



Enterprise Applications and Databases

NetApp Solutions

NetApp
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Enterprise Applications and Databases

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Solution Overview

Automated Deployment of Oracle19c for ONTAP on NFS

Organizations are automating their environments to gain efficiencies, accelerate deployments, and reduce manual effort. Configuration management tools like Ansible are being used to streamline enterprise database operations. In this solution, we demonstrate how you can use Ansible to automate the provisioning and configuration of Oracle 19c with NetApp ONTAP. By enabling storage administrators, systems administrators, and DBAs to consistently and rapidly deploy new storage, configure database servers, and install Oracle 19c software, you achieve the following benefits:

- Eliminate design complexities and human errors, and implement a repeatable consistent deployment and best practices
- Decrease time for provisioning of storage, configuration of DB hosts, and Oracle installation
- Increase database administrators, systems and storage administrators productivity
- Enable scaling of storage and databases with ease

NetApp provides customers with validated Ansible modules and roles to accelerate deployment, configuration, and lifecycle management of your Oracle database environment. This solution provides instruction and Ansible playbook code, to help you:

- Create and configure ONTAP NFS storage for Oracle Database
- Install Oracle 19c on RedHat Enterprise Linux 7/8 or Oracle Linux 7/8
- Configure Oracle 19c on ONTAP NFS storage

For more details or to begin, please see the overview videos below.

AWX/Tower Deployments

- Part 1: Getting Started, Requirements, Automation Details and Initial AWX/Tower Configuration
▶ https://docs.netapp.com/us-en/netapp-solutions/media/oracle_deployment_auto_v1.mp4 (video)
- Part 2: Variables and Running the Playbook
▶ https://docs.netapp.com/us-en/netapp-solutions/media/oracle_deployment_auto_v2.mp4 (video)

CLI Deployment

- Part 1: Getting Started, Requirements, Automation Details and Ansible Control Host Setup
▶ https://docs.netapp.com/us-en/netapp-solutions/media/oracle_deployment_auto_v4.mp4 (video)
- Part 2: Variables and Running the Playbook

► <https://docs.netapp.com/us-en/netapp-solutions/media/oracle3.mp4> (video)

Getting started

This solution has been designed to be run in an AWX/Tower environment or by CLI on an Ansible control host.

AWX/Tower

For AWX/Tower environments, you are guided through creating an inventory of your ONTAP cluster management and Oracle server (IPs and hostnames), creating credentials, configuring a project that pulls the Ansible code from NetApp Automation Github, and the Job Template that launches the automation.

1. Fill out the variables specific to your environment, and copy and paste them into the Extra Vars fields in your job template.
2. After the extra vars have been added to your job template, you can launch the automation.
3. The job template is run in three phases by specifying tags for `ontap_config`, `linux_config`, and `oracle_config`.

CLI via the Ansible control host

1. To configure the Linux host so that it can be used as an Ansible control host [click here for RHEL 7/8 or CentOS 7/8](#), or [here for Ubuntu/Debian](#)
2. After the Ansible control host is configured, you can git clone the Ansible Automation repository.
3. Edit the hosts file with the IPs and/or hostnames of your ONTAP cluster management and Oracle server's management IPs.
4. Fill out the variables specific to your environment, and copy and paste them into the `vars.yml` file.
5. Each Oracle host has a variable file identified by its hostname that contains host-specific variables.
6. After all variable files have been completed, you can run the playbook in three phases by specifying tags for `ontap_config`, `linux_config`, and `oracle_config`.

Requirements

Environment	Requirements
Ansible environment	AWX/Tower or Linux host to be the Ansible control host
	Ansible v.2.10 and higher
	Python 3
	Python libraries - netapp-lib - xmltodict - jmespath
ONTAP	ONTAP version 9.3 - 9.7
	Two data aggregates
	NFS vlan and ifgrp created

Environment	Requirements
Oracle server(s)	RHEL 7/8
	Oracle Linux 7/8
	Network interfaces for NFS, public, and optional mgmt
	Oracle installation files on Oracle servers

Automation Details

This automated deployment is designed with a single Ansible playbook that consists of three separate roles. The roles are for ONTAP, Linux, and Oracle configurations. The following table describes which tasks are being automated.

Role	Tasks
ontap_config	Pre-check of the ONTAP environment
	Creation of NFS based SVM for Oracle
	Creation of export policy
	Creation of volumes for Oracle
	Creation of NFS LIFs
linux_config	Create mount points and mount NFS volumes
	Verify NFS mounts
	OS specific configuration
	Create Oracle directories
	Configure hugepages
	Disable SELinux and firewall daemon
	Enable and start chronyd service
	increase file descriptor hard limit
	Create pam.d session file
oracle_config	Oracle software installation
	Create Oracle listener
	Create Oracle databases
	Oracle environment configuration
	Save PDB state
	Enable instance archive mode
	Enable DNFS client
	Enable database auto startup and shutdown between OS reboots

Default parameters

To simplify automation, we have preset many required Oracle deployment parameters with default values. It is generally not necessary to change the default parameters for most deployments. A more advanced user can make changes to the default parameters with caution. The default parameters are located in each role folder under defaults directory.

Deployment instructions

Before starting, download the following Oracle installation and patch files and place them in the `/tmp/archive` directory with read, write, and execute access for all users on each DB server to be deployed. The automation tasks look for the named installation files in that particular directory for Oracle installation and configuration.

```
LINUX.X64_193000_db_home.zip -- 19.3 base installer
p31281355_190000_Linux-x86-64.zip -- 19.8 RU patch
p6880880_190000_Linux-x86-64.zip -- opatch version 12.2.0.1.23
```

License

You should read license information as stated in the Github repository. By accessing, downloading, installing, or using the content in this repository, you agree the terms of the license laid out [here](#).

Note that there are certain restrictions around producing and/or sharing any derivative works with the content in this repository. Please make sure you read the terms of the [License](#) before using the content. If you do not agree to all of the terms, do not access, download, or use the content in this repository.

After you are ready, click [here for detailed AWX/Tower deployment procedures](#) or [here for CLI deployment](#).

Step-by-step deployment procedure

AWX/Tower deployment Oracle 19c Database

1. Create the inventory, group, hosts, and credentials for your environment

This section describes the setup of inventory, groups, hosts, and access credentials in AWX/Ansible Tower that prepare the environment for consuming NetApp automated solutions.

1. Configure the inventory.
 - a. Navigate to Resources → Inventories → Add, and click Add Inventory.
 - b. Provide the name and organization details, and click Save.
 - c. On the Inventories page, click the inventory created.
 - d. If there are any inventory variables, paste them in the variables field.
 - e. Navigate to the Groups sub-menu and click Add.
 - f. Provide the name of the group for ONTAP, paste the group variables (if any) and click Save.
 - g. Repeat the process for another group for Oracle.
 - h. Select the ONTAP group created, go to the Hosts sub-menu and click Add New Host.
 - i. Provide the IP address of the ONTAP cluster management IP, paste the host variables (if any), and

click Save.

