



White Paper

# NetApp HCI as Infrastructure as Code with Red Hat Ansible

James Bradshaw and Amit Borulkar, NetApp  
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## Abstract

This document describes the Red Hat Ansible integration with NetApp® HCI for managing and provisioning NetApp HCI resources through a declarative infrastructure-as-code paradigm.

## TABLE OF CONTENTS

<b>1</b>	<b>Introduction</b>	<b>3</b>
<b>2</b>	<b>Red Hat Ansible</b>	<b>3</b>
<b>3</b>	<b>Ansible Modules for NetApp HCI and SolidFire</b>	<b>4</b>
<b>4</b>	<b>Ansible Roles for NetApp HCI</b>	<b>5</b>
<b>5</b>	<b>Ansible Roles for NetApp HCI with Private Cloud and Red Hat</b>	<b>6</b>
<b>6</b>	<b>Ansible Modules for ONTAP and E-Series</b>	<b>6</b>
<b>7</b>	<b>How to Get Started with NetApp and Ansible</b>	<b>7</b>
	<b>Where to Find Additional Information</b>	<b>8</b>
	<b>Version History</b>	<b>8</b>

## LIST OF TABLES

Table 1) Ansible modules by use case	4
Table 2) Ansible roles for NetApp HCI	5
Table 3) E-Series Ansible modules	7

## 1 Introduction

As enterprises pivot toward software-defined service delivery, optimal management of compute, network, and storage resources is crucial to operational success. Virtualization, cloud technologies, and IT automation have significantly improved the operational agility of enterprises and have enabled them to meet tight SLAs. Processes such as continuous integration and continuous delivery are playing a critical role in the success of DevOps. However, adopting DevOps has both technical and cultural challenges. From an automation perspective, an organization needs to choose the right automation platform to do the job. At the same time, the automation platform must have integrations across the stack, including most of the infrastructure components for a unified management experience.

Infrastructure automation presents the following challenges:

- Infrastructure components might be in different states. The automation logic for changing the state of an infrastructure component to a certain desired state should contain logic to transition it from all the possible initial states to the desired state by applying respective logic.

For example, if a user wants to create a volume `prod_datastore` of size 1TB, the underlying system could have one of the following initial states:

- A volume `prod_datastore` doesn't exist
- `prod_datastore` exists but with a different size
- `prod_datastore` exists and is 1TB

The automation logic should be able to recognize these states and apply respective logic to result in a volume `prod_datastore` that is 1TB.

- At times, the infrastructure might require a specialist to administer the hardware. But infrastructure management that uses automation is easy to write and doesn't require extensive programming experience.
- The time-consuming and manual task of provisioning infrastructure can leave it prone to error. Automation can make it easier to manage, modify, and perform audit controls to enable infrastructure as code.

NetApp® HCI enables a software-defined infrastructure platform to enable DevOps workflows. At its core, NetApp HCI is based on NetApp Element® software. All the functions in the Element UI are exposed as outbound REST APIs. Furthermore, NetApp Element supports software development kits (SDKs) in all the major programming languages and automation platforms. Choosing declarative state-based automation for infrastructure automation offers the following benefits:

- The desired end state is specified as easy-to-read-and-write YAML files.
- The end user is not concerned with the initial state and automation application logic to invoke.
- The idempotent operations are enabled.
- Audit control using version control systems is enabled.
- The infrastructure-as-code paradigm is enabled.

This white paper discusses Red Hat Ansible as the configuration management platform for NetApp HCI. NetApp is one of only six storage-certified vendors actively contributing modules to the Ansible community. These modules enable administrators to use Ansible to handle configuration management and orchestration tasks on NetApp HCI, NetApp ONTAP®, and NetApp E-Series products. All the NetApp ONTAP and Element modules are officially supported by NetApp.

## 2 Red Hat Ansible

Red Hat Ansible is a declarative, state-based configuration management platform. It uses easy-to-read-and-write YAML files to specify the desired state. Ansible doesn't require installation of an agent on the

managed device. It communicates with the managed device (NetApp Element cluster) through SDK over HTTP/HTTPS.

