Basic Concepts for NetApp ONTAP 9.7

NAS Services, System Manager Edition

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TABLE OF CONTENTS

1 Introduction

This lab introduces the fundamentals of NetApp ONTAP®. In it you begin with a pre-created 2-node ONTAP cluster, provision storage for access through CIFS and NFS, configure a Windows 2019 client to access the storage over CIFS, and configure a Red Hat Enterprise Linux 7.5 client to access the storage over NFS.

There is a similar lab available that demonstrates how to configure these same clients to access storage on the cluster using SAN protocols instead, specifically using iSCSI. The NAS and SAN lab guides are designed so they can both be completed within the same copy of the lab. If that option interests you, then for the best user experience we recommend that you complete the NAS guide first, followed by the SAN guide, as that ordering will most closely match the workflow examples documented in the lab guides.

1.1 Why NetApp ONTAP?

One of the key ways to understand the benefits of ONTAP is to consider server virtualization. Before server virtualization, system administrators frequently deployed applications on dedicated servers in order to maximize application performance, and to avoid the instabilities often encountered when combining multiple applications on the same operating system instance. While this design approach was effective, it also had the following drawbacks:

- It did not scale well — adding new servers for every new application was expensive.
- It was inefficient — most servers are significantly under-utilized, and businesses are not extracting the full benefit of their hardware investment.
- It was inflexible — re-allocating standalone server resources for other purposes is time consuming, staff intensive, and highly disruptive.

Server virtualization directly addresses these limitations by decoupling the application instance from the underlying physical hardware. Multiple virtual servers can share a pool of physical hardware, allowing businesses to consolidate their server workloads to a smaller set of more effectively utilized physical servers. Additionally, the ability to transparently migrate running virtual machines across a pool of physical servers reduces the impact of downtime due to scheduled maintenance activities.

NetApp ONTAP brings these same benefits, and many others, to storage systems. As with server virtualization, ONTAP enables you to combine multiple physical storage controllers into a single logical cluster that can non-disruptively service multiple storage workload needs. With ONTAP you can:

- Combine different types and models of NetApp storage controllers (known as nodes) into a shared physical storage resource pool (referred to as a cluster).
- Support multiple data access protocols (CIFS, NFS, Fibre Channel, iSCSI, NVMeFC, etc.) concurrently on the same storage cluster.
- Consolidate various storage workloads to the cluster. Each workload can be assigned its own Storage Virtual Machine (SVM), which is essentially a dedicated virtual storage controller, and its own data volumes, LUNs, CIFS shares, and NFS exports.
- Support multi-tenancy with delegated administration of SVMs. Tenants can be different companies, business units, or even individual application owners, each with their own distinct administrators whose admin rights are limited to just the assigned SVM.
- Use Quality of Service (QoS) capabilities to manage resource utilization between storage workloads.
- Non-disruptively migrate live data volumes and client connections from one cluster node to another.
- Non-disruptively scale the cluster out by adding nodes. Nodes can likewise be non-disruptively removed from the cluster, meaning that you can non-disruptively scale a cluster up and down during hardware refresh cycles.
- Leverage multiple nodes in the cluster to simultaneously service a given SVM's storage workloads. This means that businesses can scale out their SVMs beyond the bounds of a single physical node in response to growing storage and performance requirements, all non-disruptively.
- Apply software and firmware updates, and configuration changes without downtime.

1.2 Lab Objectives

This lab explores fundamental concepts of ONTAP by walking you through the initial setup of a cluster, with a focus on support for NAS protocols (CIFS and NFS).

Here is a summary of the exercises in this lab, along with their Estimated Completion Times (ECT):

- Clusters (Required, ECT = 20 minutes).
  - Explore a cluster.
  - View Advanced Drive Partitioning.
  - Create a data aggregate.
  - Create a Subnet.
- Storage Virtual machines for NFS and CIFS (ECT = 40 minutes)
  - Create a Storage Virtual Machine.
  - Configure the Storage Virtual Machine for CIFS and NFS access.
  - Create a volume on the Storage Virtual Machine.
  - Mount a CIFS share from the Storage Virtual Machine on a Windows client.
  - Mount a NFS volume from the Storage Virtual Machine on a Linux client.
  - Create and NFS-export Qtrees. (Optional)

There are two versions of this lab guide, one uses System Manager (NetApp's graphical administration interface) to complete these tasks, while the other uses the ONTAP Command Line Interface (CLI). The lab end state produced by either method is exactly the same, so use the method you are the most comfortable with by selecting the appropriate lab guide.

Note: The System Manager version of this lab demonstrates the “classic” System Manager interface that is standard in ONTAP 9.7 and earlier ONTAP versions. It does not discuss the “new experience” System Manager interface that is previewed in ONTAP 9.7 and that becomes standard in ONTAP 9.8.

1.3 Prerequisites

This lab introduces NetApp ONTAP, and makes no assumptions that the user has previous experience with ONTAP. The lab does assume some basic familiarity with storage system related concepts such as RAID, CIFS, NFS, LUNs, and DNS.

This lab includes steps for mapping shares and/or mounting LUNs on a Windows client. These steps assume that the lab user has a basic familiarity with Microsoft Windows.

This lab also includes steps for mounting NFS volumes and/or LUNs on a Linux client. All steps are performed from the Linux command line, and assumes a basic working knowledge of the Linux command line. A basic working knowledge of a text editor such as vi may be useful, but is not required.

1.4 Accessing the Command Line

PuTTY is the terminal emulation program used in the lab to log into Linux hosts and storage controllers in order to run command line commands.

1. The launch icon for the PuTTY application is pinned to the task bar on the Windows host Jumphost as shown in the following screen shot; just double-click on the icon to launch it.

   Tip: If you already have a PuTTY session open and you want to start another (even to a different host), right-click the PuTTY icon and select **PuTTY** from the context menu.

