Solution Automation

NetApp Solutions

NetApp
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Solution Automation

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Introduction

In providing solutions to meet today's business challenges, NetApp delivers solutions with the following goals:

- Providing validated deployment and configuration steps,
- Providing solutions that are easily consumable,
- Providing solution deployment that has a predictable outcome, is easily repeated, and scalable across a customer's enterprise.

In order to achieve these goals, it is paramount that the deployment and configuration of infrastructure and/or applications delivered through our solutions is simplified through automation. NetApp is committed to simplifying solution consumption through automation.

Utilizing open-source automation tools such as Red Hat Ansible, HashiCorp Terraform, or Microsoft Powershell, NetApp solutions have the ability to automate application deployment, cloud provisioning, configuration management, and many other common IT tasks. NetApp's solutions take advantage of publicly available automation artifacts - as well as providing NetApp authored automation - to simplify the overall deployment of a solution.

Where automation capabilities are available, the solution collateral will guide the user through the process for automating the solution or solution steps via the specific automation tool(s).

Getting Started with NetApp solution automation

NetApp solution automation provides simplicity and repeatability for many of the common tasks utilized by the NetApp Solutions.

Prior to running any solution automation, the environment must be configured for how the automation will be executed. There are options to run the automation from the command line or through a tool such as AWX or tower.

The following sections will outline the steps required to configure the environment for each of the specified environments.

Setup the Ansible Control Node for CLI deployments on RHEL / CentOS

1. Requirements for the Ansible control node,:
   a. A RHEL/CentOS machine with the following packages installed:
      i. Python3
      ii. Pip3
      iii. Ansible (version greater than 2.10.0)
      iv. Git

If you have a fresh RHEL/CentOS machine without the above requirements installed, follow the below steps to setup that machine as the Ansible control node:

1. Enable the Ansible repository for RHEL-8/RHEL-7
   a. For RHEL-8 (run the below command as root)

```
subscription-manager repos --enable ansible-2.9-for-rhel-8-
x86_64-rpms
```

   b. For RHEL-7 (run the below command as root)

```
subscription-manager repos --enable rhel-7-server-ansible-2.9-
rpms
```

2. Paste the below content in the Terminal

```
sudo yum -y install python3 >> install.log
sudo yum -y install python3-pip >> install.log
python3 -W ignore -m pip --disable-pip-version-check install ansible
>> install.log
sudo yum -y install git >> install.log
```

Setup the Ansible Control Node for CLI deployments on Ubuntu / Debian

1. Requirements for the Ansible control node,:
   a. A Ubuntu/Debian machine with the following packages installed:
      i. Python3
      ii. Pip3
      iii. Ansible (version greater than 2.10.0)
      iv. Git

If you have a fresh Ubuntu/Debian machine without the above requirements installed, follow the below steps to setup that machine as the Ansible control node:

1. Paste the below content in the terminal

```
sudo apt-get -y install python3 >> outputlog.txt
sudo apt-get -y install python3-pip >> outputlog.txt
python3 -W ignore -m pip --disable-pip-version-check install ansible
>> outputlog.txt
sudo apt-get -y install git >> outputlog.txt
```

Setup Ansible Tower or AWX for Tower / AWX deployments

This section describes the steps required to configure the parameters 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 name and organization details and click Save.
   c. In the Inventories page, click the inventory resources you just created.
   d. If there are any inventory variables, paste them into the variables field.
   e. Go to the Groups sub-menu and click Add.
   f. Provide the name of the group, copy in the group variables (if necessary), and click Save.
   g. Click the group created, go to the Hosts sub-menu and click Add New Host.
   h. Provide the hostname and IP address of the host, paste in the host variables (if necessary), and click Save.
2. Create credential types. For solutions involving ONTAP, Element, VMware, or any other HTTPS-based transport connection, you must configure the credential type to match the username and password entries.
   a. Navigate to Administration → Credential Types and click Add.
   b. Provide the name and description.
   c. Paste the following content into the 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
```

   a. Paste the following content into the Injector Configuration:

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

1. Configure credentials.
    a. Navigate to Resources → Credentials and click Add.
    b. Enter the name and organization details.
    c. Select the correct credential type; if you intend to use the standard SSH login, select the type Machine or alternatively select the custom credential type that you created.
    d. Enter the other corresponding details and click Save.
2. Configure the project.
    a. Navigate to Resources → Projects and click Add.
    b. Enter the name and organization details.
    c. Select Git for the Source Control Credential Type.
    d. Paste the source control URL (or git clone URL) corresponding to the specific solution.
    e. Optionally, if the Git URL is access controlled, create and attach the corresponding credential in Source Control Credential.
    f. Click Save.
3. Configure 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 the playbook without actually configuring the system.
    d. Select the corresponding inventory, project, and credentials for the playbook.
    e. Select the playbook that you would like to run as a part of the job template.
    f. Usually the variables are pasted during runtime. Therefore, to get the prompt to populate the variables during runtime, make sure to tick the checkbox Prompt on Launch corresponding to the Variable field.
    g. Provide any other details as required and click Save.
4. Launch the job template.
    a. Navigate to Resources → Templates.
    b. Click the desired template and then click Launch.
    c. Fill in any variables if prompted on launch and then click Launch again.

NetApp Solution Automation

AWS Authentication Requirements for CVO and Connector Using NetApp Cloud Manager

To configure automated Deployments of CVO and Connectors using Ansible playbooks via AWX/Ansible Tower, the following information is needed:

Acquiring Access/Secret Keys from AWS

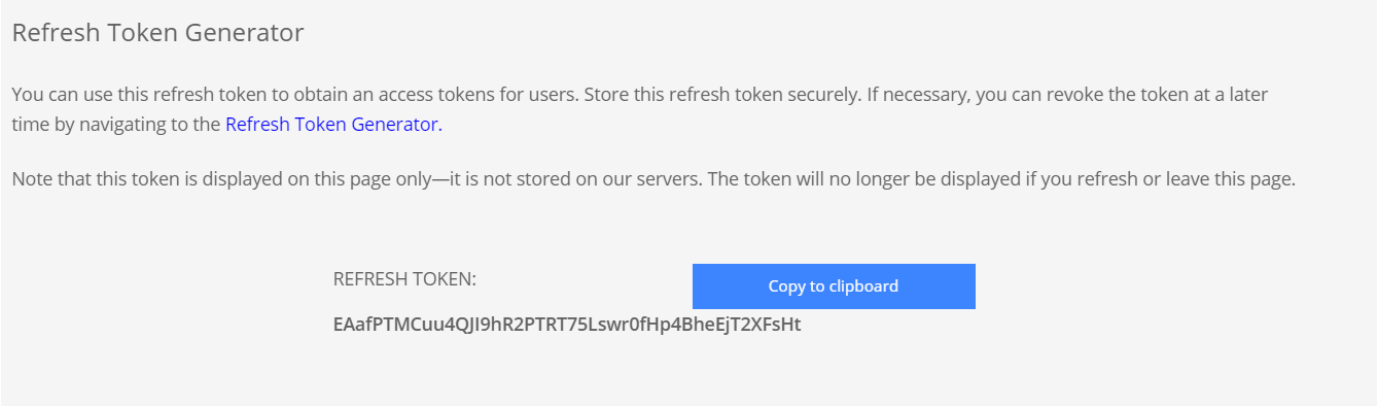
1. To deploy CVO and Connector in Cloud Manager, we need AWS Access/Secret Key. Acquire the keys in AWS console by launching IAM-→Users-→your username-→security credentials-→Create Access key.

2. Copy access keys and keep them secured to use in Connector and CVO deployment.

If you lose your key, you can create another access key and delete the one you lost

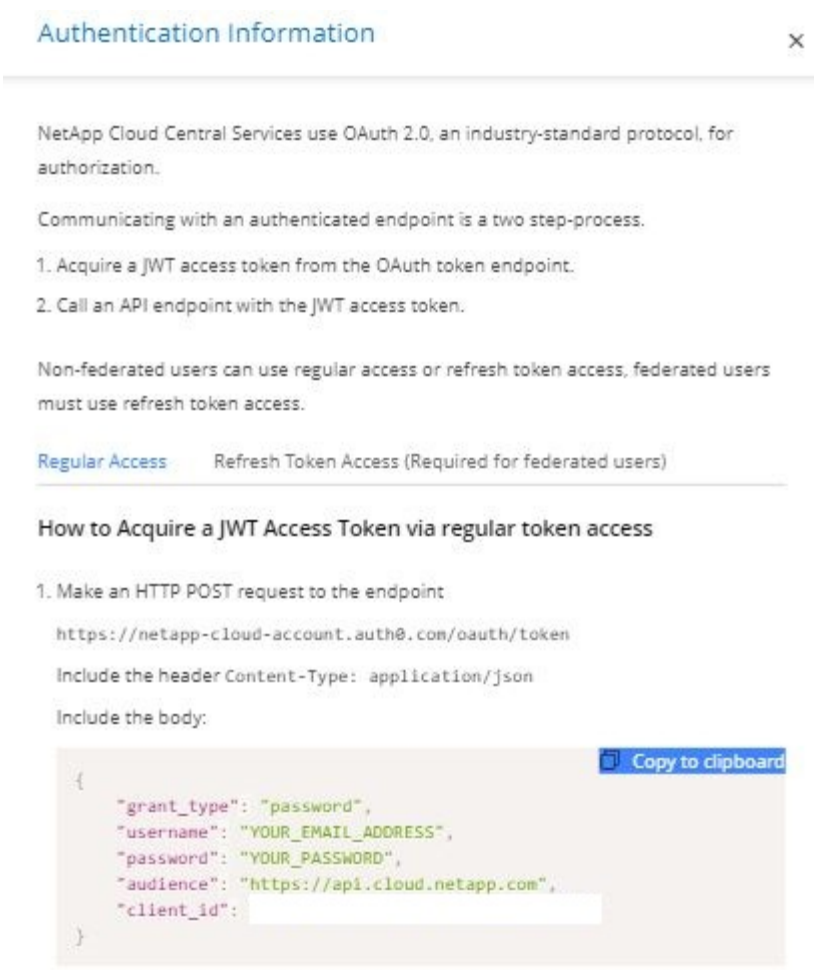
Acquiring Refresh Token from NetApp Cloud Central

1. Login into your cloud central account using your account credentials at https://services.cloud.netapp.com/refresh-token
2. Generate a refresh Token and save it for deployments.



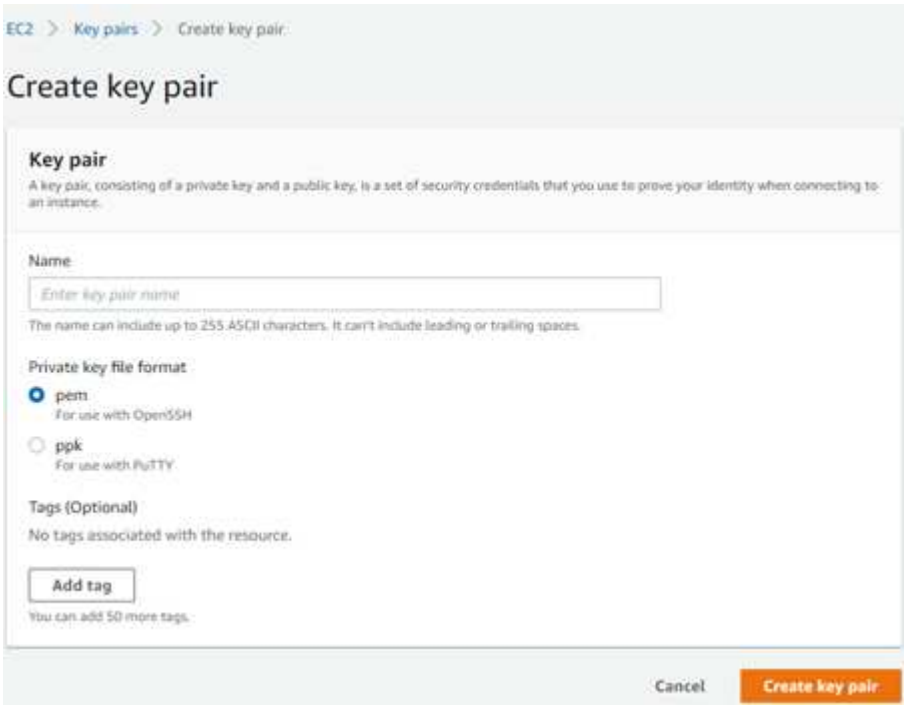
Acquiring Client ID

1. Access the API page to copy Client ID at https://services.cloud.netapp.com/developer-hub.
2. Click on "learn How to Authenticate", in the top right corner.
3. From the Authentication window that pops up, copy the Client ID from Regular Access if you require a username/password to login. Federated users with SSO should copy the client ID from the "Refresh Token Tab".



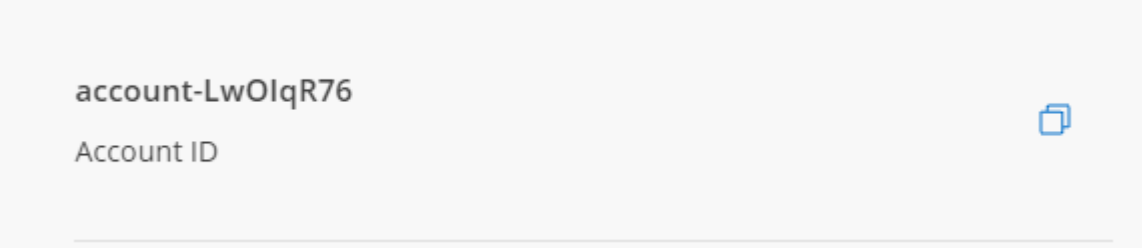
Acquiring Key Pair from AWS

1. In AWS console, search for “Key Pair” and create a key pair with “pem”. Remember the name of you key_pair, we will use it to deploy the connector.



Acquiring Account ID

1. In Cloud Manager, click on Account –> Manage Accounts and then copy the account id for use in variables for AWX.



Cloud Volumes Automation via Terraform

This solution documents the automated deployments of Cloud Volumes on AWS (CVO Single Node, CVO HA and FSX ONTAP) and Azure (CVO Single Node, CVO HA and ANF) using Terraform modules. The code can be found at https://github.com/NetApp-Automation/na_cloud_volumes_automation

Pre-requisites

1. Terraform >= 0.13
2. Cloud Manager Account
3. Cloud Provider Account – AWS, Azure
4. Host machine (any OS supported by Terraform)

Provider documentation

The documentation of Terraform provider for Cloud Manager is available at: https://registry.terraform.io/providers/NetApp/netapp-cloudmanager/latest/docs

Controlling the provider version

Note that you can also control the provider version. This is controlled by a required_providers block in your Terraform configuration.

The syntax is as follows:

```
terraform {
  required_providers {
    netapp-cloudmanager = {
      source = "NetApp/netapp-cloudmanager"
      version = "20.10.0"
    }
  }
}
```

Read more on provider version control.

Running Specific Modules

AWS

CVO Single Node Deployment

Terraform configuration files for deployment of NetApp CVO (Single Node Instance) on AWS

This section contains various Terraform configuration files to deploy/configure single node NetApp CVO (Cloud Volumes ONTAP) on AWS (Amazon Web Services).

Terraform Documentation: https://registry.terraform.io/providers/NetApp/netapp-cloudmanager/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation/
```

c. Configure AWS credentials from the CLI.

```
    aws configure
```

- AWS Access Key ID [None]: accesskey
- AWS Secret Access Key [None]: secretkey
- Default region name [None]: us-west-2
- Default output format [None]: json

d. Update the variable values in `vars/aws_cvo_single_node_deployment.tfvar`

> You can choose to deploy the connector by setting the variable "aws_connector_deploy_bool" value to true/false.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
    terraform init
```

f. Verify the terraform files using terraform validate command.

