Abstract

As enterprises make the shift to an OpenStack-based cloud infrastructure, there is an increasing need for best practices and deployment procedures that maximize availability and reduce deployment risk. This guide is targeted at architects, administrators, and others who are responsible for the deployment and maintenance of an OpenStack-based cloud. This guide shows how to use advanced deployment toolsets such as the Red Hat Enterprise Linux OpenStack Platform (RHEL-OSP) installer to greatly reduce initial deployment time, standardize components, and produce a highly available, easily maintainable cloud based on RHEL-OSP and NetApp Clustered Data ONTAP. This combination is a certified and proven solution in use today by both enterprises and service providers.
1 Solution Overview

Red Hat Enterprise Linux OpenStack Platform (RHEL-OSP) version 5.0 provides the tools needed to deploy an Icehouse-based OpenStack cloud on NetApp® FAS storage using Network File System (NFS) and iSCSI protocols. This solution deployment guide provides a deployer with the steps needed to create a highly available OpenStack cloud that can fulfill the stringent service level agreements (SLAs) typically found in both enterprises and service providers. These components are pretested and validated and provide a solution that is supportable, maintainable, and has a low total cost of ownership.

1.1 Solution Technology

This deployment guide follows the design principles set forth in the document Highly Available OpenStack Deployments Built on NetApp Storage Systems: Solution Design, which serves as a foundation for specific use cases and deployments, and many technological challenges arising from clustering and high availability (HA) are addressed there by using the RHEL-OSP Installer and the underlying Puppet manifests. This deployment guide outlines deployment methodologies and provides higher-level commentary, but those looking for a more thorough discussion of the theory and practice associated with this solution should refer to the solution design guide.

OpenStack

OpenStack is an open-source project released under the Apache 2.0 license that implements services that establish infrastructure as a service (IaaS). The project is managed by the OpenStack Foundation, a nonprofit corporate entity established in 2012 to promote, protect, and empower OpenStack software and its associated community. OpenStack technology consists of a series of modular projects that control large pools of processing, storage, and networking resources throughout a data center, all managed through a single dashboard that gives administrators control and empowers users with self-service provisioning of resources.

NetApp for OpenStack

OpenStack in its earliest inception was an open competitor to Amazon Web Services (AWS) and shared many of the same design principles as AWS. Therefore, it lacked a focus on traditional enterprise applications that benefit from highly available storage, relying instead on the applications themselves to manage data redundancy, availability, and archiving. This is changing, however, as enterprises deploy OpenStack and look to migrate all of their workloads into an internal cloud, due to the inherent efficiencies of this approach.

OpenStack has steadily gained features and deployment tools that allow for HA at the control plane, hypervisor, and storage tiers. Enterprises are looking for a single solution that can meet all of their workloads, rather than piecing together various different solutions. NetApp is the only storage solution provider that has proven deployments and the data management features to accommodate all workloads in a fully supportable manner.

Red Hat and NetApp for OpenStack

One of the key lessons of the last few years is that tightly integrated solutions are the key to unlocking business value. Just having a good stand-alone technology is no longer adequate. Such a technology must also be tightly integrated into the full stack of components (network, application, and storage) to deliver a low total cost of operations and ownership.

Another key lesson is that customers do not want integration at the expense of best-in-class components. Rather, customers want excellence in integration as well as high quality in the individual components of a solution. This is where the partnership between NetApp and Red Hat comes to the fore. The leading provider of enterprise-class storage for OpenStack deployments has joined with the leading provider of Linux and OpenStack distributions to make a compelling solution that delivers on this promise.
Description of the Solution

This solution leverages the RHEL-OSP installer, a graphical tool that deploys and manages highly available OpenStack installations. This toolset provides ease of deployment, standardization, and reduced project risk. Red Hat OpenStack has been prevalidated by Red Hat and NetApp and certified with NetApp Cinder drivers.

The storage foundation for an OpenStack cloud is the NetApp clustered Data ONTAP® operating system (OS) on NetApp FAS hardware. Features found in RHEL-OSP and Data ONTAP protect all critical components of the infrastructure. HA for the network components is achieved by using the Link Aggregation Control Protocol (LACP) and network interface bonding of the two 10GbE interfaces with virtual LAN (VLAN) tagging to provide for the separation and security of any virtual networks. This approach provides the benefits of redundancy, failover, and high throughput during normal operations with a minimum number of switch ports.

Fabric-attached storage (FAS) controllers, deployed using the same network design principles, enable seamless live migration of workloads in a shared infrastructure and can grow both horizontally and vertically. Data ONTAP does not suffer from the lack of data density or high replica counts that some open-source object and block storage solutions do. This is critical at scale and can greatly reduce the use of data center floor space, heating, cooling, and power. Data center cost per square foot becomes clearer when existing space is 100% utilized, thereby necessitating the creation of new space.

Figure 1 depicts the technical components of this solution.