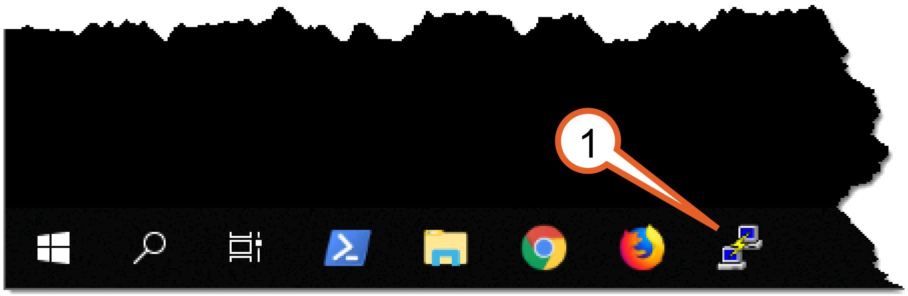

Figure 1-1:

Once PuTTY launches you need to select the lab host you want to connect to. The following example shows how to connect to the ONTAP cluster named “cluster1”.

2. By default PuTTY should launch into the “Basic options for your PuTTY session” display as shown in the screen shot. If you accidentally navigate away from this view just click on the **Session** category item to return to this view.
3. Use the scrollbar in the “Saved Sessions” box to navigate down to the desired host and double-click it to open the connection. A terminal window will open and you will be prompted to log into the host. You can find the

correct username and password for the host in the Lab Host Credentials table found in the “Lab Environment” section of this guide.

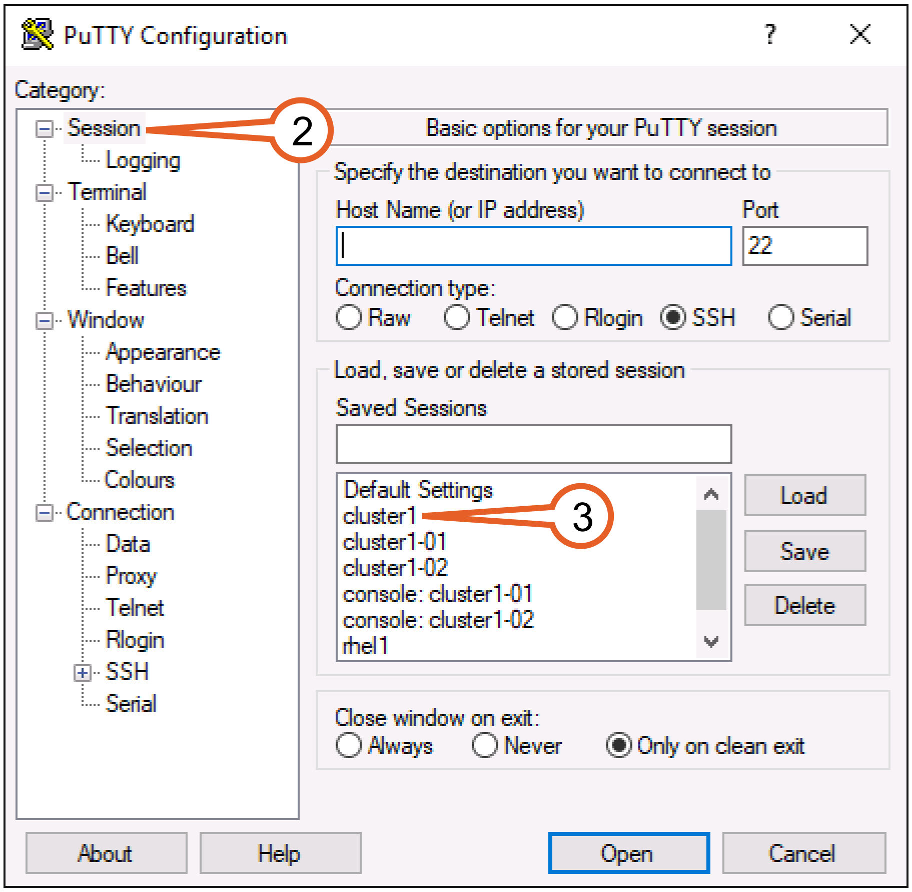

Figure 1-2:

If you are new to the ONTAP CLI, the length of the commands can seem a little intimidating. However, the commands are actually quite easy to use if you remember the following three tips:

- Make liberal use of the **Tab** key while entering commands, as the ONTAP command shell supports tab completion. If you hit the **Tab** key while entering a portion of a command word, the command shell will examine the context and try to complete the rest of the word for you. If there is insufficient context to make a single match, it will display a list of all the potential matches. Tab completion also usually works with command *argument values*, but there are some cases where there is simply not enough context for it to know what you want, in which case you will just need to type in the *argument value*.
- You can recall your previously entered commands by repeatedly pressing the **up-arrow** key, and you can then navigate up and down the list using the **up-arrow** and **down-arrow** keys. When you find a command you want to modify, you can use the **left-arrow**, **right-arrow**, and **Delete** keys to navigate around in a selected command to edit it.
- Entering a question mark character (**?**) causes the CLI to print contextual help information. You can use this character on a line by itself, or while entering a command.

The ONTAP command line supports additional usability features that make the command line easier to use. If you are interested in learning more about this topic, refer to the “Hands-On Lab for Advanced Features of ONTAP” lab, which contains an entire section dedicated to this subject.

Note: In this lab, ONTAP automatically terminates ssh sessions to cluster1 after 2 hours of idle time. If you would prefer your PuTTY sessions to cluster1 to stay open indefinitely, issue the `system timeout modify 0` command at the ONTAP CLI.

2 Lab Environment

The following figure contains a diagram of the environment for this lab.