```
    terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan -target="module.aws_sn" -var
-file="vars/aws_cvo_single_node_deployment.tfvars"
```

h. Run the deployment

```
    terraform apply -target="module.aws_sn" -var
-file="vars/aws_cvo_single_node_deployment.tfvars"
```

To delete the deployment

```
    terraform destroy
```

Recipies:

`Connector`

Terraform variables for NetApp AWS connector instance for CVO deployment.

Name	Type	Description
aws_connector_deploy_bool	Bool	(Required) Check for Connector deployment.
aws_connector_name	String	(Required) The name of the Cloud Manager Connector.
aws_connector_region	String	(Required) The region where the Cloud Manager Connector will be created.
aws_connector_key_name	String	(Required) The name of the key pair to use for the Connector instance.
aws_connector_company	String	(Required) The name of the company of the user.
aws_connector_instance_type	String	(Required) The type of instance (for example, t3.xlarge). At least 4 CPU and 16 GB of memory are required.
aws_connector_subnet_id	String	(Required) The ID of the subnet for the instance.
aws_connector_security_group_id	String	(Required) The ID of the security group for the instance, multiple security groups can be provided separated by ','.

aws_connector_iam_instance_profile_name	String	(Required) The name of the instance profile for the Connector.
aws_connector_account_id	String	(Optional) The NetApp account ID that the Connector will be associated with. If not provided, Cloud Manager uses the first account. If no account exists, Cloud Manager creates a new account. You can find the account ID in the account tab of Cloud Manager at https://cloudmanager.netapp.com.
aws_connector_public_ip_bool	Bool	(Optional) Indicates whether to associate a public IP address to the instance. If not provided, the association will be done based on the subnet's configuration.

`Single Node Instance`

Terraform variables for single NetApp CVO instance.

Name	Type	Description
cvo_name	String	(Required) The name of the Cloud Volumes ONTAP working environment.
cvo_region	String	(Required) The region where the working environment will be created.
cvo_subnet_id	String	(Required) The subnet id where the working environment will be created.
cvo_vpc_id	String	(Optional) The VPC ID where the working environment will be created. If this argument isn't provided, the VPC will be calculated by using the provided subnet ID.
cvo_svm_password	String	(Required) The admin password for Cloud Volumes ONTAP.
cvo_writing_speed_state	String	(Optional) The write speed setting for Cloud Volumes ONTAP: ['NORMAL','HIGH']. The default is 'NORMAL'.

CVO HA Deployment

Terraform configuration files for deployment of NetApp CVO (HA Pair) on AWS

This section contains various Terraform configuration files to deploy/configure NetApp CVO (Cloud Volumes ONTAP) in high availability pair on AWS (Amazon Web Services).

Terraform Documentation: https://registry.terraform.io/providers/NetApp/netapp-cloudmanager/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation/
```

c. Configure AWS credentials from the CLI.

```
    aws configure
```

- AWS Access Key ID [None]: accesskey
- AWS Secret Access Key [None]: secretkey
- Default region name [None]: us-west-2
- Default output format [None]: json

d. Update the variable values in `vars/aws_cvo_ha_deployment.tfvars`.

> You can choose to deploy the connector by setting the variable "aws_connector_deploy_bool" value to true/false.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
      terraform init
```

f. Verify the terraform files using terraform validate command.

```
    terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan -target="module.aws_ha" -var
-file="vars/aws_cvo_ha_deployment.tfvars"
```

h. Run the deployment

```
    terraform apply -target="module.aws_ha" -var
-file="vars/aws_cvo_ha_deployment.tfvars"
```

To delete the deployment

```
    terraform destroy
```

Recipies:

`Connector`

Terraform variables for NetApp AWS connector instance for CVO deployment.

Name	Type	Description
aws_connector_deploy_bool	Bool	(Required) Check for Connector deployment.
aws_connector_name	String	(Required) The name of the Cloud Manager Connector.
aws_connector_region	String	(Required) The region where the Cloud Manager Connector will be created.
aws_connector_key_name	String	(Required) The name of the key pair to use for the Connector instance.
aws_connector_company	String	(Required) The name of the company of the user.
aws_connector_instance_type	String	(Required) The type of instance (for example, t3.xlarge). At least 4 CPU and 16 GB of memory are required.
aws_connector_subnet_id	String	(Required) The ID of the subnet for the instance.
aws_connector_security_group_id	String	(Required) The ID of the security group for the instance, multiple security groups can be provided separated by ','.

aws_connector_iam_instance_profile_name	String	(Required) The name of the instance profile for the Connector.
aws_connector_account_id	String	(Optional) The NetApp account ID that the Connector will be associated with. If not provided, Cloud Manager uses the first account. If no account exists, Cloud Manager creates a new account. You can find the account ID in the account tab of Cloud Manager at https://cloudmanager.netapp.com.
aws_connector_public_ip_bool	Bool	(Optional) Indicates whether to associate a public IP address to the instance. If not provided, the association will be done based on the subnet's configuration.

`HA Pair`

Terraform variables for NetApp CVO instances in HA Pair.

Name	Type	Description
cvo_is_ha	Bool	(Optional) Indicate whether the working environment is an HA pair or not [true, false]. The default is false.
cvo_name	String	(Required) The name of the Cloud Volumes ONTAP working environment.
cvo_region	String	(Required) The region where the working environment will be created.
cvo_node1_subnet_id	String	(Required) The subnet id where the first node will be created.
cvo_node2_subnet_id	String	(Required) The subnet id where the second node will be created.
cvo_vpc_id	String	(Optional) The VPC ID where the working environment will be created. If this argument isn't provided, the VPC will be calculated by using the provided subnet ID.
cvo_svm_password	String	(Required) The admin password for Cloud Volumes ONTAP.

cvo_failover_mode	String	(Optional) For HA, the failover mode for the HA pair: ['PrivateIP', 'FloatingIP']. 'PrivateIP' is for a single availability zone and 'FloatingIP' is for multiple availability zones.
cvo_mediator_subnet_id	String	(Optional) For HA, the subnet ID of the mediator.
cvo_mediator_key_pair_name	String	(Optional) For HA, the key pair name for the mediator instance.
cvo_cluster_floating_ip	String	(Optional) For HA FloatingIP, the cluster management floating IP address.
cvo_data_floating_ip	String	(Optional) For HA FloatingIP, the data floating IP address.
cvo_data_floating_ip2	String	(Optional) For HA FloatingIP, the data floating IP address.
cvo_svm_floating_ip	String	(Optional) For HA FloatingIP, the SVM management floating IP address.
cvo_route_table_ids	List	(Optional) For HA FloatingIP, the list of route table IDs that will be updated with the floating IPs.

FSx Deployment

Terraform configuration files for deployment of NetApp ONTAP FSx on AWS

This section contains various Terraform configuration files to deploy/configure NetApp ONTAP FSx on AWS (Amazon Web Services).

Terraform Documentation: https://registry.terraform.io/providers/NetApp/netapp-cloudmanager/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation/
```

c. Configure AWS credentials from the CLI.

```
    aws configure
```

- AWS Access Key ID [None]: accesskey
- AWS Secret Access Key [None]: secretkey
- Default region name [None]: us-west-2
- Default output format [None]:

d. Update the variable values in `vars/aws_fsx_deployment.tfvars`

> You can choose to deploy the connector by setting the variable "aws_connector_deploy_bool" value to true/false.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
    terraform init
```

f. Verify the terraform files using terraform validate command.

```
    terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan -target="module.aws_fsx" -var
-file="vars/aws_fsx_deployment.tfvars"
```

h. Run the deployment

```
    terraform apply -target="module.aws_fsx" -var
-file="vars/aws_fsx_deployment.tfvars"
```

To delete the deployment

```
    terraform destroy
```

Recipes:

`Connector`

Terraform variables for NetApp AWS connector instance.

Name	Type	Description
aws_connector_deploy_bool	Bool	(Required) Check for Connector deployment.
aws_connector_name	String	(Required) The name of the Cloud Manager Connector.
aws_connector_region	String	(Required) The region where the Cloud Manager Connector will be created.
aws_connector_key_name	String	(Required) The name of the key pair to use for the Connector instance.
aws_connector_company	String	(Required) The name of the company of the user.
aws_connector_instance_type	String	(Required) The type of instance (for example, t3.xlarge). At least 4 CPU and 16 GB of memory are required.
aws_connector_subnet_id	String	(Required) The ID of the subnet for the instance.
aws_connector_security_group_id	String	(Required) The ID of the security group for the instance, multiple security groups can be provided separated by ','.
aws_connector_iam_instance_profile_name	String	(Required) The name of the instance profile for the Connector.
aws_connector_account_id	String	(Optional) The NetApp account ID that the Connector will be associated with. If not provided, Cloud Manager uses the first account. If no account exists, Cloud Manager creates a new account. You can find the account ID in the account tab of Cloud Manager at https://cloudmanager.netapp.com.
aws_connector_public_ip_bool	Bool	(Optional) Indicates whether to associate a public IP address to the instance. If not provided, the association will be done based on the subnet's configuration.

`FSx Instance`

Terraform variables for NetApp ONTAP FSx instance.

Name	Type	Description
fsx_name	String	(Required) The name of the Cloud Volumes ONTAP working environment.
fsx_region	String	(Required) The region where the working environment will be created.
fsx_primary_subnet_id	String	(Required) The primary subnet id where the working environment will be created.
fsx_secondary_subnet_id	String	(Required) The secondary subnet id where the working environment will be created.
fsx_account_id	String	(Required) The NetApp account ID that the FSx instance will be associated with. If not provided, Cloud Manager uses the first account. If no account exists, Cloud Manager creates a new account. You can find the account ID in the account tab of Cloud Manager at https://cloudmanager.netapp.com.
fsx_workspace_id	String	(Required) The ID of the Cloud Manager workspace of working environment.
fsx_admin_password	String	(Required) The admin password for Cloud Volumes ONTAP.
fsx_throughput_capacity	String	(Optional) capacity of the throughput.
fsx_storage_capacity_size	String	(Optional) EBS volume size for the first data aggregate. For GB, the unit can be: [100 or 500]. For TB, the unit can be: [1,2,4,8,16]. The default is '1'
fsx_storage_capacity_size_unit	String	(Optional) ['GB' or 'TB']. The default is 'TB'.
fsx_cloudmanager_aws_credential_name	String	(Required) The name of the AWS Credentials account name.

Azure

ANF

Terraform configuration files for deployment of ANF Volume on Azure

This section contains various Terraform configuration files to deploy/configure ANF (Azure Netapp Files) Volume on Azure.

Terraform Documentation: https://registry.terraform.io/providers/hashicorp/azurerm/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation
```

c. Login to your Azure CLI (Azure CLI must be installed).

```
    az login
```

d. Update the variable values in `vars/azure_anf.tfvars`.

> You can choose to deploy the ANF volume using an existing vnet and subnet by setting the variable "vnet_creation_bool" and "subnet_creation_bool" value to false and supplying the "subnet_id_for_anf_vol". You can also set those values to true and create a new vnet and subnet in which case, the subnet ID will automatically be taken from the newly created subnet.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
    terraform init
```

f. Verify the terraform files using terraform validate command.

```
    terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan -target="module.anf" -var
-file="vars/azure_anf.tfvars"
```

h. Run the deployment

```
    terraform apply -target="module.anf" -var
-file="vars/azure_anf.tfvars"
```

To delete the deployment

```
  terraform destroy
```

Recipies:

`Single Node Instance`

Terraform variables for single NetApp ANF Volume.

Name	Type	Description
az_location	String	(Required) Specifies the supported Azure location where the resource exists. Changing this forces a new resource to be created.
az_prefix	String	(Required) The name of the resource group where the NetApp Volume should be created. Changing this forces a new resource to be created.
az_vnet_address_space	String	(Required) The address space to be used by the newly created vnet for ANF volume deployment.
az_subnet_address_prefix	String	(Required) The subnet address prefix to be used by the newly created vnet for ANF volume deployment.
az_volume_path	String	(Required) A unique file path for the volume. Used when creating mount targets. Changing this forces a new resource to be created.
az_capacity_pool_size	Integer	(Required) Capacity Pool Size mentioned in TB.

az_vnet_creation_bool	Boolean	(Required) Set this boolean to `true` if you want to create a new vnet. Set it to `false` to use an existing vnet.
az_subnet_creation_bool	Boolean	(Required) Set this boolean to `true` to create a new subnet. Set it to `false` to use an existing subnet.
az_subnet_id_for_anf_vol	String	(Required) Mention the subnet id in case you decide to use an existing subnet by setting `subnet_creation_bool` to true. If set to false, leave it at the default value.
az_netapp_pool_service_level	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_vol_service_level	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_vol_protocol	String	(Optional) The target volume protocol expressed as a list. Supported single value include `CIFS`, `NFSv3`, or `NFSv4.1`. If argument is not defined it will default to `NFSv3`. Changing this forces a new resource to be created and data will be lost.
az_netapp_vol_security_style	String	(Optional) Volume security style, accepted values are `Unix` or `Ntfs`. If not provided, single-protocol volume is created defaulting to `Unix` if it is `NFSv3` or `NFSv4.1` volume, if `CIFS`, it will default to `Ntfs`. In a dual-protocol volume, if not provided, its value will be `Ntfs`.
az_netapp_vol_storage_quota	String	(Required) The maximum Storage Quota allowed for a file system in Gigabytes.

ANF Data Protection

Terraform configuration files for deployment of ANF Volume with Data Protection on Azure

This section contains various Terraform configuration files to deploy/configure ANF (Azure Netapp Files) Volume with Data Protection on Azure.

Terraform Documentation: https://registry.terraform.io/providers/hashicorp/azurerm/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation
```

c. Login to your Azure CLI (Azure CLI must be installed).

```
    az login
```

d. Update the variable values in `vars/azure_anf_data_protection.tfvars`.

> You can choose to deploy the ANF volume using an existing vnet and subnet by setting the variable "vnet_creation_bool" and "subnet_creation_bool" value to false and supplying the "subnet_id_for_anf_vol". You can also set those values to true and create a new vnet and subnet in which case, the subnet ID will automatically be taken from the newly created subnet.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
    terraform init
```

f. Verify the terraform files using terraform validate command.

```
    terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan -target="module.anf_data_protection" -var
-file="vars/azure_anf_data_protection.tfvars"
```

h. Run the deployment

```
    terraform apply -target="module.anf_data_protection" -var
-file="vars/azure_anf_data_protection.tfvars
```

To delete the deployment

```
  terraform destroy
```

Recipies:

`ANF Data Protection`

Terraform variables for single ANF Volume with data protection enabled.

Name	Type	Description
az_location	String	(Required) Specifies the supported Azure location where the resource exists. Changing this forces a new resource to be created.
az_alt_location	String	(Required) The Azure location where the secondary volume will be created
az_prefix	String	(Required) The name of the resource group where the NetApp Volume should be created. Changing this forces a new resource to be created.
az_vnet_primary_address_space	String	(Required) The address space to be used by the newly created vnet for ANF primary volume deployment.
az_vnet_secondary_address_space	String	(Required) The address space to be used by the newly created vnet for ANF secondary volume deployment.
az_subnet_primary_address_prefix	String	(Required) The subnet address prefix to be used by the newly created vnet for ANF primary volume deployment.
az_subnet_secondary_address_prefix	String	(Required) The subnet address prefix to be used by the newly created vnet for ANF secondary volume deployment.

az_volume_path_primary	String	(Required) A unique file path for the primary volume. Used when creating mount targets. Changing this forces a new resource to be created.
az_volume_path_secondary	String	(Required) A unique file path for the secondary volume. Used when creating mount targets. Changing this forces a new resource to be created.
az_capacity_pool_size_primary	Integer	(Required) Capacity Pool Size mentioned in TB.
az_capacity_pool_size_secondary	Integer	(Required) Capacity Pool Size mentioned in TB.
az_vnet_primary_creation_bool	Boolean	(Required) Set this boolean to `true` if you want to create a new vnet for primary volume. Set it to `false` to use an existing vnet.
az_vnet_secondary_creation_bool	Boolean	(Required) Set this boolean to `true` if you want to create a new vnet for secondary volume. Set it to `false` to use an existing vnet.
az_subnet_primary_creation_bool	Boolean	(Required) Set this boolean to `true` to create a new subnet for primary volume. Set it to `false` to use an existing subnet.
az_subnet_secondary_creation_bool	Boolean	(Required) Set this boolean to `true` to create a new subnet for secondary volume. Set it to `false` to use an existing subnet.
az_primary_subnet_id_for_anf_vol	String	(Required) Mention the subnet id in case you decide to use an existing subnet by setting `subnet_primary_creation_bool` to true. If set to false, leave it at the default value.
az_secondary_subnet_id_for_anf_vol	String	(Required) Mention the subnet id in case you decide to use an existing subnet by setting `subnet_secondary_creation_bool` to true. If set to false, leave it at the default value.

az_netapp_pool_service_level_primary	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_pool_service_level_secondary	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_vol_service_level_primary	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_vol_service_level_secondary	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_vol_protocol_primary	String	(Optional) The target volume protocol expressed as a list. Supported single value include `CIFS`, `NFSv3`, or `NFSv4.1`. If argument is not defined it will default to `NFSv3`. Changing this forces a new resource to be created and data will be lost.
az_netapp_vol_protocol_secondary	String	(Optional) The target volume protocol expressed as a list. Supported single value include `CIFS`, `NFSv3`, or `NFSv4.1`. If argument is not defined it will default to `NFSv3`. Changing this forces a new resource to be created and data will be lost.
az_netapp_vol_storage_quota_primary	String	(Required) The maximum Storage Quota allowed for a file system in Gigabytes.
az_netapp_vol_storage_quota_secondary	String	(Required) The maximum Storage Quota allowed for a file system in Gigabytes.
az_dp_replication_frequency	String	(Required) Replication frequency, supported values are `10minutes`, `hourly`, `daily`, values are case sensitive.

ANF Dual Protocol

Terraform configuration files for deployment of ANF Volume with dual protocol on Azure

This section contains various Terraform configuration files to deploy/configure ANF (Azure Netapp Files) Volume with dual protocol enabled on Azure.

Terraform Documentation: https://registry.terraform.io/providers/hashicorp/azurerm/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation
```

c. Login to your Azure CLI (Azure CLI must be installed).

```
    az login
```

d. Update the variable values in `vars/azure_anf_dual_protocol.tfvars`.