![Diagram of the solution components](image)
1.2 Use Case Summary

The primary use cases for this solution are:

- Public cloud deployment
- Private cloud deployment
- Hybrid cloud deployment

2 Cloud Deployment Methodology

2.1 Technology Requirements

The deployment of RHEL-OSP on NetApp Data ONTAP requires a number of hardware and software components to achieve high availability (HA).

Hardware Requirements

Table 1 lists the hardware components required to implement the primary use case.

Table 1) Hardware requirements.

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>x86_64 servers</td>
<td>5 or more</td>
</tr>
<tr>
<td>NetApp FAS controllers</td>
<td>A minimum of 1 Data ONTAP HA cluster</td>
</tr>
<tr>
<td>Layer 3 network switches with support for link aggregation and LACP</td>
<td>2 or more</td>
</tr>
</tbody>
</table>

Software Requirements

Table 2 lists the software components required to implement the primary use case.

Table 2) Software requirements.

<table>
<thead>
<tr>
<th>Software</th>
<th>Count / Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAS NFS license</td>
<td>1 (minimum version: NetApp Data ONTAP 8.1)</td>
</tr>
<tr>
<td>FAS FlexClone license</td>
<td>1</td>
</tr>
<tr>
<td>RHEL-OSP 5 licensing</td>
<td>5</td>
</tr>
</tbody>
</table>

Overview of Laboratory Setup

The laboratory environment used for this deployment included a Cisco® Nexus® 5020 switch running Cisco Nexus 5000 Series Switch Release 5.2(1)N1(7) with edge connectivity to the rack though Nexus 2232P 10GbE fabric extenders with four 10GbE uplinks to the 5020. For the 1GbE connections to the management network, Cisco Nexus 2248TP-E fabric extenders were used with two 10GbE uplinks to the 5020.

All storage controllers and servers were connected through two 10GbE network ports that were bonded or paired and a single 1GbE connection for management network traffic. All servers and storage were also equipped for out-of-band management through 1GbE links. Redundant network tiers were used, as in the HA reference architecture, and were provided through redundant connections to physically separate fabric extenders behaving as a single logical switch.
The servers were standard x86_64-compatible hardware with full virtualization support, 128GB of RAM, and dual Intel® Xeon® CPU E5-2630 v2 @ 2.60GHz processors. The FAS controllers used for this deployment were FAS 2240-4 nodes in a two-node cluster. The specific host configurations, described in Table 3, only apply to Cisco switches, but the Linux host settings are generic and could be used with any switch supporting LACP 802.3ad link aggregation.

Table 3) Logical network configuration for laboratory setup.

<table>
<thead>
<tr>
<th>Network Name</th>
<th>Network Address</th>
<th>VLAN ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default (management)</td>
<td>10.250.116.0/22</td>
<td>--</td>
</tr>
<tr>
<td>Public</td>
<td>192.168.126.0/24</td>
<td>300</td>
</tr>
<tr>
<td>Private</td>
<td>192.168.123.0/24</td>
<td>500</td>
</tr>
<tr>
<td>Storage</td>
<td>172.20.2.0/24</td>
<td>3002</td>
</tr>
<tr>
<td>Cluster interconnect</td>
<td>169.254.248.122/16</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: The networks indicated in Table 3 were used for this deployment. The default network on the switching gear is VLAN 0. Therefore, VLAN tagging is not required for this network.

Figure 2 illustrates the physical and logical cabling of the port-channel, VLAN-tagged networks. The management network uses a standard single VLAN access port because of the requirement for PXE/DHCP booting from the primary network interface of the servers.

Figure 2) Network overview.
2.2 Deployment Procedures

Deploying RHEL-OSP on NetApp clustered Data ONTAP requires the following high-level tasks:

- Set up switch ports using link aggregation for all nodes
- Setup Cinder and Glance volumes
- Copy installation media to the HTTP server
- Build and configure the RHEL-OSP Installer
- Perform discovery on all target hosts in the cluster
- Perform a test kickstart
- Update the NetApp Puppet module
- Configure your networks
- Configure an HA deployment
- Configure the network interfaces
- Modify necessary host-group values
- Modify the Puppet values for the cinder::volume::netapp class
- Deploy HA

Set Up Switch Ports Using Link Aggregation for All Nodes

All hosts used a single standard interface for management and a pair of 10GbE bonded interfaces for other traffic. To set up switch ports using link aggregation for all nodes, apply the following switch settings for the bonded interface ports:

```
set15020-L2E33(config-if)# show run int e104/1/8
interface Ethernet104/1/8
  switchport mode trunk
  switchport trunk allowed vlan 300,500,3002
  channel-group 1029

set15020-L2E33(config-if)# show run int e104/1/24
interface Ethernet104/1/24
  switchport mode trunk
  switchport trunk allowed vlan 300,500,3002
  channel-group 1029

set15020-L2E33(config-if)# show run int port-channel 1029
interface port-channel1029
  description "rx300s8-29 10g"
  switchport mode trunk
  switchport trunk allowed vlan 300,500,3002
  speed 10000
```

Set Up Cinder and Glance Volumes

Prior to creating FlexVol® volumes, you must have a working storage virtual machine (SVM, previously called Vserver) in the Data ONTAP cluster with either the NFS or iSCSI protocol enabled. NetApp recommends having a dedicated SVM (or SVMs) for OpenStack services. Assign FlexVol volumes to aggregates with the recommended minimum number of disks for good performance and allocate enough available free space for future growth.

