld_sc46_ntaphcl-a300e9u25	gcsdrsqlhld_sc46_copy_ANFCVODRDemo	4 minutes 56 seconds	idle	broken-off		Information
✓	gcsdrsqllog_sc46_ntaphcl-a300e9u25	gcsdrsqllog_sc46_copy_ANFCVODRDemo	10 minutes 18 seconds	idle	broken-off		Resync Reverse Resync Edit Schedule Edit Max Transfer Rate Delete

5. Restart the MSSQL server service.
6. 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

New Query Execute

Object Explorer

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) ↗ X

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

Results Messages

	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

Query executed successfully.



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.

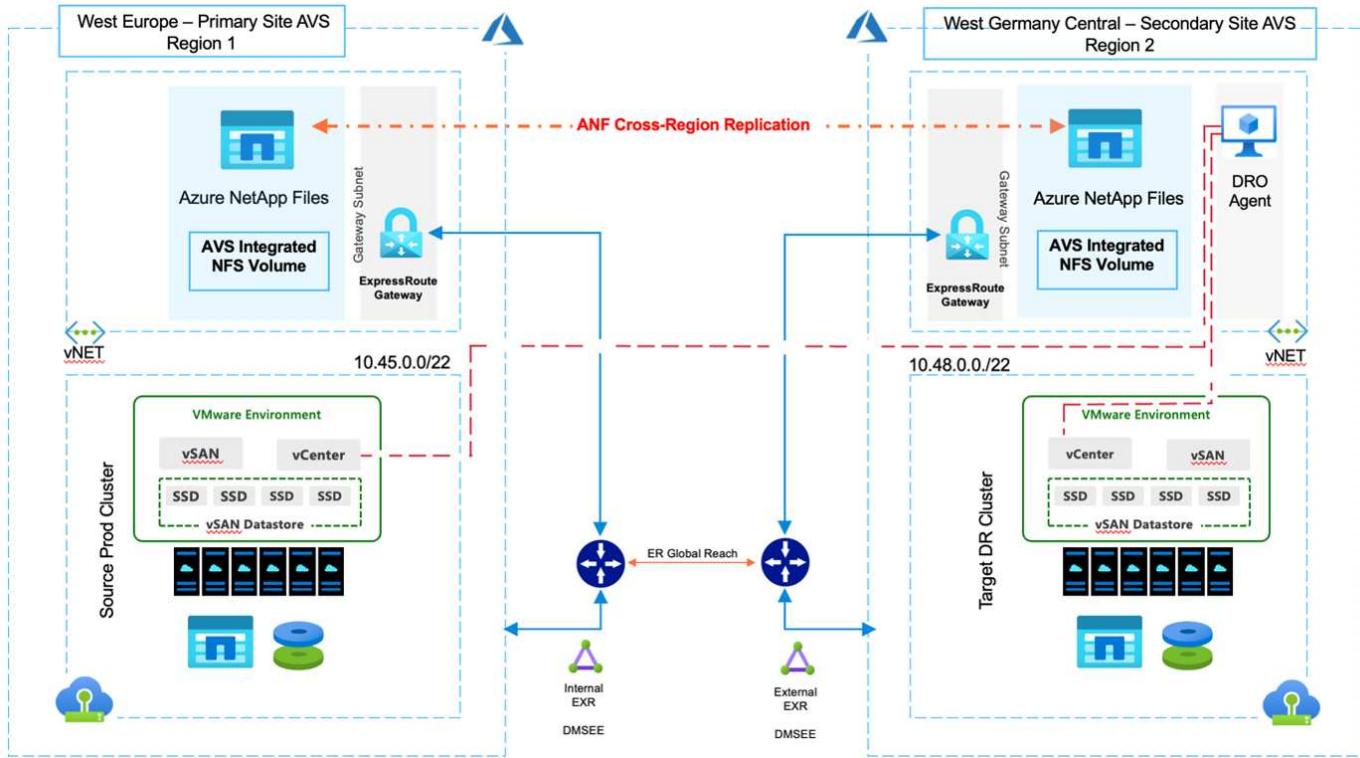
# TR-4955: Disaster Recovery with Azure NetApp Files (ANF) and Azure VMware Solution (AVS)

Author(s): Niyaz Mohamed, NetApp Solutions Engineering

## Overview

Disaster recovery using block-level replication between regions within the cloud is a resilient and cost-effective way of protecting the workloads against site outages and data corruption events (for example, ransomware). With Azure NetApp files (ANF) cross-region volume replication, VMware workloads running on an Azure VMware Solution (AVS) SDDC site using Azure NetApp files volumes as an NFS datastore on the primary AVS site can be replicated to a designated secondary AVS site in the target recovery region.

Disaster Recovery Orchestrator (DRO) (a scripted solution with a UI) can be used to seamlessly recover workloads replicated from one AVS SDDC to another. DRO automates recovery by breaking replication peering and then mounting the destination volume as a datastore, through VM registration to AVS, to network mappings directly on NSX-T (included with all AVS private clouds).



## Prerequisites and general recommendations

- Verify that you have enabled cross-region replication by creating replication peering. See [Create volume replication for Azure NetApp Files](#).
- You must configure ExpressRoute Global Reach between the source and target Azure VMware Solution private clouds.
- You must have a service principal that can access resources.
- The following topology is supported: primary AVS site to secondary AVS site.
- Configure the [replication](#) schedule for each volume appropriately based on business needs and the data-change rate.



Cascading and fan- in and fan- out topologies are not supported.

## Getting started

### Deploy Azure VMware Solution

The [Azure VMware Solution](#) (AVS) is a hybrid cloud service that provides fully functional VMware SDDCs within a Microsoft Azure public cloud. AVS is a first-party solution fully managed and supported by Microsoft and verified by VMware that uses Azure infrastructure. Therefore, customers get VMware ESXi for compute virtualization, vSAN for hyper-converged storage, and NSX for networking and security, all while taking advantage of Microsoft Azure's global presence, class-leading data-center facilities, and proximity to the rich ecosystem of native Azure services and solutions. A combination of Azure VMware Solution SDDC and Azure NetApp Files provides the best performance with minimal network latency.

To configure an AVS private cloud on Azure, follow the steps in this [link](#) for NetApp documentation and in this [link](#) for Microsoft documentation. A pilot-light environment set up with a minimal configuration can be used for DR purposes. This setup only contains core components to support critical applications, and it can scale out

and spawn more hosts to take the bulk of the load if a failover occurs.



In the initial release, DRO supports an existing AVS SDDC cluster. On-demand SDDC creation will be available in an upcoming release.

## Provision and configure Azure NetApp Files

[Azure NetApp Files](#) is a high-performance, enterprise-class, metered file- storage service. Follow the steps in this [link](#) to provision and configure Azure NetApp Files as a NFS datastore to optimize AVS private cloud deployments.

### Create volume replication for Azure NetApp Files-powered datastore volumes

The first step is to set up cross- region replication for the desired datastore volumes from the AVS primary site to the AVS secondary site with the appropriate frequencies and retentions.

The screenshot shows the Azure portal interface for managing Azure NetApp Files. The top navigation bar includes 'Home', 'Azure NetApp Files', 'WEANFAVSacct | Volumes', and 'testrepldemo (WEANFAVSacct/testcap/testrepldemo)'. The main content area displays the 'testrepldemo' volume details under the 'Replication' tab. The 'Essentials' section shows the following information:

Setting	Value
End point type	: Source
Health status	: Healthy
Mirror state	: Mirrored
Destination	: testrepldemo_copy
Relationship status	: Idle
Total progress	: 2.13 GiB

On the left side, there is a sidebar with links for 'Search', 'Refresh', 'Overview', 'Activity log', 'Access control (IAM)', and 'Tags'. A 'JSON View' link is located in the top right corner of the main content area.

Follow the steps in this [link](#) to set up cross-region replication by creating replication peering. The service level for the destination capacity pool can match that of the source capacity pool. However, for this specific use case, you can select the standard service level and then [modify the service level](#) in the event of a real disaster or DR simulations.



A cross- region replication relationship is a prerequisite and must be created beforehand.

## DRO installation

To get started with DRO, use the Ubuntu operating system on the designated Azure virtual machine and make sure you meet the prerequisites. Then install the package.

### Prerequisites:

- Service principal that can access resources.
- Make sure that appropriate connectivity exists to the source and destination SDDC and Azure NetApp Files instances.
- DNS resolution should be in place if you are using DNS names. Otherwise, use IP addresses for vCenter.

### OS requirements:

- Ubuntu Focal 20.04 (LTS)The following packages must be installed on the designated agent virtual machine:
  - Docker
  - Docker- compose
  - JqChange docker.sock to this new permission: sudo chmod 666 /var/run/docker.sock.



The deploy.sh script executes all required prerequisites.

The steps are as follows:

1. Download the installation package on the designated virtual machine:

```
git clone https://github.com/NetApp/DRO-Azure.git
```



The agent must be installed in the secondary AVS site region or in the primary AVS site region in a separate AZ than the SDDC.