> You can choose to deploy the ANF volume using an existing vnet and subnet by setting the variable "vnet_creation_bool" and "subnet_creation_bool" value to false and supplying the "subnet_id_for_anf_vol". You can also set those values to true and create a new vnet and subnet in which case, the subnet ID will automatically be taken from the newly created subnet.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
    terraform init
```

f. Verify the terraform files using terraform validate command.

```
    terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan -target="module.anf_dual_protocol" -var
-file="vars/azure_anf_dual_protocol.tfvars"
```

h. Run the deployment

```
    terraform apply -target="module.anf_dual_protocol" -var
-file="vars/azure_anf_dual_protocol.tfvars"
```

To delete the deployment

```
  terraform destroy
```

Recipies:

`Single Node Instance`

Terraform variables for single ANF Volume with dual protocol enabled.

Name	Type	Description
az_location	String	(Required) Specifies the supported Azure location where the resource exists. Changing this forces a new resource to be created.
az_prefix	String	(Required) The name of the resource group where the NetApp Volume should be created. Changing this forces a new resource to be created.
az_vnet_address_space	String	(Required) The address space to be used by the newly created vnet for ANF volume deployment.
az_subnet_address_prefix	String	(Required) The subnet address prefix to be used by the newly created vnet for ANF volume deployment.
az_volume_path	String	(Required) A unique file path for the volume. Used when creating mount targets. Changing this forces a new resource to be created.
az_capacity_pool_size	Integer	(Required) Capacity Pool Size mentioned in TB.
az_vnet_creation_bool	Boolean	(Required) Set this boolean to `true` if you want to create a new vnet. Set it to `false` to use an existing vnet.

az_subnet_creation_bool	Boolean	(Required) Set this boolean to `true` to create a new subnet. Set it to `false` to use an existing subnet.
az_subnet_id_for_anf_vol	String	(Required) Mention the subnet id in case you decide to use an existing subnet by setting `subnet_creation_bool` to true. If set to false, leave it at the default value.
az_netapp_pool_service_level	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_vol_service_level	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_vol_protocol1	String	(Required) The target volume protocol expressed as a list. Supported single value include `CIFS`, `NFSv3`, or `NFSv4.1`. If argument is not defined it will default to `NFSv3`. Changing this forces a new resource to be created and data will be lost.
az_netapp_vol_protocol2	String	(Required) The target volume protocol expressed as a list. Supported single value include `CIFS`, `NFSv3`, or `NFSv4.1`. If argument is not defined it will default to `NFSv3`. Changing this forces a new resource to be created and data will be lost.
az_netapp_vol_storage_quota	String	(Required) The maximum Storage Quota allowed for a file system in Gigabytes.
az_smb_server_username	String	(Required) Username to create ActiveDirectory object.
az_smb_server_password	String	(Required) User Password to create ActiveDirectory object.
az_smb_server_name	String	(Required) Server Name to create ActiveDirectory object.
az_smb_dns_servers	String	(Required) DNS Server IP to create ActiveDirectory object.

ANF Volume From Snapshot

Terraform configuration files for deployment of ANF Volume from Snapshot on Azure

This section contains various Terraform configuration files to deploy/configure ANF (Azure Netapp Files) Volume from Snapshot on Azure.

Terraform Documentation: https://registry.terraform.io/providers/hashicorp/azurerm/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation
```

c. Login to your Azure CLI (Azure CLI must be installed).

```
    az login
```

d. Update the variable values in `vars/azure_anf_volume_from_snapshot.tfvars`.

> You can choose to deploy the ANF volume using an existing vnet and subnet by setting the variable "vnet_creation_bool" and "subnet_creation_bool" value to false and supplying the "subnet_id_for_anf_vol". You can also set those values to true and create a new vnet and subnet in which case, the subnet ID will automatically be taken from the newly created subnet.

a. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
    terraform init
```

b. Verify the terraform files using terraform validate command.

```
    terraform validate
```

c. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan -target="module.anf_volume_from_snapshot"
-var-file="vars/azure_anf_volume_from_snapshot.tfvars"
```

d. Run the deployment

```
    terraform apply -target="module.anf_volume_from_snapshot"
-var-file="vars/azure_anf_volume_from_snapshot.tfvars"
```

To delete the deployment

```
  terraform destroy
```

Recipies:

`Single Node Instance`

Terraform variables for single ANF Volume using snapshot.

Name	Type	Description
az_location	String	(Required) Specifies the supported Azure location where the resource exists. Changing this forces a new resource to be created.
az_prefix	String	(Required) The name of the resource group where the NetApp Volume should be created. Changing this forces a new resource to be created.
az_vnet_address_space	String	(Required) The address space to be used by the newly created vnet for ANF volume deployment.
az_subnet_address_prefix	String	(Required) The subnet address prefix to be used by the newly created vnet for ANF volume deployment.
az_volume_path	String	(Required) A unique file path for the volume. Used when creating mount targets. Changing this forces a new resource to be created.
az_capacity_pool_size	Integer	(Required) Capacity Pool Size mentioned in TB.
az_vnet_creation_bool	Boolean	(Required) Set this boolean to `true` if you want to create a new vnet. Set it to `false` to use an existing vnet.

az_subnet_creation_bool	Boolean	(Required) Set this boolean to `true` to create a new subnet. Set it to `false` to use an existing subnet.
az_subnet_id_for_anf_vol	String	(Required) Mention the subnet id in case you decide to use an existing subnet by setting `subnet_creation_bool` to true. If set to false, leave it at the default value.
az_netapp_pool_service_level	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_vol_service_level	String	(Required) The target performance of the file system. Valid values include `Premium` , `Standard` , or `Ultra`.
az_netapp_vol_protocol	String	(Optional) The target volume protocol expressed as a list. Supported single value include `CIFS`, `NFSv3`, or `NFSv4.1`. If argument is not defined it will default to `NFSv3`. Changing this forces a new resource to be created and data will be lost.
az_netapp_vol_storage_quota	String	(Required) The maximum Storage Quota allowed for a file system in Gigabytes.
az_snapshot_id	String	(Required) Snapshot ID using which new ANF volume will be created.

CVO Single Node Deployment

Terraform configuration files for deployment of Single Node CVO on Azure

This section contains various Terraform configuration files to deploy/configure Single Node CVO (Cloud Volumes ONTAP) on Azure.

Terraform Documentation: https://registry.terraform.io/providers/NetApp/netapp-cloudmanager/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation
```

c. Login to your Azure CLI (Azure CLI must be installed).

```
    az login
```

d. Update the variables in `vars\azure_cvo_single_node_deployment.tfvars`.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
    terraform init
```

f. Verify the terraform files using terraform validate command.

```
    terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan
-target="module.az_cvo_single_node_deployment" -var
-file="vars\azure_cvo_single_node_deployment.tfvars"
```

h. Run the deployment

```
    terraform apply
-target="module.az_cvo_single_node_deployment" -var
-file="vars\azure_cvo_single_node_deployment.tfvars"
```

To delete the deployment

```
terraform destroy
```

Recipies:

`Single Node Instance`

Terraform variables for single node Cloud Volumes ONTAP (CVO).

Name	Type	Description
refresh_token	String	(Required) The refresh token of NetApp cloud manager. This can be generated from netapp Cloud Central.
az_connector_name	String	(Required) The name of the Cloud Manager Connector.
az_connector_location	String	(Required) The location where the Cloud Manager Connector will be created.
az_connector_subscription_id	String	(Required) The ID of the Azure subscription.
az_connector_company	String	(Required) The name of the company of the user.
az_connector_resource_group	Integer	(Required) The resource group in Azure where the resources will be created.
az_connector_subnet_id	String	(Required) The name of the subnet for the virtual machine.
az_connector_vnet_id	String	(Required) The name of the virtual network.
az_connector_network_security_group_name	String	(Required) The name of the security group for the instance.
az_connector_associate_public_ip_address	String	(Required) Indicates whether to associate the public IP address to the virtual machine.
az_connector_account_id	String	(Required) The NetApp account ID that the Connector will be associated with. If not provided, Cloud Manager uses the first account. If no account exists, Cloud Manager creates a new account. You can find the account ID in the account tab of Cloud Manager at https://cloudmanager.netapp.com.
az_connector_admin_password	String	(Required) The password for the Connector.
az_connector_admin_username	String	(Required) The user name for the Connector.

az_cvo_name	String	(Required) The name of the Cloud Volumes ONTAP working environment.
az_cvo_location	String	(Required) The location where the working environment will be created.
az_cvo_subnet_id	String	(Required) The name of the subnet for the Cloud Volumes ONTAP system.
az_cvo_vnet_id	String	(Required) The name of the virtual network.
az_cvo_vnet_resource_group	String	(Required) The resource group in Azure associated to the virtual network.
az_cvo_data_encryption_type	String	(Required) The type of encryption to use for the working environment: [`AZURE`, `NONE`]. The default is `AZURE`.
az_cvo_storage_type	String	(Required) The type of storage for the first data aggregate: [`Premium_LRS`, `Standard_LRS`, `StandardSSD_LRS`]. The default is `Premium_LRS`
az_cvo_svm_password	String	(Required) The admin password for Cloud Volumes ONTAP.
az_cvo_workspace_id	String	(Required) The ID of the Cloud Manager workspace where you want to deploy Cloud Volumes ONTAP. If not provided, Cloud Manager uses the first workspace. You can find the ID from the Workspace tab on https://cloudmanager.netapp.com.
az_cvo_capacity_tier	String	(Required) Whether to enable data tiering for the first data aggregate: [`Blob`, `NONE`]. The default is `BLOB`.
az_cvo_writing_speed_state	String	(Required) The write speed setting for Cloud Volumes ONTAP: [`NORMAL` , `HIGH`]. The default is `NORMAL`. This argument is not relevant for HA pairs.

az_cvo_ontap_version	String	(Required) The required ONTAP version. Ignored if 'use_latest_version' is set to true. The default is to use the latest version.
az_cvo_instance_type	String	(Required) The type of instance to use, which depends on the license type you chose: Explore:[`Standard_DS3_v2`], Standard:[`Standard_DS4_v2`, `Standard_DS13_v2`,`Standard_L8s_v2`], Premium:[`Standard_DS5_v2`, `Standard_DS14_v2`], BYOL: all instance types defined for PayGo. For more supported instance types, refer to Cloud Volumes ONTAP Release Notes. The default is `Standard_DS4_v2` .
az_cvo_license_type	String	(Required) The type of license to be use. For single node: [`azure-cot-explore-paygo`, `azure-cot-standard-paygo`, `azure-cot-premium-paygo`, `azure-cot-premium-byol`, `capacity-paygo`]. For HA: [`azure-ha-cot-standard-paygo`, `azure-ha-cot-premium-paygo`, `azure-ha-cot-premium-byol`, `ha-capacity-paygo`]. The default is `azure-cot-standard-paygo`. Use `capacity-paygo` or `ha-capacity-paygo` for HA on selecting Bring Your Own License type Capacity-Based or Freemium. Use `azure-cot-premium-byol` or `azure-ha-cot-premium-byol` for HA on selecting Bring Your Own License type Node-Based.
az_cvo_nss_account	String	(Required) he NetApp Support Site account ID to use with this Cloud Volumes ONTAP system. If the license type is BYOL and an NSS account isn’t provided, Cloud Manager tries to use the first existing NSS account.

az_tenant_id	String	(Required) Tenant ID of the application/service principal registered in Azure.
az_application_id	String	(Required) Application ID of the application/service principal registered in Azure.
az_application_key	String	(Required) The Application Key of the application/service principal registered in Azure.

CVO HA Deployment

Terraform configuration files for deployment of CVO HA on Azure

This section contains various Terraform configuration files to deploy/configure CVO (Cloud Volumes ONTAP) HA (High Availability) on Azure.

Terraform Documentation: https://registry.terraform.io/providers/NetApp/netapp-cloudmanager/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation
```

c. Login to your Azure CLI (Azure CLI must be installed).

```
    az login
```

d. Update the variables in `vars\azure_cvo_ha_deployment.tfvars`.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
    terraform init
```

f. Verify the terraform files using terraform validate command.

```
    terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan -target="module.az_cvo_ha_deployment" -var
-file="vars\azure_cvo_ha_deployment.tfvars"
```

h. Run the deployment

```
    terraform apply -target="module.az_cvo_ha_deployment" -var
-file="vars\azure_cvo_ha_deployment.tfvars"
```

To delete the deployment

```
  terraform destroy
```

Recipies:

`HA Pair Instance`

Terraform variables for HA pair Cloud Volumes ONTAP (CVO).

Name	Type	Description
refresh_token	String	(Required) The refresh token of NetApp cloud manager. This can be generated from netapp Cloud Central.
az_connector_name	String	(Required) The name of the Cloud Manager Connector.
az_connector_location	String	(Required) The location where the Cloud Manager Connector will be created.
az_connector_subscription_id	String	(Required) The ID of the Azure subscription.
az_connector_company	String	(Required) The name of the company of the user.
az_connector_resource_group	Integer	(Required) The resource group in Azure where the resources will be created.
az_connector_subnet_id	String	(Required) The name of the subnet for the virtual machine.
az_connector_vnet_id	String	(Required) The name of the virtual network.

az_connector_network_security_group_name	String	(Required) The name of the security group for the instance.
az_connector_associate_public_ip_address	String	(Required) Indicates whether to associate the public IP address to the virtual machine.
az_connector_account_id	String	(Required) The NetApp account ID that the Connector will be associated with. If not provided, Cloud Manager uses the first account. If no account exists, Cloud Manager creates a new account. You can find the account ID in the account tab of Cloud Manager at https://cloudmanager.netapp.com.
az_connector_admin_password	String	(Required) The password for the Connector.
az_connector_admin_username	String	(Required) The user name for the Connector.
az_cvo_name	String	(Required) The name of the Cloud Volumes ONTAP working environment.
az_cvo_location	String	(Required) The location where the working environment will be created.
az_cvo_subnet_id	String	(Required) The name of the subnet for the Cloud Volumes ONTAP system.
az_cvo_vnet_id	String	(Required) The name of the virtual network.
az_cvo_vnet_resource_group	String	(Required) The resource group in Azure associated to the virtual network.
az_cvo_data_encryption_type	String	(Required) The type of encryption to use for the working environment: [`AZURE`, `NONE`]. The default is `AZURE`.
az_cvo_storage_type	String	(Required) The type of storage for the first data aggregate: [`Premium_LRS`, `Standard_LRS`, `StandardSSD_LRS`]. The default is `Premium_LRS`
az_cvo_svm_password	String	(Required) The admin password for Cloud Volumes ONTAP.

az_cvo_workspace_id	String	(Required) The ID of the Cloud Manager workspace where you want to deploy Cloud Volumes ONTAP. If not provided, Cloud Manager uses the first workspace. You can find the ID from the Workspace tab on https://cloudmanager.netapp.com.
az_cvo_capacity_tier	String	(Required) Whether to enable data tiering for the first data aggregate: [`Blob`, `NONE`]. The default is `BLOB`.
az_cvo_writing_speed_state	String	(Required) The write speed setting for Cloud Volumes ONTAP: [`NORMAL` , `HIGH`]. The default is `NORMAL`. This argument is not relevant for HA pairs.
az_cvo_ontap_version	String	(Required) The required ONTAP version. Ignored if 'use_latest_version' is set to true. The default is to use the latest version.
az_cvo_instance_type	String	(Required) The type of instance to use, which depends on the license type you chose: Explore:[`Standard_DS3_v2`], Standard:[`Standard_DS4_v2`, `Standard_DS13_v2`, `Standard_L8s_v2`], Premium:[`Standard_DS5_v2`, `Standard_DS14_v2`], BYOL: all instance types defined for PayGo. For more supported instance types, refer to Cloud Volumes ONTAP Release Notes. The default is `Standard_DS4_v2` .

az_cvo_license_type	String	(Required) The type of license to be use. For single node: [`azure-cot-explore-paygo, azure-cot-standard-paygo, azure-cot-premium-paygo, azure-cot-premium-byol, capacity-paygo`]. For HA: [`azure-ha-cot-standard-paygo, azure-ha-cot-premium-paygo, azure-ha-cot-premium-byol, ha-capacity-paygo`]. The default is `azure-cot-standard-paygo`. Use `capacity-paygo` or `ha-capacity-paygo` for HA on selecting Bring Your Own License type Capacity-Based or Freemium. Use `azure-cot-premium-byol` or `azure-ha-cot-premium-byol` for HA on selecting Bring Your Own License type Node-Based.
az_cvo_nss_account	String	(Required) he NetApp Support Site account ID to use with this Cloud Volumes ONTAP system. If the license type is BYOL and an NSS account isn't provided, Cloud Manager tries to use the first existing NSS account.
az_tenant_id	String	(Required) Tenant ID of the application/service principal registered in Azure.
az_application_id	String	(Required) Application ID of the application/service principal registered in Azure.
az_application_key	String	(Required) The Application Key of the application/service principal registered in Azure.