Figure 3 illustrates how SVMs can span aggregates, although a flexible volume, and thus any Cinder volumes within it, must reside in a single aggregate. A larger number of spinning disks in an aggregate typically provides higher disk throughput for the flexible volumes contained within them.
Figure 3) NetApp clustered Data ONTAP objects.

Notably, NetApp Flash Cache™ and/or NetApp Flash Pool™ can also dramatically improve the performance and latency characteristics of a given flexible volume by accelerating frequently accessed data by using flash memory or solid-state disks as a caching tier. NetApp highly recommends these applications when large numbers of hypervisors are hosting bootable Cinder volumes on NetApp controllers.
You can also elect to NFS mount ephemeral disk storage space for your hypervisors (normally
/var/lib/libvirt/images with KVM) to enable features such as live migration. For either of these
scenarios, a caching tier based on Flash Cache or Flash Pool is highly desirable.

For HA and throughput, it is best practice to set up network interface groups. Whenever possible, employ
dynamic multimode or static multimode interface groups. NetApp also recommends enabling jumbo
frames on all storage network ports used for storage (switches, FAS, and servers) to achieve the best
performance. Most importantly, test your failover configuration prior to deploying a production setup. For
more information, refer to the Clustered Data ONTAP 8.2 Network Management Guide. For more details
on NFS considerations, refer to the Clustered Data ONTAP NFS Best Practice and Implementation
Guide.

The sizes of your Cinder and Glance volumes can vary greatly depending on your specific deployment,
but you should generally allocate sufficient space to accommodate the number of virtual machines you
plan to have in the cluster. You should also allocate sufficient free space for future growth in data. A
reasonable starting place is 300GB to 500GB per hypervisor, but this may vary considerably depending
on the hardware you deploy.

NetApp does not recommend using autosize with Cinder volumes because of the way the Cinder
scheduler creates Cinder volumes by choosing the volume with the most free space. The scheduler does
periodically re-scan for free space, however. Frequent resizing of NetApp FlexVol® volumes could lead to
inconsistent behavior in the Cinder scheduler and should be minimized.

For highest performance, use at least four FlexVol volumes or exports per aggregate to maximize
throughput with multiple threads. This comes into play in larger installations and is handled by changing
the Puppet $nfs_shares parameter to include multiple mount points. The NetApp Snapshot® policy for
individual FlexVol volumes should reflect the need to perform global backups, which are multi-tenant
backups, on the files in Cinder.

Applications that require file-system consistency should operate at the level of individual Cinder snapshot
instances, which generates a file-based NetApp FlexClone® instance through the NetApp Cinder driver,
rather than a Snapshot copy of the entire FlexVol volume. Hourly (or more frequent) disaster-recovery
Snapshot copies with remote, asynchronous NetApp SnapMirror® backups make the most sense in an
OpenStack environment.

In this scenario, a remote data center with free Nova or hypervisor capacity and a Cinder or Glance
SnapMirror target can be brought online rapidly in the event of a geography-dependent outage. To
implement this strategy, boot from Cinder volumes rather than ephemeral disks. Data on ephemeral disks
is not included in the remote mirror unless special care is taken to mount this disk space on a NetApp
NFS export residing on a mirrored FlexVol volume. The ephemeral files are stored in
/var/lib/nova/instances by default on Red Hat hosts.

In very large installations, it might be desirable to maximize the access patterns of Glance (high reads)
versus Cinder (mixed read and write I/O) by placing these two volumes in different disk aggregates.
However, this should not be necessary in relatively small installations on aggregates with a sufficient
number of disks.

The NetApp Cinder NFS driver automatically caches the Glance image on the Cinder volume after the
first Nova boot command is issued, further reducing the data being pulled from Glance. After the cached
image is in Cinder, the Nova boot initiates an automatic, file-based FlexClone copy from the image file,
which dramatically speeds up creation and instance boot times.

In general, Data ONTAP is affected by the total number of spindles in an aggregate, and more spindles
are better. The SVM used for these purposes can be the same or different, because SVMs can have
more than one backing disk aggregate. You specify which aggregate hosts the FlexVol volume in the
vol_create command. It is best practice to use RAID DP on your disk aggregates.

To setup Cinder export, log into the administrative console, and complete the following steps:
1. Enable the desired NFS protocol version(s). The NetApp Cinder driver automatically mounts at the highest level enabled. This deployment enabled all versions and utilized NFS v4.1 with parallel NFS (pNFS) support.