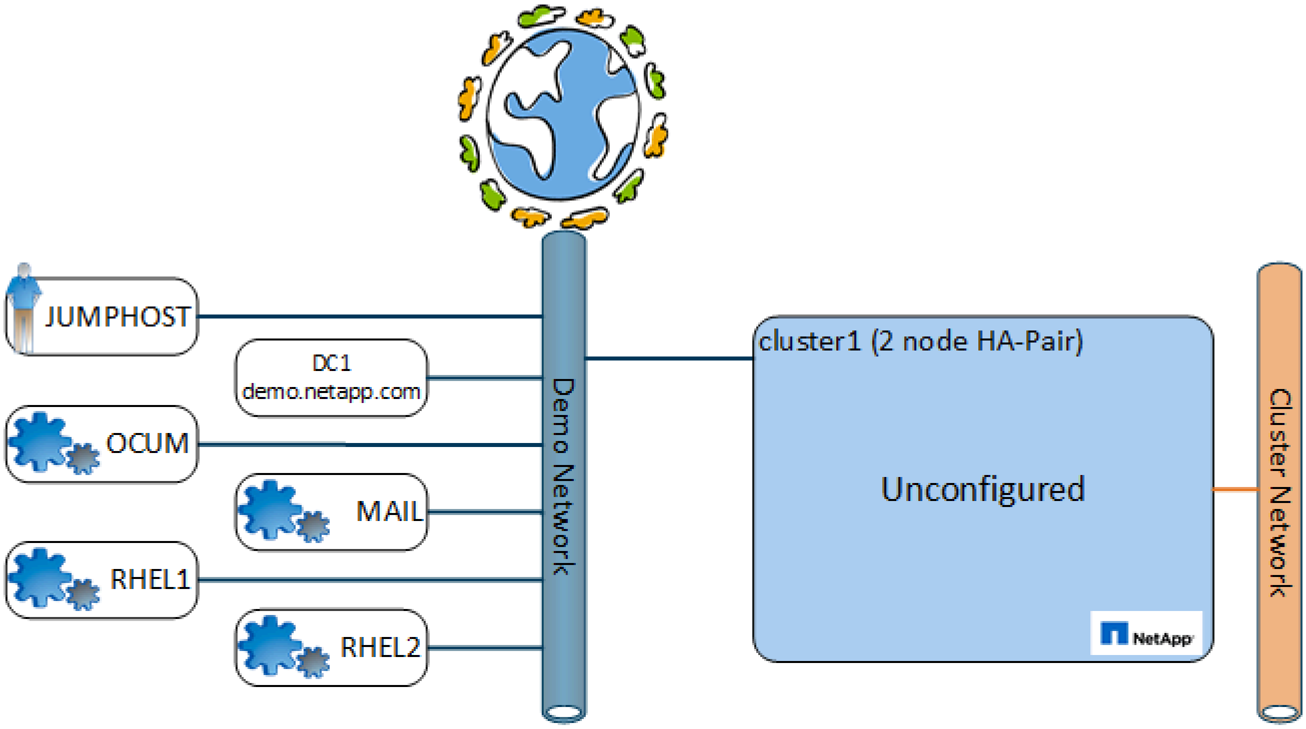

Figure 2-1:

All of the servers and storage controllers presented in this lab are virtual devices, and the networks that interconnect them are exclusive to your lab session. While we encourage you to follow the demonstration steps outlined in this lab guide, you are free to deviate from this guide and experiment with other ONTAP features that interest you. While the virtual storage controllers (vsims) used in this lab offer nearly all of the same functionality as physical storage controllers, they are not capable of providing the same performance as a physical controller, which is why these labs are not suitable for performance testing.

Table 1 provides a list of the servers and storage controller nodes in the lab, along with their IP address.

Table 1: Table 1: Lab Host Credentials

Hostname	Description	IP Address(es)	Username	Password
JUMPHOST	Windows 2019 Remote Access host	192.168.0.5	DEMO\Administrator	Netapp1!
RHEL1	Red Hat 7.5 x64 Linux host	192.168.0.61	root	Netapp1!
RHEL2	Red Hat 7.5 x64 Linux host	192.168.0.62	root	Netapp1!
DC1	Windows 2019 Active Directory Server	192.168.0.253	DEMO\Administrator	Netapp1!
cluster1	ONTAP 9.5 cluster	192.168.0.101	admin	Netapp1!
cluster1-01	ONTAP 9.5 cluster node	192.168.0.111	admin	Netapp1!
cluster1-02	ONTAP 9.5 cluster node	192.168.0.112	admin	Netapp1!
MAIL	E-Mail server/web email client	192.168.0.89	admin	Netapp1!

Hostname	Description	IP Address(es)	Username	Password
OCUM	OnCommand Unified Manager v9.5	192.168.0.71	DEMO\Administrator	Netapp1!

Table 2 lists the NetApp software that is pre-installed on the various hosts in this lab.

Table 2: Table 2: Preinstalled NetApp Software

Hostname	Description
JUMPHOST	Windows Unified Host Utility Kit v7.1.0, NetApp PowerShell Toolkit v4.7.0
RHEL1, RHEL2	Linux Unified Host Utilities Kit v7.1

3 Lab Activities

3.1 Clusters

Expected Completion Time: 20 Minutes

3.1.1 Cluster Concepts

A cluster is a group of physical storage controllers, or nodes, that are joined together for the purpose of serving data to end users. The nodes in a cluster can pool their resources together so that the cluster can distribute its work across the member nodes. Communication and data transfer between member nodes (such as when a client accesses data on a node other than the one actually hosting the data) takes place over a high-speed cluster-interconnect network (10 to 100 Gb Ethernet) to which all the nodes are connected, while management and client data traffic passes over separate management and data networks configured on the member nodes.

Clusters typically consist of one, or more, NetApp storage controller High Availability (HA) pairs. Both controllers in an HA pair actively host and serve data, but they are also capable of taking over their partner's responsibilities in the event of a service disruption by virtue of their redundant cable paths to each other's disk storage. Having multiple HA pairs in a cluster allows the cluster to scale out to handle greater workloads, and to support non-disruptive migrations of volumes and client connections to other nodes in the cluster resource pool. This means that cluster expansion and technology refreshes can take place while the cluster remains fully online, and serving data.