GCP

CVO Single Node Deployment

Terraform configuration files for deployment of NetApp CVO (Single Node Instance) on GCP

This section contains various Terraform configuration files to deploy/configure single node NetApp CVO (Cloud Volumes ONTAP) on GCP (Google Cloud Platform).

Terraform Documentation: https://registry.terraform.io/providers/NetApp/netapp-cloudmanager/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation/
```

c. Save the GCP authentication key JSON file in the directory.

d. Update the variable values in `vars/gcp_cvo_single_node_deployment.tfvar`

> You can choose to deploy the connector by setting the variable "gcp_connector_deploy_bool" value to true/false.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
    terraform init
```

f. Verify the terraform files using terraform validate command.

```
    terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
    terraform plan -target="module.gco_single_node" -var
-file="vars/gcp_cvo_single_node_deployment.tfvars"
```

h. Run the deployment

```
    terraform apply -target="module.gcp_single_node" -var
-file="vars/gcp_cvo_single_node_deployment.tfvars"
```

To delete the deployment

```
    terraform destroy
```

Recipies:

`Connector`

Terraform variables for NetApp GCP connector instance for CVO deployment.

Name	Type	Description
gcp_connector_deploy_bool	Bool	(Required) Check for Connector deployment.
gcp_connector_name	String	(Required) The name of the Cloud Manager Connector.
gcp_connector_project_id	String	(Required) The GCP project_id where the connector will be created.
gcp_connector_zone	String	(Required) The GCP zone where the Connector will be created.
gcp_connector_company	String	(Required) The name of the company of the user.
gcp_connector_service_account_email	String	(Required) The email of the service_account for the connector instance. This service account is used to allow the Connector to create Cloud Volume ONTAP.
gcp_connector_service_account_path	String	(Required) The local path of the service_account JSON file for GCP authorization purposes. This service account is used to create the Connector in GCP.

gcp_connector_account_id	String	(Optional) The NetApp account ID that the Connector will be associated with. If not provided, Cloud Manager uses the first account. If no account exists, Cloud Manager creates a new account. You can find the account ID in the account tab of Cloud Manager at https://cloudmanager.netapp.com.

`Single Node Instance`

Terraform variables for single NetApp CVO instance on GCP.

Name	Type	Description
gcp_cvo_name	String	(Required) The name of the Cloud Volumes ONTAP working environment.
gcp_cvo_project_id	String	(Required) The ID of the GCP project.
gcp_cvo_zone	String	(Required) The zone of the region where the working environment will be created.
gcp_cvo_gcp_service_account	String	(Required) The gcp_service_account email in order to enable tiering of cold data to Google Cloud Storage.
gcp_cvo_svm_password	String	(Required) The admin password for Cloud Volumes ONTAP.
gcp_cvo_workspace_id	String	(Optional) The ID of the Cloud Manager workspace where you want to deploy Cloud Volumes ONTAP. If not provided, Cloud Manager uses the first workspace. You can find the ID from the Workspace tab on https://cloudmanager.netapp.com.

gcp_cvo_license_type	String	(Optional) The type of license to use. For single node: ['capacity-paygo', 'gcp-cot-explore-paygo', 'gcp-cot-standard-paygo', 'gcp-cot-premium-paygo', 'gcp-cot-premium-byol'], For HA: ['ha-capacity-paygo', 'gcp-ha-cot-explore-paygo', 'gcp-ha-cot-standard-paygo', 'gcp-ha-cot-premium-paygo', 'gcp-ha-cot-premium-byol']. The default is 'capacity-paygo' for single node, and 'ha-capacity-paygo' for HA.
gcp_cvo_capacity_package_name	String	(Optional) The capacity package name: ['Essential', 'Professional', 'Freemium']. Default is 'Essential'.

CVO HA Deployment

Terraform configuration files for deployment of NetApp CVO (HA Pair) on GCP

This section contains various Terraform configuration files to deploy/configure NetApp CVO (Cloud Volumes ONTAP) in high availability pair on GCP (Google Cloud Platform).

Terraform Documentation: https://registry.terraform.io/providers/NetApp/netapp-cloudmanager/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation/
```

c. Save the GCP authentication key JSON file in the directory.

d. Update the variable values in `vars/gcp_cvo_ha_deployment.tfvars`.

You can choose to deploy the connector by setting the variable "gcp_connector_deploy_bool" value to true/false.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
terraform init
```

f. Verify the terraform files using terraform validate command.

```
terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
terraform plan -target="module.gcp_ha" -var
-file="vars/gcp_cvo_ha_deployment.tfvars"
```

h. Run the deployment

```
terraform apply -target="module.gcp_ha" -var
-file="vars/gcp_cvo_ha_deployment.tfvars"
```

To delete the deployment

```
terraform destroy
```

Recipies:

`Connector`

Terraform variables for NetApp GCP connector instance for CVO deployment.

Name	Type	Description
gcp_connector_deploy_bool	Bool	(Required) Check for Connector deployment.
gcp_connector_name	String	(Required) The name of the Cloud Manager Connector.
gcp_connector_project_id	String	(Required) The GCP project_id where the connector will be created.
gcp_connector_zone	String	(Required) The GCP zone where the Connector will be created.
gcp_connector_company	String	(Required) The name of the company of the user.

gcp_connector_service_account_email	String	(Required) The email of the service_account for the connector instance. This service account is used to allow the Connector to create Cloud Volume ONTAP.
gcp_connector_service_account_path	String	(Required) The local path of the service_account JSON file for GCP authorization purposes. This service account is used to create the Connector in GCP.
gcp_connector_account_id	String	(Optional) The NetApp account ID that the Connector will be associated with. If not provided, Cloud Manager uses the first account. If no account exists, Cloud Manager creates a new account. You can find the account ID in the account tab of Cloud Manager at https://cloudmanager.netapp.com.

`HA Pair`

Terraform variables for NetApp CVO instances in HA Pair on GCP.

Name	Type	Description
gcp_cvo_is_ha	Bool	(Optional) Indicate whether the working environment is an HA pair or not [true, false]. The default is false.
gcp_cvo_name	String	(Required) The name of the Cloud Volumes ONTAP working environment.
gcp_cvo_project_id	String	(Required) The ID of the GCP project.
gcp_cvo_zone	String	(Required) The zone of the region where the working environment will be created.
gcp_cvo_node1_zone	String	(Optional) Zone for node 1.
gcp_cvo_node2_zone	String	(Optional) Zone for node 2.
gcp_cvo_mediator_zone	String	(Optional) Zone for mediator.
gcp_cvo_vpc_id	String	(Optional) The name of the VPC.

gcp_cvo_subnet_id	String	(Optional) The name of the subnet for Cloud Volumes ONTAP. The default is: 'default'.
gcp_cvo_vpc0_node_and_data_connectivity	String	(Optional) VPC path for nic1, required for node and data connectivity. If using shared VPC, netwrok_project_id must be provided.
gcp_cvo_vpc1_cluster_connectivity	String	(Optional) VPC path for nic2, required for cluster connectivity.
gcp_cvo_vpc2_ha_connectivity	String	(Optional) VPC path for nic3, required for HA connectivity.
gcp_cvo_vpc3_data_replication	String	(Optional) VPC path for nic4, required for data replication.
gcp_cvo_subnet0_node_and_data_connectivity	String	(Optional) Subnet path for nic1, required for node and data connectivity. If using shared VPC, netwrok_project_id must be provided.
gcp_cvo_subnet1_cluster_connectivity	String	(Optional) Subnet path for nic2, required for cluster connectivity.
gcp_cvo_subnet2_ha_connectivity	String	(Optional) Subnet path for nic3, required for HA connectivity.
gcp_cvo_subnet3_data_replication	String	(Optional) Subnet path for nic4, required for data replication.
gcp_cvo_gcp_service_account	String	(Required) The gcp_service_account email in order to enable tiering of cold data to Google Cloud Storage.
gcp_cvo_svm_password	String	(Required) The admin password for Cloud Volumes ONTAP.
gcp_cvo_workspace_id	String	(Optional) The ID of the Cloud Manager workspace where you want to deploy Cloud Volumes ONTAP. If not provided, Cloud Manager uses the first workspace. You can find the ID from the Workspace tab on https://cloudmanager.netapp.com.

gcp_cvo_license_type	String	(Optional) The type of license to use. For single node: ['capacity-paygo', 'gcp-cot-explore-paygo', 'gcp-cot-standard-paygo', 'gcp-cot-premium-paygo', 'gcp-cot-premium-byol'], For HA: ['ha-capacity-paygo', 'gcp-ha-cot-explore-paygo', 'gcp-ha-cot-standard-paygo', 'gcp-ha-cot-premium-paygo', 'gcp-ha-cot-premium-byol']. The default is 'capacity-paygo' for single node, and 'ha-capacity-paygo' for HA.
gcp_cvo_capacity_package_name	String	(Optional) The capacity package name: ['Essential', 'Professional', 'Freemium']. Default is 'Essential'.
gcp_cvo_gcp_volume_size	String	(Optional) The GCP volume size for the first data aggregate. For GB, the unit can be: [100 or 500]. For TB, the unit can be: [1,2,4,8]. The default is '1' .
gcp_cvo_gcp_volume_size_unit	String	(Optional) ['GB' or 'TB']. The default is 'TB'.

CVS Volume

Terraform configuration files for deployment of NetApp CVS Volume on GCP

This section contains various Terraform configuration files to deploy/configure NetApp CVS (Cloud Volumes Services) Volume on GCP (Google Cloud Platform).

Terraform Documentation: https://registry.terraform.io/providers/NetApp/netapp-gcp/latest/docs

Procedure

In order to run the template:

a. Clone the repository.

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

b. Navigate to the desired folder

```
    cd na_cloud_volumes_automation/
```

c. Save the GCP authentication key JSON file in the directory.

d. Update the variable values in `vars/gcp_cvs_volume.tfvars`.

e. Initialize the Terraform repository to install all the pre-requisites and prepare for deployment.

```
terraform init
```

f. Verify the terraform files using terraform validate command.

```
terraform validate
```

g. Make a dry run of the configuration to get a preview of all the changes expected by the deployment.

```
terraform plan -target="module.gcp_cvs_volume" -var
-file="vars/gcp_cvs_volume.tfvars"
```

h. Run the deployment

```
terraform apply -target="module.gcp_cvs_volume" -var
-file="vars/gcp_cvs_volume.tfvars"
```

To delete the deployment

```
terraform destroy
```

Recipies:

`CVS Volume`

Terraform variables for NetApp GCP CVS Volume.

Name	Type	Description
gcp_cvs_name	String	(Required) The name of the NetApp CVS volume.
gcp_cvs_project_id	String	(Required) The GCP project_id where the CVS Volume will be created.
gcp_cvs_gcp_service_account_path	String	(Required) The local path of the service_account JSON file for GCP authorization purposes. This service account is used to create the CVS Volume in GCP.
gcp_cvs_region	String	(Required) The GCP zone where the CVS Volume will be created.

gcp_cvs_network	String	(Required) The network VPC of the volume.
gcp_cvs_size	Integer	(Required) The size of volume is between 1024 to 102400 inclusive (in GiB).
gcp_cvs_volume_path	String	(Optional) The name of the volume path for volume.
gcp_cvs_protocol_types	String	(Required) The protocol_type of the volume. For NFS use 'NFSv3' or 'NFSv4' and for SMB use 'CIFS' or 'SMB'.

FSx for ONTAP Monitoring and Auto-Resizing using AWS Lambda Function

Author(s): Dhruv Tyagi, Niyaz Mohamed

Overview: Monitoring and Auto-Resizing FSx for ONTAP via AWS Lambda function

FSx for ONTAP is a first party enterprise-grade cloud storage service available on AWS that provides highly reliable, scalable, high-performing and feature-rich file storage built on the popular NetApp ONTAP file system.

FSx for ONTAP provides a seamless deployment and management experience. No storage expertise is required to get started. To simplify monitoring, an AWS lambda function (to automate resizing of total storage capacity, volume size or LUN size based on threshold) can be used. This document provides a step by step guide to create an automated setup that monitors FSx for ONTAP at regular intervals, notifies and resizes when a user-specified threshold is crossed and notifies the administrator of the resizing activity.