   
   OSTK-06::> vserver nfs modify -vserver openstack -v3 enabled -v4.0 enabled -v4.1 enabled -pNFS enabled

   
   **Note:** The `v-storage enabled` command enables the NetApp copy offload feature.

2. Verify that the NFS service is running.

   
   OSTK-06::> vserver nfs status
   
   The NFS server is running.

3. Verify that the ontapi service is enabled on the FAS controller or the target SVM if you plan to use the vsadmin account. The NetApp Cinder driver requires this.

   
   OSTK-06::> vserver service web show -vserver OSTK-06

<table>
<thead>
<tr>
<th>Vserver</th>
<th>Type</th>
<th>Service Name</th>
<th>Description</th>
<th>Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSTK-06</td>
<td>admin</td>
<td>cem</td>
<td>OBSOLETE</td>
<td>true</td>
</tr>
<tr>
<td>OSTK-06</td>
<td>admin</td>
<td>disco</td>
<td>Data ONTAP Discovery</td>
<td>true</td>
</tr>
<tr>
<td>OSTK-06</td>
<td>admin</td>
<td>ontapi</td>
<td>Remote Administrative API</td>
<td>true</td>
</tr>
<tr>
<td>OSTK-06</td>
<td>admin</td>
<td>portal</td>
<td>Data ONTAP Web Services</td>
<td>true</td>
</tr>
<tr>
<td>OSTK-06</td>
<td>admin</td>
<td>spi</td>
<td>Service Processor Infrastructure</td>
<td>true</td>
</tr>
</tbody>
</table>

5 entries were displayed.

4. If the ontapi service is not enabled, run the following command to enable it:

   
   OSTK-06::> vserver services web modify -vserver openstack -name ontapi -enabled true

5. Create an export policy and a rule for OpenStack (modify for your storage network).

   
   OSTK-06::> vserver export-policy create -policyname openstack -vserver openstack
   
   OSTK-06::> vserver export-policy rule create -vserver openstack -policyname openstack -clientmatch 172.20.2.0/24 -rorule any -rwrule any -anon 0

6. Verify that the client network has access to the new volume.

   
   OSTK-06::> vserver export-policy rule show

<table>
<thead>
<tr>
<th>Vserver</th>
<th>Policy</th>
<th>Rule</th>
<th>Access</th>
<th>Client</th>
<th>RO</th>
</tr>
</thead>
<tbody>
<tr>
<td>openstack</td>
<td>default</td>
<td>1</td>
<td>any</td>
<td>0.0.0.0/0</td>
<td>any</td>
</tr>
<tr>
<td>openstack</td>
<td></td>
<td>1</td>
<td>any</td>
<td>172.20.2.0/24</td>
<td>any</td>
</tr>
</tbody>
</table>

5 entries were displayed.

7. Create FlexVol volumes for Cinder and Glance.

   
   OSTK-06::> OSTK-06::> volume create -volume cinder -aggregate aggr1 -size 1TB -state online -type RW -policy openstack -unix-permissions -rwrxrwx-x -space-guarantee volume -snapshot-policy default -foreground true -security-style unix -junction-path /vol/cinder -vserver openstack

   [Job 3098] Job succeeded: Successful

   
   OSTK-06::> volume create -volume glance -aggregate aggr1 -size 300G -state online -type RW -policy openstack -unix-permissions -rwrxrwx-x -space-guarantee volume -snapshot-policy default -foreground true -security-style unix -junction-path /vol/glance -vserver openstack

   [Job 3093] Job succeeded: Successful

8. Enable deduplication on the Glance volume. Typical space savings can exceed 90% with deduplication on Glance stores.

   
   OSTK-06::> vol efficiency on -vserver openstack -volume glance

   (volume efficiency on)

   Efficiency for volume "glance" of Vserver "openstack" is enabled. Already existing data could be processed by running "volume efficiency start -vserver openstack -volume glance -scan-old-data true".
Note: For more information on deduplication and compression for FlexVol volumes, refer to the NetApp support documentation.

9. Test the NFS exports from a host with network access to the OpenStack storage network.

```
[root@foreman ~]# mkdir /mnt/cinder
[root@foreman ~]# mount 172.20.2.18:/vol/cinder /mnt/cinder
[root@foreman ~]# touch /mnt/cinder/test
[root@foreman ~]# mkdir /mnt/glance
[root@foreman ~]# mount 172.20.2.18:/vol/glance /mnt/glance
[root@foreman ~]# touch /mnt/glance/test
```

10.Unmount the Cinder and Glance mounts. The NetApp driver automounts the Cinder export and the installer sets up the Glance mount.

```
[root@foreman ~]# umount /mnt/cinder ; umount /mnt/glance
```

Copy Installation Media to HTTP Server

To copy installation media to the HTTP server, complete the following steps:

1. Download the RHEL 7.0 x86_64 DVD ISO file, put it on a web server that is collocated with the RHEL-OSP Installer, and move it to /var/opt/rhel-server-7.0-x86_64-dvd.iso.