Since clusters are almost always comprised of one or more HA pairs, a cluster almost always contains an even number of controller nodes. There is one exception to this rule, the “single node cluster”, which is a special cluster configuration that supports small storage deployments using a single physical controller head. The primary difference between single node and standard clusters, besides the number of nodes, is that a single node cluster does not have a cluster network. Single node clusters can be converted into traditional multi-node clusters, at which point they become subject to all the standard cluster requirements like the need to utilize an even number of nodes consisting of HA pairs. This lab does not contain a single node cluster, so does not discuss them further.

ONTAP 9 clusters that only serve NFS and CIFS can scale up to a maximum of 24 nodes, although the node limit can be lower depending on the model of FAS controller and the specific ONTAP version in use. ONTAP 9 clusters that also host iSCSI and FC can scale up to a maximum of 12 nodes, but once again the limit may be lower depending on the FAS controller model.

This lab utilizes simulated NetApp storage controllers rather than physical FAS controllers. The simulated controller, also known as a “VSIM”, is a virtual machine that simulates the functionality of a physical controller without the need for dedicated controller hardware. The vsim is not designed for performance testing, but does offer much of the same functionality as a physical FAS controller, including the ability to generate I/O to disks. This makes the vsim a powerful tool to explore and experiment with ONTAP product features. The vsim is limited when a feature requires a specific physical capability that the vsim does not support. For example, vsims do not support Fibre Channel connections, which is why this lab uses iSCSI to demonstrate block storage functionality.

This lab starts with a pre-created, minimally configured cluster. The pre-created cluster already includes ONTAP licenses, the cluster's basic network configuration, and a pair of pre-configured HA controllers. In this next section you will create the aggregates that are used by the SVMs that you will create in later sections of the lab. You will also take a look at the Advanced Drive Partitioning feature.

3.1.2 Connect to the Cluster with ONTAP System Manager

ONTAP System Manager is NetApp's browser-based management tool to configure and manage NetApp storage systems and clusters. After performing ONTAP first-boot setup, point your web browser to the cluster management address to access System Manager.

On the Jumphost, the Windows 2019 Server desktop you see when you first connect to the lab, open the web browser of your choice. This lab guide uses Chrome, but you can use Firefox if you prefer that browser instead. In the lab, both browsers already have System Manager set as the home page.

1. Launch **Chrome** to open System Manager.

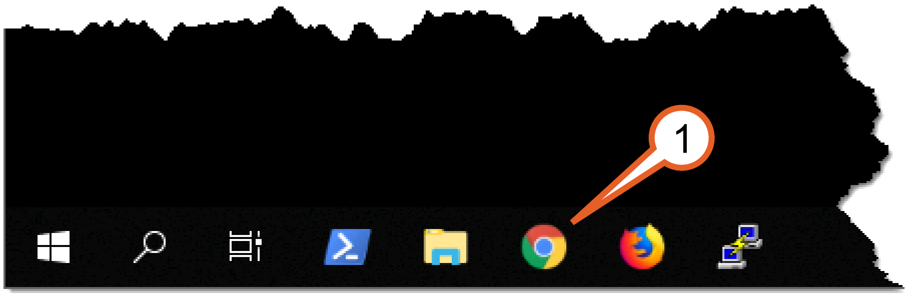

Figure 3-1:

The ONTAP System Manager Login window opens.