2. Unzip the package, run the deployment script, and enter the host IP (for example, 10.10.10.10).

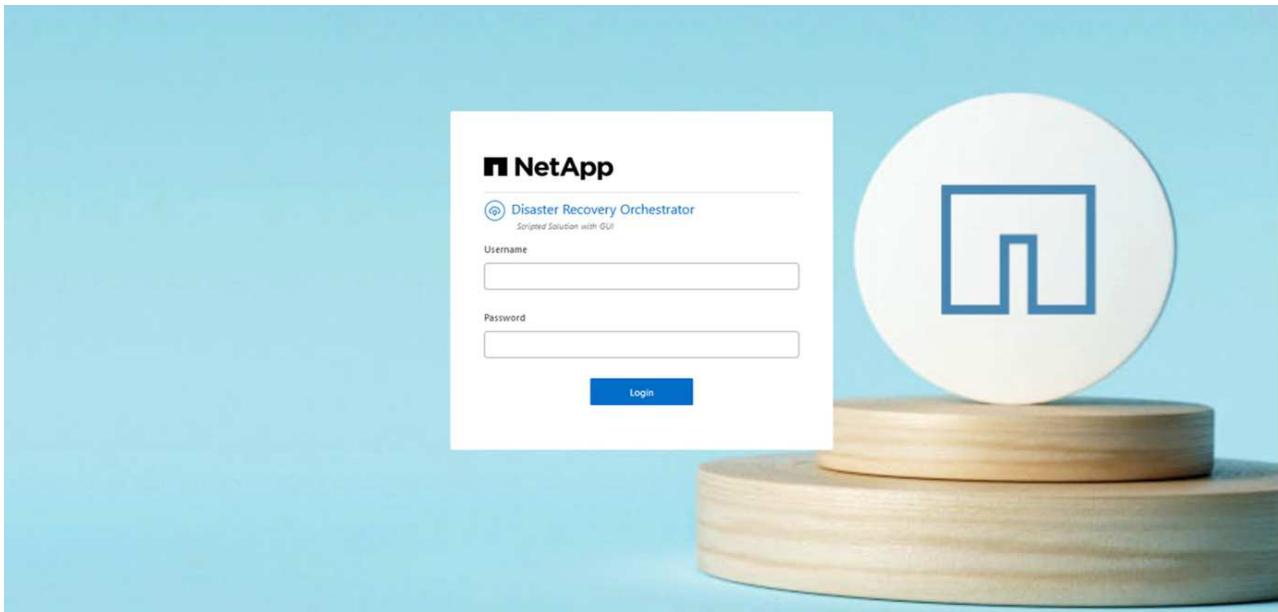
```
tar xvf draas_package.tar
```

Navigate to the directory and run the deploy script as below:

```
sudo sh deploy.sh
```

3. Access the UI using the following credentials:

- ° Username: admin
- ° Password: admin



## DRO configuration

After Azure NetApp Files and AVS have been configured properly, you can begin configuring DRO to automate the recovery of workloads from the primary AVS site to the secondary AVS site. NetApp recommends deploying the DRO agent in the secondary AVS site and configuring the ExpressRoute gateway connection so that the DRO agent can communicate via the network with the appropriate AVS and Azure NetApp Files components.

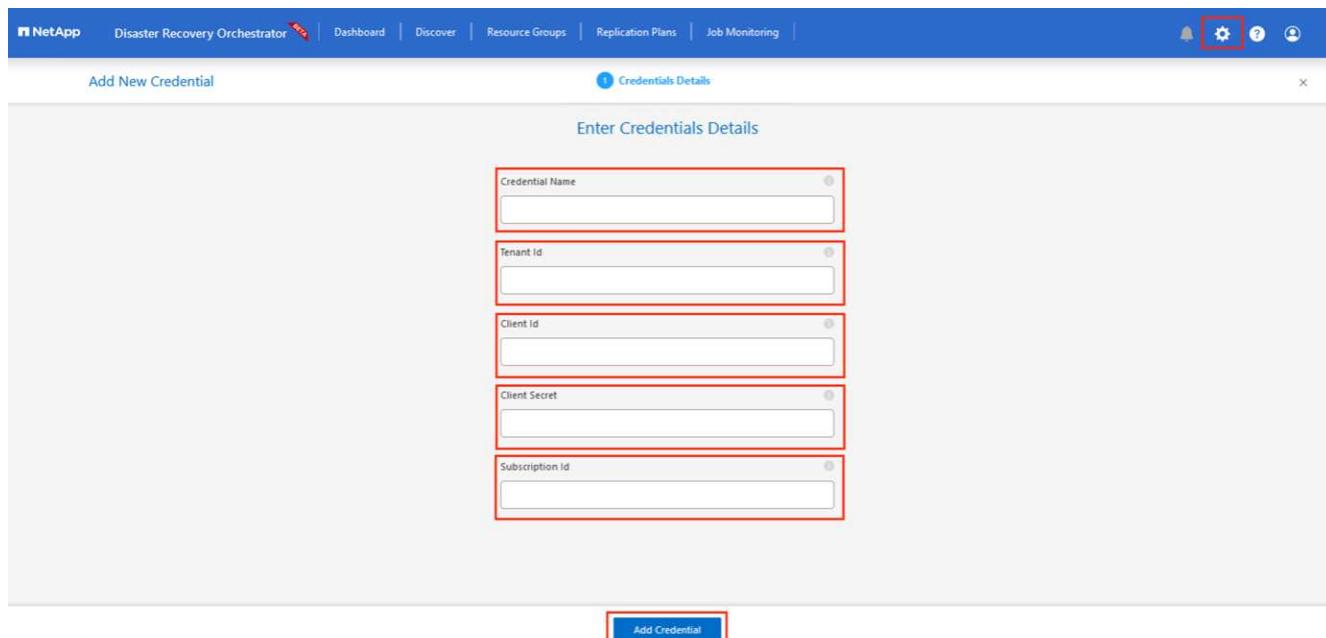
The first step is to Add credentials. DRO requires permission to discover Azure NetApp Files and the Azure VMware Solution. You can grant the required permissions to an Azure account by creating and setting up an Azure Active Directory (AD) application and by obtaining the Azure credentials that DRO needs. You must bind the service principal to your Azure subscription and assign it a custom role that has the relevant required permissions. When you add source and destination environments, you are prompted to select the credentials associated with the service principal. You need to add these credentials to DRO before you can click Add New Site.

To perform this operation, complete the following steps:

1. Open DRO in a supported browser and use the default username and password (admin/admin). The password can be reset after the first login using the Change Password option.
2. In the upper right of the DRO console, click the **Settings** icon, and select **Credentials**.
3. Click Add New Credential and follow the steps in the wizard.
4. To define the credentials, enter information about the Azure Active Directory service principal that grants the required permissions:
  - Credential name
  - Tenant ID
  - Client ID
  - Client secret
  - Subscription ID

You should have captured this information when you created the AD application.

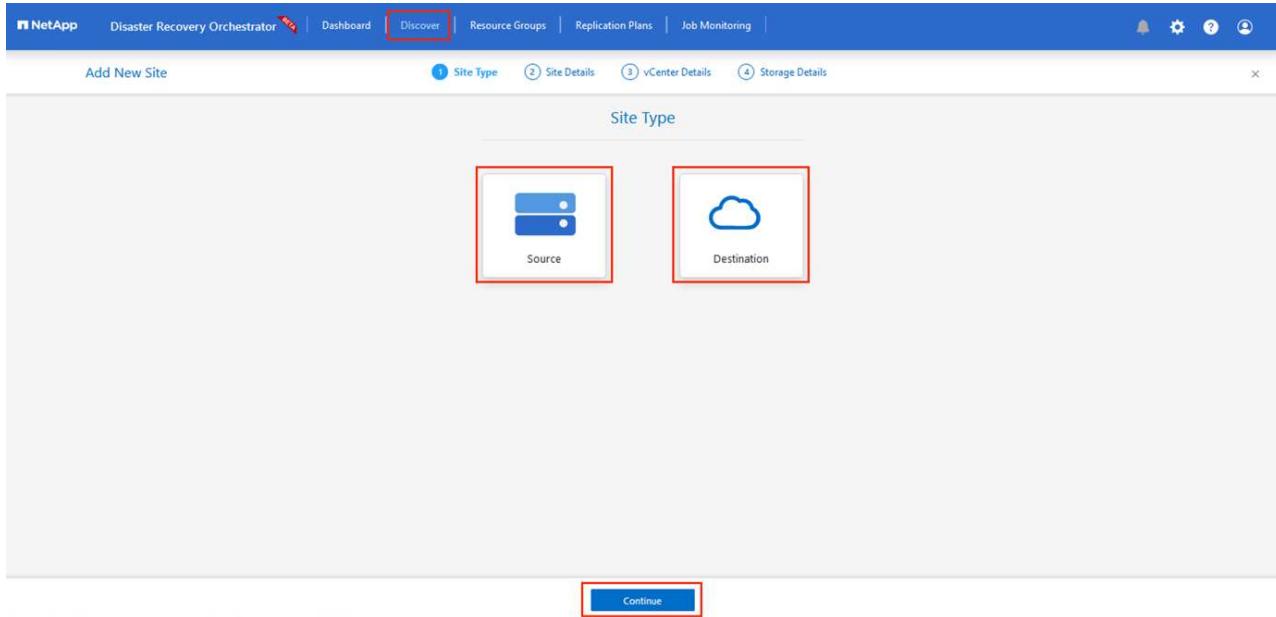
5. Confirm the details about the new credentials and click Add Credential.



After you add the credentials, it's time to discover and add the primary and secondary AVS sites (both vCenter and the Azure NetApp files storage account) to DRO. To add the source and destination site, complete the following steps:

6. Go to the **Discover** tab.

7. Click **Add New Site**.
8. Add the following primary AVS site (designated as **Source** in the console).
  - SDDC vCenter
  - Azure NetApp Files storage account
9. Add the following secondary AVS site (designated as **Destination** in the console).
  - SDDC vCenter
  - Azure NetApp Files storage account



10. Add site details by clicking **Source**, entering a friendly site name, and select the connector. Then click **Continue**.



For demonstration purposes, adding a source site is covered in this document.

11. Update the vCenter details. To do this, select the credentials, Azure region, and resource group from the dropdown for the primary AVS SDDC.
12. DRO lists all the available SDDCs within the region. Select the designated private cloud URL from the dropdown.
13. Enter the `cloudadmin@vsphere.local` user credentials. This can be accessed from Azure Portal. Follow the steps mentioned in this [link](#). Once done, click **Continue**.

14. Select the Source Storage details (ANF) by selecting the Azure Resource group and NetApp account.

15. Click **Create Site**.

Site Name	Type	Location	vCenter	Storage	VM List	Discovery Status
DemoDest	Destination	Cloud	1	1	<a href="#">View VM List</a>	<span>Success</span>
DemoSRC	Source	Cloud	1	1	<a href="#">View VM List</a>	<span>Success</span>

Once added, DRO performs automatic discovery and displays the VMs that have corresponding cross-region replicas from the source site to the destination site. DRO automatically detects the networks and segments used by the VMs and populates them.

**VM List**  
Site: DemoSRC | vCenter: <https://172.30.156.2/>

**VM Protection**  
Protected: 2  
Unprotected: 126

VM Name	VM Status	VM State	DataStore	CPU	Memory (MB)
HCI Bench_2.6.1	Not Protected	Powered On	vsanDatastore	8	8192
hci-flo-datastore-13984-0-1	Not Protected	Powered Off	HCItstDS	32	65536
ICCAz005-WO-R1	Not Protected	Powered On	vsanDatastore	8	14336
ICCAz005-NE-R1	Not Protected	Powered On	vsanDatastore	8	3072
ICCAz005-IX-R1	Not Protected	Powered On	vsanDatastore	8	3072
HCX_Demo_05	Not Protected	Powered Off	Demo002	1	2048
hci-nim-datastore-13984-0-1	Not Protected	Powered Off	HCItstDS	24	49152

The next step is to group the required VMs into their functional groups as resource groups.

