Hewlett Packard Enterprise

HPE Deployment Guide for Red Hat OpenShift Container Platform on HPE Synergy with HPE 3PAR StoreServ Storage and VMware Virtualization

Implementing a resilient on-premises Kubernetes and container solution

Contents

Overview

This document describes the steps required to create a Red Hat® OpenShift Container Platform environment running on HPE Synergy and HPE 3PAR StoreServ Storage using VMware® vSphere® as the hypervisor and virtualization management layer. It is meant to be used in conjunction with files and Ansible playbooks found at https://github.com/HewlettPackard/hpe-solutions-openshift/tree/master/synergy/scalable/vsphere/3par.

It is recommended that the installer reviews this document in its entirety and understands all prerequisites prior to beginning an installation.

The OpenShift master, etcd and load balancers are all deployed as virtual machines (VMs) to enable resource optimization and consolidation. Three HPE Synergy Compute Modules running VMware ESXi provide high availability (HA) resources to support the management plane. The OpenShift worker nodes are deployed on HPE Synergy 480 Gen10 Compute Modules running Red Hat Enterprise Linux (RHEL) 7.6 which also hosts the registry within the solution. As the workload and number of container pods grow, the solution can scale to accommodate new performance requirements.

Solution design

Figure 1 highlights the overview of the solution design from a storage layout perspective. Refer to the master deployment guide found at https://github.com/HewlettPackard/hpe-solutions-openshift/tree/master/synergy/scalable/3par for a detailed information on hardware implementation, cabling, and connectivity.

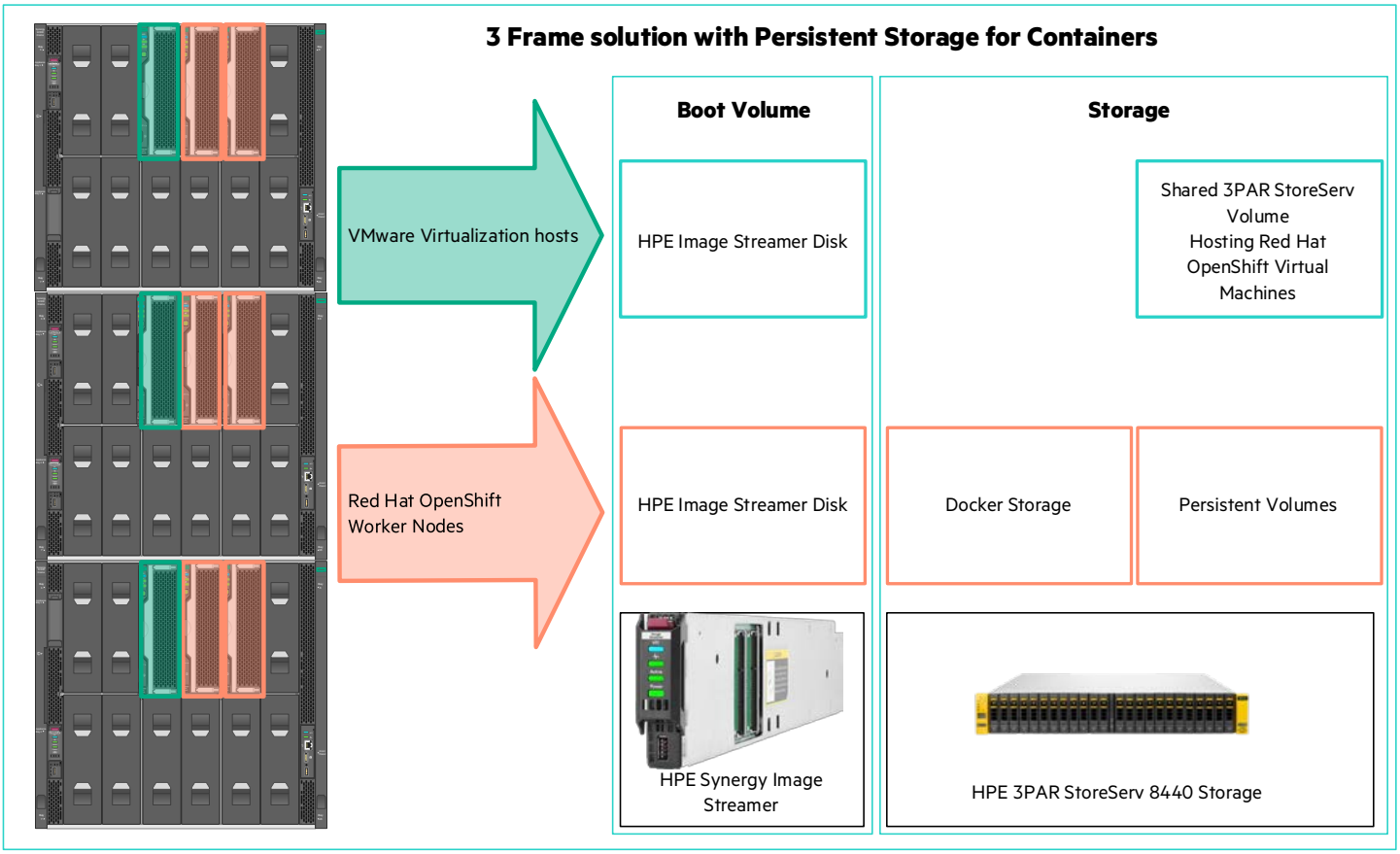

Figure 1. Solution design by function and storage type

Note

The containers and the images are created and stored in the Docker storage backend. This storage is ephemeral and separate from any persistent storage allocated to meet the needs of your applications. Docker storage in Figure 1 refers to this ephemeral storage. For more information, see https://docs.openshift.com/container-platform/3.11/install/host_preparation.html#configuring-docker-storage.

Figure 2 shows the logical design of the solution, including where the volumes are attached.

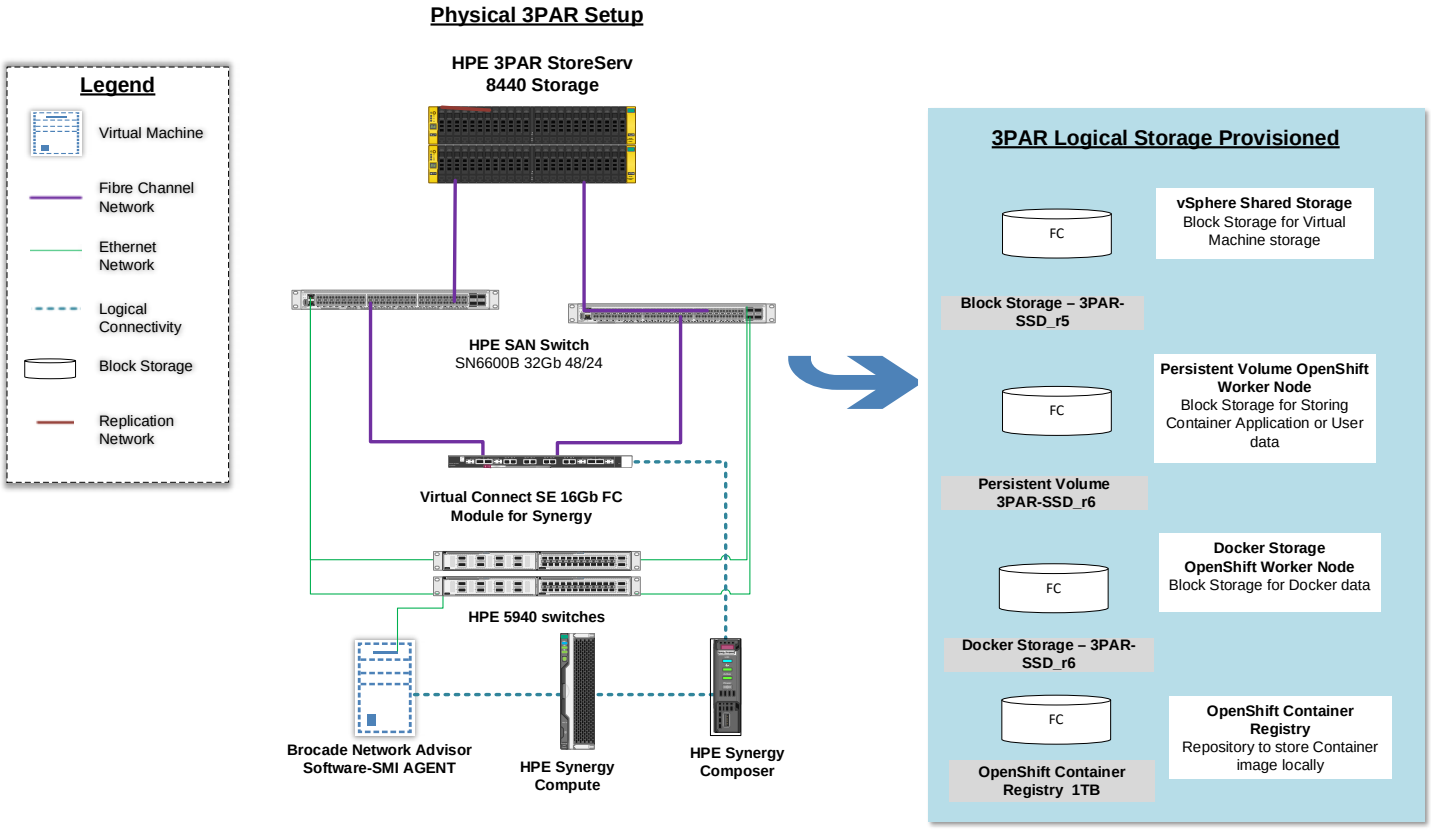

Figure 2. Logical layout of the solution stack

Solution creation process

Figure 3 shows the flow of the installation process adopted in this document. For readability, a high-resolution copy of this image is located at https://github.com/HewlettPackard/hpe-solutions-openshift/tree/master/synergy/scalable/vsphere/3par in the same folder as this document. It is recommended that the installer downloads and reviews this image before proceeding.