Here are the definitions of some commonly used terms in Ansible:

- **Modules.** Ansible modules correspond to an entity and a set of properties associated with that entity. These modules are distributed as a part of standard Ansible distribution. For example, `na_elementsw_volume` is a module that corresponds to the NetApp Element volume and has properties such as name, size, and size\_unit. Ansible modules enable idempotent operations on the entities. NetApp has developed 21 modules that correspond to different NetApp Element entities.
- **Tasks.** A task specifies the desired state using the modules and acts on the module and the properties associated with the module. For example, the following task declares a `prod_datastore` volume of size 1TB:

```
name: Create a volume for production datastore of size 1TB
na_elementsw_volume:
  hostname: "{{netapp_hci_storage}}"
  username: "{{ username }}"
  password: "{{ password }}"
  size: 1
  size_unit: tb
```

- **Playbooks.** A play is a combination of tasks, and a collection of multiple plays is a playbook.
- **Roles.** A role is a mechanism for breaking down a complex playbook with many tasks into multiple files. Ansible roles enable a clean separation of variables (with precedence) from tasks. This makes Ansible roles reusable.
- **Ansible Galaxy.** Ansible Galaxy is a central hub for sharing Ansible roles from the community. The use cases for these roles can vary from provisioning infrastructure and deploying enterprise applications to scheduling common cron jobs. Use the [search page](#) to find roles for your project, then download them onto your Ansible host by using [ansible-galaxy](#), the command line tool that comes bundled with Ansible.

For more information about Ansible, see the [Ansible documentation](#).

### 3 Ansible Modules for NetApp HCI and SolidFire

NetApp SolidFire® and NetApp HCI storage systems are based on NetApp Element software. NetApp Element Ansible modules are certified and are available as a part of upstream Ansible distribution. These 21 NetApp Element Ansible modules cover a wide range of operations such as cluster creation, volume management, data protection, and networking-related operations.

Table 1 lists the Ansible modules by use case.

Table 1) Ansible modules by use case.

Use Case	Ansible Modules
Data protection	<ul style="list-style-type: none"><li>• <code>na_elementsw_snapshot</code></li><li>• <code>na_elementsw_snapshot_restore</code></li><li>• <code>na_elementsw_snapshot_schedule</code></li><li>• <code>na_elementsw_volume_pair</code></li><li>• <code>na_elementsw_cluster_pair</code></li><li>• <code>na_elementsw_backup</code></li></ul>
Network	<ul style="list-style-type: none"><li>• <code>na_elementsw_vlan</code></li><li>• <code>na_elementsw_network_interfaces</code></li></ul>

Use Case	Ansible Modules
Volume	<ul style="list-style-type: none"> <li>• <code>na_elementsw_volume</code></li> <li>• <code>na_elementsw_volume_clone</code></li> <li>• <code>na_elementsw_initiators</code></li> <li>• <code>na_elementsw_account</code></li> <li>• <code>na_elementsw_access_group</code></li> </ul>
Cluster	<ul style="list-style-type: none"> <li>• <code>na_elementsw_node</code></li> <li>• <code>na_elementsw_ldap</code></li> <li>• <code>na_elementsw_drive</code></li> <li>• <code>na_elementsw_cluster_snmp</code></li> <li>• <code>na_elementsw_admin_users</code></li> </ul>
Element day 0 setup	<ul style="list-style-type: none"> <li>• <code>na_elementsw_cluster_config</code></li> <li>• <code>na_elementsw_check_connections</code></li> <li>• <code>na_elementsw_cluster</code></li> </ul>

The functionality of each module and its parameters is extensively documented in the module itself. The `ansible-doc` command displays information about modules installed in the Ansible libraries.

For more information about the latest list of modules available for Element software, see the [NetApp list of storage modules](#).

## 4 Ansible Roles for NetApp HCI

Table 2 lists the structure of the Ansible roles for NetApp HCI.

**Table 2) Ansible roles for NetApp HCI.**

File	Contents
<code>roles/database/tasks/main.yml</code>	Tasks
<code>roles/database/files/</code>	Files to be uploaded to the hosts
<code>roles/database/templates/</code>	Holds jinja2 template files
<code>roles/database/handlers/main.yml</code>	Handlers
<code>roles/database/vars/main.yml</code>	Variables that should not be overridden
<code>roles/database/defaults/main.yml</code>	Default variables that can be overridden
<code>roles/database/meta/main.yml</code>	Dependency information about a role

Writing custom roles is straightforward. You can generate the structure for these roles by running the `ansible-galaxy init` command. Clear demarcation between variables and the tasks makes roles reusable.

In addition to the files listed in Table 2, each role consists of a `README.md` file that provides instructions, dependencies, and descriptions of the variables.