## Resource groupings

After the platforms have been added, group the VMs you want to recover into resource groups. DRO resource groups allow you to group a set of dependent VMs into logical groups that contain their boot orders, boot delays, and optional application validations that can be executed upon recovery.

To start creating resource groups, click the **Create New Resource Group** menu item.

1. Access **Resource Groups** and click **\*Create New Resource Group**.

**Resource Groups**

**Create New Resource Group**

Resource Group Name	Site Name	Source vCenter	VM List
DemoRG	DemoSRC	https://172.30.156.2/	<a href="#">View VM List</a>

2. Under New Resource Group, select the source site from the dropdown and click **Create**.
3. Provide the resource group details and click **Continue**.
4. Select appropriate VMs using the search option.
5. Select the **Boot Order** and **Boot Delay (secs)** for all the selected VMs. Set the order of the power-on sequence by selecting each virtual machine and setting up the priority for it. The default value for all virtual machines is 3. The options are as follows:
  - The first virtual machine to power on
  - Default

- The last virtual machine to power on

VM Name	Boot Order	Boot Delay (secs)
QALin1	3	0
QALin	3	0

## 6. Click **Create Resource Group**.

Resource Group Name	Site Name	Source vCenter	VM List
DemoRG	DemoSRC	https://172.30.156.2/	<a href="#">View VM List</a>

## Replication plans

You must have a plan to recover applications in the event of a disaster. Select the source and destination vCenter platforms from the drop down, pick the resource groups to be included in this plan, and also include the grouping of how applications should be restored and powered on (for example, domain controllers, tier-1, tier-2, and so on). Plans are often called blueprints as well. To define the recovery plan, navigate to the Replication Plan tab, and click **New Replication Plan**.

To start creating a replication plan, complete the following steps:

### 1. Navigate to **Replication Plans** and click **Create New Replication Plan**.

Plan Name	Active Site	Status	Compliance	Source Site	Destination Site	Resource Groups
DemoRP	Source	Active	Partially Healthy	DemoSRC	DemoDest	<a href="#">Resource Groups</a>

### 2. On the **New Replication Plan**, provide a name for the plan and add recovery mappings by selecting the Source Site, associated vCenter, Destination Site, and associated vCenter.

Plan Name  
DemoRP

**Recovery Mapping**

Source Site	Destination Site
DemoSRC	DemoDest

**Cluster Mapping**

Source Site Resource	Destination Site Resource
Cluster-1	Cluster-1

**Source Resource      Destination Resource**

No Mappings added!	
--------------------	--

**Continue**

3. After recovery mapping is complete, select the **Cluster Mapping**.

Plan Name  
DemoRP

**Recovery Mapping**

Source Site	Destination Site
DemoSRC	DemoDest

**Cluster Mapping**

No more Source/Destination cluster resources available for mapping

Source Resource	Destination Resource
Cluster-1	Cluster-1

**Continue**

4. Select **Resource Group Details** and click **Continue**.

5. Set the execution order for the resource group. This option enables you to select the sequence of operations when multiple resource groups exist.
6. Once done, set network mapping to the appropriate segment. The segments should already be provisioned on the secondary AVS cluster, and, to map the VMs to those, select the appropriate segment.
7. Datastore mappings are automatically selected based on the selection of VMs.



Cross- region replication (CRR) is at the volume level. Therefore, all VMs residing on the respective volume are replicated to the CRR destination. Make sure to select all VMs that are part of the datastore, because only virtual machines that are part of the replication plan are processed.

Replication Plan Details

Select Execution Order

Resource Group Name	Execution Order
DemoRG	3

Network Mapping

No more Source/Destination network resources available for mapping

Source Resource	Destination Resource	Delete
SepSeg	SegDR	

DataStore Mapping

Source DataStore	Destination Volume
TestSrc01	gwc_ntap_acct/gwc_DRO_cp/testsrc01copy

[Previous](#) [Continue](#) [X](#)

- Under VM details, you can optionally resize the VMs CPU and RAM parameters. This can be very helpful when you are recovering large environments to smaller target clusters or when you are conducting DR tests without having to provision a one-to-one physical VMware infrastructure. Also, modify the boot order and boot delay (secs) for all the selected VMs across the resource groups. There is an additional option to modify the boot order if any changes are required from what you selected during resource- group boot-order selection. By default, the boot order selected during resource- group selection is used, however any modifications can be performed at this stage.

VM Details

2 VMs

VM Name	No. of CPUs	Memory (MB)	NIC/IP	Boot Order
Resource Group : DemoRG				Override
QALin1	1	1024		<input type="radio"/> Static <input checked="" type="radio"/> Dynamic <input type="radio"/> Static <input checked="" type="radio"/> Dynamic
QALin	4	1024		<input type="radio"/> Static <input checked="" type="radio"/> Dynamic <input type="radio"/> Static <input checked="" type="radio"/> Dynamic

[Previous](#) [Create Replication Plan](#) [X](#)

- Click **Create Replication Plan**. After the replication plan is created, you can exercise the failover, test failover, or migrate options depending on your requirements.

The screenshot shows the DRO dashboard with the following details:

- Replication Plans:** 1
- Resource Groups:** 1
- Source Details:** 1 Site, 1 vCenter
- Destination Details:** 1 Site, 1 vCenter
- Replication Plan Summary:**
  - Plan Name:** DemoRP
  - Active Site:** Source (green)
  - Status:** Active
  - Compliance:** Partially Healthy
  - Source Site:** DemoSRC
  - Destination Site:** DemoDest
- Task Menu (Open):**
  - Plan Details
  - Edit Plan
  - Failover** (highlighted with a red box)
  - Test Failover
  - Migrate
  - Run Compliance
  - Delete Plan

During the failover and test failover options, the most recent snapshot is used, or a specific snapshot can be selected from a point-in-time snapshot. The point-in-time option can be very beneficial if you are facing a corruption event like ransomware, where the most recent replicas are already compromised or encrypted. DRO shows all available time points.

The screenshot shows the DRO dashboard with the following details:

- Replication Plans:** 1
- Resource Groups:** 1
- Source Details:** 1 Site, 1 vCenter
- Destination Details:** 1 Site, 1 vCenter
- Replication Plan Summary:**
  - Plan Name:** DemoRP
  - Active Site:** Source
- Testfailover Details Dialog:**
  - Options: Use latest snapshot (radio button), Select specific snapshot (radio button, selected).
  - Table: Shows a list of volumes and their corresponding snapshots. One row is highlighted with a blue background.
  - Buttons: Start Testfailover (blue button).

To trigger failover or test failover with the configuration specified in the replication plan, you can click **Failover** or **Test Failover**. You can monitor the replication plan in the task menu.

After failover is triggered, the recovered items can be seen in the secondary site AVS SDDC vCenter (VMs, networks, and datastores). By default, the VMs are recovered to Workload folder.

Failback can be triggered at the replication plan level. In case of test failover, the tear down option can be used to roll back the changes and remove the newly created volume. Failbacks related to failover are a two-step process. Select the replication plan and select **Reverse Data sync**.

After this step is complete, trigger failback to move back to the primary AVS site.

The screenshot shows two views of the DRO interface. The top view displays a summary of replication plans and resource groups, with a specific replication plan (DemoRP) highlighted. A red box highlights the 'Resource Groups' button and the 'Plan Details' section, which includes a 'Fallback' link. The bottom view shows a more detailed dashboard with sections for environments, SDDC summary, execution jobs, and replication plans. A red box highlights the 'Topology Canvas' section, which shows a connection between two clouds labeled 'DemoSRC' and 'DemoDest'. Another red box highlights the 'Replication Plans' table, showing the status of the replication plan.

Replication Plan	Active Site	Status	Compliance	Source Site	Destination Site
DemoRP	Destination	Active	Healthy	DemoSRC	DemoDest

Replication Plan	Active Site	Status
DemoRP	Source	Active

From the Azure portal, we can see that the replication health has been broken off for the appropriate volumes that were mapped to the secondary site AVS SDDC as read/write volumes. During test failover, DRO does not map the destination or replica volume. Instead, it creates a new volume of the required cross-region replication snapshot and exposes the volume as a datastore, which consumes additional physical capacity from the capacity pool and ensures that the source volume is not modified. Notably, replication jobs can continue during DR tests or triage workflows. Additionally, this process makes sure that the recovery can be cleaned up without the risk of the replica being destroyed if errors occur or corrupted data is recovered.

## Ransomware recovery

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

DRO addresses these concerns by allowing organizations to recover from any available point-in-time. Workloads are then recovered to functional and yet isolated networks, so that applications can function and communicate with each other but are not exposed to any north-south traffic. This process gives security teams

a safe place to conduct forensics and identify any hidden or sleeping malware.

## Conclusion

The Azure NetApp Files and Azure VMware disaster recovery solution provide you with the following benefits:

- Leverage efficient and resilient Azure NetApp Files cross- region replication.
- Recover to any available point-in-time with snapshot retention.
- Fully automate all required steps to recover hundreds to thousands of VMs from the storage, compute, network, and application validation steps.
- Workload recovery leverages the “Create new volumes from the most recent snapshots” process, which doesn’t manipulate the replicated volume.
- Avoid any risk of data corruption on the volumes or snapshots.
- Avoid replication interruptions during DR test workflows.
- Leverage DR data and cloud compute resources 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 allowing recovery to smaller compute clusters.

## Where to find additional information

To learn more about the information that is described in this document, review the following documents and/or websites:

- Create volume replication for Azure NetApp Files

<https://learn.microsoft.com/en-us/azure/azure-netapp-files/cross-region-replication-create-peering>

- Cross-region replication of Azure NetApp Files volumes

<https://learn.microsoft.com/en-us/azure/azure-netapp-files/cross-region-replication-introduction#service-level-objectives>

- Azure VMware Solution

<https://learn.microsoft.com/en-us/azure/azure-vmware/introduction>

- Deploy and configure the Virtualization Environment on Azure

<https://docs.netapp.com/us-en/netapp-solutions/ehc/azure/azure-setup.html>

- Deploy and configure Azure VMware Solution

<https://learn.microsoft.com/en-us/azure/azure-vmware/deploy-azure-vmware-solution?tabs=azure-portal>

## Using Veeam Replication and Azure NetApp Files datastore for disaster recovery to Azure VMware Solution

Author: Niyaz Mohamed - NetApp Solutions Engineering

## Overview

Azure NetApp Files (ANF) datastores decouples storage from compute and unlocks the flexibility needed for any organisation to take their workloads to the cloud. It provides customers with flexible, high-performance storage infrastructure that scales independently of compute resources. Azure NetApp Files datastore's simplifies and optimizes the deployment alongside Azure VMware Solution (AVS) as a disaster recovery site for on premises VMWare environments.