   Note: The installation server cannot function in this role without changes to the Apache configuration (discouraged).

2. Create the following directory on the web server.

   ```
   [root@webhost ~]# mkdir -p /var/www/html/rhel/7.0/os/x86_64
   ```

3. Mount the DVD ISO media to the correct location.

   ```
   [root@webhost ~]# mount -t iso9660 -o loop,ro /var/opt/rhel-server-7.0-x86_64-dvd.iso /var/www/html/rhel/7.0/os/x86_64
   ```

Build and Configure Red Hat Enterprise Linux OpenStack Platform Installer

To setup the RHEL-OSP Installer, refer to the Red Hat documentation.

To build and configure the RHEL-OSP Installer, complete the following steps:

1. When the installer asks for the installation media, select the HTTP protocol, name it RHEL, and use the following URL, in which 10.250.117.41 is replaced by the management network address of your web host:

   ```
   http://10.250.117.41/rhel/7.0/os/x86_64
   ```

2. Configure the OS installation media in the RHEL-OSP Installer administrative interface to use the RHEL source as follows:
Test Kickstart

To test Kickstart, complete the following steps:

1. Boot one machine using PXE/DHCP (network interface boot). Upon successful boot, the following menu is displayed:
2. Allow the machine to boot and register with the RHEL-OSP Installer. The machine should then show up as discovered in the administrative console. Select the host name in blue (host names are auto-assigned by the RHEL platform installer) and select the Provision option.

3. Select the base\_RedHat\_7 host group.

Note: Host names in the RHEL-OSP Installer are automatically assigned by using the MAC address of the network interface card (NIC) that PXE boots from.
4. Click Submit and then reboot the host if it does not do so automatically. Allow Kickstart to proceed and then verify that the host is correctly configured. If you must modify partitions or other settings, do so now.

5. When you are satisfied with your base OS installation (disk layout, customizations, and so on), delete the host and reboot it to again place it in the Discovered Hosts category.

**Update NetApp Puppet Module**

To update the NetApp Puppet module, complete the following steps:

1. Replace the uncommented text in `/usr/share/openstack-puppet/modules/cinder/manifests/volume/netapp.pp` with the following text:

   ```bash
   class cinder::volume::netapp {
   $netapp_login,
   $netapp_password,
   $netapp_server_hostname,
   $netapp_server_port           = '80',
   $netapp_size_multiplier       = '1.2',
   $netapp_storage_family        = 'ontap_cluster',
   $netapp_storage_protocol      = 'nfs',
   $netapp_transport_type        = 'http',
   $netapp_vfiler                = '',
   }
$netapp_volume_list = '','
$netapp_vserver = '','
$expiry_thres_minutes = '720',
$thres_avl_size_perc_start = '20',
$thres_avl_size_perc_stop = '60',
$nfs_shares = [],
$nfs_shares config = '/etc/cinder/shares.conf',
$netapp_copyoffload_tool_path = '','
$netapp_controller_ips = '','
$netapp_sa_password = '','
$netapp_storage_pools = '','
$netapp_webservice_path = '/devmgr/v2',
)
}
cinder::backend::netapp { 'DEFAULT':
  netapp_login => $netapp_login,  
  netapp_password => $netapp_password, 
  netapp_server_hostname => $netapp_server_hostname,  
  netapp_server_port => $netapp_server_port, 
  netapp_size_multiplier => $netapp_size_multiplier, 
  netapp_storage_family => $netapp_storage_family, 
  netapp_storage_protocol => $netapp_storage_protocol, 
  netapp_transport_type => $netapp_transport_type, 
  netapp_vfiler => $netapp_vfiler, 
  netapp_volume_list => $netapp_volume_list, 
  netapp_vserver => $netapp_vserver, 
  expiry_thres_minutes => $expiry_thres_minutes, 
  thres_avl_size_perc_start => $thres_avl_size_perc_start, 
  thres_avl_size_perc_stop => $thres_avl_size_perc_stop, 
  nfs_shares => $nfs_shares, 
  nfs_shares_config => $nfs_shares_config, 
  netapp_copyoffload_tool_path => $netapp_copyoffload_tool_path, 
  netapp_controller_ips => $netapp_controller_ips, 
  netapp_sa_password => $netapp_sa_password, 
  netapp_storage_pools => $netapp_storage_pools, 
  netapp_webservice_path => $netapp_webservice_path, 
)

if $nfs_shares {
  file {$nfs_shares_config:
    content => join($nfs_shares, "\n"),
  }
  replace $nfs_shares_config
}
require => Package['cinder'],
notify => Service['cinder-volume']
}
}

cinder_config {
  "${volume_backend_name}/volume_backend_name": value => $volume_backend_name;
  "${volume_backend_name}/volume_driver": value =>
    'cinder.volume.drivers.netapp.common.NetAppDriver';
  "${volume_backend_name}/netapp_login": value => $netapp_login;
  "${volume_backend_name}/netapp_password": value => $netapp_password, secret =>
    true;
  "${volume_backend_name}/netapp_server_hostname": value => $netapp_server_hostname;
  "${volume_backend_name}/netapp_server_port": value => $netapp_server_port;
  "${volume_backend_name}/netapp_size_multiplier": value => $netapp_size_multiplier;
  "${volume_backend_name}/netapp_storage_family": value => $netapp_storage_family;
  "${volume_backend_name}/netapp_storage_protocol": value => $netapp_storage_protocol;
  "${volume_backend_name}/netapp_transport_type": value => $netapp_transport_type;
  "${volume_backend_name}/netapp_vfiler": value => $netapp_vfiler;
  "${volume_backend_name}/netapp_volume_list": value => $netapp_volume_list;
  "${volume_backend_name}/netapp_vserver": value => $netapp_vserver;
  "${volume_backend_name}/expiry_thres_minutes": value => $expiry_thres_minutes;
  "${volume_backend_name}/thres_avl_size_perc_start": value => $thres_avl_size_perc_start;
  "${volume_backend_name}/thres_avl_size_perc_stop": value => $thres_avl_size_perc_stop;
  "${volume_backend_name}/netapp_copyoffload_tool_path": value =>
    $netapp_copyoffload_tool_path;
  "${volume_backend_name}/netapp_controller_ips": value => $netapp_controller_ips;
  "${volume_backend_name}/netapp_sa_password": value => $netapp_sa_password, secret =>
    true;
  "${volume_backend_name}/netapp_storage_pools": value => $netapp_storage_pools;
  "${volume_backend_name}/netapp_webservice_path": value =>
    $netapp_webservice_path;
}

if $netapp_storage_family == 'eseries' {
  cinder_config {
    "${volume_backend_name}/use_multipath_for_image_xfer": value => true;
  }
}

3. To prevent future updates from affecting these changes, set these specific files to be immutable.