Features

The solution provides the following features:

- Ability to monitor:
  - Usage of overall Storage Capacity of FSx for ONTAP
  - Usage of each volume (thin provisioned / thick provisioned)
  - Usage of each LUN (thin provisioned / thick provisioned)
- Ability to resize any of the above when a user-defined threshold is breached
- Alerting mechanism to receive usage warning and resizing notifications via email
- Ability to delete snapshots older than user-defined threshold
- Ability to get a list of FlexClone volumes and snapshots associated
- Ability to monitor the checks at a regular interval
- Ability to use the solution with or without internet access
- Ability to deploy manually or using AWS CloudFormation Template

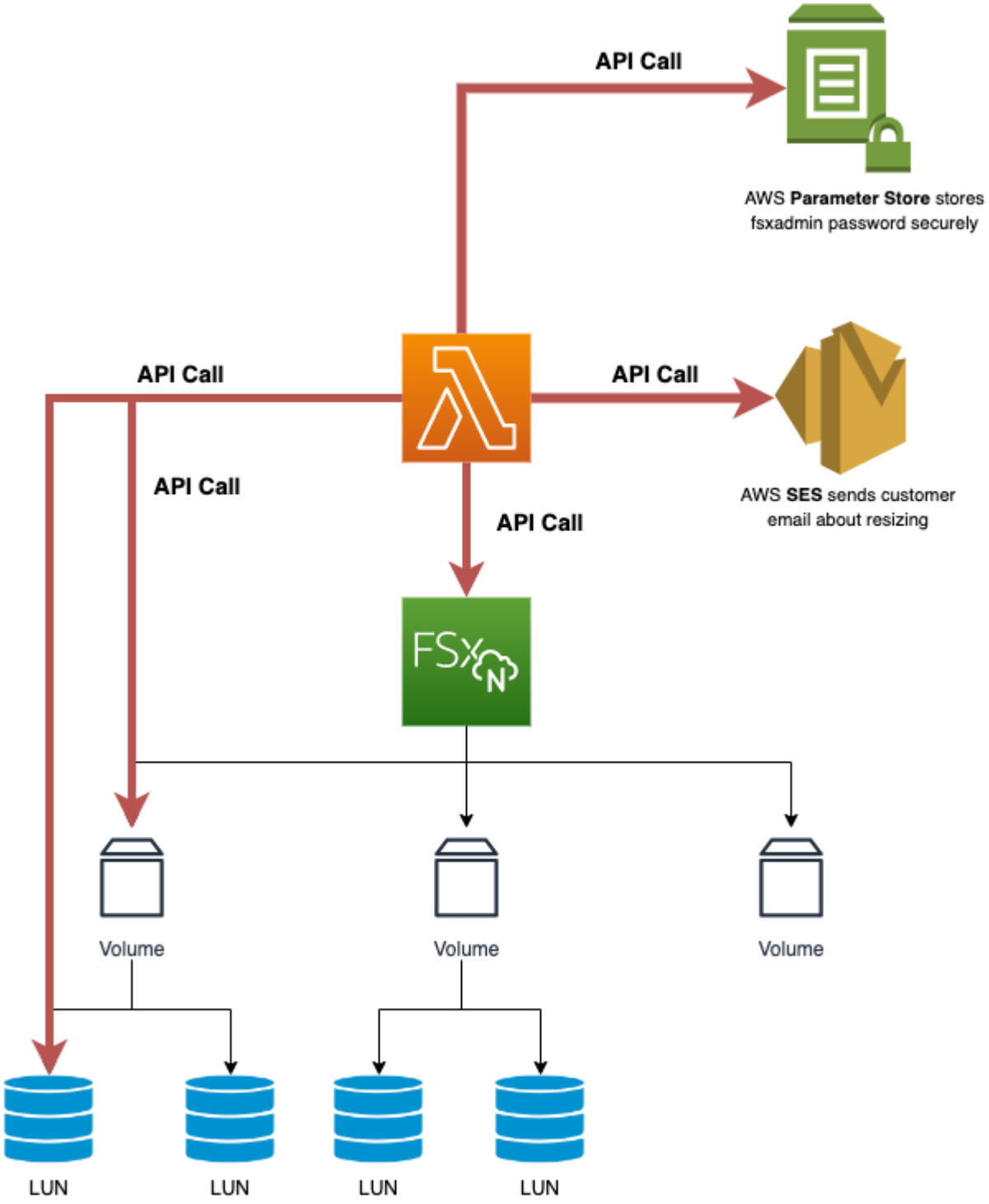
Pre-requisites

Before you begin, ensure that the following prerequisites are met:

- FSx for ONTAP is deployed
- Private subnet with connectivity to FSx for ONTAP
- "fsxadmin" password has been set for FSx for ONTAP

High Level Architecture

- AWS Lambda Function makes API calls to FSx for ONTAP for retrieving and updating the size of Storage Capacity, Volumes and LUNs.
- "fsxadmin" password stored as secure string in AWS SSM Parameter Store for added layer of security.
- AWS SES (Simple Email Service) is used to notify end-users when a resizing event occurs.
- If deploying the solution in a VPC without internet access, VPC Endpoints for AWS SSM, FSx and SES are setup to allow Lambda to reach these services via AWS internal network.



Solution Deployment

Automated Deployment

Follow the series of steps to complete the automated deployment of this solution:

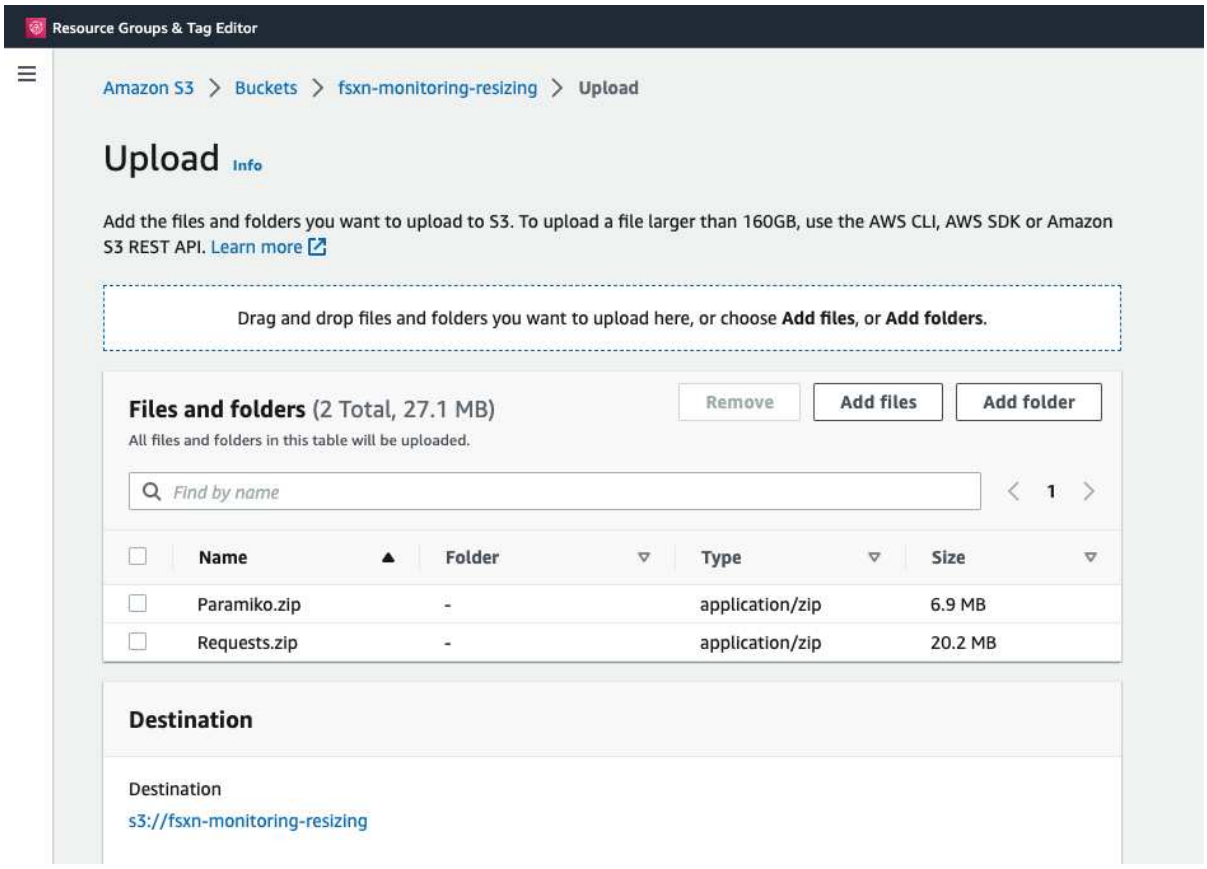
Step 1: Clone the GitHub repository

Clone the GitHub repository on your local system:

```
git clone https://github.com/NetApp-Automation/fsxn-monitoring-auto-resizing.git
```

Step 2: Setup an AWS S3 bucket

1. Navigate to AWS Console > **S3** and click on **Create bucket**. Create the bucket with the default settings.
2. Once inside the bucket, click on **Upload** > **Add files** and select **Paramiko.zip** and **Requests.zip** from the cloned GitHub repository on your system.

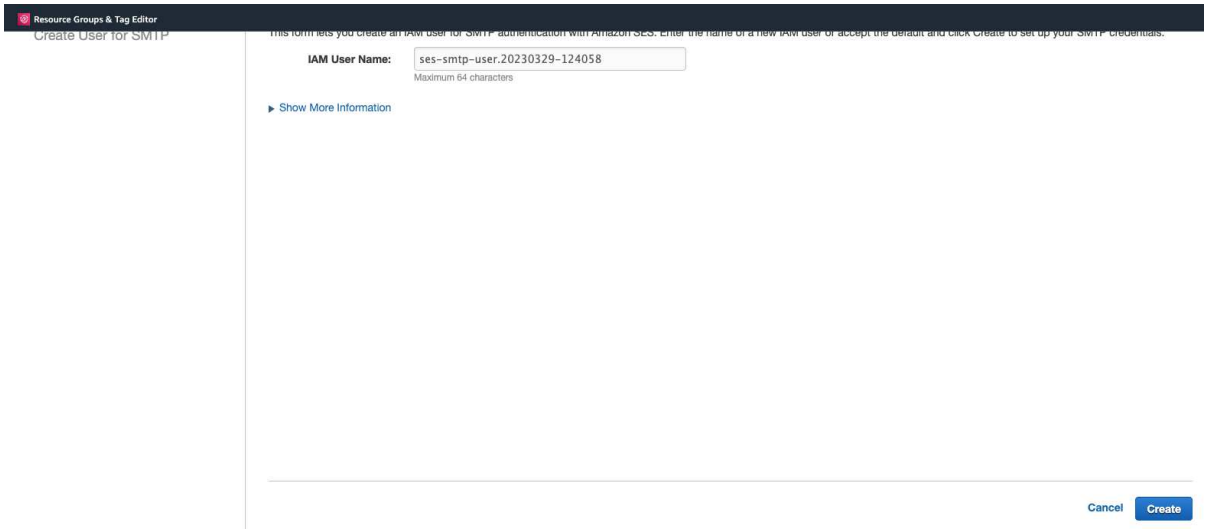


Step 3: AWS SES SMTP Setup (required if no internet access available)

Follow this step if you want to deploy the solution without internet access (Note: There will be added costs associated due to VPC endpoints being setup.)

1. Navigate to AWS Console > **AWS Simple Email Service (SES)** > SMTP Settings and click on **Create SMTP credentials**
2. Enter an IAM User Name or leave it at the default value and click on Create. Save the username and password for further use.

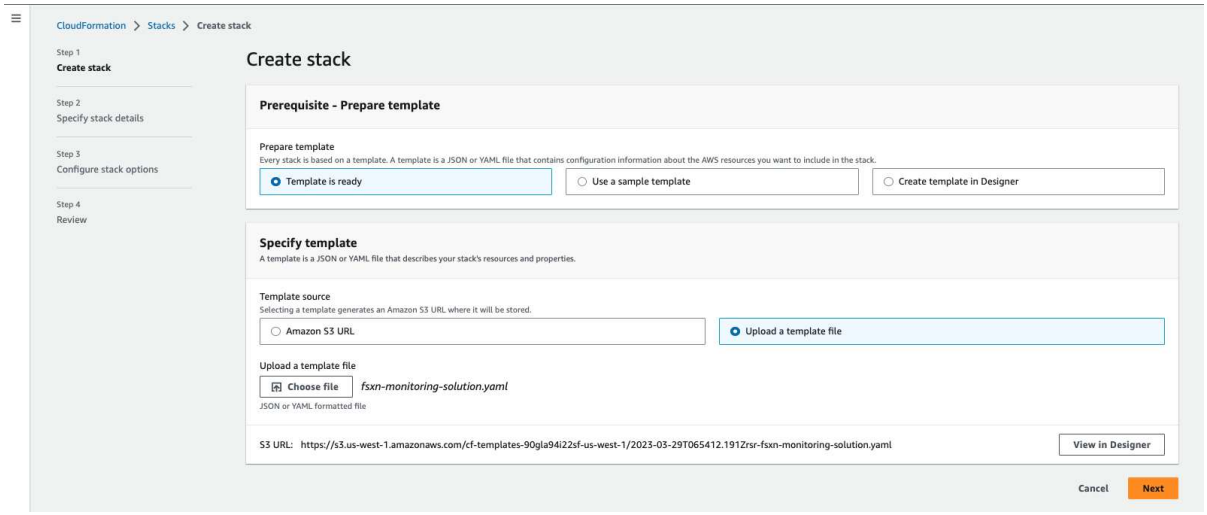
> Skip this step if SES SMTP setup is already in place.



Step 4: AWS CloudFormation Deployment

1. Navigate to AWS Console > **CloudFormation** > Create stack > With New Resources (Standard).

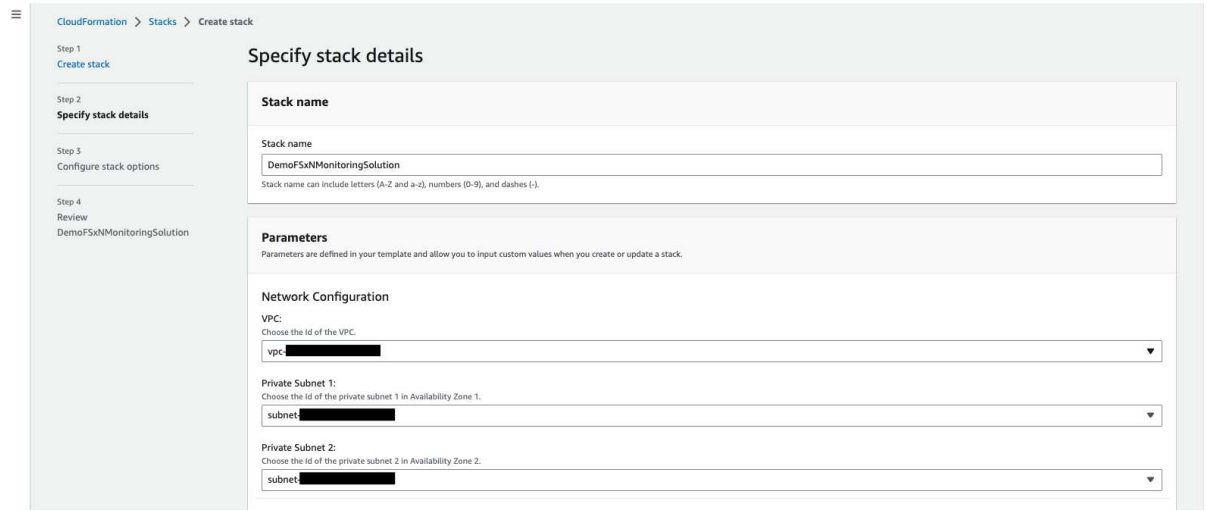
```
Prepare template: Template is ready
Specify template: Upload a template file
Choose file: Browse to the cloned GitHub repo and select fsxn-monitoring-solution.yaml
```