Azure NetApp Files (ANF) volume based NFS datastores can be used to replicate data from on-premises using any validated third-party solution that provides VM replication capability. By adding Azure NetApp Files datastores, it will enable cost optimised deployment vs building an Azure VMware Solution SDDC with enormous amount of ESXi hosts to accommodate the storage. This approach is called a "Pilot Light Cluster". A pilot light cluster is a minimal AVS host configuration (3 x AVS nodes) along with Azure NetApp Files Datastore capacity.

The objective is to maintain a low-cost infrastructure with all the core components to handle a failover. A pilot light cluster can scale out and provision more AVS hosts if a failover does occur. And once the failover is complete and normal operations are restored, the pilot light cluster can scale back down to low-cost mode of operations.

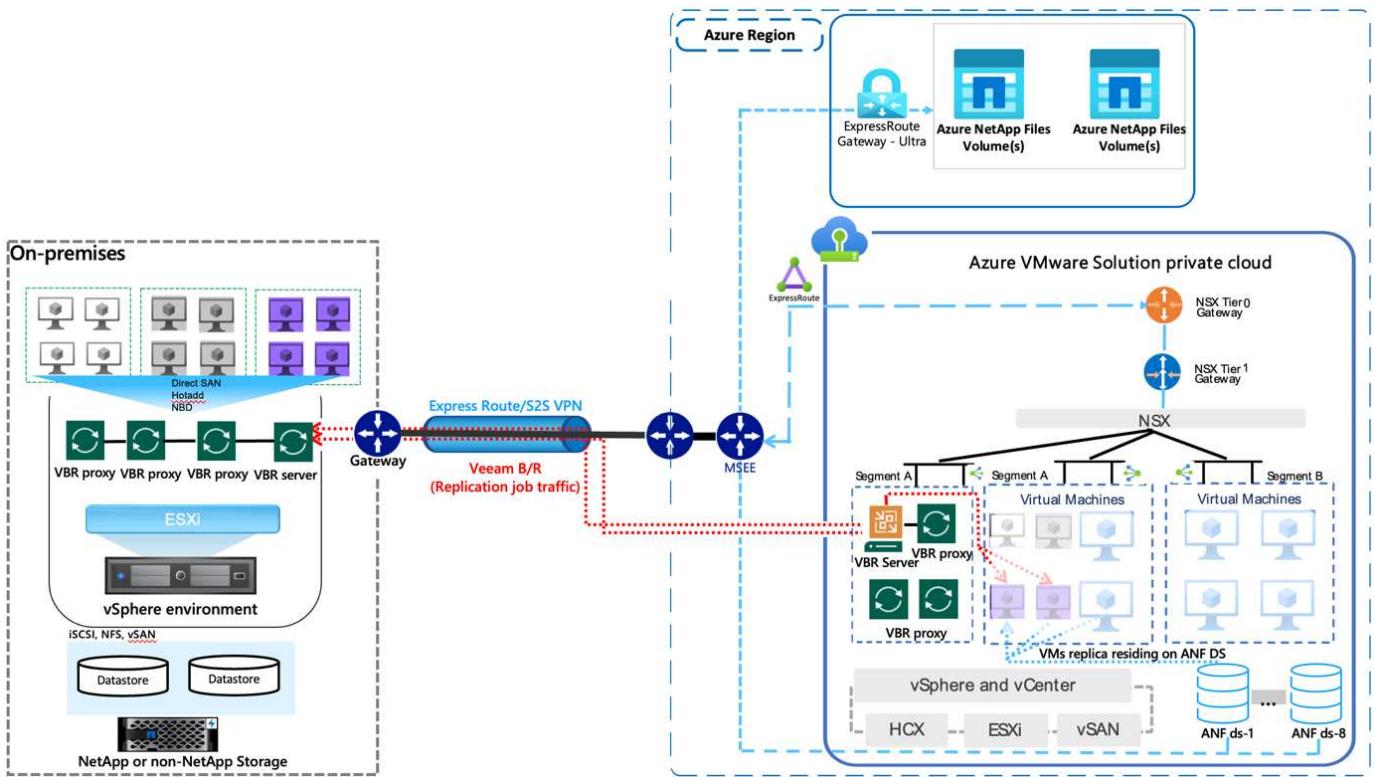
## Purposes of this document

This article describes how to use Azure NetApp Files datastore with Veeam Backup and replication to set up disaster recovery for on-premises VMware VMs to (AVS) using the Veeam VM replication software functionality.

Veeam Backup & Replication is a backup and replication application for virtual environments. When virtual machines are replicated, Veeam Backup & Replication is replicated from on AVS, the software will create an exact copy of the VMs in the native VMware vSphere format on the target AVS SDDC cluster. Veeam Backup & Replication will keep the copy synchronized with the original VM. Replication provides the best recovery time objective (RTO) as there is a mounted copy of a VM at the DR site in a ready-to-start state.

This replication mechanism ensures that the workloads can quickly start in a AVS SDDC in the case of a disaster event. The Veeam Backup & Replication software also optimizes traffic transmission for replication over WAN and slow connections. In addition, it also filters out duplicate data blocks, zero data blocks, swap files, and "excluded VM guest OS files". The software will also compress the replica traffic. To prevent replication jobs from consuming the entire network bandwidth, WAN accelerators and network throttling rules can be utilized.

The replication process in Veeam Backup & Replication is job driven which means replication is performed by configuring replication jobs. In the case of a disaster event, failover can be triggered to recover the VMs by failing over to its replica copy. When failover is performed, a replicated VM takes over the role of the original VM. Failover can be performed to the latest state of a replica or to any of its good known restore points. This enables ransomware recovery or isolated testing as needed. Veeam Backup & Replication offers multiple options to handle different disaster recovery scenarios.



## Solution Deployment

### High level steps

1. Veeam Backup and Replication software is running in an on-premises environment with appropriate network connectivity.
2. Deploy Azure VMware Solution (AVS) private cloud and attach Azure NetApp Files datastores to Azure VMware Solution hosts.

A pilot-light environment set up with a minimal configuration can be used for DR purposes. VMs will fail over to this cluster in the event of an incident, and additional nodes can be added).

3. Set up replication job to create VM replicas using Veeam Backup and Replication.
4. Create failover plan and perform failover.
5. Switch back to production VMs once the disaster event is complete and primary site is Up.

### Pre-requisites for Veeam VM Replication to AVS and ANF datastores

1. Ensure the Veeam Backup & Replication backup VM is connected to the source as well as the target AVS SDDC clusters.
2. The backup server must be able to resolve short names and connect to source and target vCenters.
3. The target Azure NetApp Files datastore must have enough free space to store VMDKs of replicated VMs.

For additional information, refer to "Considerations and Limitations" covered [here](#).

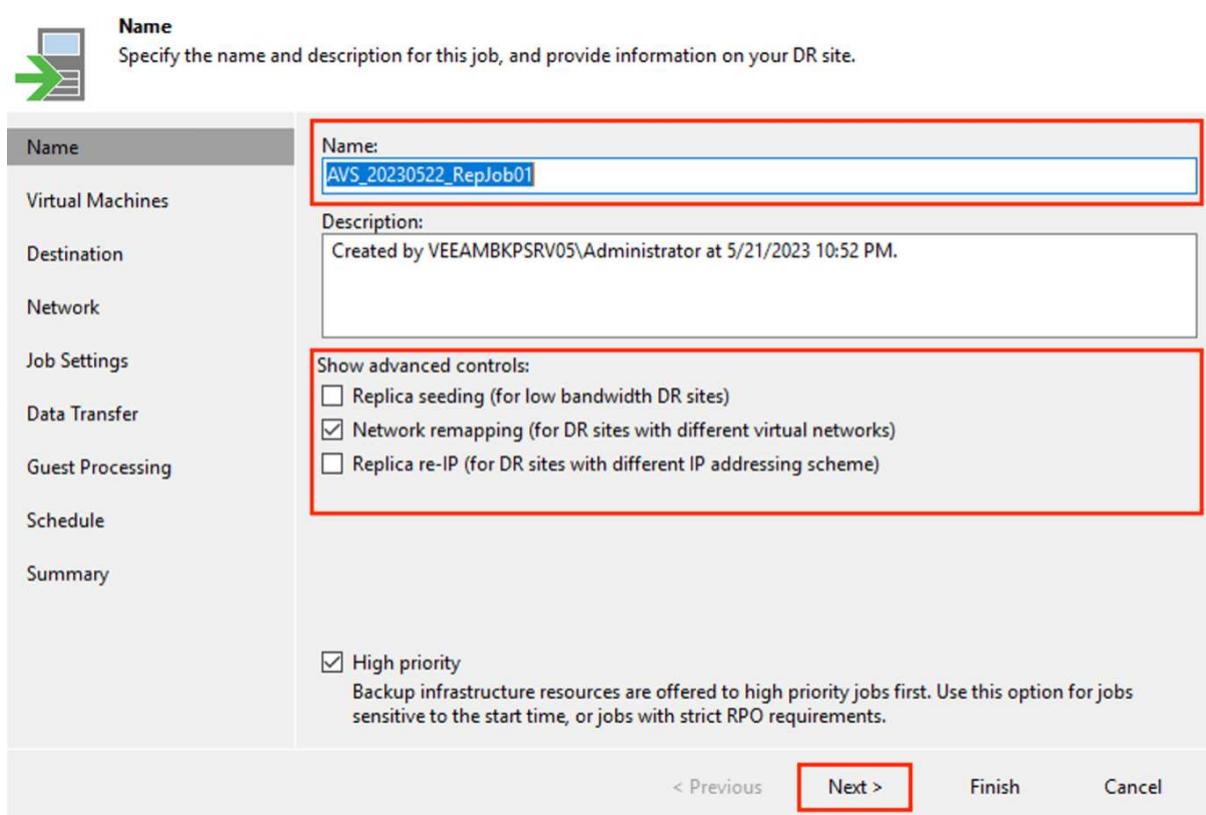
### Deployment Details

## Step 1: Replicate VMs

Veeam Backup & Replication leverages VMware vSphere snapshot capabilities/During replication, Veeam Backup & Replication requests VMware vSphere to create a VM snapshot. The VM snapshot is the point-in-time copy of a VM that includes virtual disks, system state, configuration and metadata. Veeam Backup & Replication uses the snapshot as a source of data for replication.