2. Enter the User Name as **`admin`**, and the Password as **`Netapp1!`**, and click **Sign In**.

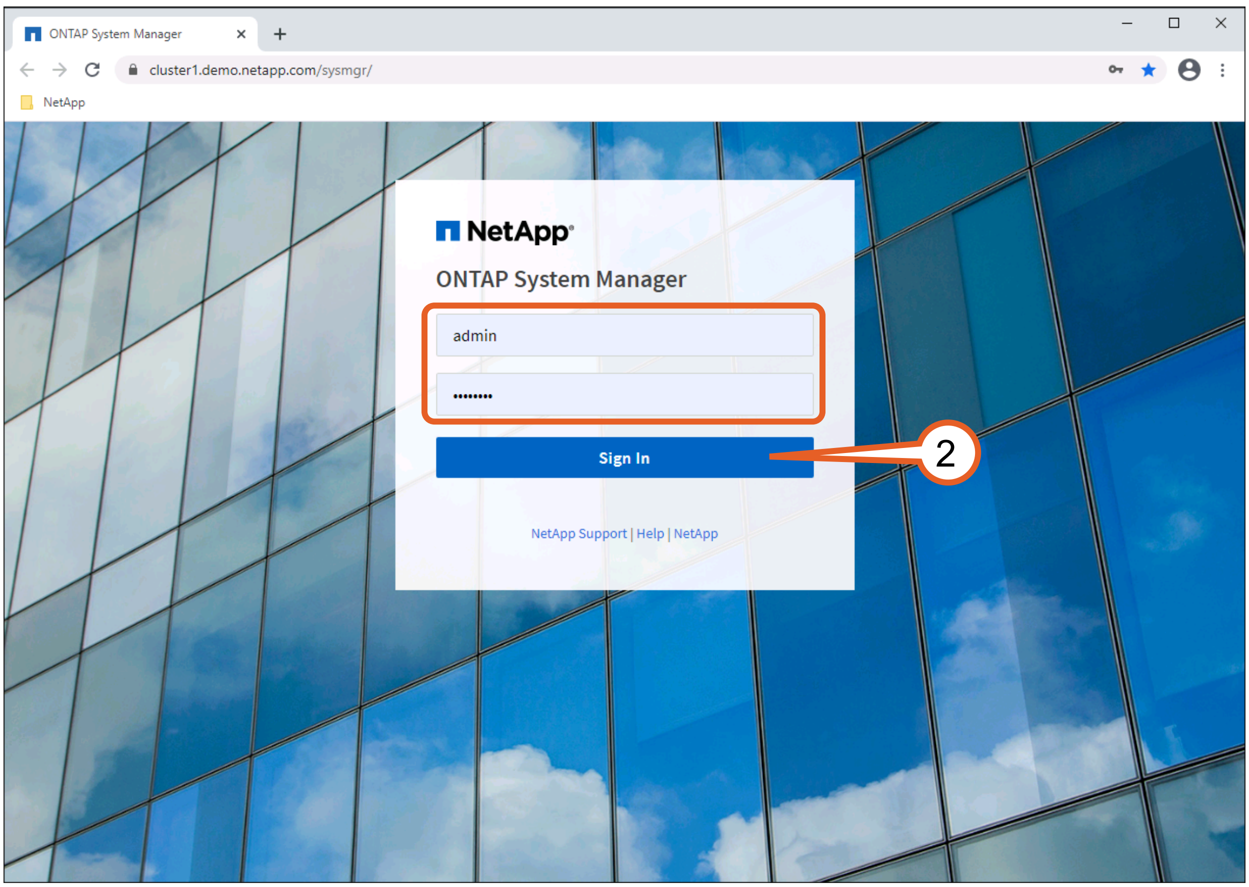

Figure 3-2:

System Manager logs in to cluster1 and presents the “classic” System Manager interface that has been the default in recent releases up through ONTAP 9.7.

As ONTAP 9 has evolved, System Manager's user interface (UI) has undergone some fundamental redesign in order to improve usability. If you are unfamiliar with System Manager, or have used a prior version, here is a brief overview of the current ONTAP System Manager interface.

3. ONTAP 9.7 offers a preview of the new System Manager interface that will become the default in ONTAP 9.8, but since this new interface is not yet complete in 9.7 this lab guide only covers the “classic” System Manager interface.

   Tip: If you wish to preview the new interface on your own, we recommend you do so only after completing the exercises in this lab guide so that any actions you might take in the new interface won’t interfere with the workflows documented here.

   Once you are ready to try out the new interface, you can click the green **Switch to the new experience** button in the upper left corner of the System Manager page. This link will re-direct you to the URL for the new System Manager interface, where you will be prompted to log in again using the same credentials you used for the classic interface. If you subsequently wish to return to the classic interface you can do so at any time by clicking the **(Return to classic version)** link located at the top of the “new experience” interface page next to the “ONTAP System Manager” title bar.
4. The Dashboard is the first page you see when you log into System Manager, and it displays summary information for the whole cluster. You can return to this view at any time by clicking **Dashboard** in the navigation pane.
5. **Applications & Tiers** provides access to templates you can use to provision storage configurations for a number of common applications, and also provides access to ONTAP's storage tiering features (i.e., FabricPool).
6. **Storage** is where you create and manage aggregates, Storage Virtual Machines, volumes, LUNs, and CIFS/NFS shares.
7. **Network** provides access to the all the network interfaces for the cluster and the storage virtual machines.
8. **Protection** allows you to manage settings for SnapMirror and SnapVault relationships.
9. **Events & Jobs** provides access to ONTAP's system logs and alerts, and is where you interface with processes running in ONTAP's background.
10. **Configuration** is where you find cluster controls for activities like ONTAP upgrades, installing licenses, adding/removing nodes, High Availability (HA), cluster peering, and so on.
11. The **Plus Sign** button just above the far right upper right of the main pane list allows you to quickly launch wizards for many common administrative tasks such as creating an aggregate, creating a subnet, and creating/resizing/moving a volume.

12. The main pane of the dashboard provides real-time details on cluster alert status, health, performance, node status, and application/client metrics. Some of these widgets will not show meaningful information until after you configure the cluster in later exercises.

Take some time to expand and browse these tabs to familiarize yourself with their contents.