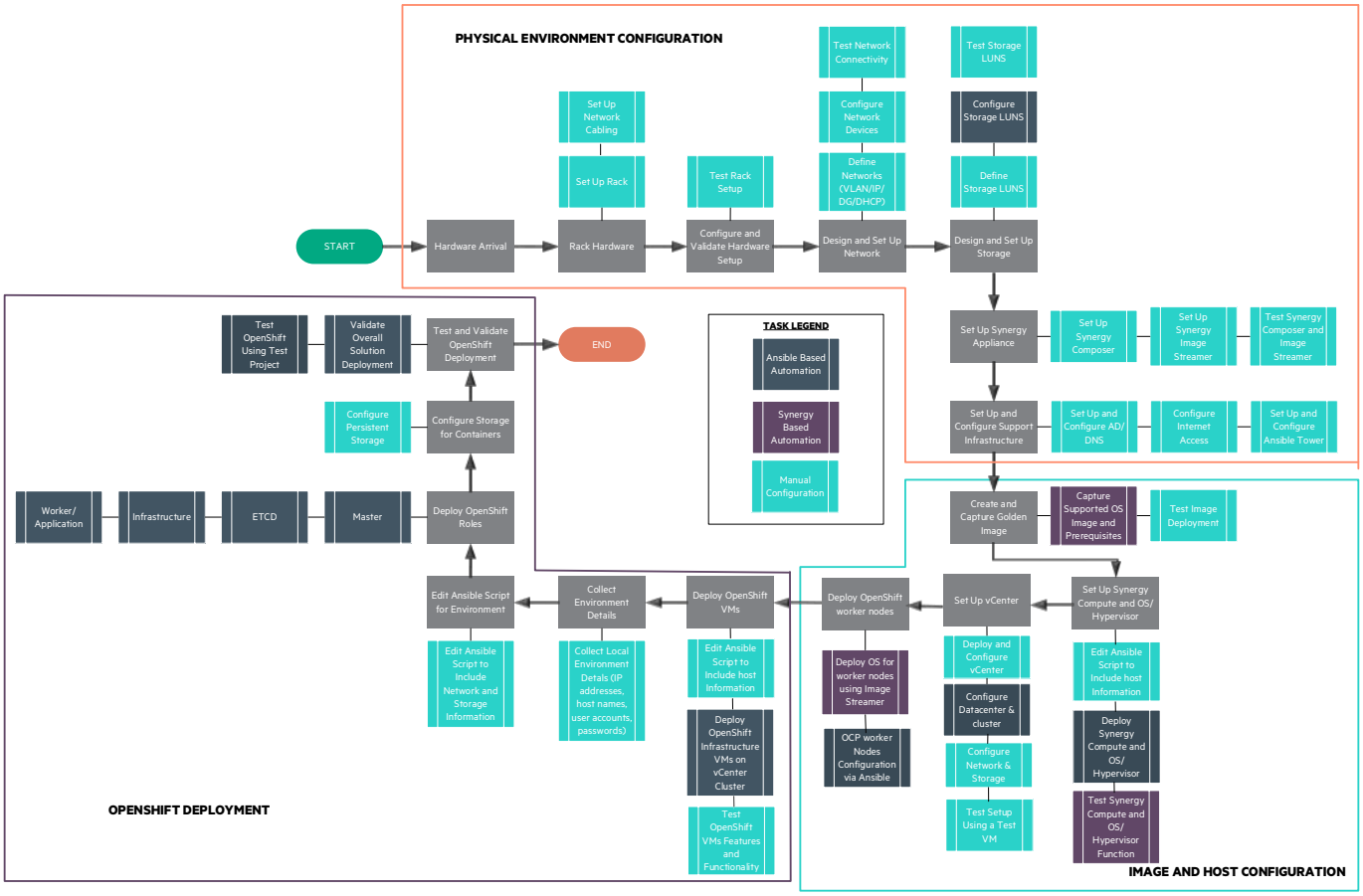

Figure 3. Solution creation flow diagram

Note

The scripts described in this document and provided on GitHub are sample scripts and are not supported by Hewlett Packard Enterprise or Red Hat.

Prerequisites

Software versions

Table 1 describes the versions of important software utilized in the creation of this solution. The installer should ensure to download or have access to this software and that appropriate subscriptions and licensing are in place to enable use within the planned timeframe.

Table 1. Major software versions used in solution creation

Component	Version
Red Hat Enterprise Linux Server	7.6
VMware vSphere	6.7
VMware vCenter Server Appliance™	6.7
Red Hat OpenShift Container Platform	3.11
VMware Tools	10.3.5

Deployment environment

This document is built with the assumptions that the required services and networks are available within the implementation environment. This section discusses those assumptions and, where applicable, provides details on how they should be configured. If a service is optional, it is noted as well.

Services

Table 2 disseminates the services utilized in the creation of this solution and provides a high-level explanation of their function and whether or not they are required.

Table 2. Services used in the creation of this solution

Service	Required/Optional	Description/Notes
DNS	Required	Provides name resolution on management and data center networks, optionally on iSCSI networks.
DHCP	Required	Provides IP address leases on Preboot Execution Environment (PXE), management and usually for data center networks. Optionally used to provide addresses on iSCSI networks.
NTP	Required	Required to ensure consistent time across the solution stack.
Active Directory/LDAP	Optional	May be used for authentication functions on various networks. This solution is utilized for local authentication.

DNS

Name services must be in place for management and data center networks. Once a host has become active, ensure that both forward and reverse lookups are working on the management and data center networks.

DHCP

Dynamic Host Configuration Protocol (DHCP) services must be in place for the PXE and management networks. DHCP services are generally in place on data center networks. As a convenience, it may be useful to have them in place on iSCSI networks. Because Virtual Connect exposes the MAC address of the network interfaces before installation has begun, it is easy to create address reservations for the hosts. A reservation is required for a single adapter on the management network of each physical server. This facilitates post-deployment configuration over Secure Shell (SSH) as well as a secure communication channel for running Ansible scripts. If DHCP services are present on the iSCSI networks, reservations can simplify post-deployment configuration of the host on those networks.

NTP

A Network Time Protocol (NTP) server should be available to hosts within the solution environment.

Installer laptop

A laptop system with the ability to connect to various components within the solution stack is required.

Ansible Engine

This document assumes that Ansible Engine exists within the deployment environment and is accessible to the installer. Hewlett Packard Enterprise built this solution using Ansible version 2.7.9. The following repositories need to be enabled on the Ansible Engine host:

- rhel-7-server-extras-rpms
- rhel-7-server-rpms
- rhel-7-server-ose-3.11-rpms
- rhel-7-server-ansible-2.7-rpms
- rhel-7-rhv-4-mgmt-agent-rpms

The following components need to be installed on the Ansible Engine host:

- Python 2.7.9 and above
- Python module for HPE OneView
  - hpOneView is the Python Software Development Kit (SDK) for the OneView Application Programming Interface (API) that allows managing OneView functionalities.
  - Download the python repository at https://github.com/HewlettPackard/python-hpOneView and follow the instructions in its readme file to install the repository.
- Ansible module for HPE OneView
  - oneview-ansible is the Ansible Module for HPE OneView which utilizes the Python SDK to enable infrastructure as a code.
  - Download the repository at https://github.com/HewlettPackard/oneview-ansible/ and follow the instructions in its readme file to install the repository.
- Python SDK for the VMware vSphere APIs
  - PyVmomi is the Python SDK for the VMware vSphere API that allows managing ESX, ESXi, and vCenter®.
  - Execute the following command to install PyVmomi:

```
# pip install PyVmomi
```

Physical environment configuration

The configuration deployed for this solution is described in detail in this section. Figure 4 describes the various components involved in the solution. At a high level, Hewlett Packard Enterprise and Red Hat deployed the following hardware as described in Table 3.

Table 3. Components utilized in the creation of this solution

Component	QTY	Description
HPE Synergy 12000 Frame	3	Three (3) HPE Synergy 12000 Frames house the infrastructure used for the solution
HPE Virtual Connect 40GB SE F8 Module	2	A total of two (2) HPE Virtual Connect 40Gb SE F8 Modules provide network connectivity into and out of the frames
HPE Virtual Connect 16Gb SE FC Module	2	A total of two (2) HPE Virtual Connect 16Gb SE FC Modules per HPE Synergy 12000 Frame
HPE Synergy 480 Gen10 Compute Module	9	Three (3) virtualized management hosts and six (6) bare metal or virtualized hosts for worker nodes
HPE FlexFabric 2-Slot Switch	2	Each switch contains one (1) each of the HPE 5930 modules listed below
HPE 5930 24p SFP+ and 2p QSFP+ Module	2	One module per HPE FlexFabric 2-Slot Switch
HPE 5930 8-port QSFP+ Module	2	One module per HPE FlexFabric 2-Slot Switch
HPE SN6600B Fibre Channel Switches	2	Provides connectivity from the Synergy infrastructure to the HPE 3PAR StoreServ SAN
HPE 3PAR StoreServ 8440 Storage	1	One array for virtual machines, Docker storage and persistent volumes
HPE Synergy Image Streamer	2	Provides OS volumes to OpenShift worker nodes
HPE Synergy Composer	2	Core configuration and lifecycle management for the Synergy components

This configuration was built on an HPE Converged Solution 750 which offers an improved time to deployment and a tested firmware recipe. That baseline can be retrieved at http://h17007.www1.hpe.com/us/en/enterprise/integrated-systems/info-library/index.aspx?cat=convergedsystems&subcat=cs750 and is updated on a regular basis. The user also has the flexibility of customizing the HPE components throughout this stack according to their unique IT and workload requirements or building with individual components.

Figure 4 shows the physical configuration of the racks used in this solution.

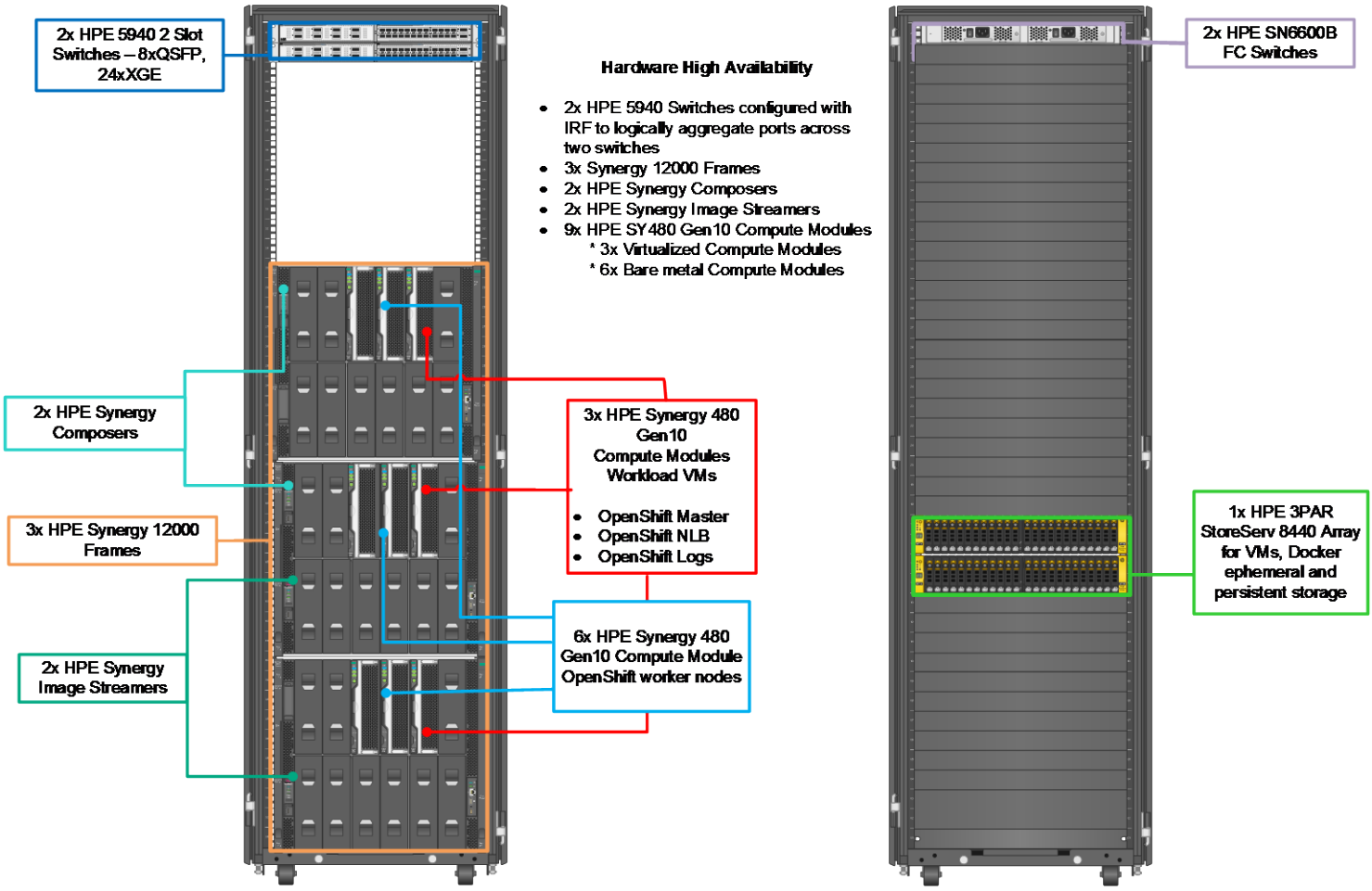

Figure 4. Physical layout of the compute within the solution

Firmware recipes for the individual components adhere to the HPE Converged Solution 750 for VMware specifications which can be found at https://support.hpe.com/hpsc/doc/public/display?sp4ts.oid=null&docLocale=en_US&docId=emr_na-a00051226en_us. It is recommended that the installer utilize the latest available matrix.