To replicate VMs, follow the below steps:

1. Open the Veeam Backup & Replication Console.
2. On the Home view. Right click the jobs node and select Replication Job > Virtual machine.
3. Specify a job name and select the appropriate advanced control checkbox. Click Next.
  - Select the Replica seeding check box if connectivity between on-premises and Azure has restricted bandwidth.  
\*Select the Network remapping (for AVS SDDC sites with different networks) check box if segments on Azure VMware Solution SDDC do not match that of on-premises site networks.
  - If the IP addressing scheme in on-premises production site differs from the scheme in the target AVS site, select the Replica re-IP (for DR sites with different IP addressing scheme) check box.



4. Select the VMs to be replicated to Azure NetApp Files datastore attached to a Azure VMware Solution SDDC in the **Virtual Machines\*** step. The Virtual machines can be placed on vSAN to fill the available vSAN datastore capacity. In a pilot light cluster, the usable capacity of a 3-node cluster will be limited. The rest of the data can be easily placed on Azure NetApp Files datastores so that the VMs can recovered, and cluster can be expanded to meet the CPU/mem requirements. Click **Add**, then in the **Add Object** window select the necessary VMs or VM containers and click **Add**. Click **Next**.

**Virtual Machines**  
Select one or more VMs to replicate. Use exclusion settings to exclude specific VMs and virtual disks from replication.

Name	Virtual machines to replicate:
Virtual Machines	TestVeeam21 TestVeeam22 TestVeeam23 TestVeeam24 TestVeeam25 TestVeeam26 TestVeeam27 TestVeeam28 TestVeeam29 TestVeeam30 TestVeeam31 TestVeeam32 TestVeeam33 TestVeeam34 TestVeeam35 WinSQL401 WinSQL405
Destination	
Network	
Job Settings	
Data Transfer	
Guest Processing	
Schedule	
Summary	

Add... Remove Exclusions... Source... Up Down Recalculate Total size: 120 GB

< Previous Next > Finish Cancel

5. After that, select the destination as Azure VMware Solution SDDC cluster / host and the appropriate resource pool, VM folder and FSx for ONTAP datastore for VM replicas. Then click **Next**.

Edit Replication Job [AVS\_20230522\_RepJob01]

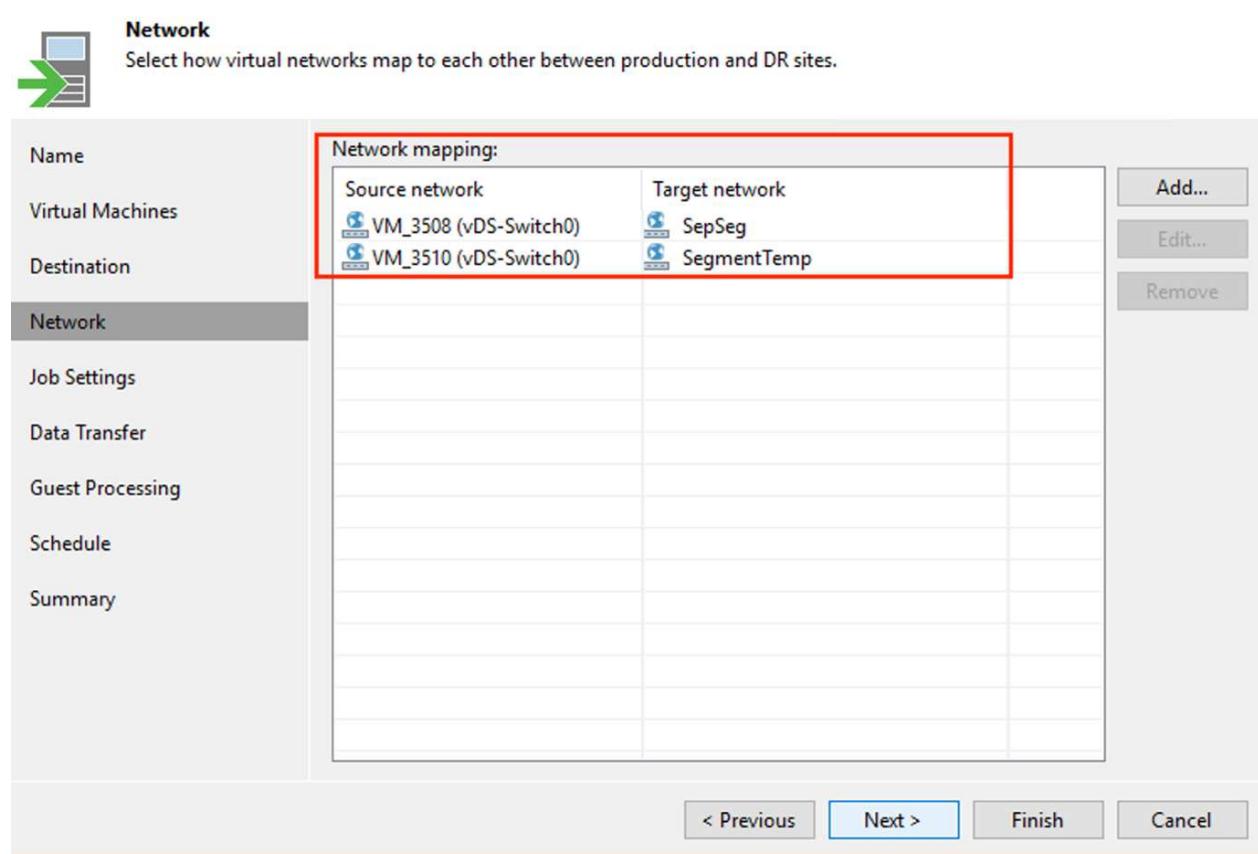
**Destination**  
Specify where replicas should be created in the DR site.

Name	Host or cluster:
Virtual Machines	Cluster-1
Destination	
Network	
Job Settings	
Data Transfer	
Guest Processing	
Schedule	
Summary	

Host or cluster: Cluster-1 Choose...  
Resource pool: Resources Choose...  
VM folder: vm Choose...  
Datastore: ds001 [152.6 GB free] ds001 is an ANF Datastore Choose...  
Pick resource pool for selected replicas  
Pick VM folder for selected replicas  
Pick datastore for selected virtual disks

< Previous Next > Finish Cancel

6. In the next step, create the mapping between source and destination virtual network as needed.



7. In the **Job Settings** step, specify the backup repository that will store metadata for VM replicas, retention policy and so on.
8. Update the **Source** and **Target** proxy servers in the **Data Transfer** step and leave **Automatic** selection (default) and keep **Direct** option selected and click **Next**.
9. At the **Guest Processing** step, select **Enable application-aware processing** option as needed. Click **Next**.

**Guest Processing**  
Choose guest OS processing options available for running VMs.

Name  **Enable application-aware processing**  
Virtual Machines  Detects and prepares applications for consistent backup, performs transaction logs processing, and configures the OS to perform required application restore steps upon first boot.  
Destination  
Network  
Job Settings  
Data Transfer  
**Guest Processing**  
Schedule  
Summary

Customize application handling options for individual machines and applications [Applications...](#)

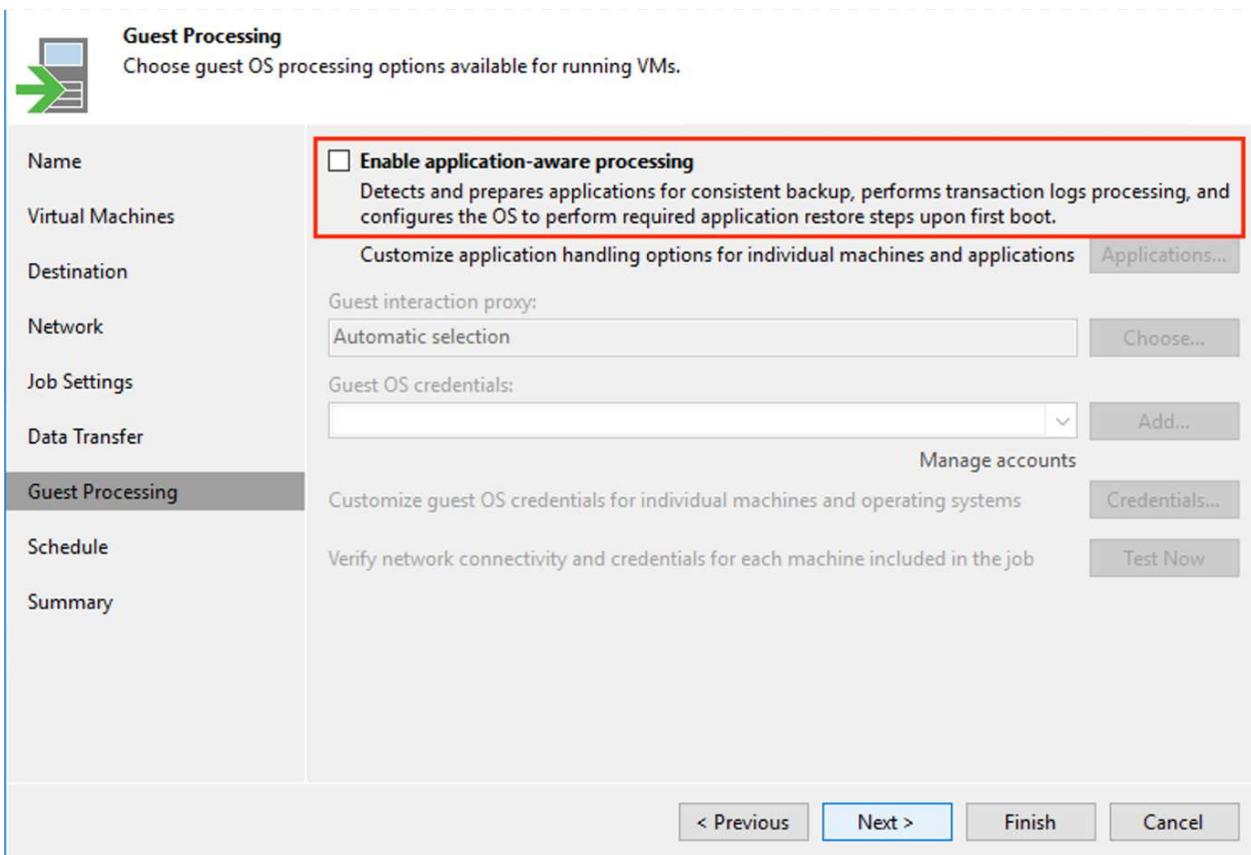
Guest interaction proxy:  
Automatic selection [Choose...](#)

Guest OS credentials:  
[Add...](#) [Manage accounts](#) [Credentials...](#)