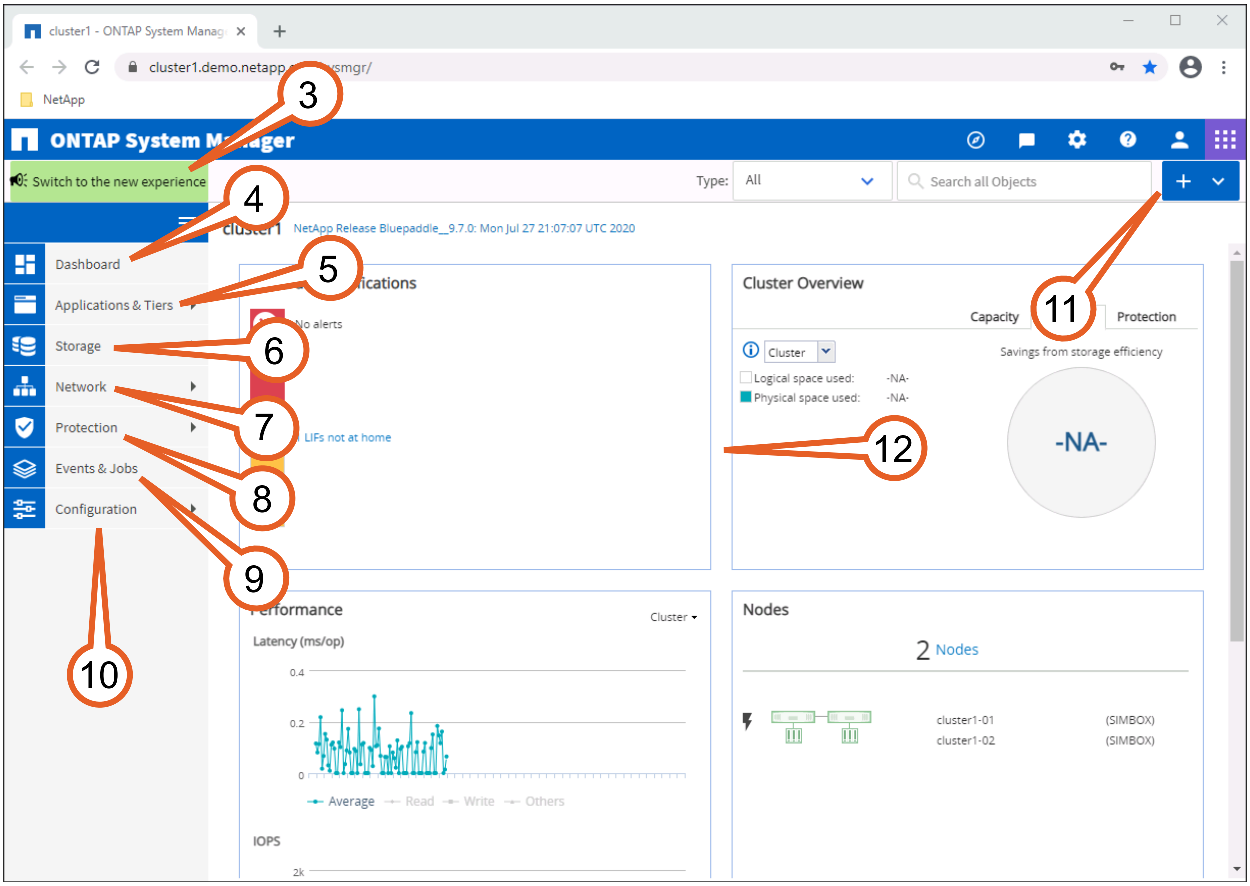

Figure 3-3:

Note: As you use System Manager in this lab, you may encounter situations where buttons at the bottom of a System Manager pane are beyond the viewing size of the window, and no scroll bar exists to allow you to scroll down to see them. If this occurs you have two options; either increase the size of the remote desktop browser window, or in the System Manager window, use the **tab** key to cycle through all the various fields and buttons, which eventually forces the window to scroll down to the non-visible items.

3.1.3 Advanced Drive Partitioning

3.1.3.1 Advanced Drive Partitioning Concepts

Disks, whether Hard Disk Drives (HDD) or Solid State Disks (SSD), are the fundamental unit of physical storage in ONTAP, and are tied to a specific cluster node by virtue of their physical connectivity (i.e., cabling) to a given controller head.

ONTAP manages disks in groups called aggregates. An aggregate defines the RAID properties for a group of disks that are all physically attached to the same node. A given disk can only be a member of a single aggregate.

By default each cluster node has one aggregate known as the root aggregate, which is a group of the node's local disks that host the node's ONTAP operating system. A node's root aggregate is automatically created during ONTAP installation in a minimal RAID-DP configuration This means it is initially comprised of 3 disks (1 data, 2 parity), and it has a name that begins the string aggr0. For example, in this lab the root aggregate of the node cluster1-01 is named “aggr0_cluster1_01”, and the root aggregate of the node cluster1-02 is named “aggr0_cluster1_02”.

On higher end FAS systems that have many disks, the requirement to dedicate 3 disks for each controller's root aggregate is not a burden, but for FAS systems that only have 24 or 12 disks, or for AFF systems with expensive high-capacity SSDs, this root aggregate disk overhead requirement significantly reduces the disks available for storing user data. To improve usable capacity, NetApp introduced Advanced Drive Partitioning (ADP), which divides the disks on nodes that have this feature enabled into two partitions; a small root partition, and a much larger data partition. ONTAP allocates the root partitions to the node root aggregate, and the data partitions for data aggregates. Each partition behaves like a virtual disk, so in terms of RAID, ONTAP treats these partitions just like physical disks when creating aggregates. The key benefit is that a much higher percentage of the node's overall disk capacity is now available to host user data.

For a FAS controller that uses Advanced Drive Partitioning, ONTAP dynamically determines the size of the root and data disk partitions at system installation time based on the quantity and size of the available disks assigned to each node.

ONTAP only supports HDD ADP for entry-level FAS controllers, and only for HDDs installed in their internal shelf on those models. ADP can only be enabled at system installation time, and there is no way to convert an existing system to use ADP other than to completely evacuate the affected HDDs and re-install ONTAP.

All-Flash FAS (AFF) supports ADP V2 that utilizes SSDs instead of HDDs, and divides the SSD into three partitions; a small root partition, plus two equal-sized data partitions. ADP V2 supports entry-level, mid-range, and high-end AFF platforms.

3.1.3.2 Advanced Drive Partitioning Exercise

In this lab activity, you use System Manager to determine if a cluster node is utilizing Advanced Drive Partitioning. System Manager provides a basic view into this information, but some details are only available through the ONTAP CLI.

1. In System Manager, navigate to **Storage** > **Aggregates & Disks** > **Disks** tab.
2. Click the **Summary** tab if it is not already selected.
3. The graphic in the middle of the page indicates that there are a total of 24 SSDs in the cluster. If you hover the mouse over the shaded portion of the bar chart you will see that the two cluster node root aggregates together consume about 70 GB of disk capacity. If you hover the mouse over the unshaded portion of the bar chart you will see that there is nearly 600 GB of spare disk capacity available for the creation of data aggregates.

4. In the “Spare Disks” pane at the bottom of the window, the spare disks are broken out by cluster node. There are 12 disks on each node, and each spare is 24.8 GB in size.