- j. This process must be repeated for the Oracle group and Oracle host(s) management IP/hostname.
2. Create credential types. For solutions involving ONTAP, you must configure the credential type to match username and password entries.
 - a. Navigate to Administration → Credential Types, and click Add.
 - b. Provide the name and description.
 - c. Paste the following content in Input Configuration:

```
fields:
  - id: username
    type: string
    label: Username
  - id: password
    type: string
    label: Password
    secret: true
  - id: vsadmin_password
    type: string
    label: vsadmin_password
    secret: true
```

- d. Paste the following content into Injector Configuration:

```
extra_vars:
  password: '{{ password }}'
  username: '{{ username }}'
  vsadmin_password: '{{ vsadmin_password }}'
```

3. Configure the credentials.
 - a. Navigate to Resources → Credentials, and click Add.
 - b. Enter the name and organization details for ONTAP.
 - c. Select the custom Credential Type you created for ONTAP.
 - d. Under Type Details, enter the username, password, and vsadmin_password.
 - e. Click Back to Credential and click Add.
 - f. Enter the name and organization details for Oracle.
 - g. Select the Machine credential type.
 - h. Under Type Details, enter the Username and Password for the Oracle hosts.
 - i. Select the correct Privilege Escalation Method, and enter the username and password.

2. Create a project

1. Go to Resources → Projects, and click Add.

- a. Enter the name and organization details.
- b. Select Git in the Source Control Credential Type field.
- c. enter https://github.com/NetApp-Automation/na_oracle19c_deploy.git as the source control URL.
- d. Click Save.
- e. The project might need to sync occasionally when the source code changes.

3. Configure Oracle host_vars

The variables defined in this section are applied to each individual Oracle server and database.

1. Input your environment-specific parameters in the following embedded Oracle hosts variables or host_vars form.



The items in blue must be changed to match your environment.

Unresolved directive in ent-apps-db/awx_automation.adoc - include::ent-apps-db/host_vars.adoc[]

- a. Fill in all variables in the blue fields.
- b. After completing variables input, click the Copy button on the form to copy all variables to be transferred to AWX or Tower.
- c. Navigate back to AWX or Tower and go to Resources → Hosts, and select and open the Oracle server configuration page.
- d. Under the Details tab, click edit and paste the copied variables from step 1 to the Variables field under the YAML tab.
- e. Click Save.
- f. Repeat this process for any additional Oracle servers in the system.

4. Configure global variables

Variables defined in this section apply to all Oracle hosts, databases, and the ONTAP cluster.

1. Input your environment-specific parameters in following embedded global variables or vars form.



The items in blue must be changed to match your environment.

Unresolved directive in ent-apps-db/awx_automation.adoc - include::ent-apps-db/vars.adoc[]

2. Fill in all variables in blue fields.
3. After completing variables input, click the Copy button on the form to copy all variables to be transferred to AWX or Tower into the following job template.

5. Configure and launch the job template.

1. Create the job template.
 - a. Navigate to Resources → Templates → Add and click Add Job Template.
 - b. Enter the name and description
 - c. Select the Job type; Run configures the system based on a playbook, and Check performs a dry run of a playbook without actually configuring the system.

- d. Select the corresponding inventory, project, playbook, and credentials for the playbook.
- e. Select the all_playbook.yml as the default playbook to be executed.
- f. Paste global variables copied from step 4 into the Template Variables field under the YAML tab.
- g. Check the box Prompt on Launch in the Job Tags field.
- h. Click Save.

2. Launch the job template.

- a. Navigate to Resources → Templates.
- b. Click the desired template and then click Launch.
- c. When prompted on launch for Job Tags, type in requirements_config. You might need to click the Create Job Tag line below requirements_config to enter the job tag.



requirements_config ensures that you have the correct libraries to run the other roles.

- d. Click Next and then Launch to start the job.
- e. Click View → Jobs to monitor the job output and progress.
- f. When prompted on launch for Job Tags, type in ontap_config. You might need to click the Create "Job Tag" line right below ontap_config to enter the job tag.
- g. Click Next and then Launch to start the job.
- h. Click View → Jobs to monitor the job output and progress
- i. After the ontap_config role has completed, run the process again for linux_config.
- j. Navigate to Resources → Templates.
- k. Select the desired template and then click Launch.
- l. When prompted on launch for the Job Tags type in linux_config, you might need to select the Create "job tag" line right below linux_config to enter the job tag.
- m. Click Next and then Launch to start the job.
- n. Select View → Jobs to monitor the job output and progress.
- o. After the linux_config role has completed, run the process again for oracle_config.
- p. Go to Resources → Templates.
- q. Select the desired template and then click Launch.
- r. When prompted on launch for Job Tags, type oracle_config. You might need to select the Create "Job Tag" line right below oracle_config to enter the job tag.
- s. Click Next and then Launch to start the job.
- t. Select View → Jobs to monitor the job output and progress.

6. Deploy additional database on same Oracle host

The Oracle portion of the playbook creates a single Oracle container database on an Oracle server per execution. To create additional container databases on the same server, complete the following steps.

1. Revise host_vars variables.
 - a. Go back to step 2 - Configure Oracle host_vars.
 - b. Change the Oracle SID to a different naming string.

- c. Change the listener port to different number.
 - d. Change the EM Express port to a different number if you are installing EM Express.
 - e. Copy and paste the revised host variables to the Oracle Host Variables field in the Host Configuration Detail tab.
2. Launch the deployment job template with only the oracle_config tag.

Unresolved directive in ent-apps-db/awx_automation.adoc - include::ent-apps-db/validation.adoc[]

Step-by-step deployment procedure

CLI deployment Oracle 19c Database

This section covers the steps required to prepare and deploy Oracle19c Database with the CLI. Make sure that you have reviewed the [Getting Started and Requirements section](#) and prepared your environment accordingly.

Download Oracle19c repo

1. From your ansible controller, run the following command:

```
git clone https://github.com/NetApp-Automation/na_oracle19c_deploy.git
```

2. After downloading the repository, change directories to na_oracle19c_deploy <cd na_oracle19c_deploy>.

Edit the hosts file

Complete the following before deployment:

1. Edit your hosts file na_oracle19c_deploy directory.
2. Under [ontap], change the IP address to your cluster management IP.
3. Under the [oracle] group, add the oracle hosts names. The host name must be resolved to its IP address either through DNS or the hosts file, or it must be specified in the host.
4. After you have completed these steps, save any changes.

The following example depicts a host file:

```

#ONTAP Host<div>
[ontap]
<div>
<span <div contenteditable="false" style="color:#7EAF97
; font-weight:bold; font-style:italic; text-
decoration:;"/>10.61.184.183<i></i></span>
</div>
#Oracle hosts<div>
<div>
[oracle]<div>
<span <div contenteditable="false" style="color:#7EAF97
; font-weight:bold; font-style:italic; text-
decoration:;"/>rtpora01<i></i></span>
<div>
<span <div contenteditable="false" style="color:#7EAF97
; font-weight:bold; font-style:italic; text-
decoration:;"/>rtpora02<i></i></span>
</div>

```

This example executes the playbook and deploys oracle 19c on two oracle DB servers concurrently. You can also test with just one DB server. In that case, you only need to configure one host variable file.