Customize guest OS credentials for individual machines and operating systems [Credentials...](#)

Verify network connectivity and credentials for each machine included in the job [Test Now](#)

< Previous [Next >](#) [Finish](#) [Cancel](#)



10. Choose the replication schedule to run the replication job to run on a regular basis.

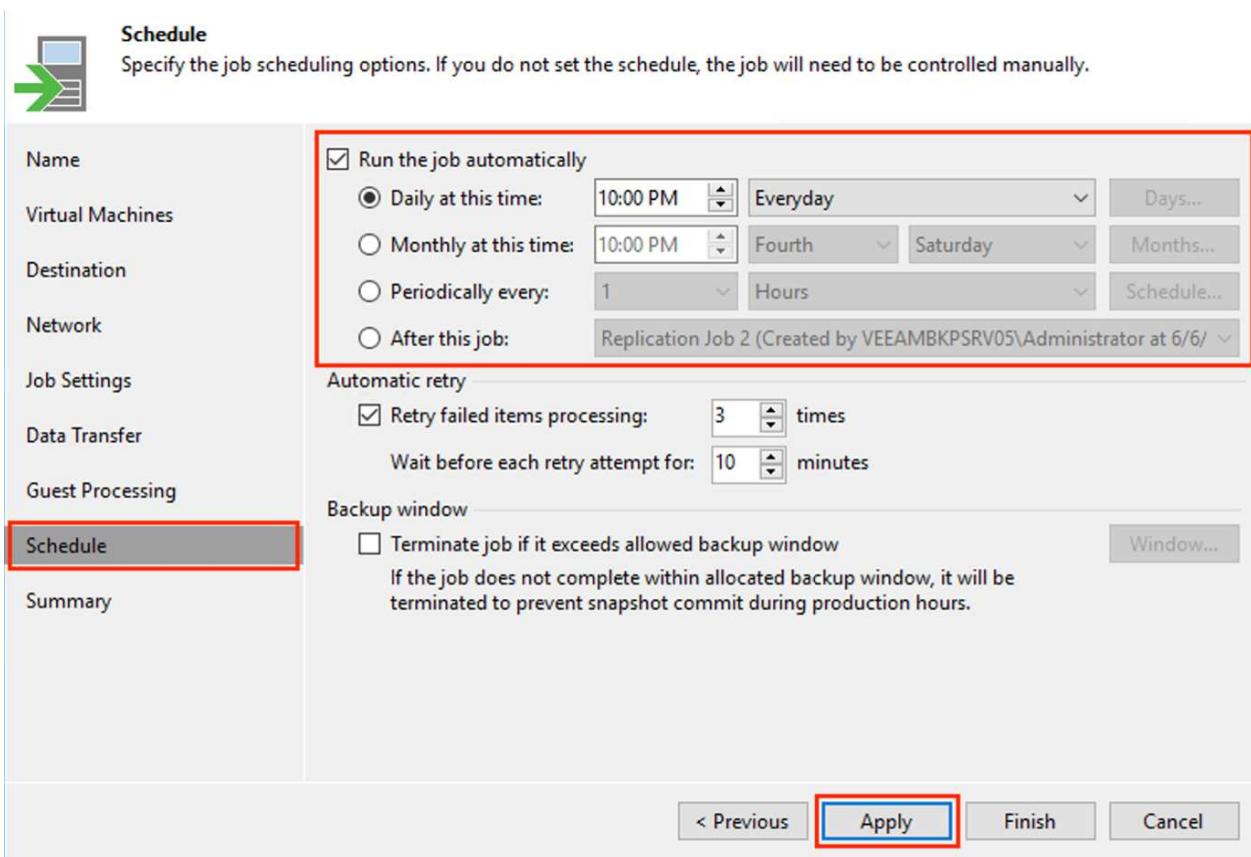
**Schedule**  
Specify the job scheduling options. If you do not set the schedule, the job will need to be controlled manually.

Name  **Run the job automatically**  
Virtual Machines  **Daily at this time:** 10:00 PM [Everyday](#) [Days...](#)  
Destination  **Monthly at this time:** 10:00 PM [Fourth](#) [Saturday](#) [Months...](#)  
Network  **Periodically every:** 1 [Hours](#) [Schedule...](#)  
Job Settings  
Data Transfer  
Guest Processing  
**Schedule**  
Summary

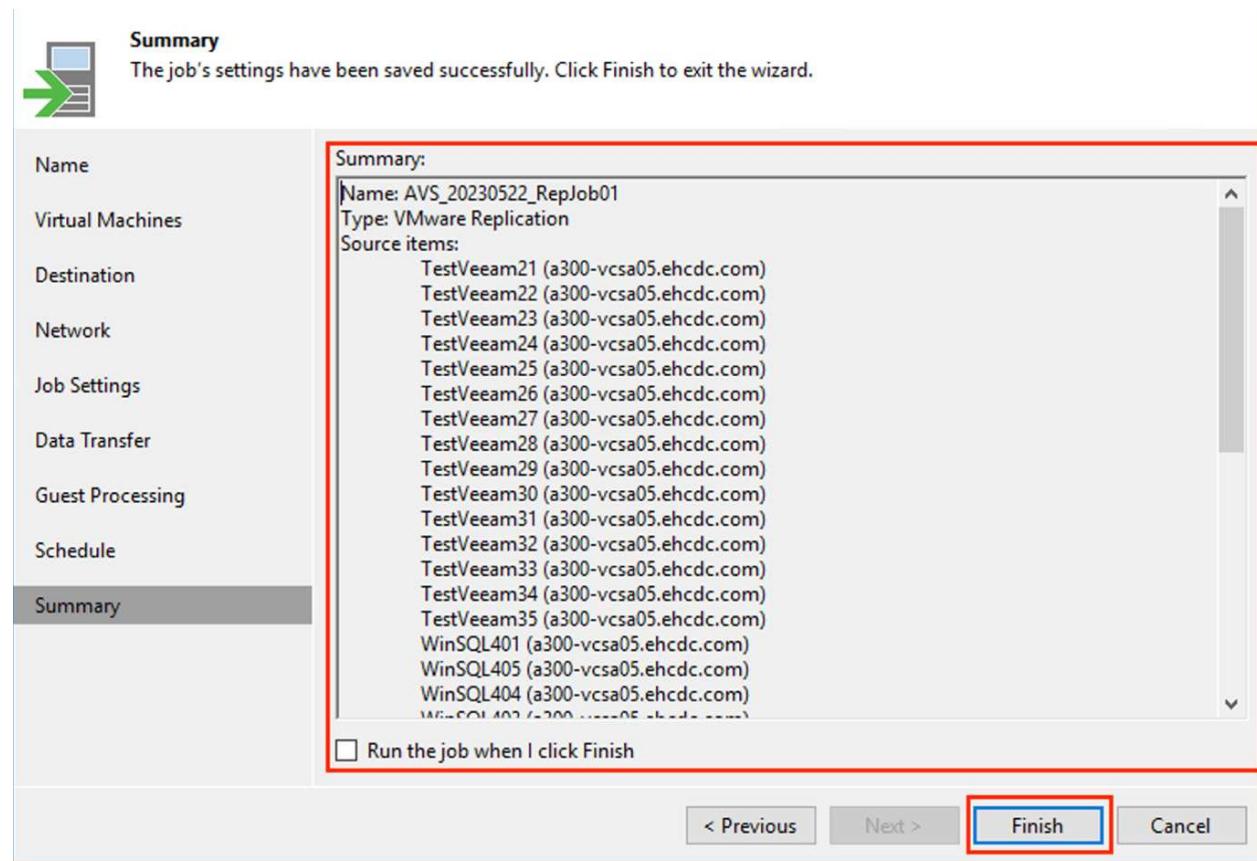
Automatic retry  
 **Retry failed items processing:** 3 [times](#)  
Wait before each retry attempt for: 10 [minutes](#)

Backup window  
 **Terminate job if it exceeds allowed backup window** [Window...](#)  
If the job does not complete within allocated backup window, it will be terminated to prevent snapshot commit during production hours.

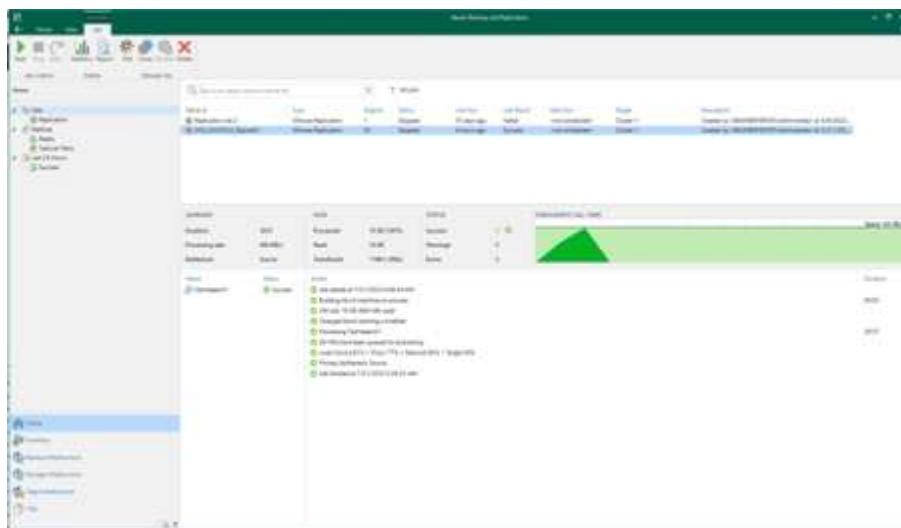
< Previous [Apply](#) [Finish](#) [Cancel](#)



11. At the **Summary** step of the wizard, review details of the replication job. To start the job right after the wizard is closed, select the **Run the job when I click Finish** check box, otherwise leave the check box unselected. Then click **Finish** to close the wizard.



Once the replication job starts, the VMs with the suffix specified will be populated on the destination AVS SDDC cluster / host.