Figure 5 describes the logical storage layout used in the solution. HPE Synergy Image Streamer provides the operating system (OS) disk for the bare metal worker nodes as well as the virtualization hosts. HPE 3PAR StoreServ 8440 Storage provides dedicated and shared volumes as outlined in the figure.

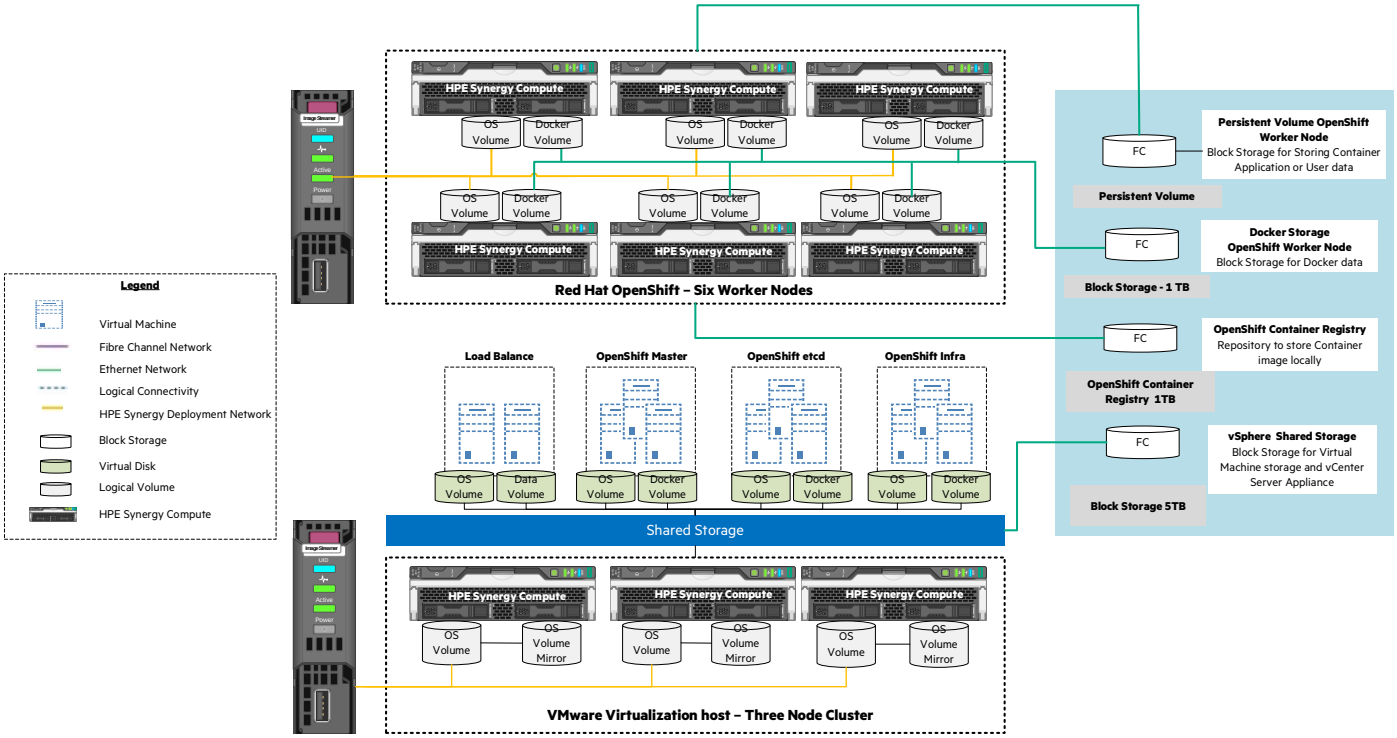

Figure 5. HPE 3PAR StoreServ Storage solution logical layout

Information about storage volumes/disks is described in Table 3. The installer may choose to manually create and present these volumes or use the Ansible resources specified after Table 4.

Table 4. Volumes and sources used in this solution

Volume/Disk Function	Qty	Size	Source	Hosts	Shared/Dedicated
Hypervisor	3	15 GB+	HPE Image Streamer	vSphere hosts	Streamed
Operating System	6	29 BG+	HPE Image Streamer	OpenShift worker nodes	Streamed
Virtual Machine Hosting	1	5 TB	HPE 3PAR StoreServ	vSphere hosts	Shared
Persistent Application Data	N	App Specific	HPE 3PAR StoreServ	OpenShift worker nodes	Dedicated
Docker Local Storage	3	80 GB	HPE 3PAR StoreServ	1 per OpenShift worker node	Dedicated
OpenShift Container Registry	1	1 TB	HPE 3PAR StoreServ	OpenShift worker node	Shared

Prior to defining these volumes, the array must be initialized and configured. Hewlett Packard Enterprise has provided resources to automate the initialization and configuration of the array. Refer to Appendix B of the master deployment guide at https://github.com/HewlettPackard/hpe-solutions-openshift/tree/master/synergy/scalable/3par.

Executing Ansible playbooks

Prior to configuring the compute modules, the installer should retrieve the required Ansible plays and files from GitHub by running the following command on the Ansible Engine host:

```
# cd /etc/ansible
# git clone https://github.com/HewlettPackard/hpe-solutions-openshift.git
```

Host configuration

This section describes the configuration of the virtualized hosts. The configuration of the bare metal hosts is described in the master deployment guide found at https://github.com/HewlettPackard/hpe-solutions-openshift/tree/master/synergy/scalable/3par. Required configuration steps are outlined. These may be in the form of pointers to code or command line options. It is up to the installer to decide how to reach the desired end state.

Warning

During host deployment, ensure that adapter names and functions are accurately recorded for the installation environment as variations in the installation procedures may result in different adapter functions than what is represented in the following sections. This will result in the failure of some default automated configuration steps.

Compute module configuration

A server profile allows a set of configuration parameters, including firmware recipe, network and SAN connectivity, BIOS tuning, boot order configuration, local storage configuration, and more to be templatized. These templates are key to delivering the "infrastructure as code" capabilities of the HPE Synergy platform. For the purpose of this solution, a template is used to define virtualized management nodes.

Management nodes

Management nodes will be deployed and customized using HPE Synergy Image Streamer while ensuring that the required storage volumes are created and attached. This section outlines the steps required to install the host. At a high level, these steps can be described as:

1. Download the artifacts for HPE Synergy Image Streamer from the HPE GitHub site.
2. Add the artifact bundles to HPE Synergy Image Streamer.
3. Create a server profile with an empty volume.
4. Install the hypervisor.
5. Capture the ESXi base golden image.
6. Delete the empty volume server profile.
7. Add ESXi golden image to the deployment plan.
8. Create the HPE 3PAR StoreServ Storage volume.
9. Deploy the ESXI hosts using the golden image.
10. Utilize the virtualized hosts.

Download the artifacts for HPE Synergy Image Streamer

VMware ESXi 6.7 artifact bundle for HPE Image Streamer 4.2 is **HPE - ESXi 6.7-2018-08-02-v4.2.zip.** It can be downloaded at https://github.com/HewlettPackard/image-streamer-esxi/tree/v4.2/artifact-bundles. Sample foundation artifact bundles can be downloaded from https://github.com/HewlettPackard/image-streamer-esxi/tree/v4.2/artifact-bundles.

Add the artifact bundles to HPE Synergy Image Streamer

1. From the HPE Synergy Image Streamer interface, navigate to the **Artifact Bundles** page.
2. From the **Actions** menu, select **Add** to add the downloaded VMware ESXi artifact bundle. If not already present, add the sample foundation bundle.
3. From the **Actions** menu, select **Extract** to extract the artifacts from each uploaded bundle.

Create a server profile with an empty volume

HPE Synergy Image Streamer deployment process is initiated from within the HPE Synergy Composer interface through the server profile creation process:

1. Log in to HPE OneView.
2. From the **OneView** drop-down list, select **Server Profiles**.
3. Click **+ Create profile**.
4. Provide the values for the following parameters:
   - **Name:** Provide a unique name.
   - **Server profile template**: None
   - **Server Hardware**: Select any available server.
   - **Enclosure Group**: <Enclosure Group name>
   - **Affinity**: Device Bay
   - **OS deployment plan**: From the drop-down list, select the **HPE - Foundation 1.0 - create empty OS Volume-2017-10-13** OS build plan.
   - **Volume Size**: 40960 MiB
   - Configure the **Connections**:
     I. Deployment Network A, Deployment VLAN 100, 1Gb/s iSCSI primary
     II. Deployment Network B, Deployment VLAN 100, 1Gb/s iSCSI secondary
     III. Management_A, Management VLAN
     IV. Management_B, Management VLAN
     V. Data center_A, Data center VLAN
     VI. Data center_B, Data center VLAN
     VII. SAN_A, Fiber Channel A, Fabric attach
     VIII. SAN_B, Fiber Channel B, Fabric attach
5. Enable the **Manage boot** mode and configure the following values:
   I. **Boot mode:** UEFI optimized
   II. **Secure boot:** Disabled
   III. **PXE boot policy:** Auto
6. Click **Create**.

Install the hypervisor

1. In the HPE OneView interface, navigate to the server profiles and select the **ESXi-empty-volume Server Profile** created earlier.
2. Select **Actions** > **Launch Console.**
3. On the Remote Console window, select **Virtual Drives > Image File CD-ROM/DVD** from the iLO[1] options menu.
4. Navigate to the **VMware ESXI 6.7 .iso** file located on the installation system.
5. Select the image and click **Open**.
6. If the server is in the powered off state, power on the server by selecting **Power Switch > Momentary Press.**
7. During boot, press **F11** to navigate to the Boot Menu and select **iLO Virtual USB 3: iLO Virtual CD-ROM**.
8. When the ESXi installation media has finished loading, proceed through the VMware installer prompts. For **Storage Device**, select the 40 GiB OS volume created on the image streamer during server profile creation and set the root password.
9. Once the OS installation is complete, navigate to **Power Switch** from the iLO options menu and select the **Momentary press** from the drop-down list to power off the server.

Capture the ESXi base golden image

1. From the top-left corner of HPE Synergy Image Streamer UI, navigate to **Image Streamer > Golden Images**.
2. Click **Create Golden Image**.
3. Enter the following details as shown in Figure 6.
   a. **Name**: Provide a name for the golden image.
   b. **OS volume**: Select the OS volume associated with the ESXi-empty-volume server profile.
   c. **OS Build Plan**: From the drop-down list, select **ESXi 6.7: HPE - Foundation 1.0 - capture OS Volume as is-2017-03-24** OS build plan.