The playbook executes the same way regardless of how many Oracle hosts and databases you deploy.

Edit the `host_name.yml` file under `host_vars`

Each Oracle host has its host variable file identified by its host name that contains host-specific variables. You can specify any name for your host. Edit and copy the `host_vars` from the Host VARS Config section and paste it into your desired `host_name.yml` file.



The items in blue must be changed to match your environment.

Unresolved directive in ent-apps-db/cli_automation.adoc - include::ent-apps-db/host_vars.adoc[]

Edit the `vars.yml` file

The `vars.yml` file consolidates all environment-specific variables (ONTAP, Linux, or Oracle) for Oracle deployment.

- Edit and copy the variables from the VARS section and paste these variables into your `vars.yml` file.

Unresolved directive in ent-apps-db/cli_automation.adoc - include::ent-apps-db/vars.adoc[]

Run the playbook

After completing the required environment prerequisites and copying the variables into `vars.yml` and `your_host.yml`, you are now ready to deploy the playbooks.



<username> must be changed to match your environment.

1. Run the ONTAP playbook by passing the correct tags and ONTAP cluster username. Fill the password for ONTAP cluster, and vsadmin when prompted.

```
ansible-playbook -i hosts all_playbook.yml -u username -k -K -t
ontap_config -e @vars/vars.yml
```

2. Run the Linux playbook to execute Linux portion of deployment. Input for admin ssh password as well as sudo password.

```
ansible-playbook -i hosts all_playbook.yml -u username -k -K -t
linux_config -e @vars/vars.yml
```

3. Run the Oracle playbook to execute Oracle portion of deployment. Input for admin ssh password as well as sudo password.

```
ansible-playbook -i hosts all_playbook.yml -u username -k -K -t
oracle_config -e @vars/vars.yml
```

Deploy Additional Database on Same Oracle Host

The Oracle portion of the playbook creates a single Oracle container database on an Oracle server per execution. To create additional container database on the same server, complete the following steps:

1. Revise the `host_vars` variables.
 - a. Go back to step 3 - Edit the `host_name.yml` file under `host_vars`.
 - b. Change the Oracle SID to a different naming string.
 - c. Change the listener port to different number.
 - d. Change the EM Express port to a different number if you have installed EM Express.
 - e. Copy and paste the revised host variables to the Oracle host variable file under `host_vars`.
2. Execute the playbook with the `oracle_config` tag as shown above in [Run the playbook](#).

Unresolved directive in ent-apps-db/cli_automation.adoc - include::ent-apps-db/validation.adoc[]

Microsoft SQL Server

TR-4897: SQL Server on Azure NetApp Files - Real Deployment View

Niyaz Mohamed, NetApp

IT organizations face constant change. Gartner reports nearly 75% of all databases will require cloud-based storage by 2022. As a leading relational database management system (RDBMS), Microsoft SQL Server is the go-to choice for Windows platform-designed applications and organizations that rely on SQL Server for everything from enterprise resource planning (ERP) to analytics to content management. SQL Server has helped to revolutionize the way enterprises manage massive data sets and power their applications to meet the schema and query performance demands.

Most IT organizations follow a cloud-first approach. Customers in a transformation phase evaluate their current IT landscape and then migrate their database workloads to the cloud based on an assessment and discovery exercise. Some factors driving customers toward cloud migration include elasticity/burst, data center exit, data center consolidation, end-of-life scenarios, mergers, acquisitions, and so on. The reason for migration can vary based on each organization and their respective business priorities. When moving to the cloud, choosing the right cloud storage is very important in order to unleash the power of SQL Server database cloud deployment.

Use case

Moving the SQL Server estate to Azure and integrating SQL Server with Azure's vast array of platform-as-a-service (PaaS) features such as Azure Data Factory, Azure IoT Hub, and Azure Machine Learning creates tremendous business value to support digital transformation. Adopting the cloud also enables the respective business unit to focus on productivity and delivering new features and enhancements faster (DevTest use case) than relying on the CAPEX model or traditional private cloud models. This document covers a real-time deployment of SQL Server Always On availability group (AOAG) on Azure NetApp Files leveraging Azure Virtual Machines.

Azure NetApp Files provides enterprise-grade storage with continuously available file shares. Continuously available shares are required by SQL Server production databases on SMB file share to make sure that the node always has access to the database storage, including during disruptive scenarios such as controller upgrades or failures. Continuously available file shares eliminate the need to replicate data between storage nodes. Azure NetApp Files uses SMB 3.0 scale-out, persistent handles, and transparent failover to support nondisruptive operations (NDOs) for planned and unplanned downtime events, including many administrative tasks.

When planning cloud migrations, you should always evaluate the best approach to use. The most common and easiest approach for application migration is rehosting (also known as lift and shift). The example scenario provided in this document uses the rehosting method. SQL Server on Azure virtual machines with Azure NetApp Files allows you to use full versions of SQL Server in the cloud without having to manage on-premises hardware. SQL Server virtual machines (VMs) also simplify licensing costs when you pay as you go and provides elasticity and bursting capabilities for development, test, and estate refresh scenarios.

Factors to consider

VM performance

Selecting the right VM size is important for optimal performance of a relational database in a public cloud. Microsoft recommends that you continue using the same database performance-tuning options that are applicable to SQL Server in on-premises server environments. Use [memory-optimized](#) VM sizes for the best performance of SQL Server workloads. Collect the performance data of existing deployment to identify the RAM and CPU utilization while choosing the right instances. Most deployments choose between the D, E, or M series.

Notes:

- For the best performance of SQL Server workloads, use memory-optimized VM sizes.
- NetApp and Microsoft recommend that you identify the storage performance requirements before choosing the instance type with the appropriate memory-to-vCore ratio. This also helps select a lower-instance type with the right network bandwidth to overcome storage throughput limits of the VM.

VM redundancy

To increase redundancy and high availability, SQL Server VMs should either be in the same [availability set](#) or different [availability zones](#). When creating Azure VMs, you must choose between configuring availability sets versus availability zones; an Azure VM cannot participate in both.

High availability

For high availability, configuring SQL Server AOAG or Always On Failover Cluster Instance (FCI) is the best option. For AOAG, this involves multiple instances of SQL Server on Azure Virtual Machines in a virtual network. If high availability is required at the database level, consider configuring SQL Server availability groups.

Storage configuration

Microsoft SQL Server can be deployed with an SMB file share as the storage option. Starting with SQL Server 2012, system databases (master, model, msdb, or tempdb), and user databases can be installed with Server Message Block (SMB) file server as a storage option. This applies to both SQL Server stand-alone and SQL Server FCI.



File share storage for SQL Server databases should support continuously available property. This provides uninterrupted access to the file-share data.