For additional information for Veeam replication, refer [How Replication Works](#)

## Step 2: Create a failover plan

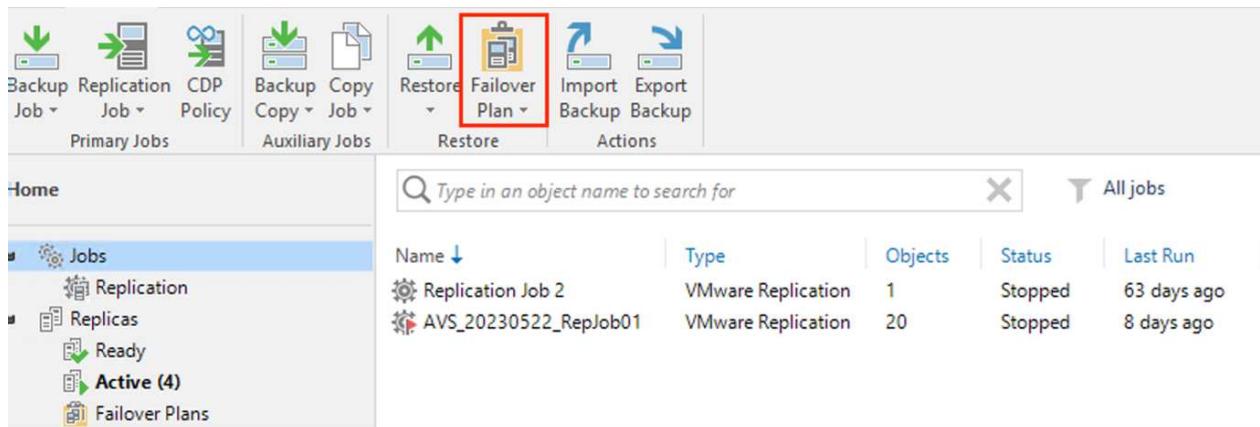
When the initial replication or seeding is complete, create the failover plan. Failover plan helps in performing failover for dependent VMs one by one or as a group automatically. Failover plan is the blueprint for the order in which the VMs are processed including the boot delays. The failover plan also helps to ensure that critical dependant VMs are already running.

To create the plan, navigate to the new sub section called **Replicas** and select **Failover Plan**. Choose the appropriate VMs. Veeam Backup & Replication will look for the closest restore points to this point in time and use them to start VM replicas.

- i The failover plan can only be added once the initial replication is complete and the VM replicas are in Ready state.
- i The maximum number of VMs that can be started simultaneously when running a failover plan is 10
- i During the failover process, the source VMs will not be powered off

To create the **Failover Plan**, do the following:

1. On the Home view. Right click the Replicas node and select Failover Plans > Failover Plan > VMware vSphere.



2. Next provide a name and a description to the plan. Pre and Post-failover script can be added as required. For instance, run a script to shutdown VMs before starting the replicated VMs.

## Edit Failover Plan [ANF\_AVF\_FP01]

X



### General

Type in name and description for this failover plan, and optionally specify scripts to trigger before and after the failover.

General

Virtual Machines

Summary

Name:

ANF\_AVF\_FP01

Description:

Created by VEEAMBKPSRV05\Administrator at 5/24/2023 9:08 AM.

Pre-failover script:

Browse...

Post-failover script:

Browse...

< Previous

Next >

Finish

Cancel

3. Add the VMs to the plan and modify the VM boot order and boot delays to meet the application dependencies.

## Edit Failover Plan [ANF\_AVN\_FP01]

X



### Virtual Machines

Add virtual machines to be failed over as a part of this plan. Use VM order and delays to ensure all application dependencies are met.

General

Virtual Machines

Summary

#### Virtual machines:

Name	Delay	Replica state
TestVeeam21	2 sec	63 days ago (5:52 AM T...)
TestVeeam23	2 sec	7 days ago (10:12 AM T...)
TestVeeam24	2 sec	7 days ago (10:20 AM T...)
TestVeeam22	2 sec	7 days ago (10:10 AM T...)
WinSQL401	2 sec	7 days ago (3:52 AM Tu...)
WinSQL405	2 sec	8 days ago (4:05 PM Mo...)
TestVeeam25	2 sec	7 days ago (10:14 AM T...)
TestVeeam26	2 sec	7 days ago (10:17 AM T...)
TestVeeam27	2 sec	7 days ago (10:18 AM T...)
TestVeeam28	2 sec	7 days ago (10:14 AM T...)
TestVeeam29	2 sec	7 days ago (10:18 AM T...)
TestVeeam30	2 sec	7 days ago (10:15 AM T...)
TestVeeam31	2 sec	7 days ago (10:21 AM T...)
TestVeeam32	2 sec	7 days ago (10:13 AM T...)
TestVeeam33	2 sec	7 days ago (10:15 AM T...)
TestVeeam34	2 sec	7 days ago (10:14 AM T...)
TestVeeam35	2 sec	7 days ago (10:20 AM T...)

Add VM

Remove

Set Delay...

Up

Down

< Previous

Apply

Finish

Cancel

For additional information for creating replication jobs, refer [Creating Replication Jobs](#).

### Step 3: Run the failover plan

During failover, the source VM in the production site is switched over to its replica at the disaster recovery site. As part of the failover process, Veeam Backup & Replication restores the VM replica to the required restore point and moves all I/O activities from the source VM to its replica. Replicas can be used not only in case of a disaster, but also to simulate DR drills. During failover simulation, the source VM remains running. Once all the necessary tests have been conducted, you can undo the failover and return to normal operations.



Make sure network segmentation is in place to avoid IP conflicts during failover.

To start the failover plan, simply click in **Failover Plans** tab and right click on your failover plan. Select **\*Start**. This will failover using the latest restore points of VM replicas. To fail over to specific restore points of VM replicas, select **Start to...**.

The screenshot shows the Veeam Backup & Replication software interface. On the left, there's a navigation sidebar with options like Jobs, Replicas, Active (4), Failover Plans (which is selected and highlighted in blue), and Last 24 Hours. The main area has tabs for Actions (with icons for Start, Start to..., Retry, Undo, Statistics, Edit, and Delete), Details, and Manage Plan. Below these tabs is a search bar. The main content area displays a table of failover plans. One row is selected, showing 'ANF\_AVN\_FP01' as the Name, 'VMware' as the Platform, 'Completed' as the Status, and '20' as the Number of VMs. A context menu is open over this row, listing the same actions as the top bar: Start, Start to..., Undo, Statistics, Delete, and Edit... The 'Start' and 'Start to...' items are specifically highlighted with red boxes.

## Executing failover Plan: ANF\_AVs\_FP01

X

Name: **ANF\_AVs\_FP01**

Status: **In progress**

Restore type: **Failover Plan**

Start time: **8/9/2023 3:37:41 AM**

Initiated by: **VEEAMBKPSRV05\Administrator**

[Cancel restore task](#)

VM name	Status
TestVeeam21	Proce...
TestVeeam23	Proce...
TestVeeam24	Proce...
TestVeeam22	Proce...
WinSQL401	Proce...
WinSQL405	Proce...
TestVeeam25	Proce...
TestVeeam26	Proce...
TestVeeam27	Pendi...
TestVeeam28	Pendi...
TestVeeam29	Pendi...
TestVeeam30	Pendi...
TestVeeam31	Pendi...
TestVeeam32	Pendi...
TestVeeam33	Pendi...

Log
Duration

Message	Duration
✓ Waiting 2 sec before the next VM	0:00:02
▷ Processing VM: TestVeeam22	0:00:13
✓ Waiting 2 sec before the next VM	0:00:02
▷ Processing VM: WinSQL401	0:00:10
✓ Waiting 2 sec before the next VM	0:00:02
▷ Processing VM: WinSQL405	0:00:08
✓ Waiting 2 sec before the next VM	0:00:02
▷ Processing VM: TestVeeam25	0:00:06
✓ Waiting 2 sec before the next VM	0:00:02
▷ Processing VM: TestVeeam26	0:00:04
✓ Waiting 2 sec before the next VM	0:00:02
▷ Processing VM: TestVeeam27	0:00:02
✓ Waiting 2 sec before the next VM	0:00:02

[Close](#)

The state of the VM replica changes from Ready to Failover and VMs will start on the destination Azure VMware Solution (AVS) SDDC cluster / host.

**VMs powered on AVS SDDC after failover**

Name	Status	Powered On	User Space	Host CPU	Host Mem	IP Address
TestVeeam21	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam23	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam24	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam22	Powered On	1.00 GB	0.12 GHz	233 MB		
WinSQL401	Powered On	1.00 GB	0.12 GHz	233 MB		
WinSQL405	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam25	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam26	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam27	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam28	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam29	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam30	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam31	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam32	Powered On	1.00 GB	0.12 GHz	233 MB		
TestVeeam33	Powered On	1.00 GB	0.12 GHz	233 MB		

**Recent Tasks**

Task Name	Target	Status	Details	Initial	Elapsed	Start Time	Completion Time	Server
Power On virtual machine	WinSQL402	Completed	Powering on the new Virtual Machine	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:49 AM	07/19/2023, 9:09:49 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	3 ms	07/19/2023, 9:09:46 AM	07/19/2023, 9:09:49 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:43 AM	07/19/2023, 9:09:45 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:40 AM	07/19/2023, 9:09:42 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	3 ms	07/19/2023, 9:09:37 AM	07/19/2023, 9:09:39 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:35 AM	07/19/2023, 9:09:36 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Power On virtual machine	WinSQL402	Completed	Powering on the new Virtual Machine	VSPHERE.LOCAL\VirtualMachine	3 ms	07/19/2023, 9:09:31 AM	07/19/2023, 9:09:43 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:32 AM	07/19/2023, 9:09:34 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	3 ms	07/19/2023, 9:09:29 AM	07/19/2023, 9:09:32 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	3 ms	07/19/2023, 9:09:29 AM	07/19/2023, 9:09:32 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:28 AM	07/19/2023, 9:09:30 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Reconfigure virtual machine	WinSQL402	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	3 ms	07/19/2023, 9:09:21 AM	07/19/2023, 9:09:25 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Revert snapshot	WinSQL402	Completed	VSphere API: Revert Snapshot	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:03 AM	07/19/2023, 9:09:28 AM	vsphere.local\VirtualMachine\WinSQL402.veeameurope.avs.azure.com
Power On virtual machine	TestVeeam35	Completed	Powering on the new Virtual Machine	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:02 AM	07/19/2023, 9:09:04 AM	vsphere.local\VirtualMachine\TestVeeam35.veeameurope.avs.azure.com
Power On virtual machine	TestVeeam33	Completed	Powering on the new Virtual Machine	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:19 AM	07/19/2023, 9:09:20 AM	vsphere.local\VirtualMachine\TestVeeam33.veeameurope.avs.azure.com
Power On virtual machine	TestVeeam34	Completed	Powering on the new Virtual Machine	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:19 AM	07/19/2023, 9:09:20 AM	vsphere.local\VirtualMachine\TestVeeam34.veeameurope.avs.azure.com
Power On virtual machine	TestVeeam32	Completed	Powering on the new Virtual Machine	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:09:00 AM	07/19/2023, 9:09:04 AM	vsphere.local\VirtualMachine\TestVeeam32.veeameurope.avs.azure.com
Reconfigure virtual machine	TestVeeam35	Completed	Reconfiguring Virtual Machine on destination host	VSPHERE.LOCAL\VirtualMachine	2 ms	07/19/2023, 9:08:59 AM	07/19/2023, 9:09:20 AM	vsphere.local\VirtualMachine\TestVeeam35.veeameurope.avs.azure.com

Once the failover is complete, the status of the VMs will change to "Failover".