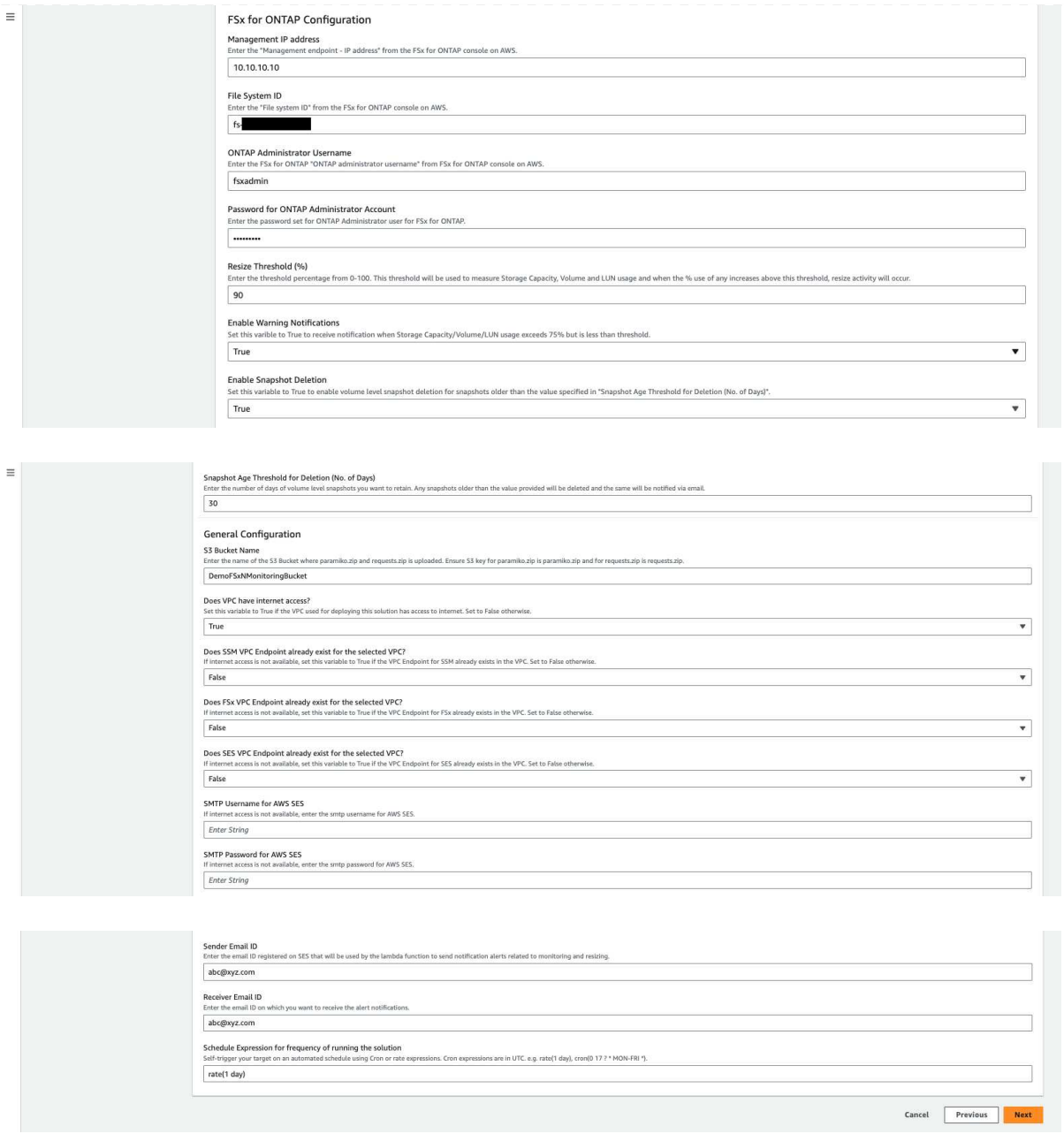


Click on Next

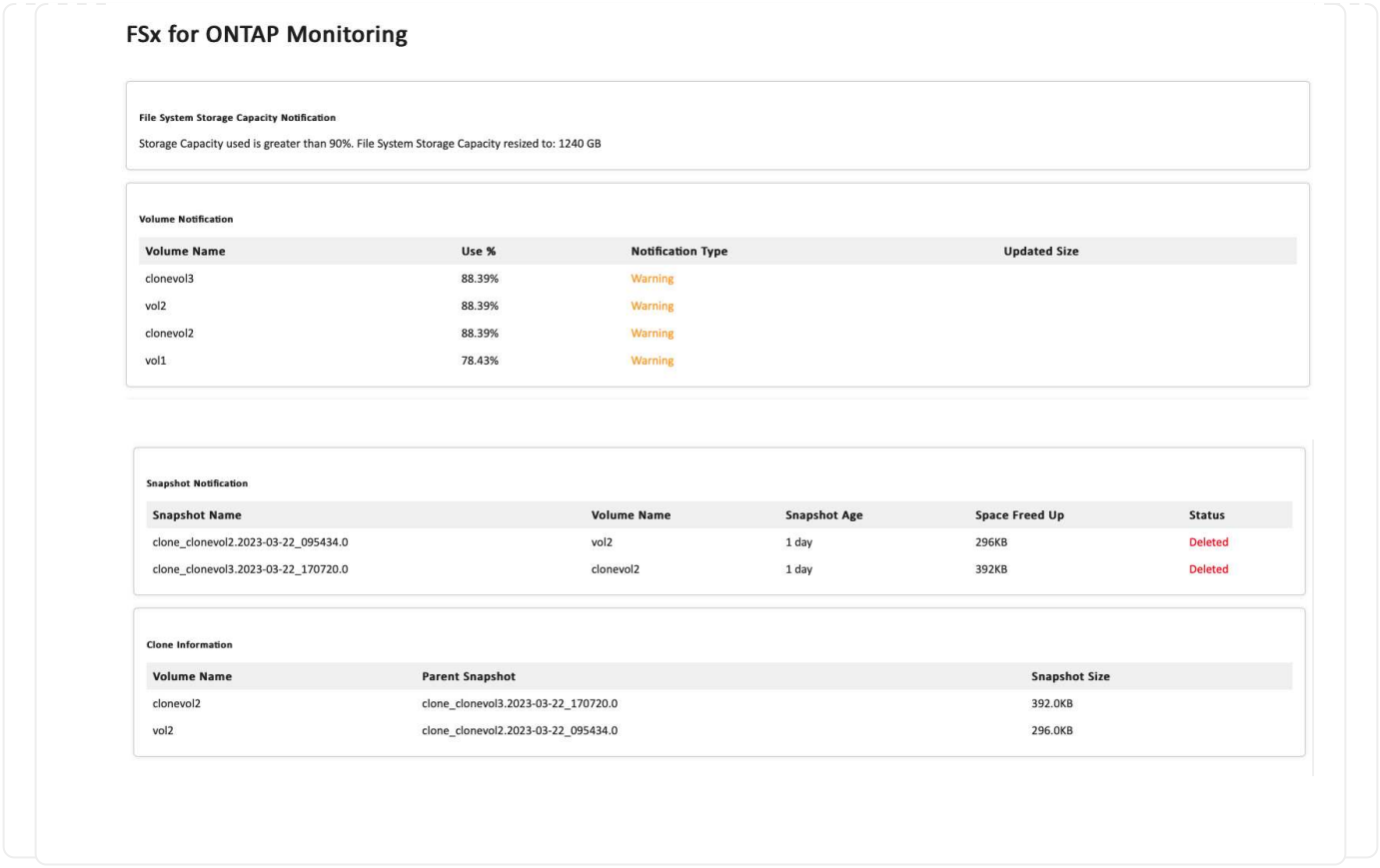
2. Enter the stack details. Click on Next and check the checkbox for "I acknowledge that AWS CloudFormation might create IAM resources" and click on Submit.

> If "Does VPC have internet access?" is set to False, "SMTP Username for AWS SES" and "SMTP Password for AWS SES" are required. Otherwise, they can be left empty.





3. Once the CloudFormation deployment starts, the email ID mentioned in the "sender email ID" will get an email asking them to authorize use of the email address with AWS SES. Click on the link to verify the email address.
4. Once the CloudFormation stack deployment is completed, if there are any warnings/notifications, an email will be sent to the recipient email ID with the notification details.



Manual Deployment

Follow the series of steps to complete the manual deployment of this solution:

Step 1: Clone the GitHub repository

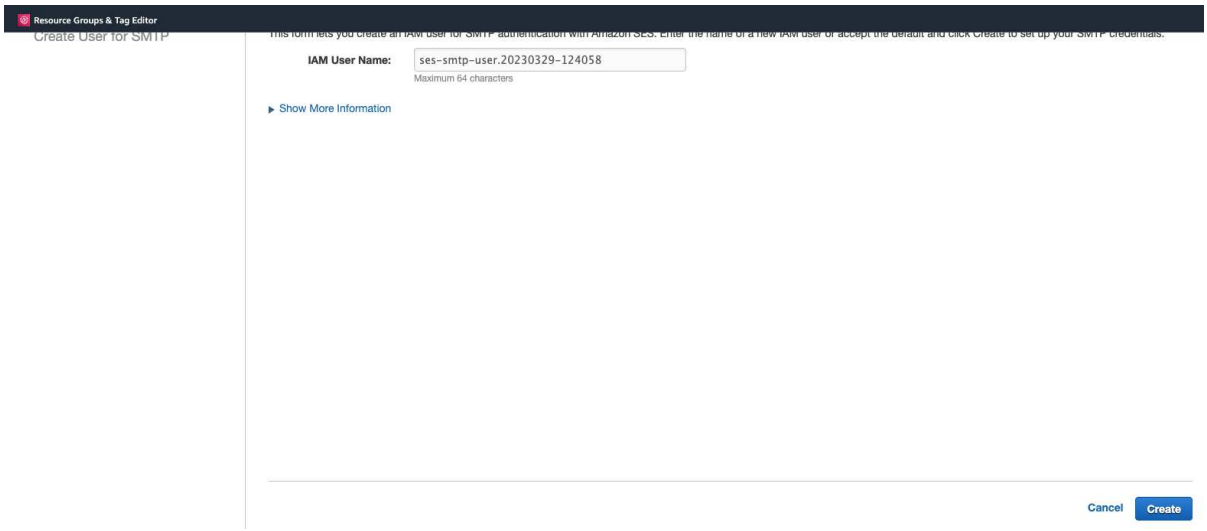
Clone the GitHub repository on your local system:

```
git clone https://github.com/NetApp-Automation/fsxn-monitoring-auto-resizing.git
```

Step 2: AWS SES SMTP Setup (required if no internet access available)

Follow this step if you want to deploy the solution without internet access (Note: There will be added costs associated due to VPC endpoints being setup.)

1. Navigate to AWS Console > **AWS Simple Email Service (SES)** > SMTP Settings and click on **Create SMTP credentials**
2. Enter an IAM User Name or leave it at the default value and click on Create. Save the username and password for further use.

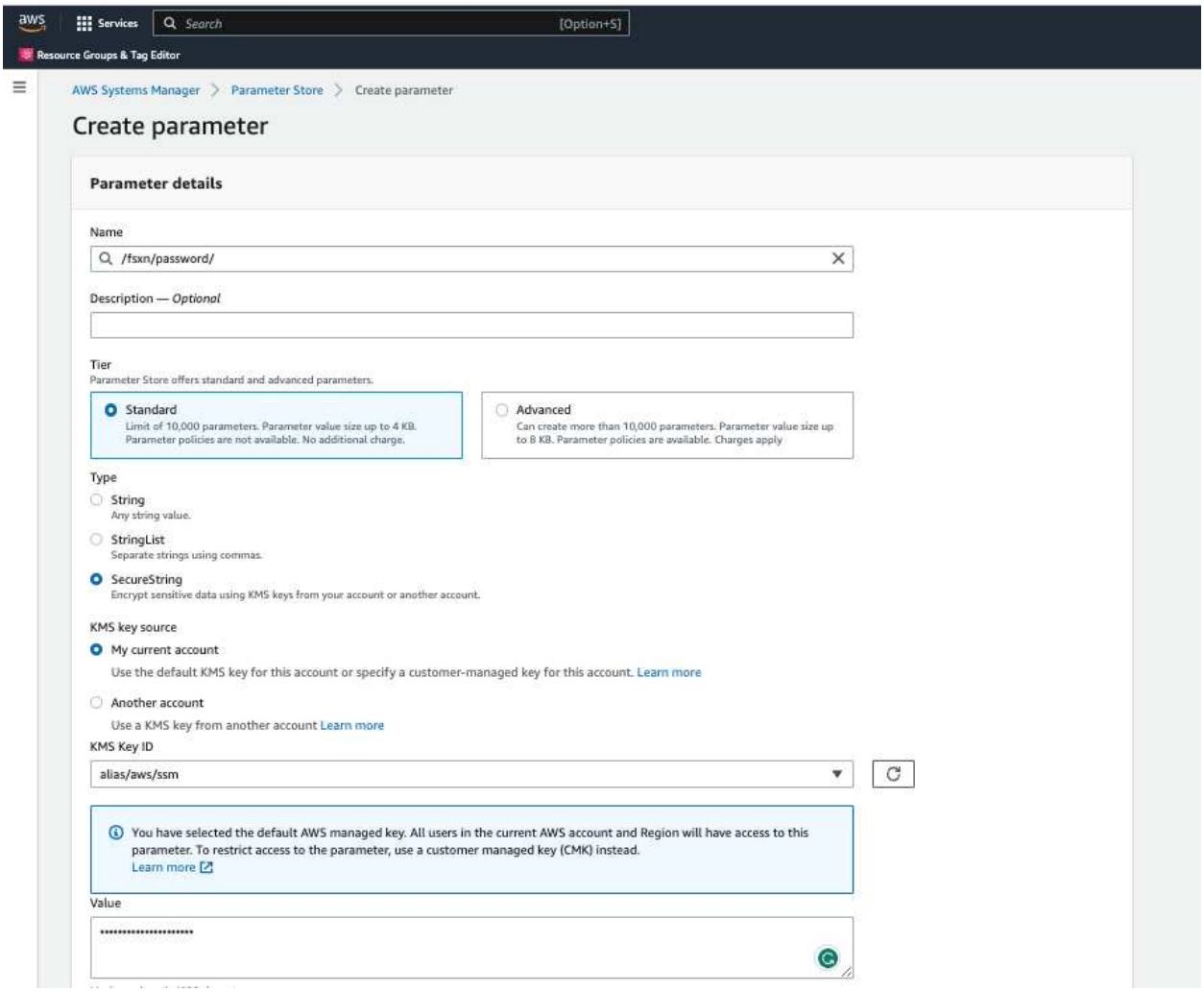


Step 3: Create SSM parameter for fsxadmin password

Navigate to AWS Console > **Parameter Store** and click on **Create Parameter**.

```
Name: <Any name/path for storing fsxadmin password>
Tier: Standard
Type: SecureString
KMS key source: My current account
  KMS Key ID: <Use the default one selected>
Value: <Enter the password for "fsxadmin" user configured on FSx
for ONTAP>
```

Click on **Create parameter**.



Perform the same steps for storing smtp username and smtp password if deploying the solution without internet access. Otherwise, skip adding these 2 parameters.

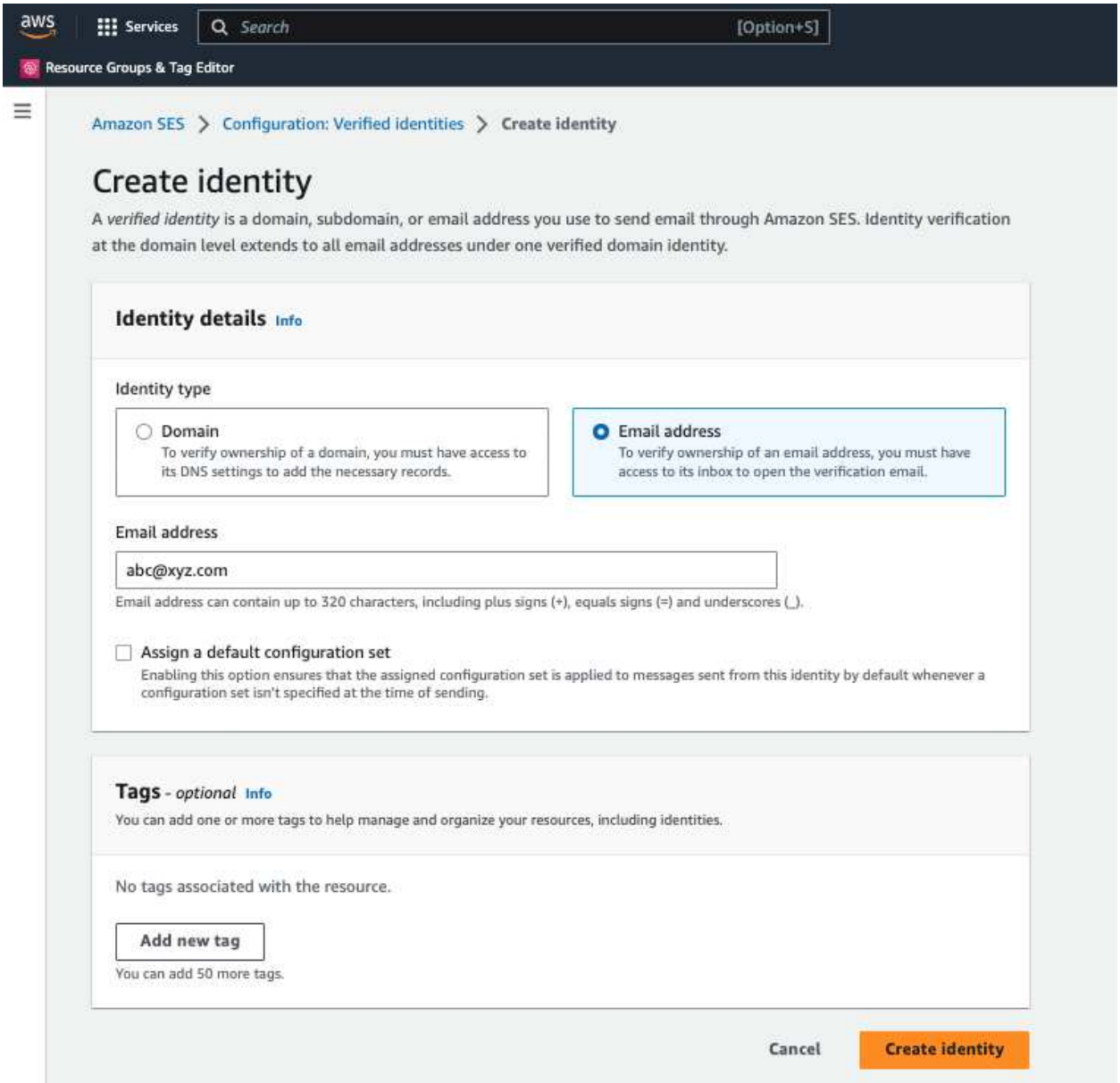
Step 4: Setup Email Service

Navigate to AWS Console > **Simple Email Service (SES)** and click on **Create Identity**.

```
Identity type: Email address
Email address: <Enter an email address to be used for sending
resizing notifications>
```

Click on **Create identity**

The email ID mentioned in the "sender email ID" will get an email asking the owner to authorize use of the email address with AWS SES. Click on the link to verify the email address.