Azure NetApp Files provides high performing file storage to meet any demanding workload, and it reduces SQL Server TCO as compared to block storage solutions. With block storage, VMs have imposed limits on I/O and bandwidth for disk operations; network bandwidth limits alone are applied against Azure NetApp Files. In other words, no VM-level I/O limits are applied to Azure NetApp Files. Without these I/O limits, SQL Server running on smaller VMs connected to Azure NetApp Files can perform as well as SQL Server running on much larger VMs. Azure NetApp Files reduce SQL Server deployment costs by reducing compute and software licensing costs. For detailed cost analysis and performance benefits of using Azure NetApp Files for SQL Server deployment, see the [Benefits of using Azure NetApp Files for SQL Server deployment](#).

Benefits

The benefits of using Azure NetApp Files for SQL Server include the following:

- Using Azure NetApp Files allows you to use smaller instances, thus reducing compute cost.
- Azure NetApp Files also reduces software licensing costs, which reduce the overall TCO.
- Volume reshaping and dynamic service level capability optimizes cost by sizing for steady-state workloads and avoiding overprovisioning.

Notes:

- To increase redundancy and high availability, SQL Server VMs should either be in the same [availability set](#) or in different [availability zones](#). Consider file path requirements if user-defined data files are required; in which case, select SQL FCI over SQL AOAG.
- The following UNC path is supported: `\\ANFSMB-b4ca.anf.test\SQLDB` and `\\ANFSMB-b4ca.anf.test\SQLDB\`.

- The loopback UNC path is not supported.
- For sizing, use historic data from your on-premises environment. For OLTP workloads, match the target IOPS with performance requirements using workloads at average and peak times along with the disk reads/sec and disk writes/sec performance counters. For data warehouse and reporting workloads, match the target throughput using workloads at average and peak times and the disk read bytes/sec and disk write bytes/sec. Average values can be used in conjunction with volume reshaping capabilities.

Create continuously available shares

Create continuously available shares with the Azure portal or Azure CLI. In the portal, select the Enable Continuous Availability property option. For the Azure CLI, specify the share as a continuously available share by using the `az netappfiles volume create` with the `smb-continuously-avl` option set to `$True`. To learn more about creating a new, continuous availability-enabled volume, see [Creating a Continuously Available Share](#).

Notes:

- Enable continuous availability for the SMB volume as shown in the following image.
- If a non-administrator domain account is used, make sure the account has the required security privilege assigned.
- Set the appropriate permissions at the share level and proper file-level permissions.
- A continuously available property cannot be enabled on existing SMB volumes. To convert an existing volume to use a continuously available share, use NetApp Snapshot technology. For more information, see [Convert existing SMB volumes to use Continuous Availability](#).

Create a volume



Basics **Protocol** Tags Review + create

Configure access to your volume.

Access

Protocol type NFS SMB Dual-protocol (NFSv3 and SMB)

Configuration

Active Directory * ⓘ

Share name * ⓘ

Enable Continuous Availability ⓘ

Review + create

< Previous

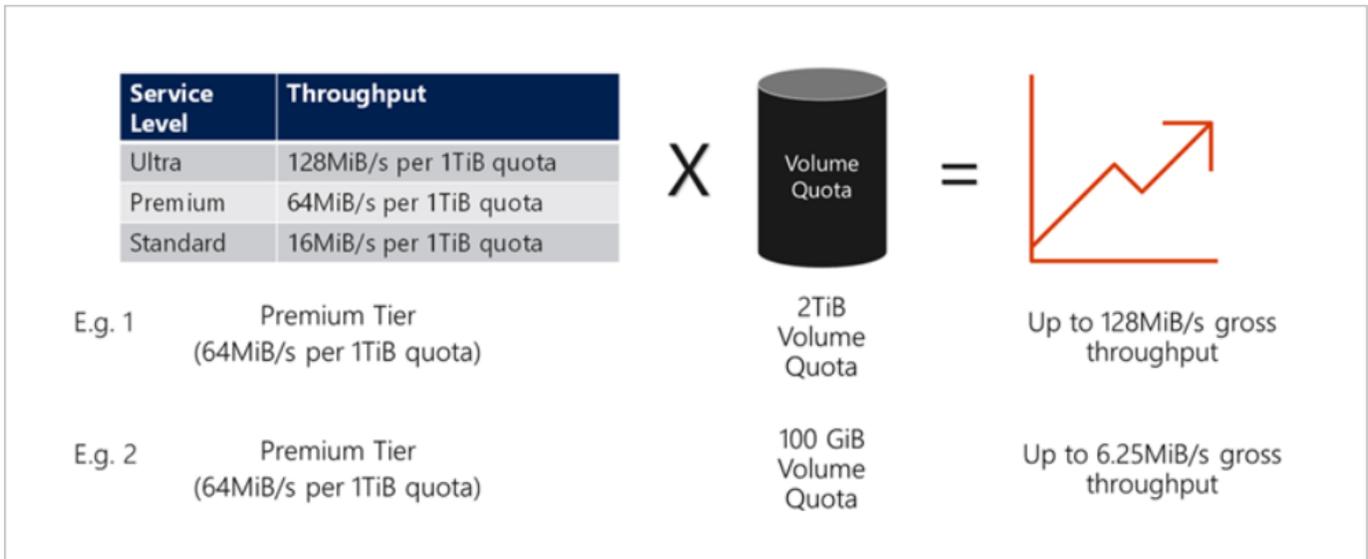
Next : Tags >

Performance

Azure NetApp Files supports three service levels: Standard (16MBps per terabyte), Premium (64MBps per terabyte), and Ultra (128MBps per terabyte). Provisioning the right volume size is important for optimal performance of the database workload. With Azure NetApp Files, volume performance and the throughput limit are based on a combination of the following factors:

- The service level of the capacity pool to which the volume belongs
- The quota assigned to the volume
- The quality of service (QoS) type (auto or manual) of the capacity pool

For more information, see [Service levels for Azure NetApp Files](#).