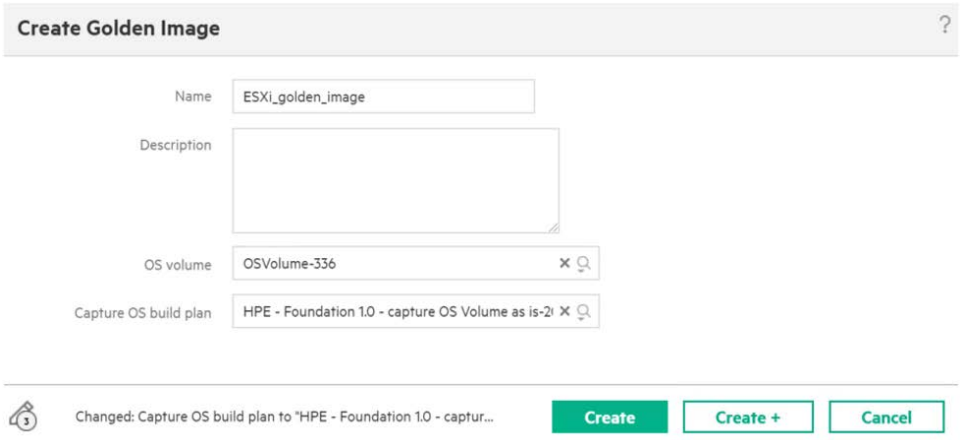

Figure 6. Create golden image

4. Click **Create.**

[1] Integrated Lights-Out (iLO) is a remote server management processor embedded on the system boards of HPE Servers.

Delete ESXi empty volume server profile

1. On the HPE OneView webpage, select **OneView > Server Profiles**.
2. Select the ESXi-empty-volume server profile and then select **Actions** > **Power Off**.
3. With the ESXi-empty-volume server profile selected, select **Actions** > **Edit**.
4. Unassign the assigned server hardware and wait until the unassignment task completes.
5. With the ESXi-empty-volume server profile selected, choose **Actions** > **Delete**.
6. Click **Yes, Delete**.

Add the ESXi golden image to the deployment plan

1. From the top-left corner of HPE Synergy Image Streamer UI, select **Image Streamer > Deployment Plans**.
2. Click **Create Deployment Plan**.
3. Provide the values for the following parameters as shown in Figure 7:
   a. **Name**: Provide a name for the deployment plan.
   b. **OS build plan**: From the drop-down list, select HPE - ESXi 6.7 - deploy with multiple management NIC HA config - 2018-08-02 as the OS build plan.
   c. **SSH**: enabled
   d. **Password**: Leave blank
   e. **ManagementNIC**: N/A
   f. **ManagementNIC2**: N/A
   g. **HostName**: Leave blank
   h. **DomainName**: Provide the management network domain name.
   i. **Golden Image**: From the drop-down list, select the ESXI 6.7 golden image that you already created.

Figure 7 shows the sample values for the parameters to create a deployment plan.

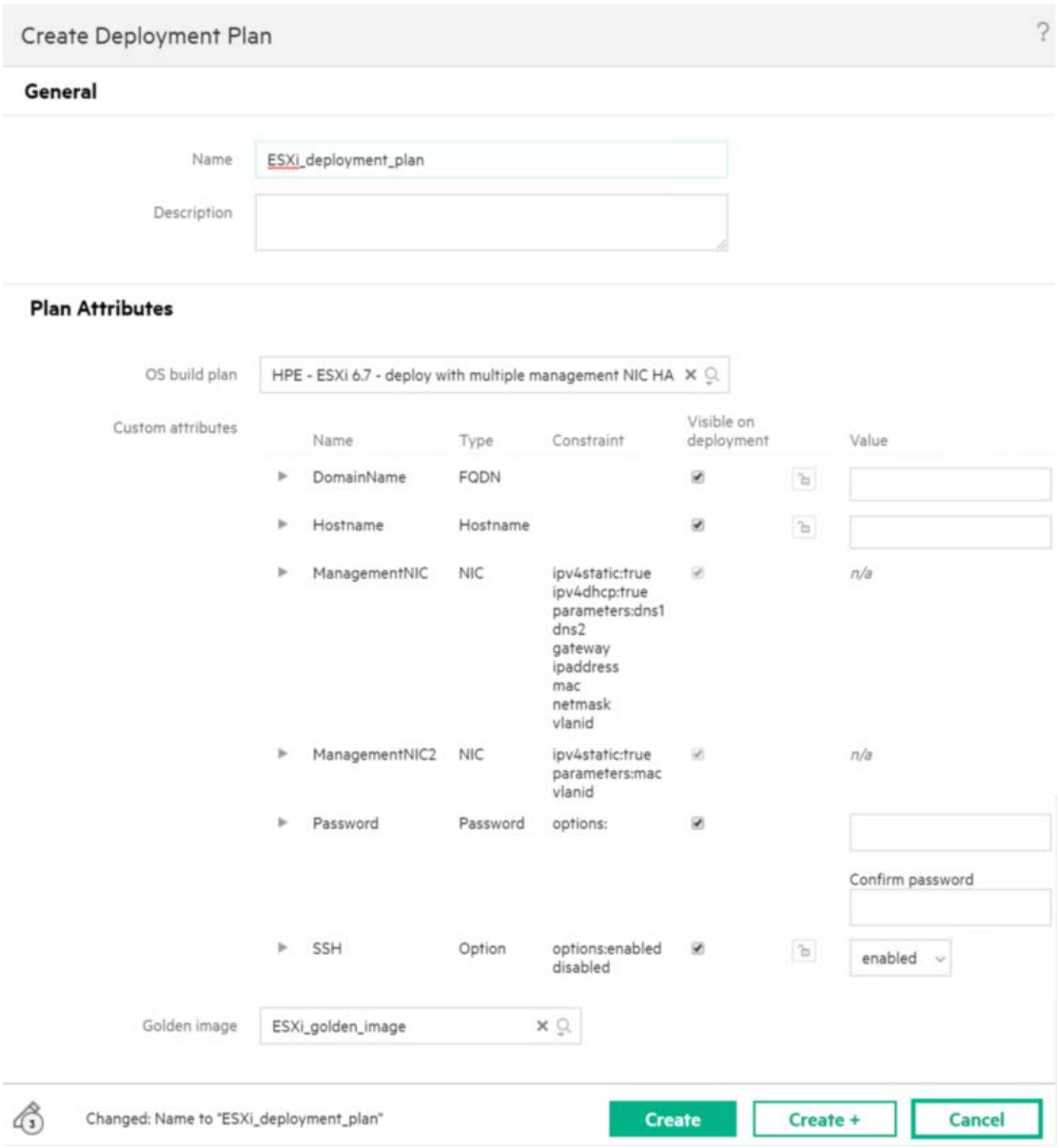

Figure 7. Create deployment plan

4. Click **Create**.

Create HPE 3PAR StoreServ volume

The virtualization hosts require a volume for the virtual machine storage. The size of the volume is 5 TB and is shared among the virtualization hosts. A volume is carved out of the HPE 3PAR StoreServ Storage system and is associated with each of the hosts through the server profiles. The following steps will create the volume and are highlighted in Figure 8.

1. From HPE OneView, select **Storage > Volume**.
2. Click **Create Volume** and provide the following values. Figure 8 shows the sample values provided for the volume:
   a. In the General section, complete the following fields:
      - **Name:** Provide a name of the volume.
      - **Volume template:** None
      - **Storage pool:** Provide the storage pool of the 3PAR.
   b. In the Volume Properties section, complete the following fields:
      - **Capacity:** 5120 GiB
      - **Sharing:** Enable the **Shared** option to enable multiple hosts to access the HPE 3PAR StoreServ volume.
   c. In the Advanced section, complete the following fields:
      - **Provisioning:** Thin
      - **Storage Snapshot Pool:** Provide the snapshot storage pool of 3PAR.

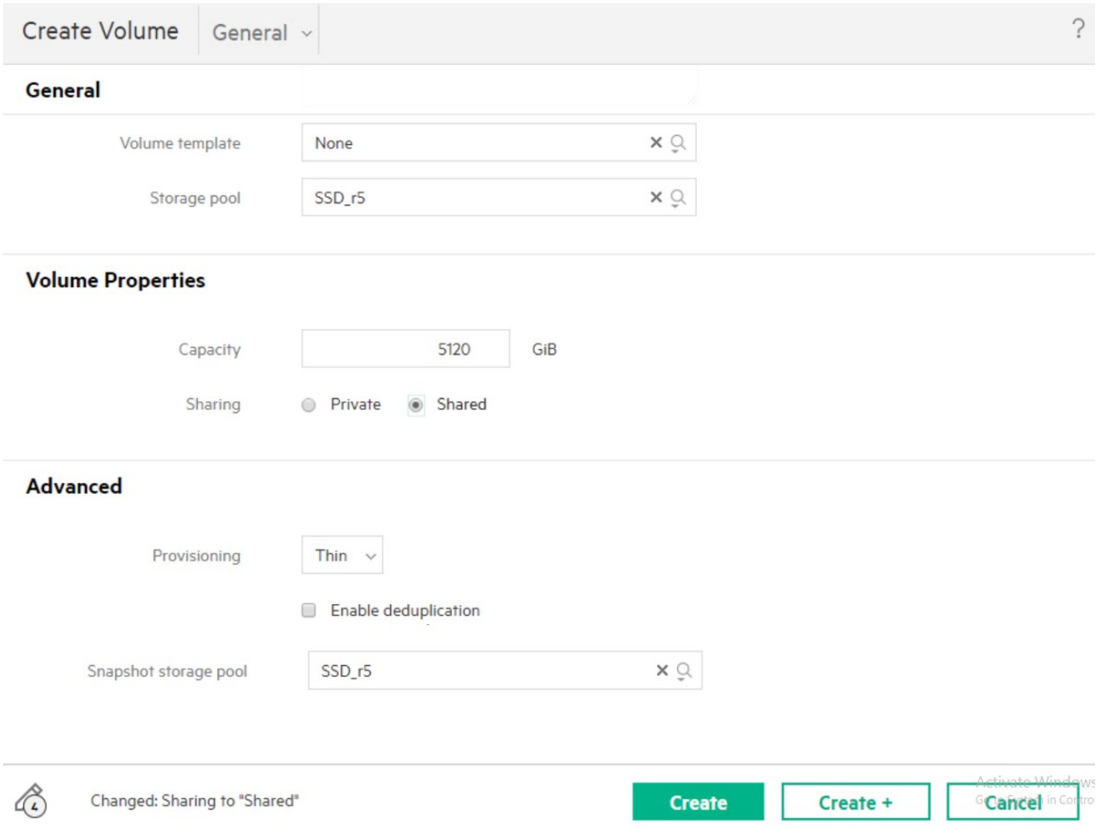

Figure 8. Creating a volume in HPE OneView

3. Click **Create**.

Deploy the golden image

The virtualization hosts are deployed using the golden image created in the earlier steps. This is achieved by creating the server profiles with the appropriate deployment plan and the network connections. The consistency among the virtualization hosts is achieved using the server profile template.

The playbooks `ServerProfileTemplate.yml` and `ServerProfile.yml` located at `/etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/DeployESXiHosts` create the server profile template and server profile.