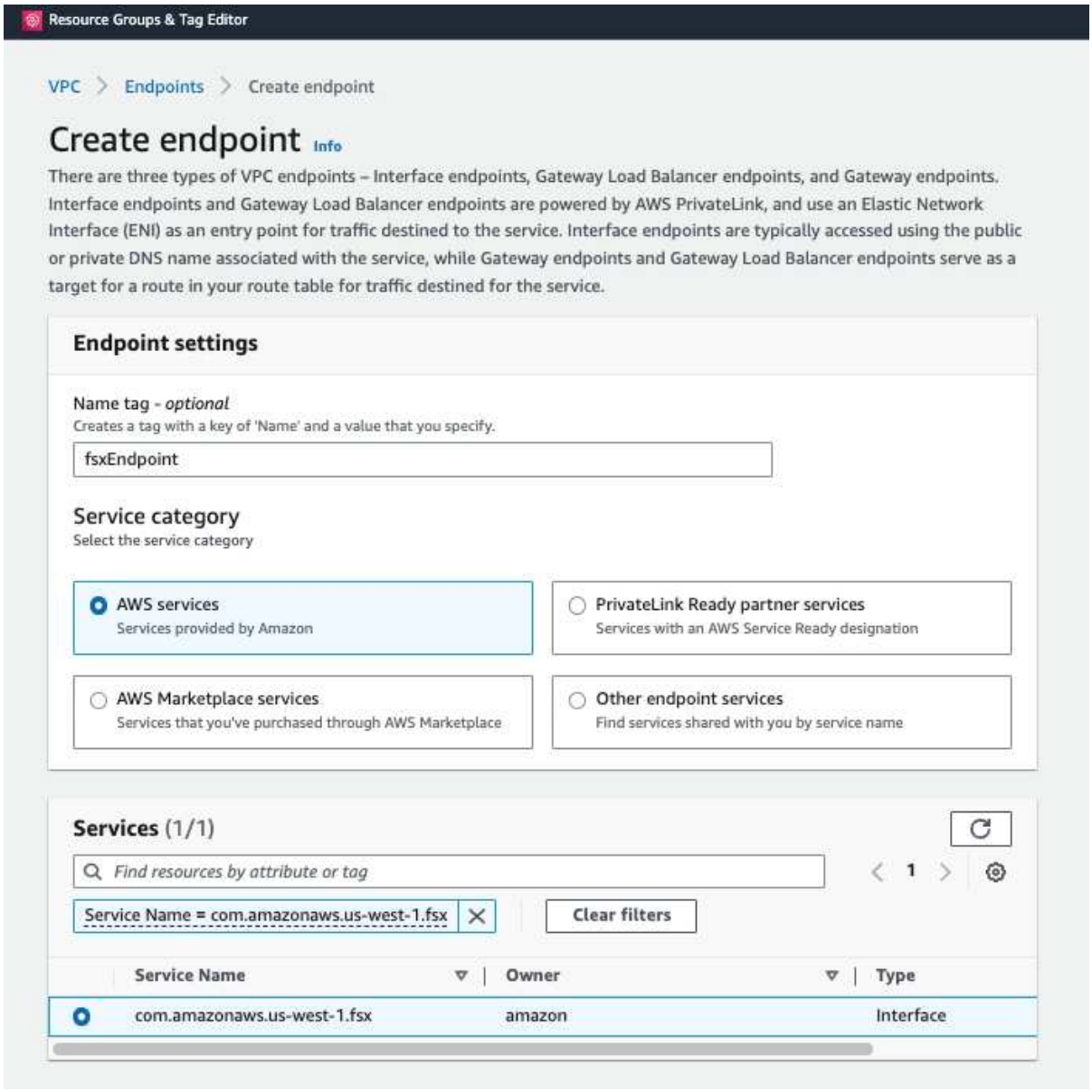
Step 5: Setup VPC Endpoints (required if no internet access available)

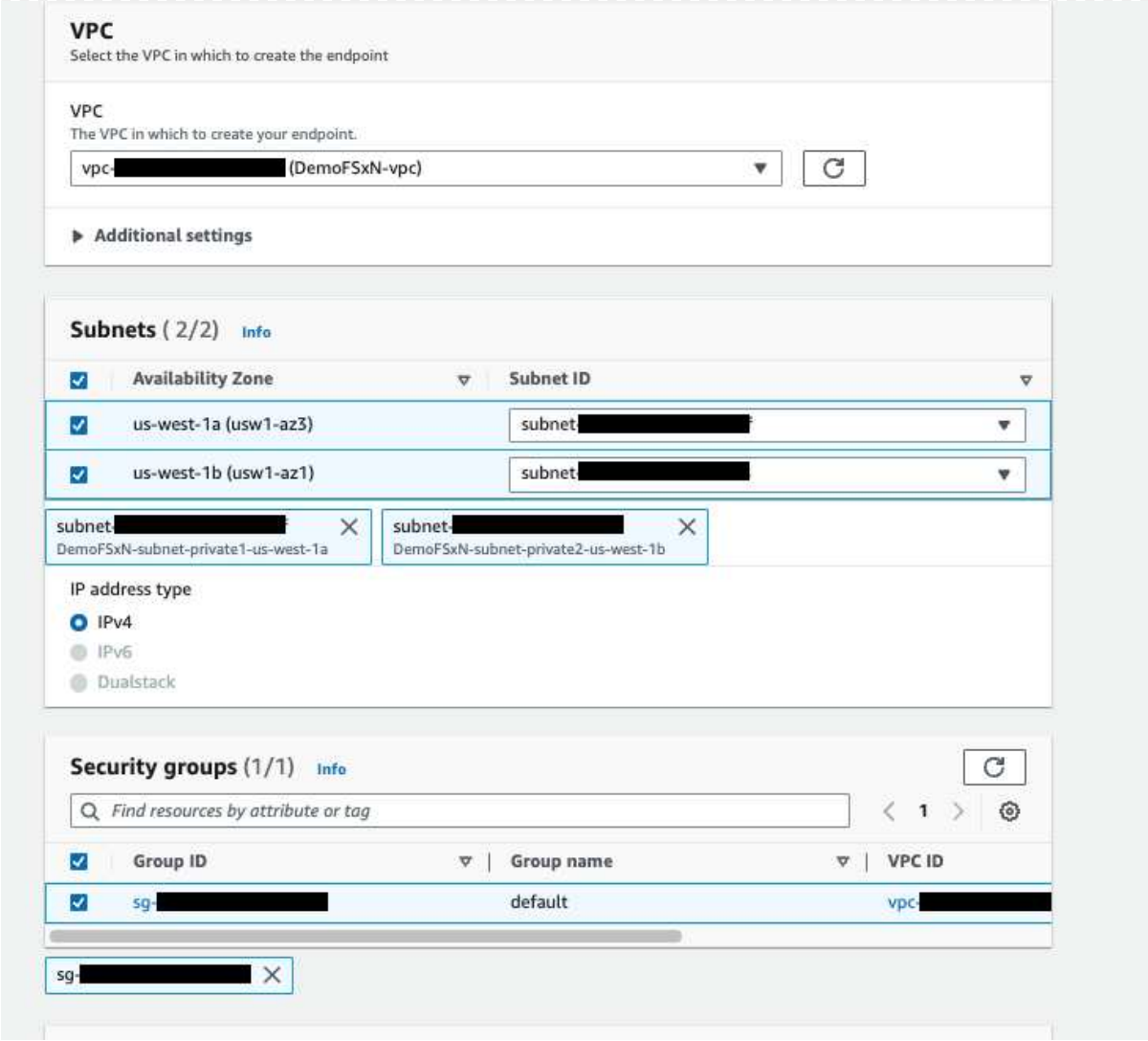
Required only if deployed without internet access. There will be additional costs associated due to VPC endpoints.

1. Navigate to AWS Console > **VPC** > **Endpoints** and click on **Create Endpoint** and enter the following details:

```
Name: <Any name for the vpc endpoint>
Service category: AWS Services
Services: com.amazonaws.<region>.fsx
vpc: <select the vpc where lambda will be deployed>
subnets: <select the subnets where lambda will be deployed>
Security groups: <select the security group>
Policy: <Either choose Full access or set your own custom
policy>
```

   Click on Create endpoint.


Resource Groups & Tag Editor
VPC > Endpoints > Create endpoint
Create endpoint Info
There are three types of VPC endpoints – Interface endpoints, Gateway Load Balancer endpoints, and Gateway endpoints. Interface endpoints and Gateway Load Balancer endpoints are powered by AWS PrivateLink, and use an Elastic Network Interface (ENI) as an entry point for traffic destined to the service. Interface endpoints are typically accessed using the public or private DNS name associated with the service, while Gateway endpoints and Gateway Load Balancer endpoints serve as a target for a route in your route table for traffic destined for the service.
Endpoint settings
Name tag - optional
Creates a tag with a key of 'Name' and a value that you specify.
fsxEndpoint
Service category
Select the service category
AWS services
Services provided by Amazon
PrivateLink Ready partner services
Services with an AWS Service Ready designation
AWS Marketplace services
Services that you've purchased through AWS Marketplace
Other endpoint services
Find services shared with you by service name
Services (1/1)
Find resources by attribute or tag
1
Service Name = com.amazonaws.us-west-1.fsx
Clear filters
Service Name
Owner
Type
com.amazonaws.us-west-1.fsx
amazon
Interface



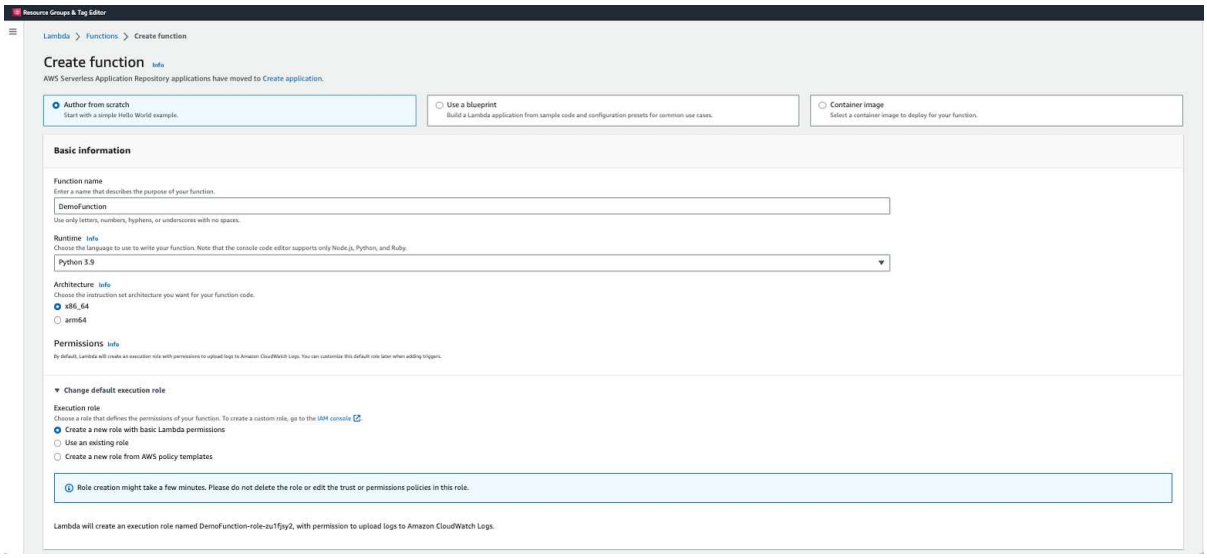
2. Follow the same process for creating SES and SSM VPC endpoints. All parameters remain same as above except Services which will correspond to **com.amazonaws.<region>.smtp** and **com.amazonaws.<region>.ssm** respectively.

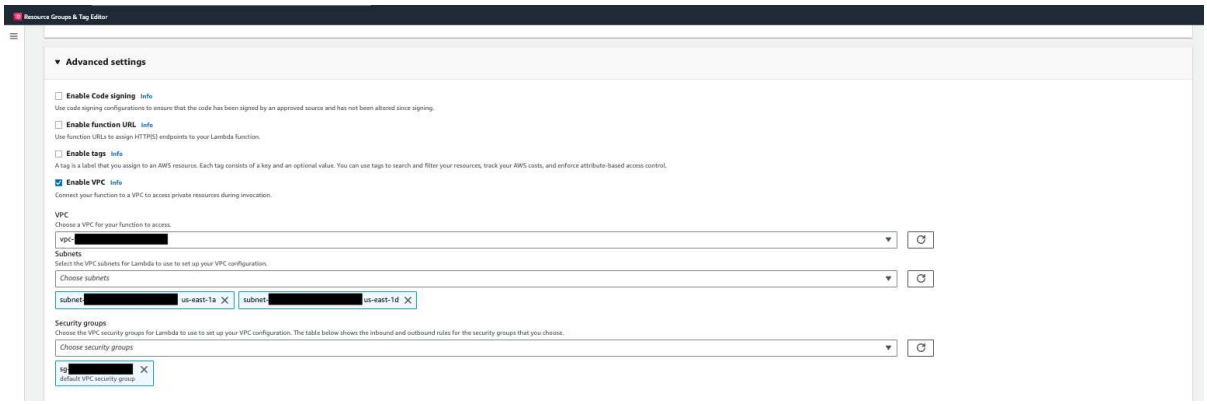
Step 6: Create and setup the AWS Lambda Function

1. Navigate to AWS Console > **AWS Lambda** and click on **Create function** in the same region as FSx for ONTAP
2. Use the default **Author from scratch** and update the following fields:

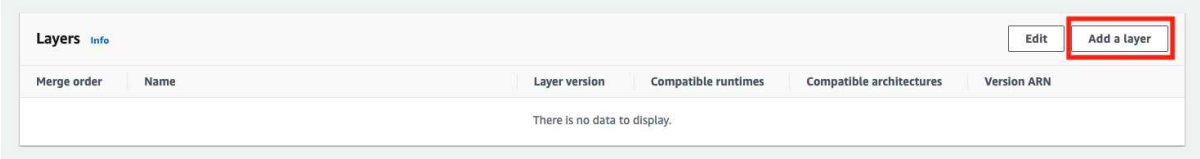
```
Function name: <Any name of your choice>
Runtime: Python 3.9
Architecture: x86_64
Permissions: Select "Create a new role with basic Lambda
permissions"
Advanced Settings:
  Enable VPC: Checked
    VPC: <Choose either the same VPC as FSx for ONTAP or a VPC
that can access both FSx for ONTAP and the internet via a
private subnet>
    Subnets: <Choose 2 private subnets which have NAT gateway
attached pointing to public subnets with internet gateway and
subnets that have internet access>
    Security Group: <Choose a Security Group>
```

Click on **Create function**.