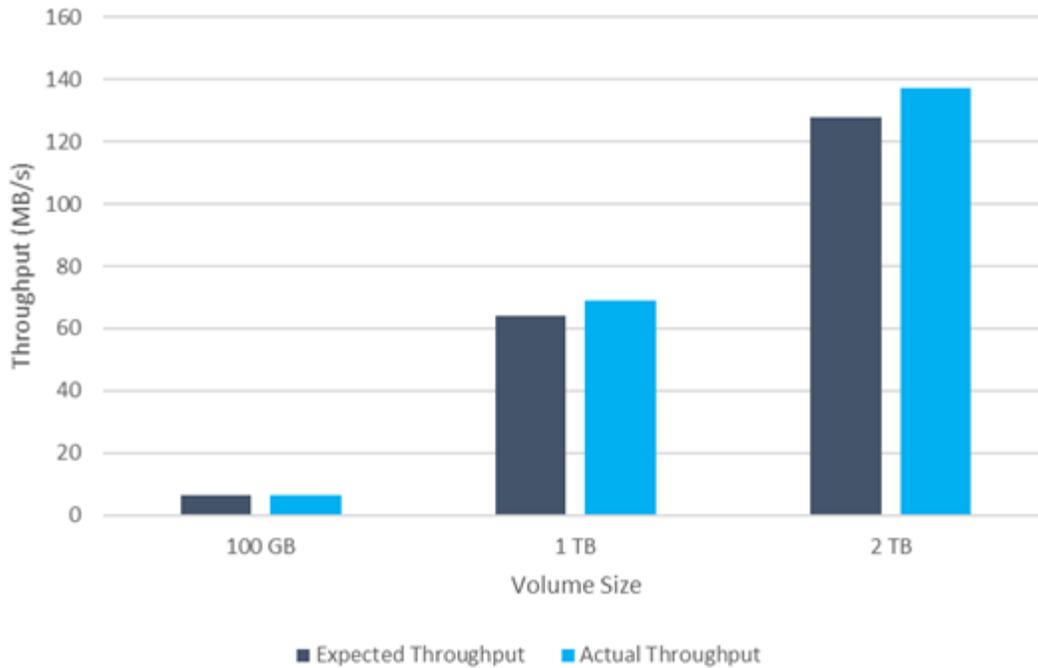


Performance validation

As with any deployment, testing the VM and storage is critical. For storage validation, tools such as HammerDB, Apploader, the [SQL Server storage benchmark \(SB\) tool](#), or any custom script or FIO with the appropriate read/write mix should be used. Keep in mind however that most SQL Server workloads, even busy OLTP workloads, are closer to 80%–90% read and 10%–20% write.

To showcase performance, a quick test was performed against a volume using premium service levels. In this test, the volume size was increased from 100GB to 2TB on the fly without any disruption to application access and zero data migration.

ANF Premium Tier Quotas

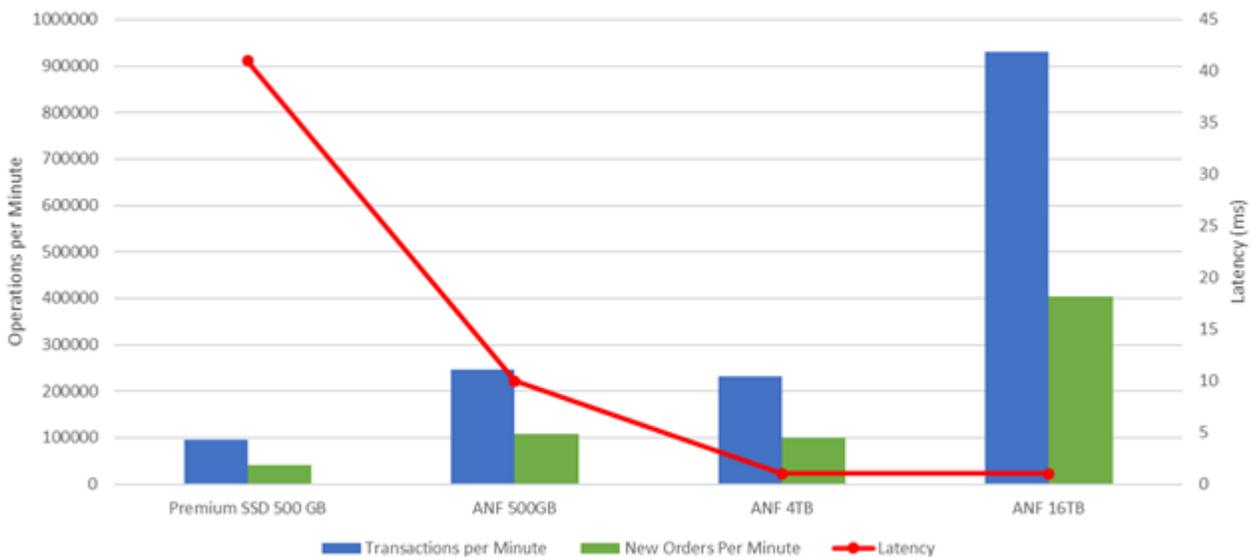


Here is another example of real time performance testing with HammerDB performed for the deployment covered in this paper. For this testing, we used a small instance with eight vCPUs, a 500GB Premium SSD, and a 500GB SMB Azure NetApp Files volume. HammerDB was configured with 80 warehouses and eight users.

The following chart shows that Azure NetApp Files was able to deliver 2.6x the number of transactions per minute at 4x lower latency when using a comparable sized volume (500GB).

An additional test was performed by resizing to a larger instance with 32x vCPUs and a 16TB Azure NetApp Files volume. There was a significant increase in transactions per minute with consistent 1ms latency. HammerDB was configured with 80 warehouses and 64 users for this test.

SQL Hammer DB Results



Cost optimization

Azure NetApp Files allows nondisruptive, transparent volume resizing and the ability to change the service levels with zero downtime and no effect on applications. This is a unique capability allowing dynamic cost management that avoids the need to perform database sizing with peak metrics. Rather, you can use steady state workloads, which avoids upfront costs. The volume reshaping and dynamic service-level change allows you to adjust the bandwidth and service level of Azure NetApp Files volumes on demand almost instantaneously without pausing I/O, while retaining data access.

Azure PaaS offerings such as LogicApp or Functions can be used to easily resize the volume based on a specific webhook or alert rule trigger to meet the workload demands while dynamically handling the cost.

For example, consider a database that needs 250MBps for steady state operation; however, it also requires a peak throughput of 400MBps. In this case, the deployment should be performed with a 4TB volume within the Premium service level to meet the steady-state performance requirements. To handle the peak workload, increase the volume size using Azure functions to 7TB for that specific period, and then downsize the volume to make the deployment cost effective. This configuration avoids overprovisioning of the storage.