```
[root@foreman ] chattr +i /usr/share/openstack-puppet/modules/cinder/manifests/backend/netapp.pp
[root@foreman ] chattr +i /usr/share/openstack-puppet/modules/cinder/manifests/volume/netapp.pp
```

## Configure Your Networks

To configure the networks, complete the following steps:

1. Select Infrastructure > Storage. Then select the Subnets tab and precreate all of the networks used in your deployment.
   
a. Enter the network, mask, gateway, and so on.
   
b. Select the internal DB value from the IPAM options.
   
c. Provide the installer a start and end of range for IP addresses it can use for auto-suggesting IP addresses within that network.

   **Note:** This entire range should be free from other hosts and have no IP conflicts.
   
d. Enter the correct VLAN ID for the network.
2. From the Domain tab, select the domain of which this network is a part.

<table>
<thead>
<tr>
<th>Subnet</th>
<th>Domains</th>
<th>Capsules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain</td>
<td>Select All</td>
<td>netapp.corp</td>
</tr>
</tbody>
</table>

   Domains in which this subnet is part

3. From the Capsules tab, select the DNS capsule so that DNS records are created for each network.

<table>
<thead>
<tr>
<th>Subnet</th>
<th>Domains</th>
<th>Capsules</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHCP Capsule</td>
<td>None</td>
<td>DHCP Capsule to use within this subnet</td>
</tr>
<tr>
<td>TFTP Capsule</td>
<td>None</td>
<td>TFTP Capsule to use within this subnet</td>
</tr>
<tr>
<td>DNS Capsule</td>
<td>foreman.netapp.corp</td>
<td>DNS Capsule to use within this subnet for managing PTR records, note that A records are managed via Domain DNS Capsule</td>
</tr>
</tbody>
</table>

4. Repeat steps 1 through 3 for all of the networks except for the default or management network, which was setup during the RHEL-OSP installation process.

The following networks should then be listed:
Configure HA Deployment

To configure HA deployment, complete the following steps:

1. In the OpenStack Installer, select New Deployment and configure the deployment settings:
   a. Name this deployment HA OpenStack.
   b. Select High Availability Controllers/Compute.
   c. Configure the remaining required fields (as shown in the following screenshot).
   d. Click Next.
2. Configure networking to meet the requirements of your particular environment by dragging the desired network from Available Network Traffic Types onto the target subnet. Click Next.

![Network Configuration screen](image)

**Note:** The installer does not allow you to place External, Storage, or Tenant service types onto a single subnet, in accordance with the installer’s predefined rules. Attempting to do so produces the following warning. You can create more subnets on this page if you need more isolation of service types by clicking New Subnet. Refer to the [Highly Available OpenStack Deployments Built on NetApp Storage Systems Solution Design guide](#) for more information on exposing various network types in an OpenStack deployment. The installer is tolerant of shared functions on the default network.

![Warning message](image)

3. Review the summary on the Services Overview window and click Next.
4. On the Neutron Service Configuration window, select VLAN segmentation and enter a range of VLANs that are free and from which Neutron can create new networks. Leave the core plug-ins alone, as indicated in the default settings.
5. On the Glance Service Configuration window, enter the NetApp Data LIF address and path to the Glance export created in step 7 in the section “Setup Cinder and Glance Volumes”.
6. On the Cinder Service Configuration window, enter the NetApp Data LIF address and export that was created in step 7 in the section “Setup Cinder and Glance Volumes”. Do not enter the NetApp management address. That setting is configured later with Puppet.
7. Click submit, but do not deploy at this time.

**Configure Network Interfaces**

To configure the network interfaces, complete the following steps:

1. Select OpenStack Installer > Deployments, and then click HA OpenStack.
2. Click the Hosts tab.
3. Assign hosts within the cluster by clicking the deployment roles for the HA Controller and Compute (Neutron), assigning hosts as desired, and then clicking Assign Hosts.
4. Select all of the nodes in your deployment for which you want to configure network interface bonding. In this example, we bonded the 10GbE NICs that are the third and fourth interfaces (enp4s0f0 and enp4s0f1 in this example).