In the hosts file located at `/etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/DeployESXiHosts/hosts`, under the servers section, add the enclosure serial number with the bay number of the server hardware, type of the server hardware, name, IP address, and hostname which needs be assigned for the servers utilized as the virtualization hosts. Assign one of the servers among them under the server profile template section as highlighted below.

```
[servers]
"2S1721PK4K, bay 5" name=ESXI_01 ip=10.0.x.x hostname=vspherehost01 type="SY 480 Gen10 4"
"MXQ73007JR, bay 11" name=ESXI_02 ip=10.0.x.x hostname=vspherehost02 type="SY 480 Gen10 2"
"MXQ73007JQ, bay 5" name=ESXI_03 ip=10.0.x.x hostname=vspherehost03 type="SY 480 Gen10 3"

[server_profile_template]
"2S1721PK4K, bay 5" type="SY 480 Gen10 4"
```

To create the server profile template and the server profile, the installer should edit the variables YAML file. Using an editor such as VIM or nano, open the file `/etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/DeployESXiHosts/HostVariables.yaml` to provide the configuration details of the OneView, image streamer, network connections, IP address details, enclosure group name, server hardware name, server hardware type, path to the template files for the server profile template, and server profile. A sample file is shown below. This file should be edited to match the installation environment.

```
Deployment_network_name: Deployment
management_network_name: TenNet
SAN_A_network_name: Fiber_Channel_A
SAN_B_network_name: Fiber_Channel_B
datacenter_network_name: TwentyNet

dns_ip: 10.0.x.x
gateway: 10.0.x.x
subnet_mask: 255.255.0.0
domain_name: tennet.local

enclosure_group_name: Enclosure_Group
deployment_plan_name: ESXi_deployment_plan
server_profile_template_name: vsphere_template
```

Update the HPE OneView IP address and credentials and the HPE Synergy Image Streamer IP address in the OneViewConfig.json file located at `/etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/DeployESXiHosts`. It is recommended to follow the same structure as shown below:

```
{
"ip": "10.0.x.x",
"credentials":{
"username": "your username",
"password": "your password" },
"image_streamer_ip": "10.0.x.x",
"api_version": 1000
}
```

Once the host file, `OneViewConfig.json`, and the variable files are updated with the appropriate values, execute the following commands from the Ansible Engine to create the server profile template and server profile.

```
# Ansible-playbook -i /etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/DeployESXiHosts/hosts
/etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/DeployESXiHosts/ServerProfileTemplate.yml
```

```
# Ansible-playbook -i /etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/DeployESXiHosts/hosts
/etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/DeployESXiHosts/ServerProfileWithoutVolume.yml
```

Update the hosts with the SAN storage volume

1. From HPE OneView, navigate to the **Server Profiles** section and select the server profile to which the volume needs to be attached.
2. Scroll down to SAN Storage and select **Manage SAN Storage** and then from the **Host OS type** drop-down list, select **VMware (ESXi)** as shown in Figure 9.

Figure 9. Update server profile with the SAN storage

3. Click **Add volume**.
4. Enter the values for the following parameters, as shown in Figure 10:
   a. **Type:** From the drop-down list, select **Existing volume**.
   b. **Attach Volume:** From the drop-down list, select the volume that is created earlier for the vSphere hosts.
   c. **Boot:** From the drop-down list, select **Not bootable**.
   d. **LUN:** Select **Auto**.
   e. **Storage Paths:** Add the corresponding storage paths.

Figure 10 highlights updating the server profile to add the SAN storage volume.

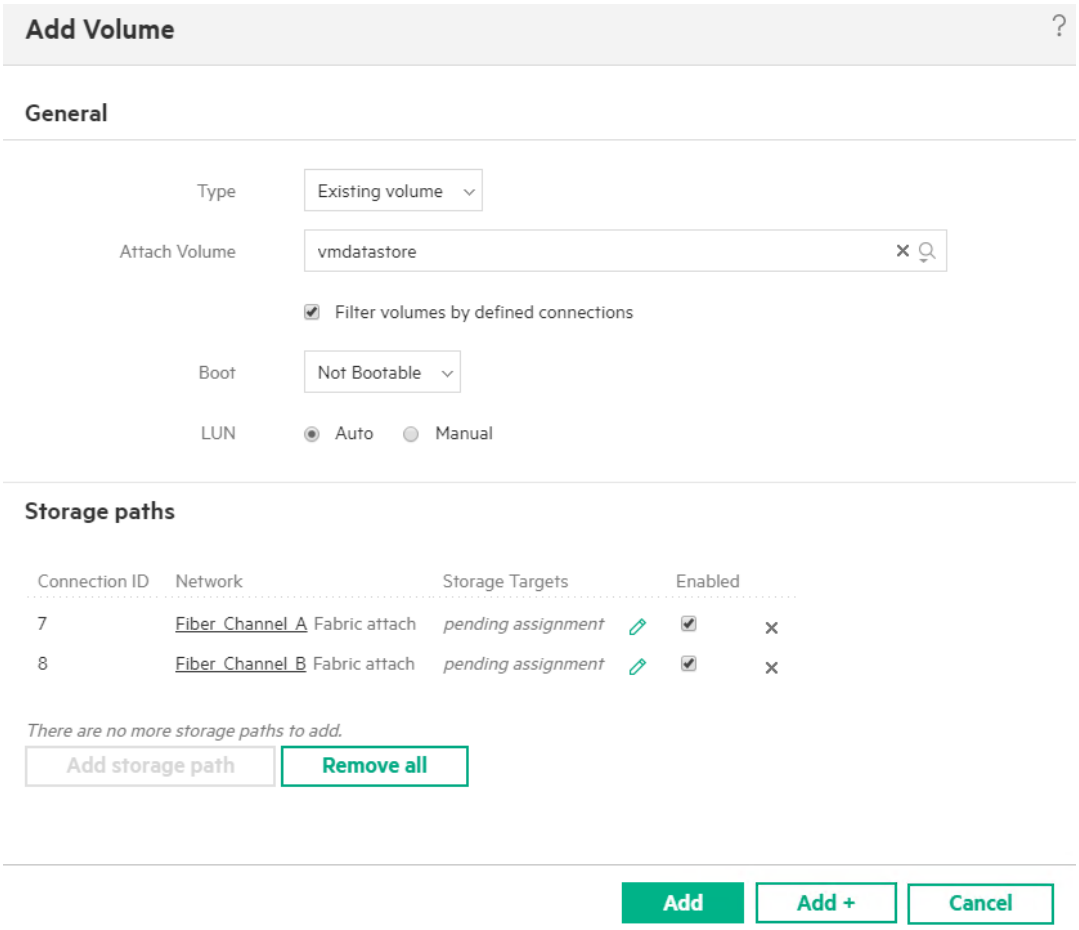

Figure 10. Add SAN storage in the server profile

5. Click **Add** to attach the volume to the server profile.
6. Once the SAN storage volume is added to the server profile, click **OK** to update the server profile.
7. Repeat the process for all the virtualized hosts.

Utilize the virtualization platform

Power on the server hardware and wait for the ESXi to be installed. It will take a couple of minutes after which the server hardware is ready to be used.

Note

Log into each of the ESXi hosts and make sure that the NIC for the management network is enabled to ensure connectivity.

VMware vCenter Server Appliance

In this solution, VMware vCenter Server Appliance (vCenter) is used to manage the virtualized environment. This section illustrates the deployment of the vCenter. If an acceptable vCenter is available in your environment, then skip forward to Red Hat OpenShift deployment.

Pre-requisites

Ensure that a DNS entry is present for the vCenter.

Procedure

Install VMware vCenter Server Appliance The installation of the vCenter is a two-stage process:

1. Stage 1 - Deployment
2. Stage 2 - Configuration

Stage 1 - Deploy the appliance

1. From the installer's laptop, navigate to the location of the vCenter iso file and double-click to open it.
2. Depending on the OS, navigate to the vcsa-ui-installer/<OS type> folder and run the **installer.exe** file.
3. On the installation window, click **Install** to proceed with the installation of a new vCenter.
4. Accept the end user license agreement and click **Next**.
5. Select the deployment type as "vCenter server with an Embedded Platform Service Controller" and click **Next**.
6. Provide the root credentials of the vSphere host where the vCenter is to be installed and click **Next**.
7. Accept the SSL certificate of the selected host.
8. Enter a unique name for the vCenter, provide a password, and click **Next**.
9. Based on your environment, provide the deployment size and the storage size and click **Next**.
10. Select the datastore of the host which needs to be used and click **Next**.
11. Configure the network settings and click **Next**.
12. Provide the values for the following parameters:
    a. **IP address**: IP address for the vCenter
    b. **Domain name**: Domain name of the management network of the vCenter
    c. **FQDN**: Fully-qualified domain name of the vCenter
    d. **Subnet mask:** Subnet mask for the vCenter network
    e. DNS server: IP address for the DNS server
13. Click **Finish** to start the installation. The vCenter will be deployed to the specified host.
14. When Stage 1 is successfully completed, click **Continue** to resume the Stage 2 installation.

Stage 2 - Set Up the vCenter

1. When the Stage 2 installation screen is displayed, click **Next** to begin the configuration process.
2. Specify an NTP server and enable **SSH access**. Click **Next**. Enabling SSH is required to enable execution of Ansible playbooks.
3. Select the **Create a new SSO domain** option, and provide an SSO domain name and a unique SSO password. Click **Next** when complete.
4. Click **Finish** to finalize the deployment and then click **OK** to proceed. The setup process is then instantiated.
5. When Stage 2 is executed successfully, the vCenter deployment is complete.

Accessing vCenter

To access the appliance, type the address https:// <vCenter Server Appliance IP address>:443 in the browser and enter the root credentials.

Red Hat OpenShift deployment

Overview of the tasks

1. Create a data center in vCenter.
2. Create a cluster for hosting the ESXi hosts.
3. Bring the ESXi hosts into the newly created cluster.
4. Create a datastore with the HPE 3PAR StoreServ volume.
5. Create a Red Hat Enterprise Linux (RHEL) 7.6 VM template.
6. Deploy the RHEL 7.6 template to create the management VMs for the OCP installation.
7. Deploy Red Hat OpenShift Container Platform.

Pre-requisites

- Ansible Engine should be installed and configured and capable of communicating with the hosts within this solution.
- VMware ESXi 6.7 is installed on at least three HPE Synergy 480 Compute Modules.
- A VMware vCenter is configured and available.
- Make sure that both storage and networking are configured within vCenter.
- DNS entries should exist for all hosts.
- VM entries in the DNS server is a must.

Create a data center in the VMware vCenter Server Appliance

A data center is a structure in vCenter which holds the host clusters, hosts, datastore, and so on. To begin with, the installer should create a data center.

In order to create the data center, the installer performs the following steps:

1. Edit the variables YAML file. Using an editor, open the file `/etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/PrepareVCSA/vCenterVars.yaml to` provide the vCenter hostname and credentials, vSphere hosts and credentials, data center, and cluster name. A sample variable file can be found below. The installer needs to modify its file to suit their environment.

```
vcenter_hostname: 10.0.x.x OR vcsa.tennet.local
vcenter_username: << vCenter_username >>
vcenter_password: << vCenter_password >>
datacenter_name: 3par_datacenter
cluster_name: 3par_clsuter
esxi_01: 10.0.x.x
esxi_02: 10.0.x.x
esxi_03: 10.0.x.x
esxi_uname: << esxi_username >>
esxi_pwd: << esxi_host_password >>
```

2. Once the variable file is updated with the appropriate values, execute the following command to create the data center.

```
# Ansible-playbook /etc/ansible/Openshift-Synergy-
  RA/synergy/scalable/vsphere/3par/PrepareVCSA/CreateDatacenter.yml
```

Creating a cluster for hosting the ESXi hosts

Cluster in vCenter is a pool of ESXi hosts which provides high availability and reliability to the VMs deployed in them. Execute the following command to create a cluster in vCenter.

```
# Ansible-playbook /etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/PrepareVCSA/CreateCluster.yml
```

Add the ESXi hosts into the cluster in vCenter

Once the cluster is created within vCenter, the ESXi hosts need to be added into the cluster. Execute the following command to add the hosts into the cluster in vCenter.

```
# Ansible-playbook /etc/ansible/Openshift-Synergy-
  RA/synergy/scalable/vsphere/3par/PrepareVCSA/AddHostsToCluster.yml
```

Creating a datastore with the HPE 3PAR StoreServ Storage

A datastore needs to be created to store the VMs. The following steps create a datastore on the HPE 3PAR StoreServ Storage:

1. From the vSphere vCenter Web Client navigator, right-click on the **Cluster** and select **Storage.** From the drop-down list, select the **New Datastore** icon.
2. Select **VMFS** as the datastore type as shown in Figure 11 and click **Next**.