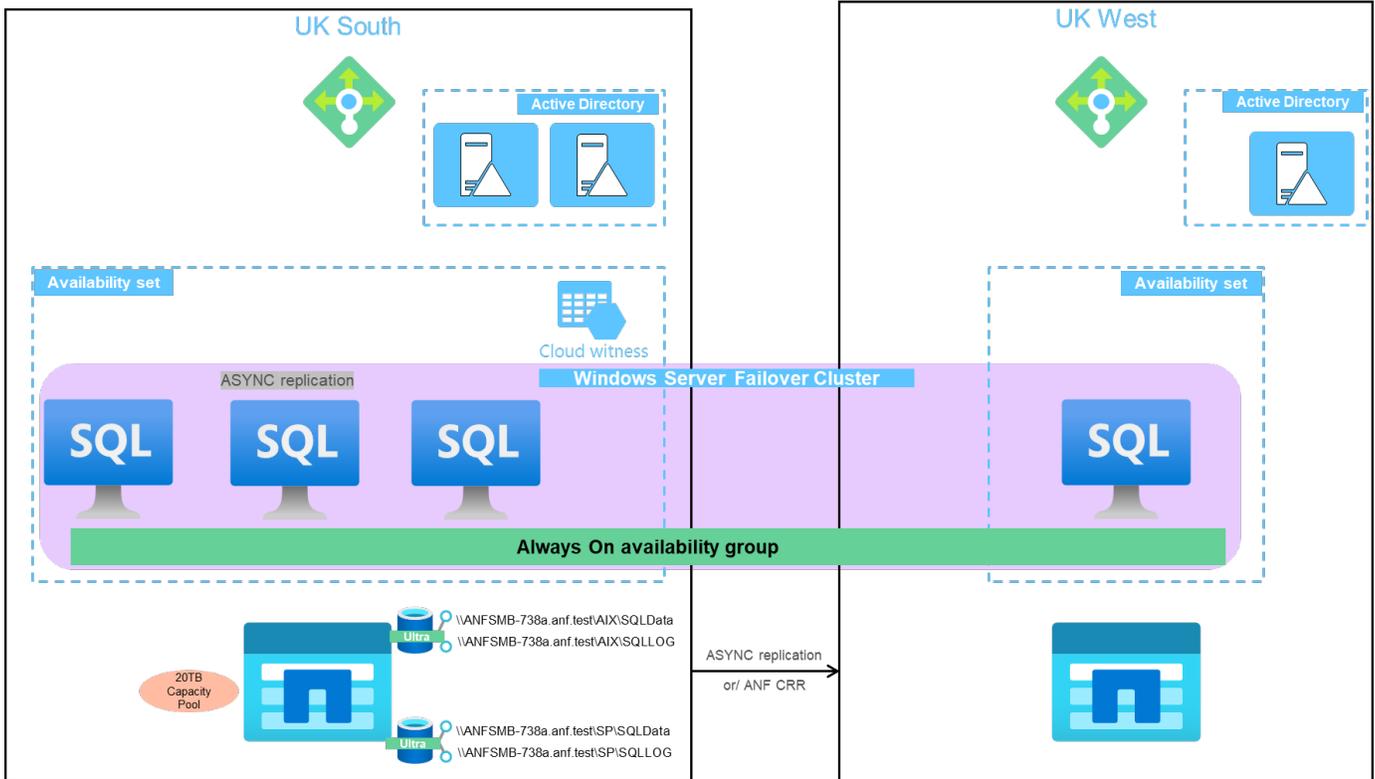
Real-time, high-level reference design

This section covers a real-time deployment of a SQL database estate in an AOAG configuration using an Azure NetApp Files SMB volume.

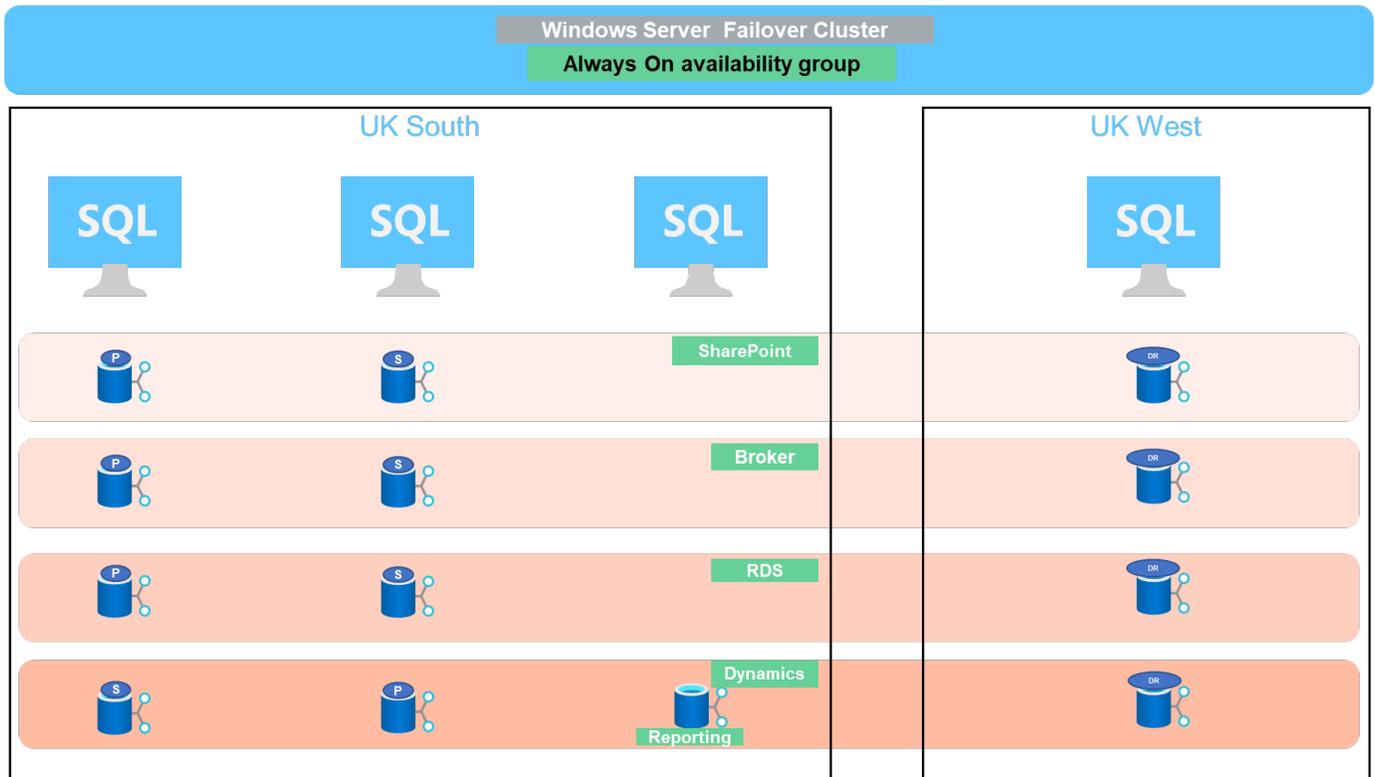
- Number of nodes: 4
- Number of databases: 21
- Number of availability groups: 4
- Backup retention: 7 days
- Backup archive: 365 days



Deploying FCI with SQL Server on Azure virtual machines with an Azure NetApp Files share provides a cost-efficient model with a single copy of the data. This solution can prevent add-file operation issues if the file path differs from the secondary replica.



The following image shows the databases within AOAG spread across the nodes.



Data layout

The user database files (.mdf) and user database transaction log files (.ldf) along with tempDB are stored on the same volume. The service level is Ultra.

The configuration consists of four nodes and four AGs. All 21 databases (part of Dynamic AX, SharePoint, RDS connection broker, and indexing services) are stored on the Azure NetApp Files volumes. The databases are balanced between the AOAG nodes to use the resources on the nodes effectively. Four D32 v3 instances are added in the WSFC, which participates in the AOAG configuration. These four nodes are provisioned in the Azure virtual network and are not migrated from on-premises.

Notes:

- If the logs require more performance and throughput depending on the nature of the application and the queries executed, the database files can be placed on the Premium service level, and the logs can be stored at the Ultra service level.
- If the tempdb files have been placed on Azure NetApp Files, then the Azure NetApp Files volume should be separated from the user database files. Here is an example distribution of the database files in AOAG.