**Note:** When configuring with a bulk method, all hardware and cabling must be the same. Otherwise, each host must be configured individually.

5. Click Configure Networks.
6. The resulting window presents the option to bond interfaces. Select them as follows:

7. Select the bonding mode as follows:
8. Drag the following networks to the shared, bonded 10GbE network interfaces, as shown in the following example. VLAN tagging and separation preserve the security of these traffic types and prevent intermixing of traffic on the virtual LAN.

**Note:** Place the most critical networks on the bond0 pair. This arrangement might vary according to your internal network scheme and use case.

![Bonding Mode: 802.3ad]

- balance-rr
- active-backup
- balance-xor
- broadcast
- 802.3ad
- balance-tlb
- balance-alb

9. Click Submit to save the settings.

**Modify Necessary Host-Group Values**

To modify the necessary host-group values, complete the following steps:

1. Select Configure > Host Groups and select the `base_RedHat_7/HA OpenStack/HA Controller` host group.
2. Click the Puppet Classes tab and search for `netapp`.
3. Click the `cinder::volume::netapp` class to add it to the list of classes included in the host group. The following window is displayed:
4. Click Submit.

**Modify the Puppet Values for the cinder::volume::netapp Class**

To modify the Puppet values for the `cinder::volume netapp` class, complete the following steps:

1. Select Configure > Puppet Classes and search for `netapp`.
2. Click to modify the `cinder::volume::netapp` class.
3. Click Smart Class Parameter to produce the following window:
4. Scroll down to the section for the parameter NetApp Server Hostname that says Override Value for Specific Hosts. Enter `hostgroup=base_RedHat_7/HA OpenStack/HA Controller` in the Match* field and then the NetApp controller administrative IP address in the Value field (10.250.117.106 in this example). If you do not see the following fields, click Add Matcher-Value.

Override Value For Specific Hosts

<table>
<thead>
<tr>
<th>Order</th>
<th>fqdn</th>
</tr>
</thead>
<tbody>
<tr>
<td>hostgroup</td>
<td></td>
</tr>
<tr>
<td>os</td>
<td></td>
</tr>
<tr>
<td>domain</td>
<td></td>
</tr>
</tbody>
</table>

- The order in which values are resolved

<table>
<thead>
<tr>
<th>Match *</th>
<th>hostgroup=base_RedHat_7/HA OpenStack/HA Controller</th>
</tr>
</thead>
</table>

- Explain matchers

| Value       | 10.250.117.106 |

- Add Matcher-Value
5. Repeat steps 1 through 4 for the following smart class parameters, in each case using the same filter as in the previous example. This sets the values you specify on all hosts that match the base_RedHat_7/HA OpenStack/HA Controller host group (all of the OpenStack controller hosts).

<table>
<thead>
<tr>
<th>Smart Class Parameter</th>
<th>Sample Value and Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>netapp_server_hostname</td>
<td>10.250.117.106</td>
</tr>
<tr>
<td></td>
<td>Covered previously—the administrative IP for the NetApp controller</td>
</tr>
<tr>
<td>netapp_password</td>
<td>NetApp21</td>
</tr>
<tr>
<td></td>
<td>The administrative password for the NetApp controller</td>
</tr>
<tr>
<td>netapp_server_port</td>
<td>443</td>
</tr>
<tr>
<td></td>
<td>The port through which the NetApp Cinder driver makes ZAPI and administrative calls</td>
</tr>
<tr>
<td>netapp_transport_type</td>
<td>https</td>
</tr>
<tr>
<td></td>
<td>Protocol used for administrative calls</td>
</tr>
<tr>
<td>netapp_vserver</td>
<td>openstack</td>
</tr>
<tr>
<td></td>
<td>The name of the SVM that hosts volumes</td>
</tr>
<tr>
<td>nfs_shares</td>
<td>172.20.2.18:/vol/cinder</td>
</tr>
<tr>
<td></td>
<td>The ip:/share path in which Cinder creates volumes</td>
</tr>
<tr>
<td>nfs_shares_config</td>
<td>/etc/cinder/shares.conf</td>
</tr>
<tr>
<td></td>
<td>The file that stores the NFS shares data</td>
</tr>
</tbody>
</table>

Table 4) Smart class parameters.

Deploy HA

To deploy HA, complete the following steps:

1. Verify that all hosts to be deployed are in the discovered state and do not yet have an OS.
2. When you are satisfied with the configuration of the HA deployment and node layout, click Deploy. The following installations are displayed.
3 Validation and Postinstallation

When the deployment is complete, log on to one of the controllers and source the keystonerc_admin file and run the following command:

```
[root@mac901b0e0e3959 ~ (openstack_admin)]# cinder create 1
```

**Note:** This command validates that NetApp Cinder configuration.

Run the command `# cinder show <id>`, in which the ID is the actual volume ID. Verify that the Cinder volume has in fact been created on a backend that corresponds to a backend owned by NetApp Cinder driver. You can see the backends by running the `# cinder service-list` command. In addition, you can disable or enable backends with the `# cinder service-[disable/enable]` command. NetApp recommends disabling the generic NFS driver by running the following command:

```
[root@mac901b0e0e3959 ~ (openstack_admin)]# cinder service-disable ha-controller@nfs cinder-volume
```

<table>
<thead>
<tr>
<th>Host</th>
<th>Binary</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ha-controller@nfs</td>
<td>cinder-volume</td>
<td>disabled</td>
</tr>
</tbody>
</table>

To verify that the Glance NFS mounts are active, run the following command on the controller nodes:

```
[root@mac901b0e0e3959 ] systemctl status var-lib-glance-images.mount
data-glance-images.mount: loaded (/proc/self/mountinfo)
Active: active (mounted) since Mon 2014-12-01 09:41:21 EST; 9min ago
Where: /var/lib/glance/images
What: 172.20.2.18:/vol/glance
```
4 Troubleshooting

If the deployment runs into any issues, it might hang at some point. Go to the console, click Hosts, and then select a specific host. From there, select Reports, and investigate any red reports.

NetApp recommends correcting any issues or mistakes with the Puppet configurations that arise and then running the `puppet agent -t` command on any node that requires a refresh, rather than restarting the deployment without understanding what change is needed. If you receive a message that Puppet is already running, you can try the change on another node that is in the same host group. This invokes a new Puppet run in the console and shows the results of your changes, facilitating further corrections.

If there are issues with the Cinder deployment, messages might be hidden until you enable debug and verbose logging in the `/etc/cinder/cinder.conf` file and restart the Cinder volume service.

Note: This change is overridden on the next Puppet run and should not be allowed to persist in a production setting.

5 Known Issues

In some cases, the bonding configuration files in `/etc/sysconfig/network-scripts/ifcfg-bond0.xxx` are not properly formed. If this happens, these files can be corrected manually by making the necessary changes on a host and then running `ifup bond.300` for the specific interface having the issue. The bonding configuration is not under the control of Puppet, and therefore this manual intervention is not overridden on subsequent Puppet runs.

6 Additional Use Cases

This guide does not cover the deployment of Swift object stores on NetApp E-Series controllers, but this information is covered in the NetApp OpenStack Deployment and Operations Guide.

7 Conclusion

Red Hat is the leading provider of open-source software solutions and a top contributor to OpenStack. Red Hat provides industry-leading services and support that provides its customers with an edge in the design, deployment, and maintenance of OpenStack. NetApp is the provider of the number one storage OS in the world with Data ONTAP, has the greatest number of OpenStack deployments in the enterprise storage market, and has a proven track record of providing storage for cloud environments at scale. Together, these two companies can support your OpenStack deployment, minimize risk at the critical storage layer, and provide you with reliable partners with vision and a development roadmap to support your continued success as the cloud evolves.

References

This report references the following documents and resources:

- Creating a Highly Available Red Hat OpenStack Platform Configuration (RHEL-OSP5 and RHEL7) [https://access.redhat.com/articles/1150463](https://access.redhat.com/articles/1150463)
- Clustered Data ONTAP NFS Best Practice and Implementation Guide

- Clustered Data ONTAP 8.2 Network Management Guide
  https://library.netapp.com/ecm/ecm_download_file/ECMP1196907
- NetApp compression and deduplication support documentation
  https://library.netapp.com/ecmdocs/ECMP1196906/html/GUID-9C88C1A6-990A-4826-83F8-0C8EAD6C3613.html

**Version History**

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Document Version History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version 1.0</td>
<td>January 2015</td>
<td>Initial release</td>
</tr>
</tbody>
</table>
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