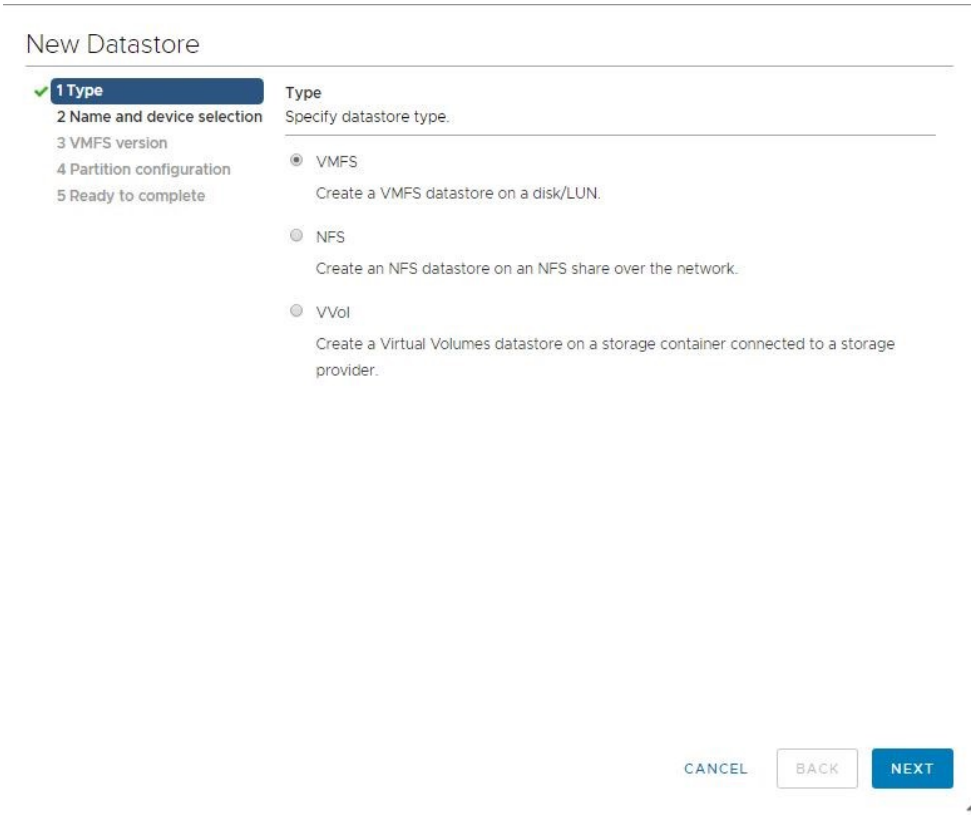

Figure 11. Datastore type screen within vCenter

3. On the **Name and device selection** page, complete the following fields as in Figure 12:
   a. Enter a unique name for the datastore.
   b. Select a host to view its accessible disk/LUNs. Any of the hosts that are associated with the HPE 3PAR StoreServ Storage volume may be selected.
   c. Select the volume from HPE 3PAR StoreServ Storage and click **Next**.

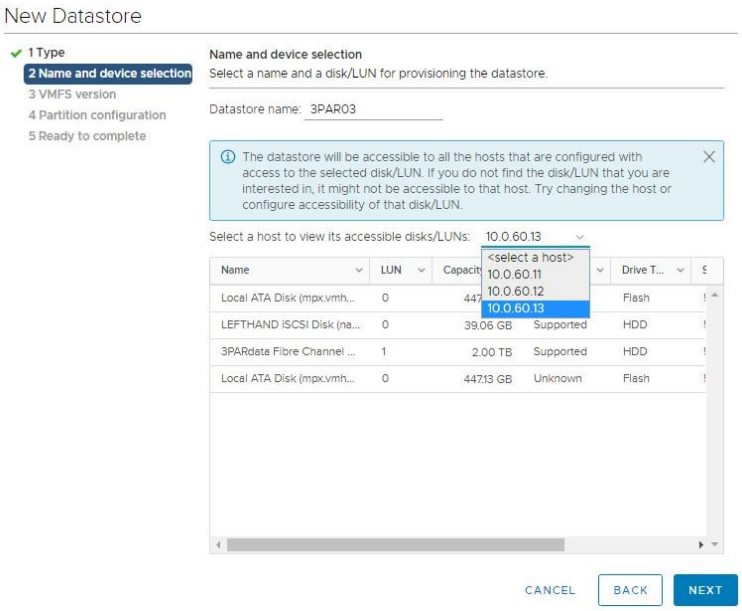

Figure 12. Name and device selection screen within vCenter

4. Specify the VMFS version as VMFS 6 and click **Next** as shown in Figure 13.

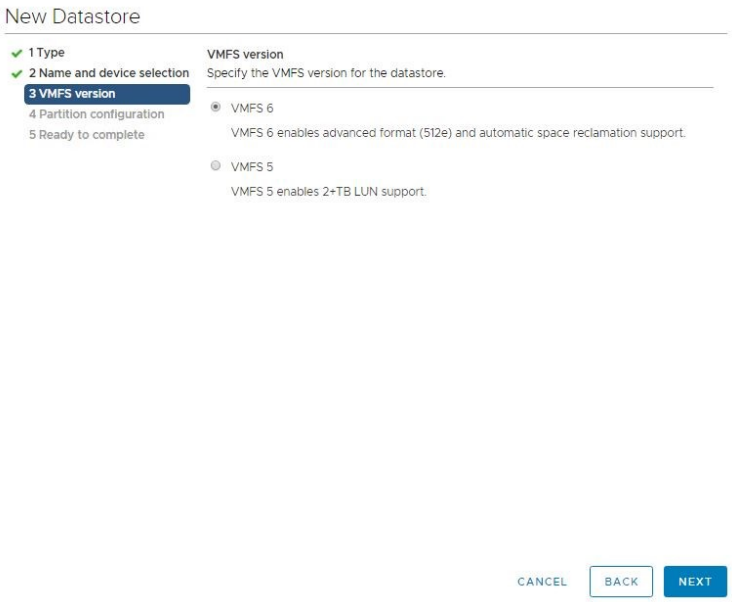

Figure 13. VMFS version screen within vCenter

5. Specify the details for partition configuration and click **Next** as shown in Figure 14. By default, the entire free space on the storage device is allocated.

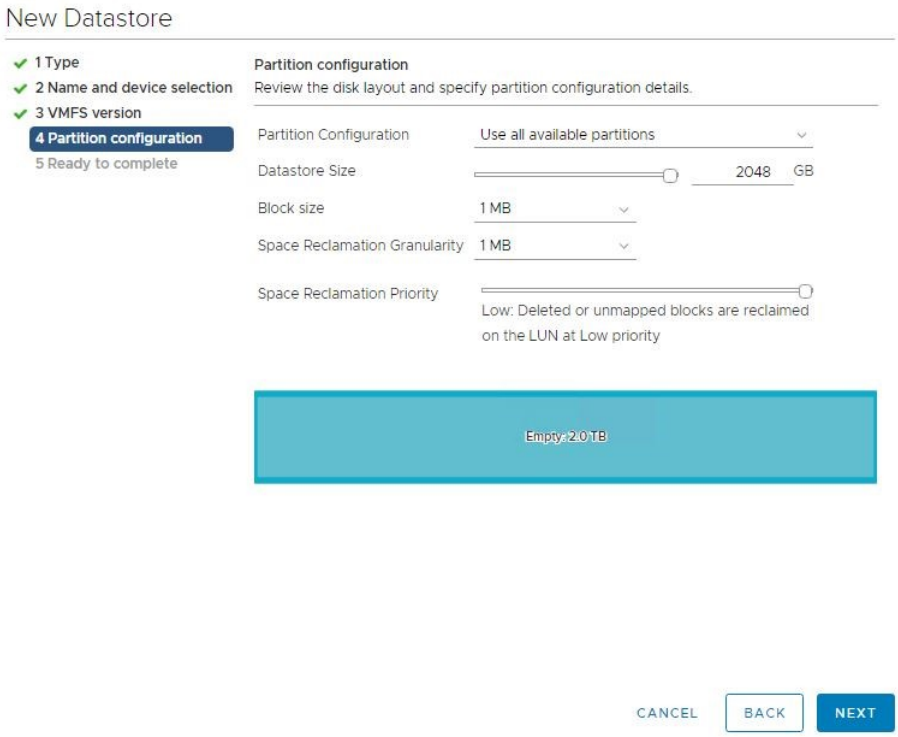

Figure 14. Partition configuration of the new datastore in vCenter

6. Review the datastore configuration and click **Finish**.

Note

Install and configure any adapters that the storage requires. To discover newly-added storage devices, perform a re-scan. Verify if the storage devices that are planned to use for the datastores are available.

Create a Red Hat Enterprise Linux 7.6 VM template

A VM template with the Red Hat Enterprise Linux 7.6 operating system with VMware tools is utilized. The following section explains the steps that are required to create a RHEL 7.6 VM template.

Overview of the tasks

1. Create a VM with RHEL 7.6 OS.
2. Convert the VM to a template.

Create a VM with RHEL 7.6 operating system

1. Log in to Virtual Center using Web Client or vSphere Client and navigate to the new virtual machine wizard.

2. From the **Select a creation type** drop-down list, select **Create a new virtual machine** and click **Next** as shown in Figure 15.

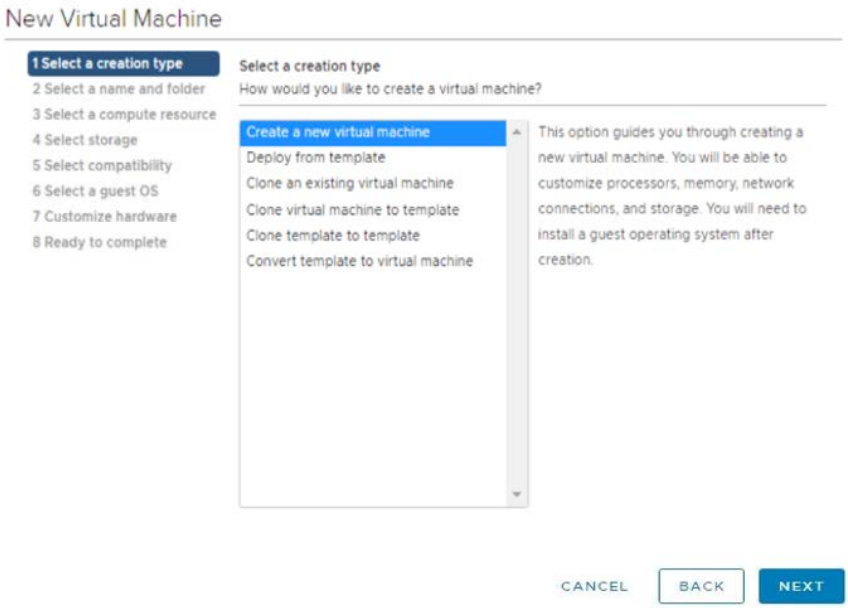

Figure 15. Creation type screen within vCenter.