Notes:

- To retain the benefits of Snapshot copy-based data protection, NetApp recommends not combining data and log data into the same volume.
- An add-file operation performed on the primary replica might fail on the secondary databases if the file path of a secondary database differs from the path of the corresponding primary database. This can happen if the share path is different on primary and secondary nodes (due to different computer accounts). This failure could cause the secondary databases to be suspended. If the growth or performance pattern cannot be predicted and the plan is to add files later, a SQL Server failover cluster with Azure NetApp Files is an acceptable solution. For most deployments, Azure NetApp Files meets the performance requirements.

Migration

There are several ways to migrate an on-premises SQL Server user database to SQL Server in an Azure virtual machine. The migration can be either online or offline. The options chosen depend on the SQL Server version, business requirements, and the SLAs defined within the organization. To minimize downtime during the database migration process, NetApp recommends using either the AlwaysOn option or the transactional replication option. If it is not possible to use these methods, you can migrate the database manually.

The simplest and most thoroughly tested approach for moving databases across machines is backup and restore. Typically, you can start with a database backup followed by a copy of the database backup into Azure. You can then restore the database. For the best data transfer performance, migrate the database files into the Azure VM using a compressed backup file. The high-level design referenced in this document uses the backup approach to Azure file storage with Azure file sync and then restore to Azure NetApp files.



Azure Migrate can be used to discover, assess, and migrate SQL Server workloads.

To perform a migration, complete the following high-level steps:

1. Based on your requirements, set up connectivity.
2. Perform a full database backup to an on-premises file-share location.
3. Copy the backup files to an Azure file share with Azure file sync.
4. Provision the VM with the desired version of SQL Server.
5. Copy the backup files to the VM by using the `copy` command from a command prompt.
6. Restore the full databases to SQL Server on Azure virtual machines.



To restore 21 databases, it took approximately nine hours. This approach is specific to this scenario. However, other migration techniques listed below can be used based on your situation and requirements.

Other migration options to move data from an on-premises SQL Server to Azure NetApp Files include the following:

- Detach the data and log files, copy them to Azure Blob storage, and then attach them to SQL Server in the Azure VM with an ANF file share mounted from the URL.
- If you are using Always On availability group deployment on-premises, use the [Add Azure Replica Wizard](#) to create a replica in Azure and then perform failover.
- Use SQL Server [transactional replication](#) to configure the Azure SQL Server instance as a subscriber, disable replication, and point users to the Azure database instance.
- Ship the hard drive using the Windows Import/Export Service.

Backup and recovery

Backup and recovery are an important aspect of any SQL Server deployment. It is mandatory to have the appropriate safety net to quickly recover from various data failure and loss scenarios in conjunction with high availability solutions such as AOAG. SQL Server Database Quiesce Tool, Azure Backup (streaming), or any third-party backup tool such as Commvault can be used to perform an application- consistent backup of the databases,

Azure NetApp Files Snapshot technology allows you to easily create a point-in-time (PiT) copy of the user databases without affecting performance or network utilization. This technology also allows you to restore a Snapshot copy to a new volume or quickly revert the affected volume to the state it was in when that Snapshot copy was created by using the revert volume function. The Azure NetApp Files snapshot process is very quick and efficient, which allows for multiple daily backups, unlike the streaming backup offered by Azure backup. With multiple Snapshot copies possible in a given day, the RPO and RTO times can be significantly reduced. To add application consistency so that data is intact and properly flushed to the disk before the Snapshot copy is taken, use the SQL Server database quiesce tool ([SCSQLAPI tool](#); access to this link requires NetApp SSO login credentials). This tool can be executed from within PowerShell, which quiesces the SQL Server database and in turn can take the application-consistent storage Snapshot copy for backups.

*Notes: *

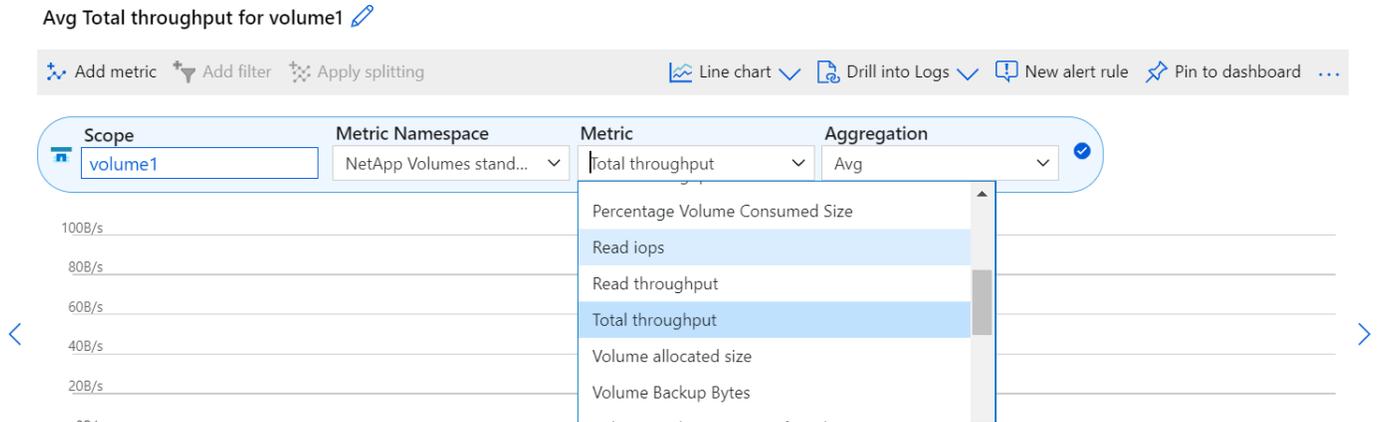
- The SCSQLAPI tool only supports the 2016 and 2017 versions of SQL Server.
- The SCSQLAPI tool only works with one database at a time.
- Isolate the files from each database by placing them onto a separate Azure NetApp Files volume.

Because of SCSQL API's vast limitations, [Azure Backup](#) was used for data protection in order to meet the SLA requirements. It offers a stream-based backup of SQL Server running in Azure Virtual Machines and Azure NetApp Files. Azure Backup allows a 15-minute RPO with frequent log backups and PiT recovery up to one second.

Monitoring

Azure NetApp Files is integrated with Azure Monitor for the time series data and provides metrics on allocated storage, actual storage usage, volume IOPS, throughput, disk read bytes/sec, disk write bytes/sec, disk reads/sec and disk writes/sec, and associated latency. This data can be used to identify bottlenecks with alerting and to perform health checks to verify that your SQL Server deployment is running in an optimal configuration.

In this HLD, ScienceLogic is used to monitor Azure NetApp Files by exposing the metrics using the appropriate service principal. The following image is an example of the Azure NetApp Files Metric option.