Ansible roles for NetApp HCI simplify and automate common data management operations and network configuration. The uses cases covered by Ansible roles include:

- Ansible role for 2-node HA deployment of NetApp ONTAP Select
- Ansible roles for configuring Mellanox and Nexus switches
- Ansible roles for data protection, such as creating NetApp Snapshot™ copies and managing the schedule
- Ansible roles for Element to Element replication
- Ansible roles for Element to ONTAP replication by using NetApp SnapMirror® technology

When Ansible roles become available or are updated, NetApp publishes them to this [location](#). Apart from NetApp Element specific roles, file services use-case roles that are specific to ONTAP can also be used with ONTAP Select on NetApp HCI to enable easy provisioning of file services.

The blog [Simplicity at Its Finest, Roles for Ansible ONTAP Use](#) demonstrates how to obtain the Ansible roles and get started.

## 5 Ansible Roles for NetApp HCI with Private Cloud and Red Hat

In addition to the roles that cover the common operations as described in the previous section, NetApp also composed a set of roles that bootstrap the NetApp HCI system for the Red Hat OpenStack platform. The roles and the playbooks to invoke these roles can be found on the [NetApp support site](#). These nodes bootstrap the NetApp HCI system before Red Hat OpenStack Platform Director deploys the overcloud, thereby providing a turnkey experience for a private cloud deployment.

## 6 Ansible Modules for ONTAP and E-Series

All the NetApp Ansible modules are available upstream as part of the standard Ansible distribution. The ONTAP and Element software modules are Ansible certified. The modules align with the following naming conventions:

- All the module names start with “na.”
- Followed by the storage operating system (such as `_ontap_`, `_elements_`, or `_e_`).
- Followed by the logical functionality of the module.

The ONTAP modules cover an extensive range of functionality:

- Cluster create, aggregate operations, and day-0 operations
- Configuring protocols and storage virtual machines
- Enabling file shares NFS and CIFS
- Enabling block protocols, LUN operations, Fibre Channel, and NVMe
- Data protection operations, such as using Snapshot and SnapMirror technologies

For other ONTAP specific features that are not covered with a module, the `na_ontap_command` module encapsulates the ONTAP CLI command as an Ansible module.

Table 3 lists the NetApp E-Series Ansible modules.

**Table 3) E-Series Ansible modules.**

Use Case	Modules
Data protection	<ul style="list-style-type: none"><li>• netapp_e_amg</li><li>• netapp_e_snapshot_group</li><li>• netapp_e_amg_role</li><li>• netapp_e_amg_sync</li><li>• netapp_e_snapshot_images</li><li>• netapp_e_snapshot_volume</li><li>• netapp_e_volume_copy</li></ul>
Cluster	<ul style="list-style-type: none"><li>• netapp_e_global</li><li>• netapp_e_host</li><li>• netapp_e_auditlog</li><li>• netapp_e_auth</li><li>• netapp_e_facts</li><li>• netapp_e_ldap</li><li>• netapp_e_mgmt_interface</li><li>• netapp_e_asup</li><li>• netapp_e_alerts</li><li>• netapp_e_storage_system</li><li>• netapp_e_syslog</li></ul>
SAN	<ul style="list-style-type: none"><li>• netapp_e_hostgroup</li><li>• netapp_e_iscsi_interface</li><li>• netapp_e_flashcache</li><li>• netapp_e_lun_mapping</li><li>• netapp_e_iscsi_target</li><li>• netapp_e_storagelpool</li><li>• netapp_e_volume</li></ul>

For an extensive list of NetApp Ansible modules, see the [Ansible Documentation > Storage Modules page](#).

## 7 How to Get Started with NetApp and Ansible

For a complete guide to help you get started with Ansible, see the [Ansible Documentation page](#). This documentation contains pointers to a large collection of items that cover all the items from installation to overview of modules, writing playbooks, and using roles.

The configuration management page on [netapp.io](#) is an excellent resource for how-tos that are geared toward a strictly technical audience. It contains a series of blog posts from NetApp Ansible SMEs about using Ansible for various day-0 configuration and provisioning operations. Also, join NetApp TMEs and developers for Ansible in the #configurationmgmt channel on NetApp thePub [Slack workplace](#).

## Where to Find Additional Information

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

- NetApp Ansible modules  
[https://docs.ansible.com/ansible/latest/modules/list\\_of\\_storage\\_modules.html](https://docs.ansible.com/ansible/latest/modules/list_of_storage_modules.html)
- NetApp thePub  
<https://netapp.io>
- NetApp Ansible roles  
<https://github.com/netapp/ansible>
- NetApp product documentation  
<https://docs.netapp.com>

## Version History

Version	Date	Document Version History
Version 1.0	May 2019	Initial release.

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