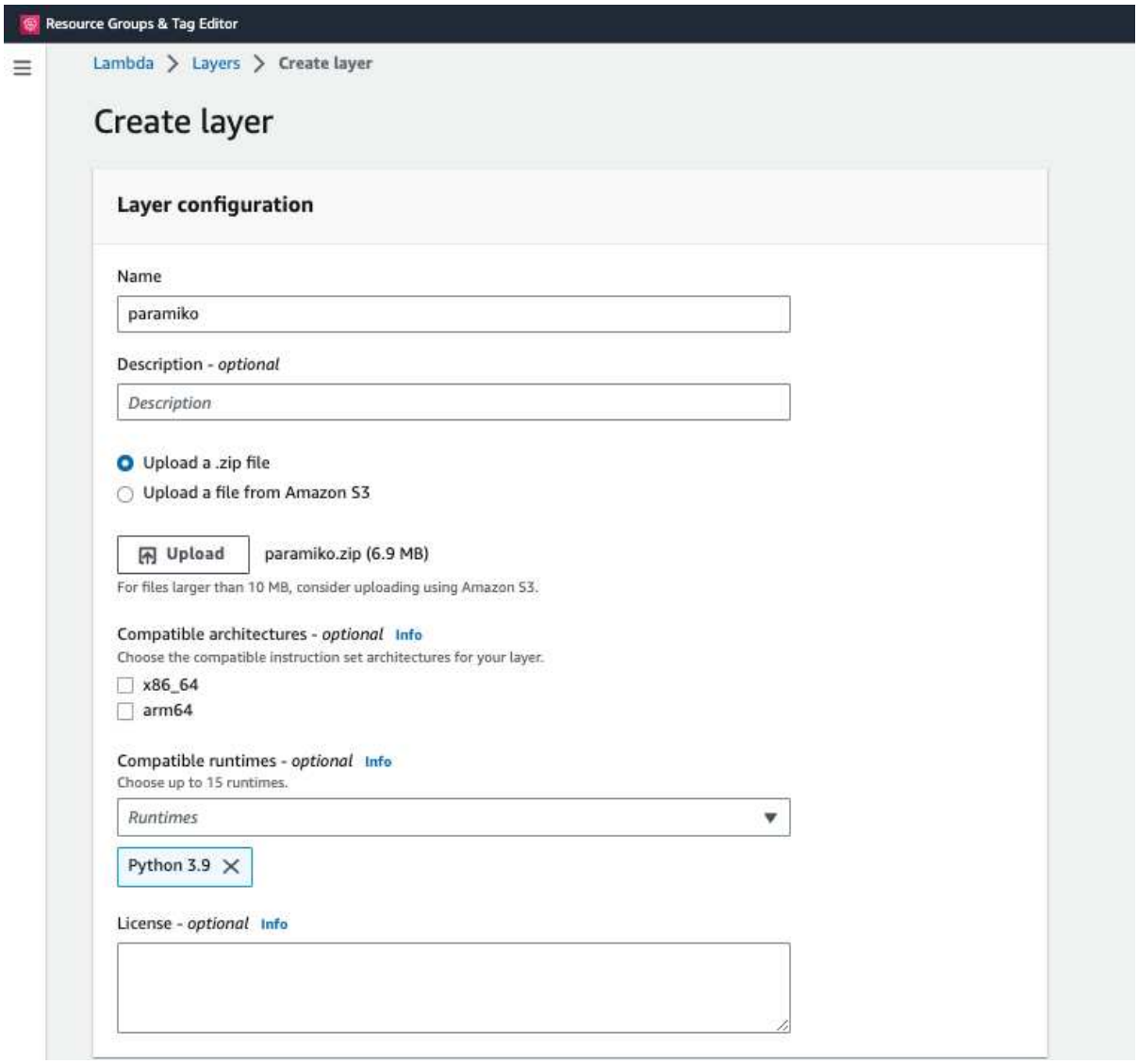




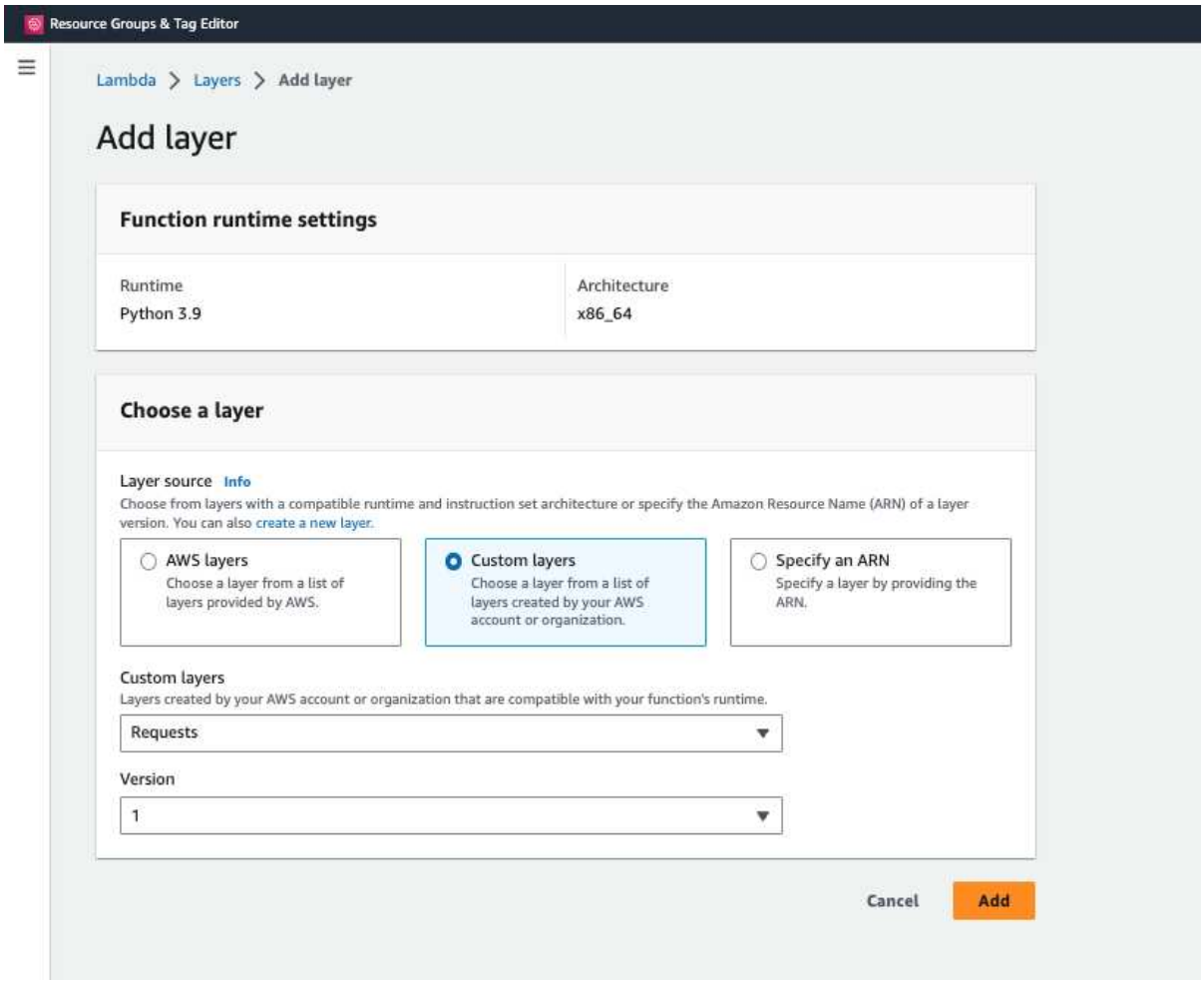
3. Scroll down to the **Layers** section of the newly created Lambda function and click on **Add a layer**.



4. Click on **create a new layer** under **Layer source**
5. Create 2 Layers - 1 for Requests and 1 for Paramiko and upload **Requests.zip** and **Paramiko.zip** files. Select **Python 3.9** as the compatible runtime and click on **Create**.



6. Navigate back to AWS Lambda **Add Layer** > **Custom Layers** and add the paramiko and requests layer one after the other.

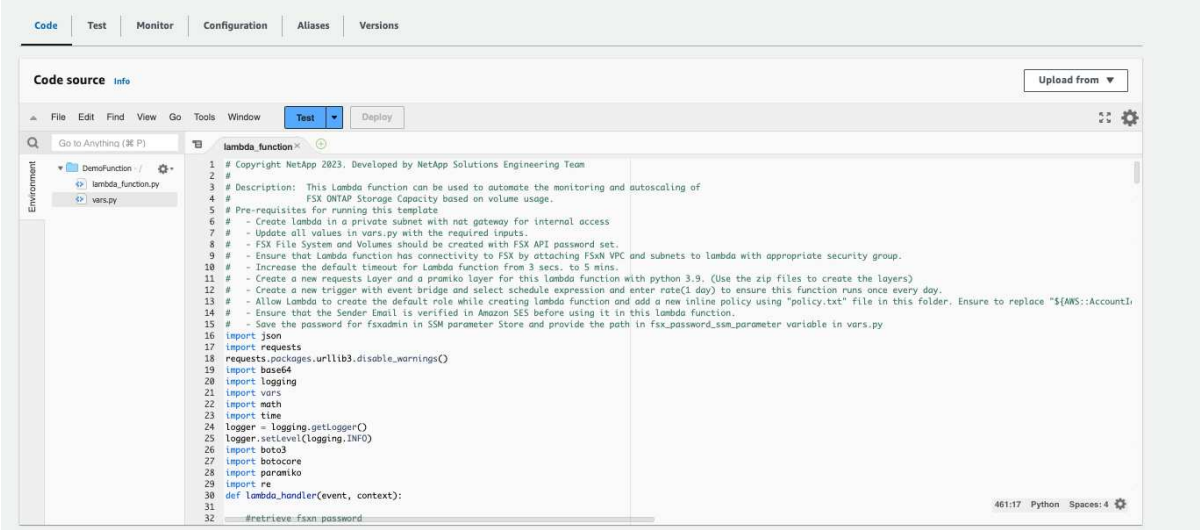


7. Navigate to the **Configuration** tab of the Lambda function and click on **Edit** under **General Configuration**. Change the Timeout to **5 mins** and click Save.
8. Navigate to **Permissions** tab of the Lambda function and click on the role assigned. In the permissions tab of the role, click on **Add permissions** > **Create Inline policy**.
   a. Click on the JSON tab and paste the contents of the file policy.json from the GitHub repo.
   b. Replace every occurrence of ${AWS::AccountId} with your account ID and click on **Review Policy**
   c. Provide a Name for the policy and click on **Create policy**
9. Copy the contents of **fsxn_monitoring_resizing_lambda.py** from the git repo to **lambda_function.py** in the AWS Lambda function Code Source section.
10. Create a new file in the same level as lambda_function.py and name it **vars.py** and copy the contents of vars.py from the git repo to the lambda function vars.py file. Update the variable values in vars.py. Reference variable definitions below and click on **Deploy**:

Name	Type	Description

fsxMgmtIp	String	(Required) Enter the "Management endpoint - IP address" from the FSx for ONTAP console on AWS.
fsxId	String	(Required) Enter the "File system ID" from the FSx for ONTAP console on AWS.
username	String	(Required) Enter the FSx for ONTAP "ONTAP administrator username" from FSx for ONTAP console on AWS.
resize_threshold	Integer	(Required) Enter the threshold percentage from 0-100. This threshold will be used to measure Storage Capacity, Volume and LUN usage and when the % use of any increases above this threshold, resize activity will occur.
sender_email	String	(Required) Enter the email ID registered on SES that will be used by the lambda function to send notification alerts related to monitoring and resizing.
recipient_email	String	(Required) Enter the email ID on which you want to receive the alert notifications.
fsx_password_ssm_parameter	String	(Required) Enter the path name used in AWS Parameter Store for storing "fsxadmin" password.
warn_notification	Bool	(Required) Set this variable to True to receive notification when Storage Capacity/Volume/LUN usage exceeds 75% but is less than threshold.
enable_snapshot_deletion	Bool	(Required) Set this variable to True to enable volume level snapshot deletion for snapshots older than the value specified in "snapshot_age_threshold_in_days".

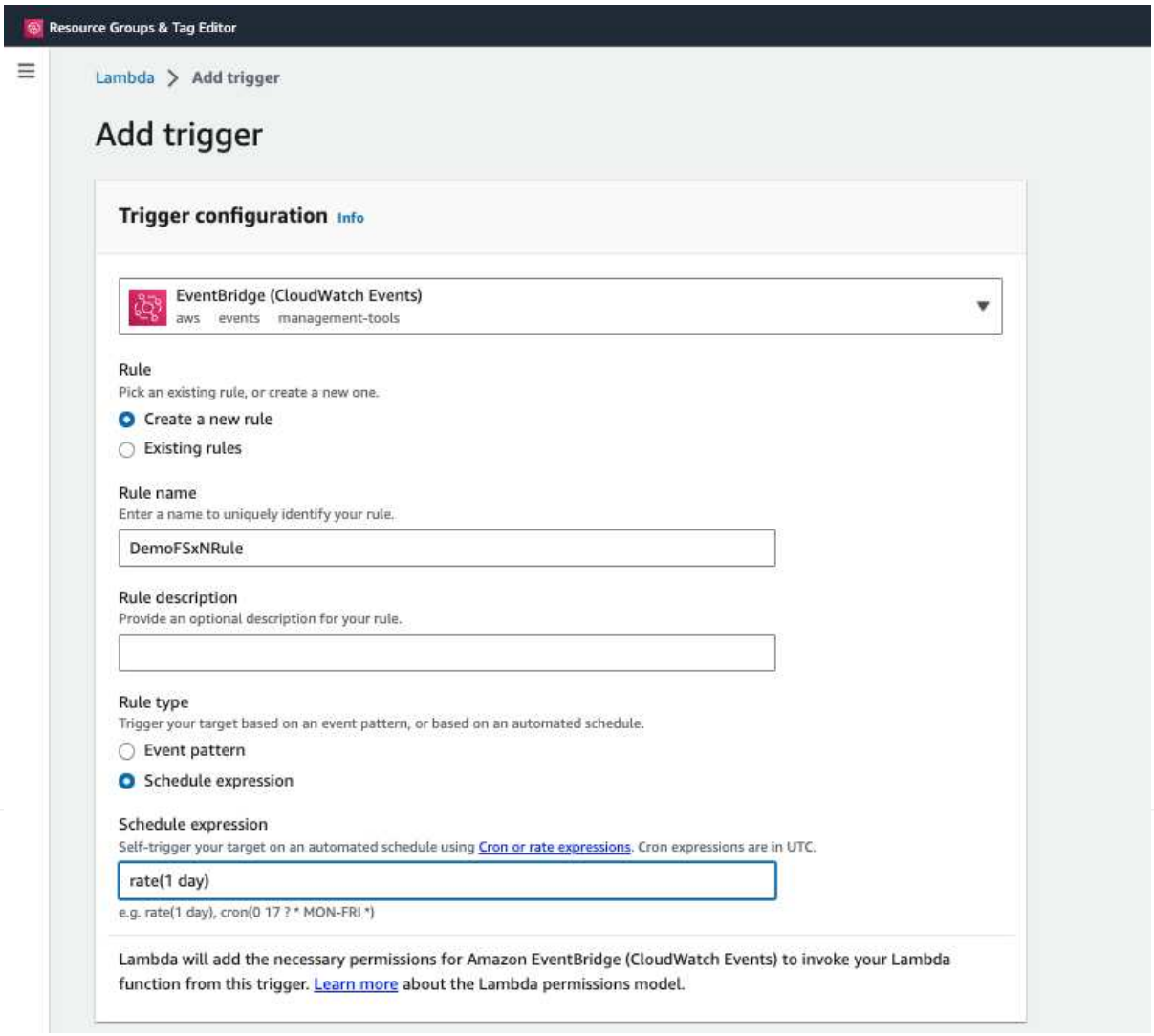
snapshot_age_threshold_in_days	Integer	(Required) Enter the number of days of volume level snapshots you want to retain. Any snapshots older than the value provided will be deleted and the same will be notified via email.
internet_access	Bool	(Required) Set this variable to True if internet access is available from the subnet where this lambda is deployed. Otherwise set it to False.
smtp_region	String	(Optional) If "internet_access" variable is set to False, enter the region in which lambda is deployed. E.g. us-east-1 (in this format)
smtp_username_ssm_parameter	String	(Optional) If "internet_access" variable is set to False, enter the path name used in AWS Parameter Store for storing the SMTP username.
smtp_password_ssm_parameter	String	(Optional) If "internet_access" variable is set to False, enter the path name used in AWS Parameter Store for storing the SMTP password.



11. Click on **Test**, create an empty test event and run the test and check if the script is running properly.
12. Once tested successfully, navigate to **Configuration** > **Triggers** > **Add Trigger**.

```
Select a Source: EventBridge
Rule: Create a new rule
Rule name: <Enter any name>
Rule type: Schedule expression
Schedule expression: <Use "rate(1 day)" if you want the function
to run daily or add your own cron expression>
```

Click on Add.



Conclusion

With the provided solution, it is easy to setup a monitoring solution that regularly monitors FSx for ONTAP Storage, resizes it based on user-specified threshold and provides an alerting mechanism. This makes the process of using and monitoring FSx for ONTAP seamless freeing up administrators to focus on business-critical activities while storage grows automatically when required.

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