DevTest using thick clones

With Azure NetApp Files, you can create instantaneous copies of databases to test functionality that should be implemented by using the current database structure and content during the application development cycles, to use the data extraction and manipulation tools when populating data warehouses, or to even recover data that was mistakenly deleted or changed. This process does not involve copying data from Azure Blob containers, which makes it very efficient. After the volume is restored, it can be used for read/write operations, which significantly reduces validation and time to market. This needs to be used in conjunction with SCSQLAPI for application consistency. This approach provides yet another continuous cost optimization technique along with Azure NetApp Files leveraging the Restore to New volume option.

Notes:

- The volume created from the Snapshot copy using the Restore New Volume option consumes capacity from the capacity pool.
- You can delete the cloned volumes by using REST or Azure CLI to avoid additional costs (in case the capacity pool must be increased).

Hybrid storage options

Although NetApp recommends using the same storage for all the nodes in SQL Server availability groups, there are scenarios in which multiple storage options can be used. This scenario is possible for Azure NetApp Files in which a node in AOAG is connected with an Azure NetApp Files SMB file share and the second node is connected with an Azure Premium disk. In these instances, make sure that the Azure NetApp Files SMB share is holding the primary copy of the user databases and the Premium disk is used as the secondary copy.

Notes:

- In such deployments, to avoid any failover issues, make sure that continuous availability is enabled on the SMB volume. With no continuously available attribute, the database can fail if there is any background maintenance at the storage layer.
- Keep the primary copy of the database on the Azure NetApp Files SMB file share.

Business continuity

Disaster recovery is generally an afterthought in any deployment. However, disaster recovery must be addressed during the initial design and deployment phase to avoid any impact to your business. With Azure

NetApp Files, the cross-region replication (CRR) functionality can be used to replicate the volume data at the block level to the paired region to handle any unexpected regional outage. The CRR-enabled destination volume can be used for read operations, which makes it an ideal candidate for disaster recovery simulations. In addition, the CRR destination can be assigned with the lowest service level (for instance, Standard) to reduce the overall TCO. In the event of a failover, replication can be broken, which makes the respective volume read/write capable. Also, the service level of the volume can be changed by using the dynamic service level functionality to significantly reduce disaster recovery cost. This is another unique feature of Azure NetApp Files with block replication within Azure.

Long-term Snapshot copy archive

Many organizations must perform long-term retention of snapshot data from database files as a mandatory compliance requirement. Although this process is not used in this HLD, it can be easily accomplished by using a simple batch script using [AzCopy](#) to copy the snapshot directory to the Azure Blob container. The batch script can be triggered based on a specific schedule by using scheduled tasks. The process is straightforward—it includes the following steps:

1. Download the AzCopy V10 executable file. There is nothing to install because it is an `exe` file.
2. Authorize AzCopy by using a SAS token at the container level with the appropriate permissions.
3. After AzCopy is authorized, the data transfer begins.

Notes:

- In batch files, make sure to escape the `%` characters that appear in SAS tokens. This can be done by adding an additional `%` character next to existing `%` characters in the SAS token string.
- The [Secure Transfer Required](#) setting of a storage account determines whether the connection to a storage account is secured with Transport Layer Security (TLS). This setting is enabled by default. The following batch script example recursively copies data from the Snapshot copy directory to a designated Blob container:

```
SET source="Z:\~snapshot"  
echo %source%  
SET  
dest="https://testanfacct.blob.core.windows.net/azcoptst?sp=racwdl&st=2020-10-21T18:41:35Z&se=2021-10-22T18:41:00Z&sv=2019-12-12&sr=c&sig=ZxRUJwF1LXgHS8As7HzXJOaDXXVJ7PxxIX3ACpx56XY%%3D"  
echo %dest%
```

The following example cmd is executed in PowerShell:

```
-recursive
```

```
INFO: Scanning...
INFO: Any empty folders will not be processed, because source and/or
destination doesn't have full folder support
Job b3731dd8-da61-9441-7281-17a4db09ce30 has started
Log file is located at: C:\Users\niyaz\.azcopy\b3731dd8-da61-9441-7281-
17a4db09ce30.log
0.0 %, 0 Done, 0 Failed, 2 Pending, 0 Skipped, 2 Total,
INFO: azcopy.exe: A newer version 10.10.0 is available to download
0.0 %, 0 Done, 0 Failed, 2 Pending, 0 Skipped, 2 Total,
Job b3731dd8-da61-9441-7281-17a4db09ce30 summary
Elapsed Time (Minutes): 0.0333
Number of File Transfers: 2
Number of Folder Property Transfers: 0
Total Number of Transfers: 2
Number of Transfers Completed: 2
Number of Transfers Failed: 0
Number of Transfers Skipped: 0
TotalBytesTransferred: 5
Final Job Status: Completed
```

Notes:

- A similar backup feature for long-term retention will soon be available in Azure NetApp Files.
- The batch script can be used in any scenario that requires data to be copied to a Blob container in any region.

Cost optimization

With volume reshaping and dynamic service level change, which is completely transparent to the database, Azure NetApp Files allows continuous cost optimizations in Azure. This capability is used in this HLD extensively to avoid overprovisioning of additional storage to handle workload spikes.

Resizing the volume can be easily accomplished by creating an Azure function in conjunction with the Azure alert logs.

Conclusion

Whether you are targeting an all-cloud or hybrid cloud with stretch databases, Azure NetApp Files provides excellent options to deploy and manage the database workloads while reducing your TCO by making data requirements seamless to the application layer.

This document covers recommendations for planning, designing, optimizing, and scaling Microsoft SQL Server deployments with Azure NetApp Files, which can vary greatly between implementations. The right solution depends on both the technical details of the implementation and the business requirements driving the project.

Takeaways

The key points of this document include:

- You can now use Azure NetApp Files to host the database and file share witness for SQL Server cluster.

- You can boost the application response times and deliver 99.9999% availability to provide access to SQL Server data when and where it is needed.
- You can simplify the overall complexity of the SQL Server deployment and ongoing management, such as raid striping, with simple and instant resizing.
- You can rely on intelligent operations features to help you deploy SQL Server databases in minutes and speed development cycles.
- If Azure Cloud is the destination, Azure NetApp Files is the right storage solution for optimized deployment.

Where to find additional information

To learn more about the information described in this document, refer to the following website links:

- Solution architectures using Azure NetApp Files

<https://docs.microsoft.com/en-us/azure/azure-netapp-files/azure-netapp-files-solution-architectures>

- Benefits of using Azure NetApp Files for SQL Server deployment

<https://docs.microsoft.com/en-us/azure/azure-netapp-files/solutions-benefits-azure-netapp-files-sql-server>

- SQL Server on Azure Deployment Guide Using Azure NetApp Files

<https://www.netapp.com/pdf.html?item=/media/27154-tr-4888.pdf>

- Fault tolerance, high availability, and resilience with Azure NetApp Files

<https://cloud.netapp.com/blog/azure-anf-blg-fault-tolerance-high-availability-and-resilience-with-azure-netapp-files>

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