Name	Job Name	Type	Status	Creation Time	Restore Points	Original Location	Replica Location	Platform
TestVeeam22	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 5:53 AM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam23	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 5:52 AM	4	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam24	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 5:52 AM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam25	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 7:48 AM	4	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam26	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 10:44 AM	2	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam27	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 1:19 PM	5	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam28	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 1:07 PM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam29	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 1:16 PM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam30	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 2:24 PM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam31	AVS_20230522_RepJob01	Regular	Failover	7/3/2023 4:43 AM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam32	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 8:31 PM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam33	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 3:31 PM	4	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam34	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 4:31 PM	4	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
TestVeeam35	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 5:30 PM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
WinSQL401	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 8:52 AM	5	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
WinSQL402	AVS_20230522_RepJob01	Regular	Failover	6/7/2023 6:11 AM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
WinSQL403	AVS_20230522_RepJob01	Regular	Failover	6/7/2023 1:53 AM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
WinSQL404	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 8:29 PM	5	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware
WinSQL405	AVS_20230522_RepJob01	Regular	Failover	6/6/2023 7:50 AM	3	a800-vee05.ehdc.com/Cluster05	172.20.156.2\Cluster-1	VMware



Veeam Backup & Replication stops all replication activities for the source VM until its replica is returned to the Ready state.

For detailed information about failover plans, refer [Failover Plans](#).

## Step 4: Failback to the Production site

When the failover plan is running, it is considered as an intermediate step and needs to be finalized based on the requirement. The options include the following:

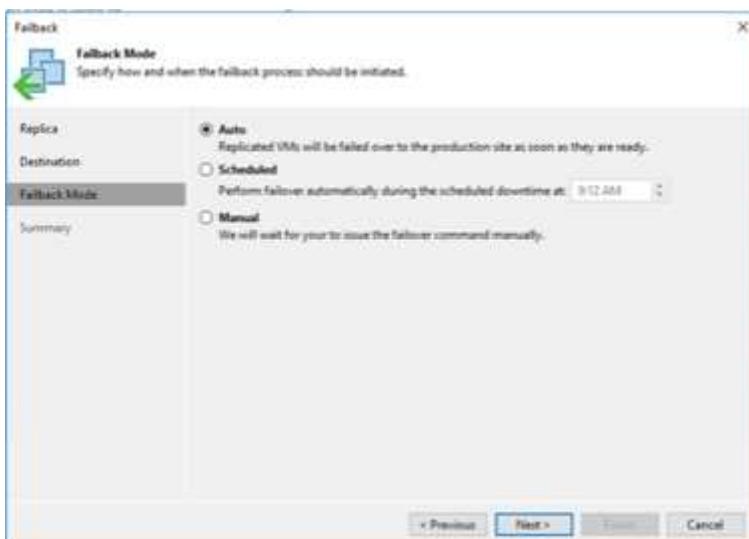
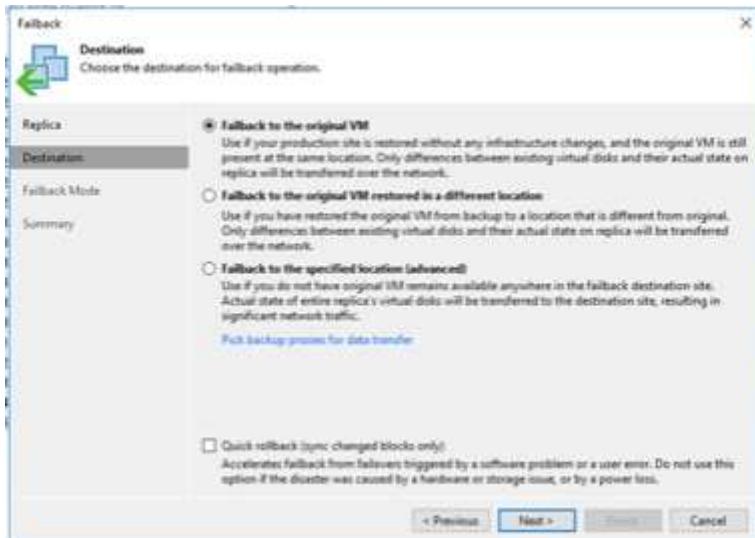
- **Failback to production** - switch back to the original VM and transfer all changes that took place while the VM replica was running to the original VM.

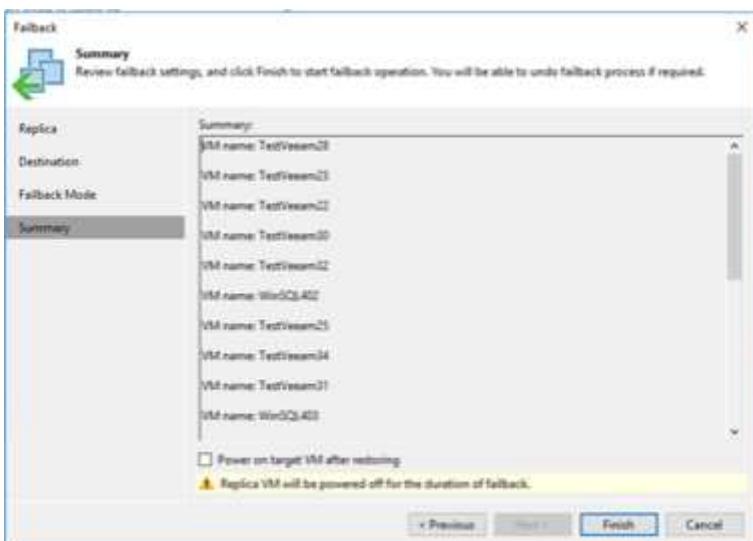
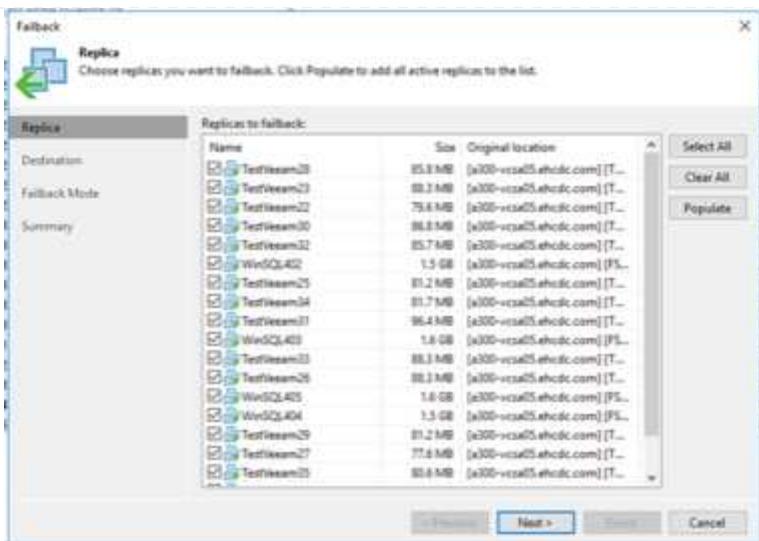


When you perform failback, changes are only transferred but not published. Choose **Commit failback** (once the original VM is confirmed to work as expected) or Undo failback to get back to the VM replica If the original VM is not working as expected.

- **Undo failover** - switch back to the original VM and discard all changes made to the VM replica while it was running.
- **Permanent Failover** - permanently switch from the original VM to a VM replica and use this replica as the original VM.

In this demo, Failback to production was chosen. Failback to the original VM was selected during the Destination step of the wizard and “Power on VM after restoring” check box was enabled.





Fallback commit is one of the ways to finalize failback operation. When failback is committed, it confirms that the changes sent to the VM which is failed back (the production VM) are working as expected. After the commit operation, Veeam Backup & Replication resumes replication activities for the production VM.

For detailed information about the failback process, refer Veeam documentation for [Failover and Failback for replication](#).

The screenshot shows the Veeam Backup & Replication software interface. The left sidebar has sections for Home, Inventory, Backup Infrastructure, Storage Infrastructure, Tape Infrastructure, and Files. The main area displays a table of jobs. A context menu is open over the row for 'TestVteam34', listing options such as 'Failover now...', 'Planned failover...', 'Add to failover plan', 'Fallback to production...', 'Commit failback', 'Undo failback', 'Restore guest files', 'Remove from configuration', 'Delete from disk', and 'Properties...'. The table columns include Name, Job Name, Type, Status, Creation Time, Restore Points, Original Location, Replica Location, and Platform.

After failback to production is successful, the VMs are all restored back to the original production site.

The screenshot shows the vSphere Client interface. The left sidebar shows a tree view of datacenters, hosts, and clusters. The main area is titled 'VeeamTest' and has tabs for Summary, Monitor, Configure, Permissions, Resource Pools, and VMs. The VMs tab is selected, displaying a list of virtual machines. The table columns are Name, State, Status, Provisioned Space, Used Space, Host CPU, and Host Mem. The list includes TestVteam21, TestVteam22, TestVteam23, TestVteam24, TestVteam25, TestVteam26, TestVteam27, TestVteam28, TestVteam29, TestVteam30, TestVteam31, TestVteam32, TestVteam33, TestVteam34, TestVteam35, WinSQL401, WinSQL402, WinSQL403, WinSQL404, and WinSQL405. The status column indicates whether each VM is Powered On or Powered Off.

## Conclusion

Azure NetApp Files datastore capability enables Veeam or any validated third-party tool to provide a low-cost DR solution by leveraging Pilot light clusters instead of standing up a large cluster only to accommodate VM replicas. This provides an efficacious way to handle a tailored, customized disaster recovery plan and to reuse existing backup products in house for DR, enabling cloud-based disaster recovery by exiting on-premises DR datacenters. It is possible to failover by clicking a button in case of disaster or to failover automatically if a

disaster occurs.

To learn more about this process, feel free to follow the detailed walkthrough video.

<https://netapp.hosted.panopto.com/Panopto/Pages/Embed.aspx?id=2855e0d5-97e7-430f-944a-b061015e9278>

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