3. Enter a unique name for the VM, select the data center to deploy the VM, and then click **Next** as shown in Figure 16.

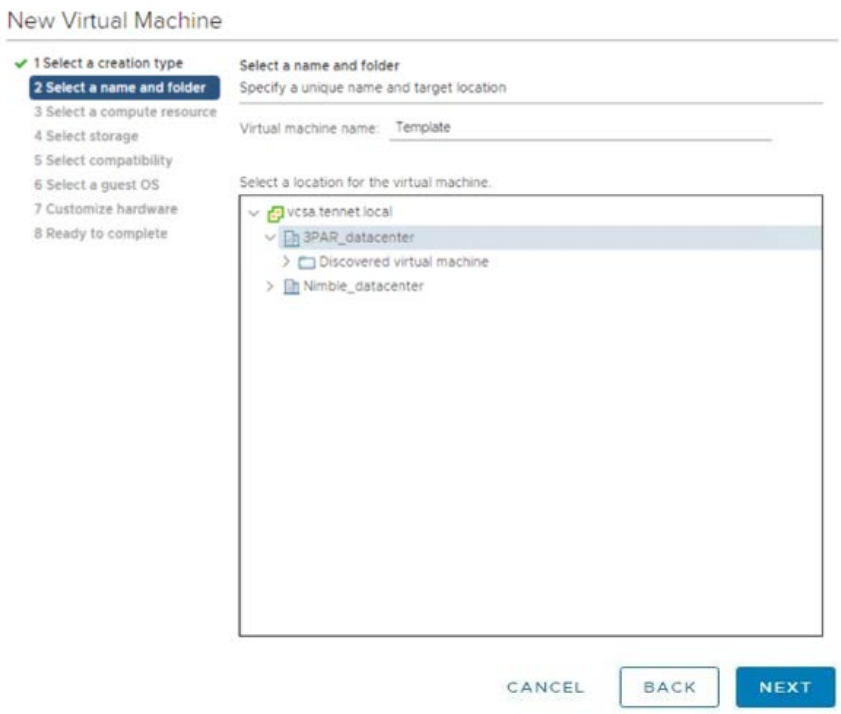

Figure 16. Name and folder screen within vCenter

4. Select the cluster on which the VM can be deployed and click **Next**.
5. Select the VM storage policy and datastore on which the VM configuration files and disks can be stored and then click **Next** as shown in Figure 17.

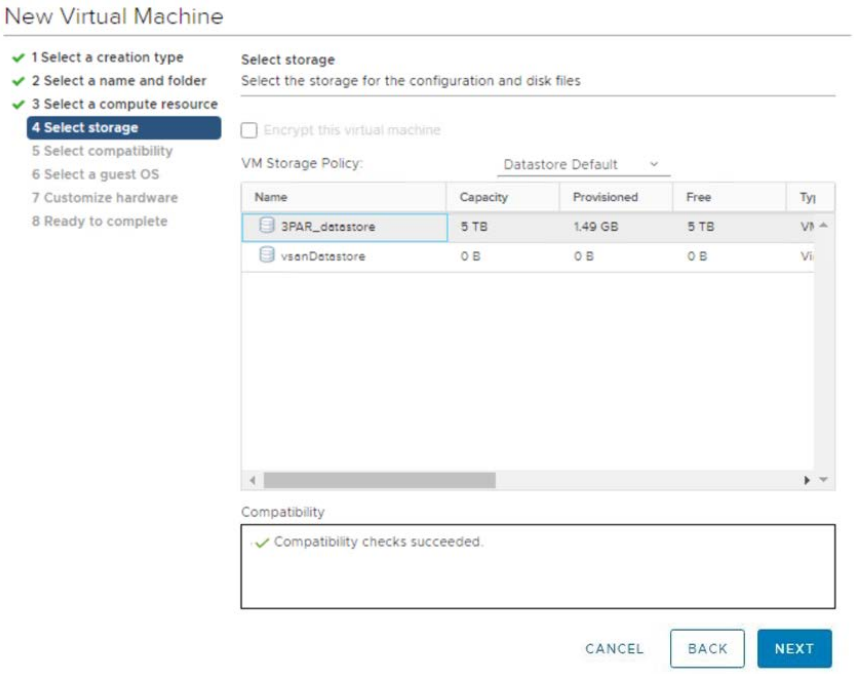

Figure 17. Storage selection screen within vCenter

6. On the **Select compatibility** page, from the **Compatible with** drop-down list, select **ESXI 6.7 and later**, and then click **Next** as shown in Figure 18.

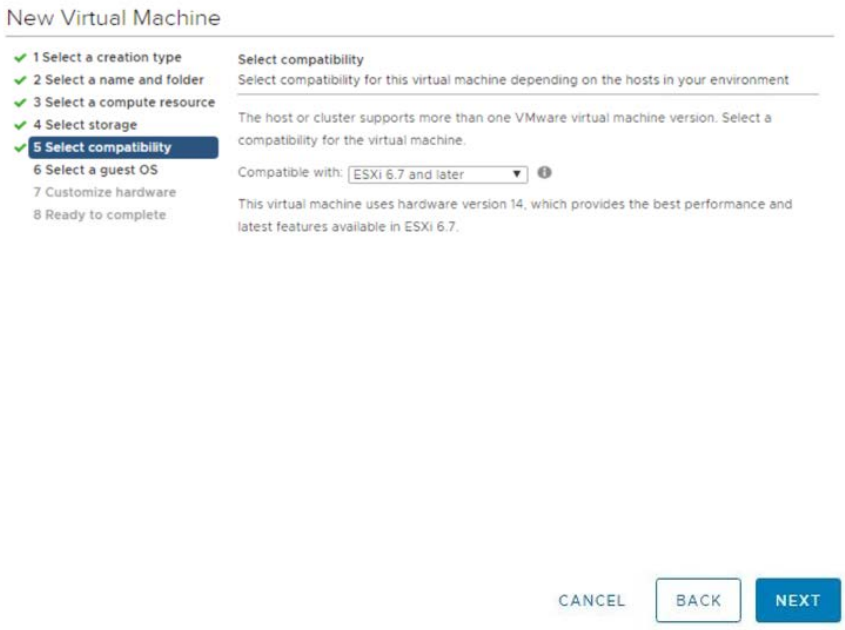

Figure 18. Select compatibility screen in vCenter

7. On the **Select a guest OS** page, select **Linux** from the **Guest OS family** drop-down list. From the **Guest OS Version** drop-down list, select **Red Hat Enterprise Linux 7 (64 bit)**, and then click **Next** as shown in Figure 19.

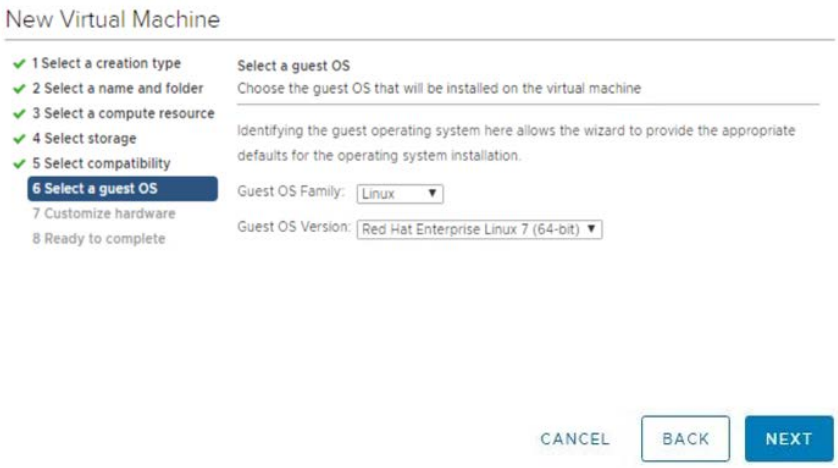

Figure 19. Guest OS selection screen in vCenter

8. On the **Customize hardware** page, configure the virtual hardware with 4 CPU, 16 GB memory, and two (2) 50 GB hard disks. Attach the RHEL 7.6 operating system ISO file. Select the **Connect at Power on** option and click **Next** as shown in Figure 20.

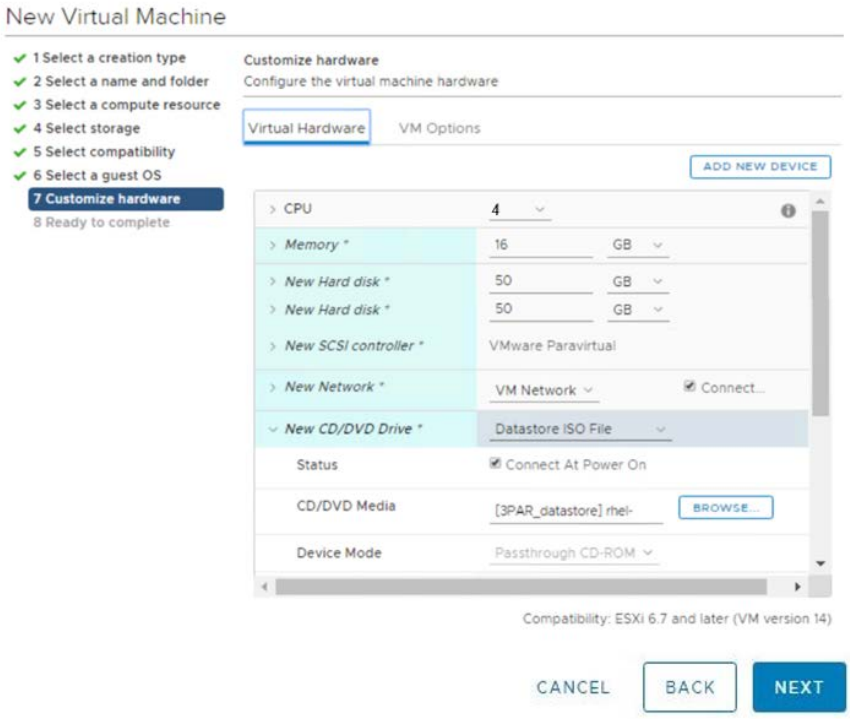

Figure 20. Customize hardware screen within vCenter

9. Review the virtual machine configuration before deploying the virtual machine. Click **Finish** to complete the new virtual machine creation.

Once the new VM is created, install the RHEL 7.6 guest operating system to complete the creation procedure. To Install a guest OS, follow the steps listed in the blog from Red Hat at, https://developers.redhat.com/products/rhel/hello-world#fndtn-vmware. It is strongly recommended that the installer registers the template, updates all packages using Yum, and then unregisters the template.

Note

The installation of VMware tools is necessary for the proper execution of Ansible playbooks. Install VMware tools on the VM intended to be converted to a template by following the steps listed in the blog from Red Hat at https://access.redhat.com/solutions/1447193.

Convert the VM to a template

1. Log in to vCenter and select the VM created to be converted to a template.
2. If the VM is powered on, go to **Actions > Power > Power off the VM**.
3. Go to **Actions** and select **Template > Convert to Template** as shown in Figure 21.

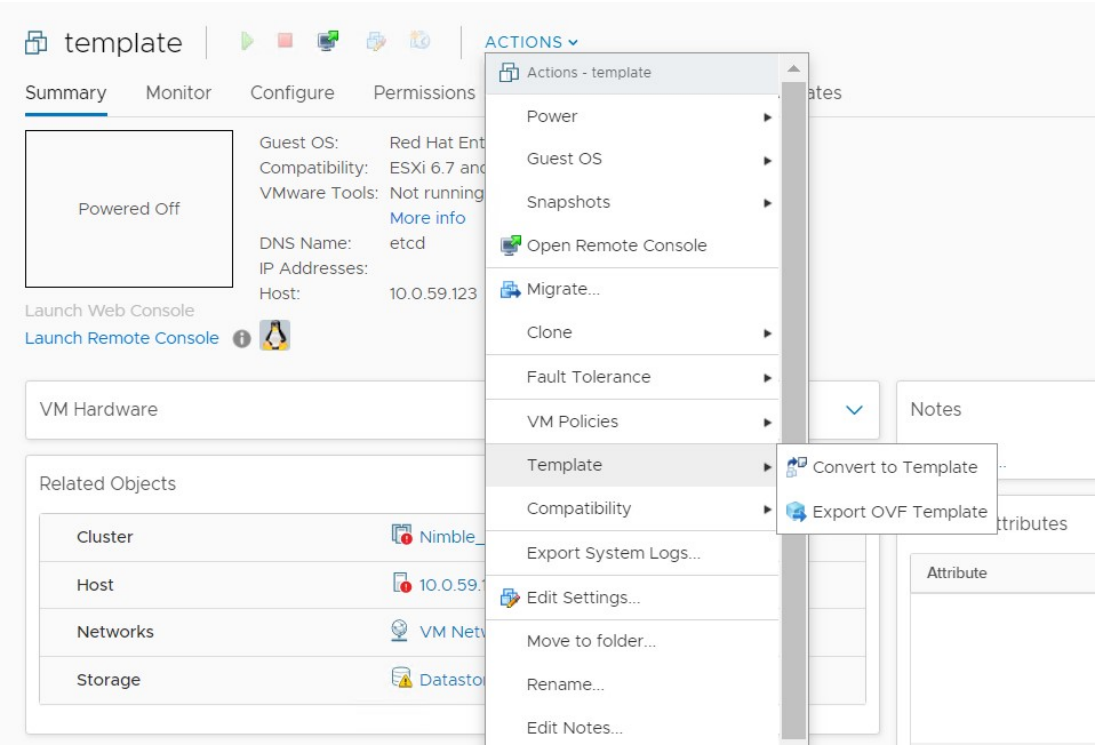

Figure 21. VM template within vCenter

Deploy VMs from the template

To clone the VMs from the template for OpenShift deployment, the installer performs the following steps:

1. Edit the variables YAML file. Using an editor such as VIM or nano, open the file `/etc/ansible/Openshift-Synergy-RA/synergy/scalable/vsphere/3par/DeployVMs/VirtualMachineVars.yaml`. The file contains information about the VMs, vCenter, hostnames, IPs, memory, and CPU. Update the variable file with the details to suit the needs of the installation environment.

```
vcenter_hostname: 10.0.x.x / vCenter.tennet.local
vcenter_username: << vCenter_username >>
vcenter_password: << vCenter_password >>
cluster_name: 3PAR_cluster
datacenter_name: 3PAR_datacenter
datastore_name: 3PAR_datastore
vmtemplate: 3PAR_template

# Disk size in GB/GiB
master_disk_size: 50
infra_disk_size: 50
etcd_disk_size: 50
lb_disk_size: 50

# number of CPUs
master_cpu_size: 4
infra_cpu_size: 6
etcd_cpu_size: 4
lb_cpu_size: 4

# Memory size in MB/MiB
master_memory_size: 16184
infra_memory_size: 24276
etcd_memory_size: 16184
lb_memory_size: 8192

master01_ip: 10.0.x.x
master02_ip: 10.0.x.x
master03_ip: 10.0.x.x
infra01_ip: 10.0.x.x
infra02_ip: 10.0.x.x
infra03_ip: 10.0.x.x
etcd01_ip: 10.0.x.x
etcd02_ip: 10.0.x.x
etcd03_ip: 10.0.x.x
lb01_ip: 10.0.x.x
lb02_ip: 10.0.x.x

master01_ip2: 30.0.x.x
master02_ip2: 30.0.x.x
master03_ip2: 30.0.x.x
infra01_ip2: 30.0.x.x
infra02_ip2: 30.0.x.x
infra03_ip2: 30.0.x.x
etcd01_ip2: 30.0.x.x
etcd02_ip2: 30.0.x.x
etcd03_ip2: 30.0.x.x
```

```
lb01_ip2: 30.0.x.x
lb02_ip2: 30.0.x.x

master01_ip3: 40.0.x.x
master02_ip3: 40.0.x.x
master03_ip3: 40.0.x.x
infra01_ip3: 40.0.x.x
infra02_ip3: 40.0.x.x
infra03_ip3: 40.0.x.x
etcd01_ip3: 40.0.x.x
etcd02_ip3: 40.0.x.x
etcd03_ip3: 40.0.x.x
lb01_ip3: 40.0.x.x
lb02_ip3: 40.0.x.x

master01_fqdn: master01.tennet.local
master02_fqdn: master02.tennet.local
master03_fqdn: master03.tennet.local
etcd01_fqdn: etcd01.tennet.local
etcd02_fqdn: etcd02.tennet.local
etcd03_fqdn: etcd03.tennet.local
infra01_fqdn: infra01.tennet.local
infra02_fqdn: infra02.tennet.local
infra03_fqdn: infra03.tennet.local
lb01_fqdn: lb01.tennet.local
lb02_fqdn: lb02.tennet.local

master01_name: master01
master02_name: master02
master03_name: master03
etcd01_name: etcd01
etcd02_name: etcd02
etcd03_name: etcd03
infra01_name: infra01
infra02_name: infra02
infra03_name: infra03
lb01_name: lb01
lb02_name: lb02

subnet_mask: 255.255.0.0
gateway_address: 10.0.x.x
dns_server_address: 10.0.x.x
domain_name: "tennet.local"
network_name: "VM Network"
```

2. Execute the following command to deploy all the VMs that have been specified:

```
# ansible-playbook /etc/ansible/Openshift-Synergy-
RA/synergy/scalable/vsphere/3par/DeployVMs/DeployManagementVMs.yml
```

The play `DeployManagementVMs.yml` creates the following control plane VMs in vCenter and configures the IP address for each of them.

```
master01
master02
master03
infra01
infra02
infra03
etcd01
etcd02
etcd03
lb01
lb02
```

3. After the VMs are created, SSH into each VM and update their hostnames to their fully-qualified domain names with the command listed below:

```
# hostnamectl set-hostname <fqdn as hostname of the virtual machine>
```

Deploying Red Hat OpenShift Container Platform

Once the deployment of the management VMs is complete, the processes of deploying the worker nodes and then deploying Red Hat OpenShift Container Platform can begin. The processes to complete these steps are found in the master deployment guide found at https://github.com/HewlettPackard/hpe-solutions-openshift/tree/master/synergy/scalable/3par. Refer the master deployment guide for detailed steps.

Note

The value for the variable second_disk_physical in the VMware VMs is /dev/sdb. This value will be used in the subsequent stages of the Red Hat OpenShift Container Platform deployment.

Appendix A - Playbook variables

Table A1 describes the variables used with the DeployESXiHosts.

Table A1. Variables used in the Deploy ESXi hosts

Variable	Scope	Description
config	OneView	Path to the configuration file with OneView and Image Streamer IP address and credentials
Network Connections Name **deployment_network_name** **management_network_name** **SAN_A_network_name** **SAN_B_network_name** **datacenter_network_name**	OneView	Names of the network connections utilized in the server profile
OneViewConfig.json **Ip** **userName** **password** **image_streamer_ip**	OneView	IP address and credentials of the OneView and the Image Streamer IP address
Network Details **dns_ip** **gateway** **subnet_mask** **domain_name**	OneView	Network configuration details for the hosts
esxi_ip	OneView	IP address that needs to be assigned to the host
esxi_hostname	OneView	Hostname that needs to be assigned to the host
enclosure_group_name	OneView	Name of the enclosure group where the server belongs to
deployment_plan_name	OneView	Name of the deployment plan which will be applied to the servers
server_hardware_name	OneView	Server hardware name
server_profile_template_name:	OneView	Name that needs to be associated to the server profile template
server_profile_name	OneView	Name that needs to be associated to the server profile
server_profile_template_file	OneView	Path of the template file utilized for the server profile template creation
server_profile_file	OneView	Path of the template file utilized for the server profile creation

Table A2 describes the variables used with the Prepare VCSA.

Table A2. Variables used in the Prepare VCSA

Variable	Scope	Description
vcenter_hostname	vCenter	vCenter hostname/IP address
vcenter_username	vCenter	Username for the vCenter hosts
vcenter_password	vCenter	Password for the vCenter hosts
datacenter_name	vCenter	Data center within vCenter which will be used for template deployment
cluster_name	vCenter	Cluster within vCenter which will be used for template deployment
esxi_x	vCenter	vSphere host x's hostname
esxi_uname	vCenter	Username for the vSphere hosts

esxi_pwd	vCenter	Password for the vSphere hosts

Table A3 describes the variables used in the deployment of the VMs.

Table A3. Variables used for deploying VMs

Variable	Scope	Description
vcenter_hostname	vCenter	FQDN/IP address of the vCenter
vcenter_username	vCenter	Username for the vCenter host
vcenter_password	vCenter	Password for the vCenter host
datacenter_name	vCenter	Data center within vCenter which will be used for template deployment
cluster_name	vCenter	Compute Cluster within vCenter for the management VMs
<node>_name	vCenter	Name of the corresponding master, infra, etcd, load balancer VMs
<node>_fqdn	vCenter	FQDN of the corresponding master, infra, etcd, load balancer VMs
domain	vCenter	Domain name of the management network
subnet_mask	vCenter	Subnet mask
gateway_address	vCenter	Gateway IP address
dns_server_address	vCenter	DNS Server IP address
Ip, ip2, ip3	vCenter	IP address corresponding to the management and the data center networks
disk_size **master_disk_size** **infra_disk_size** **etcd_disk_size** **lb_disk_size**	vCenter	Disk size in GB/GiB for the master, infra, etcd, and the load balancer VMs
cpu_size **master_cpu_size** **infra_cpu_size** **etcd_cpu_size** **lb_cpu_size**	vCenter	Number of vCPUs for the master, infra, etcd, and the load balancer VMs
memory_size **master_memory_size** **infra_memory_size** **etcd_memory_size** **lb_memory_size**	vCenter	Memory size in MB/MiB for the master, infra, etcd, and the load balancer VMs

Table A4 describes the variables used during host preparation.

Table A4. Variables used during host preparation.

Variable	Scope	Description
second_disk_physical	Worker node	Path to the second disk

Change Tracker

Version	Release Date	Changes
1.0	7/14/2019	Initial Release

Resources and Additional Links

Red Hat, https://www.redhat.com

Red Hat OpenShift Container Platform 3.11 Documentation, https://docs.openshift.com/container-platform/3.11/welcome/index.html

HPE Synergy, https://www.hpe.com/info/synergy

HPE 3PAR StoreServ Storage, https://www.hpe.com/info/3PAR

HPE Solutions for OpenShift GitHub, https://github.com/hewlettpackard/hpe-solutions-openshift

Red Hat OpenShift Container Platform on HPE Synergy with HPE 3PAR StoreServ Storage, the master deployment guide, https://github.com/HewlettPackard/hpe-solutions-openshift/tree/master/synergy/scalable/3par

HPE FlexFabric 5940 switching, https://www.hpe.com/us/en/product-catalog/networking/networking-switches/pip.hpe-flexfabric-5940-switch-series.1009148840.html

HPE Workload Aware Security for Linux, https://h20392.www2.hpe.com/portal/swdepot/displayProductInfo.do?productNumber=WASL

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