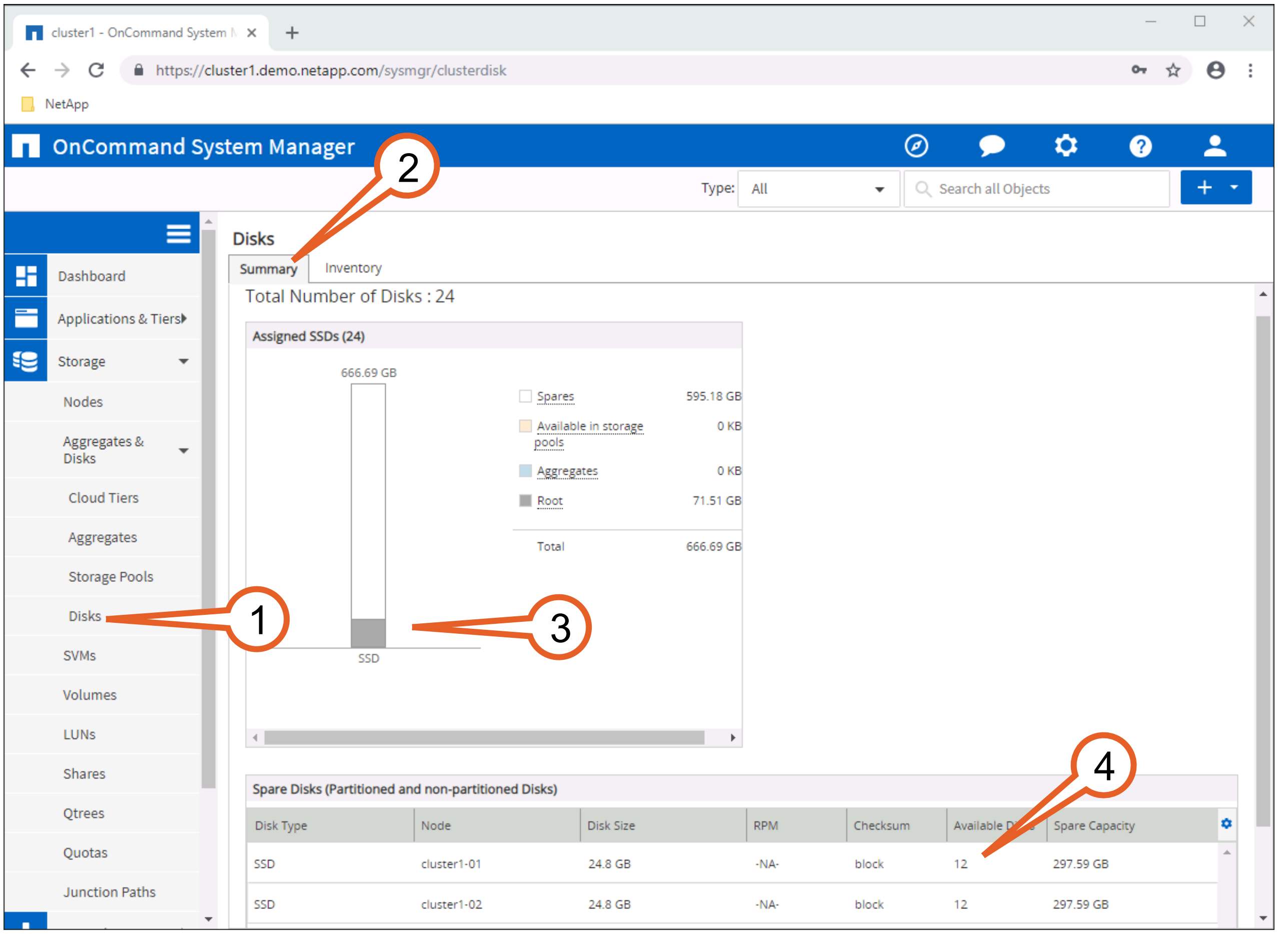

Figure 3-4:

5. Click on the **Inventory** tab at the top of the right pane .

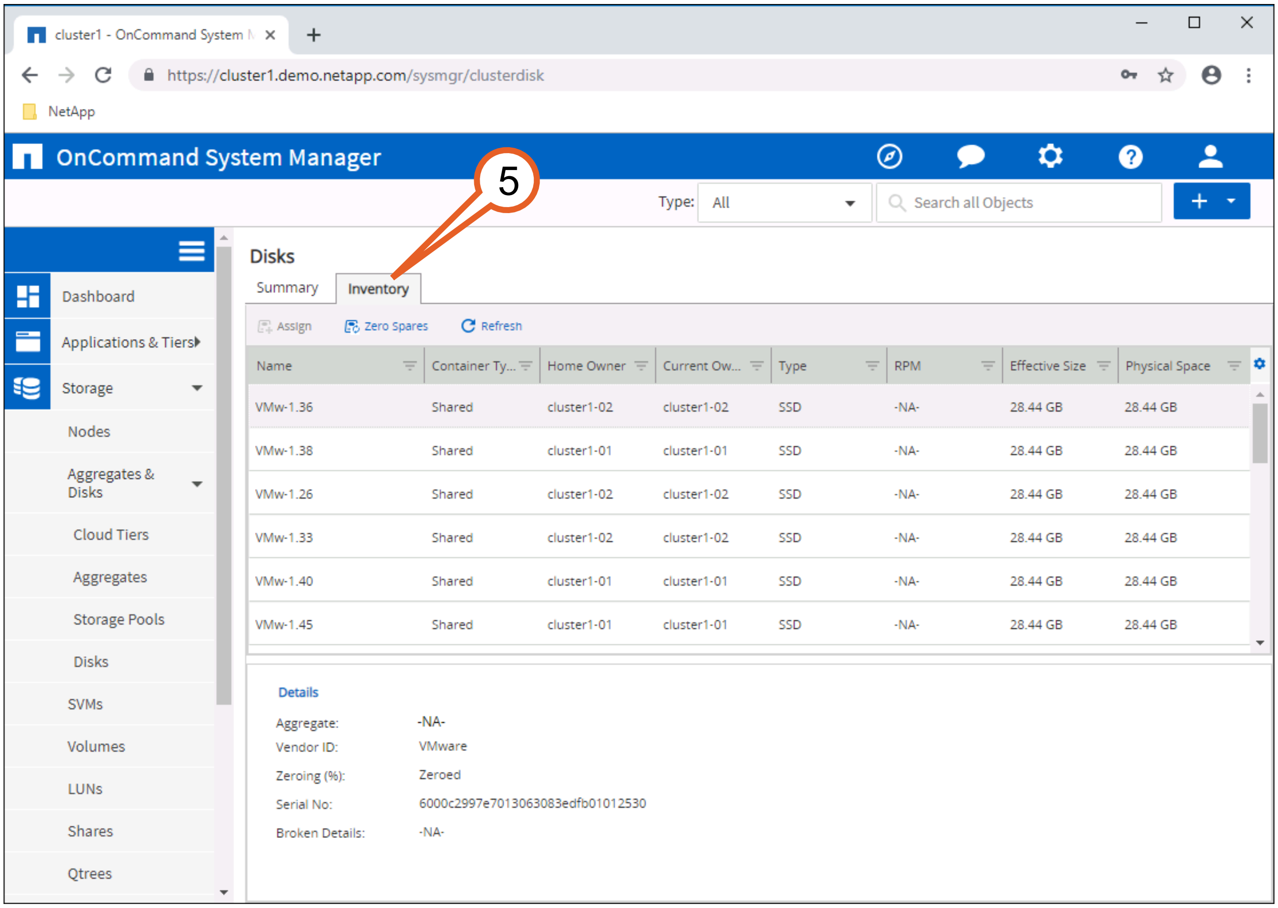

Figure 3-5:

System Manager's main pane now shows a list of the disks available across all the nodes in the cluster, which nodes own those disks, their effective and physical capacity, and so on. If you look at the “Container Type” column you see that the disks in your lab all show a value of “shared”; this value indicates that the physical disk is partitioned. For disks that are not partitioned you would typically see values like “spare”, “data”, “parity”, and “dparity”.

In this lab each cluster node has twelve 32 GB SSDs attached. Each SSD reports having 28.8 GB of capacity, which is the capacity remaining after formatting/overhead.

6. Navigate to **Storage** > **Aggregates & Disks** > **Aggregates**
7. Expand the entry for “aggr0_cluster1_01”.

8. The “aggr0_cluster1_01” aggregate is comprised of ten disks. Click on the **10** link to see more details.

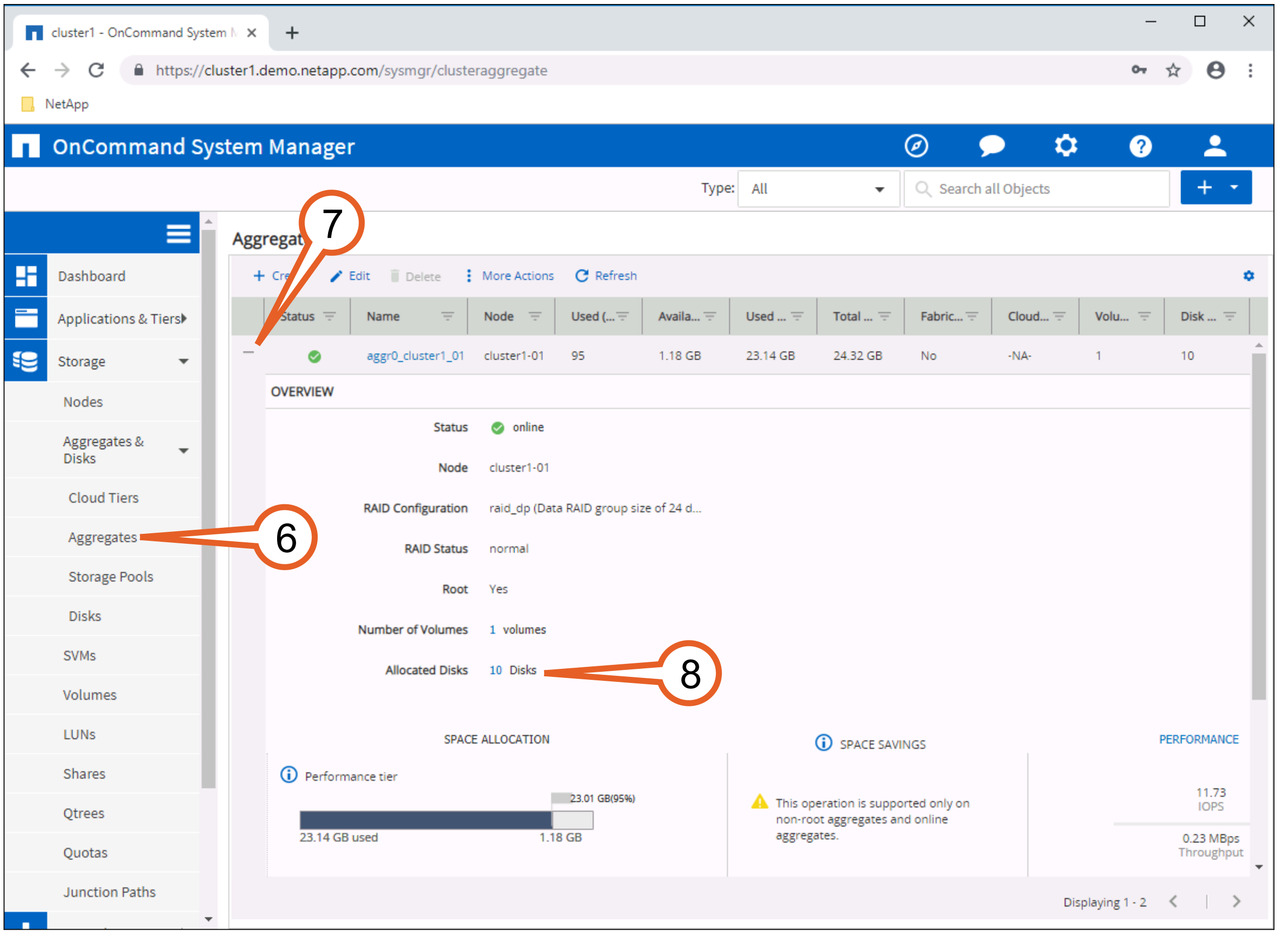

Figure 3-6:

System Manager displays the “Aggregate: aggr0_cluster1_01” page.

9. Click the **Disk Information** tab.
10. The main pane displays a list of the disks that are in the aggregate. The “Usable Space” column shows that all the disks have a capacity of 3.58 GB, which represents the size of the root partition established on each disk by ADP.

Note: Recall that the cluster1-01 node has twelve local disks. The root partitions of ten of those disks form cluster1-01’s root aggregate (aggr0_cluster1_01). The other two disks are also partitioned, but are configured as spares as protection against potential drive failure.

11. Click **Back to all Aggregates** to return to the main aggregates window.

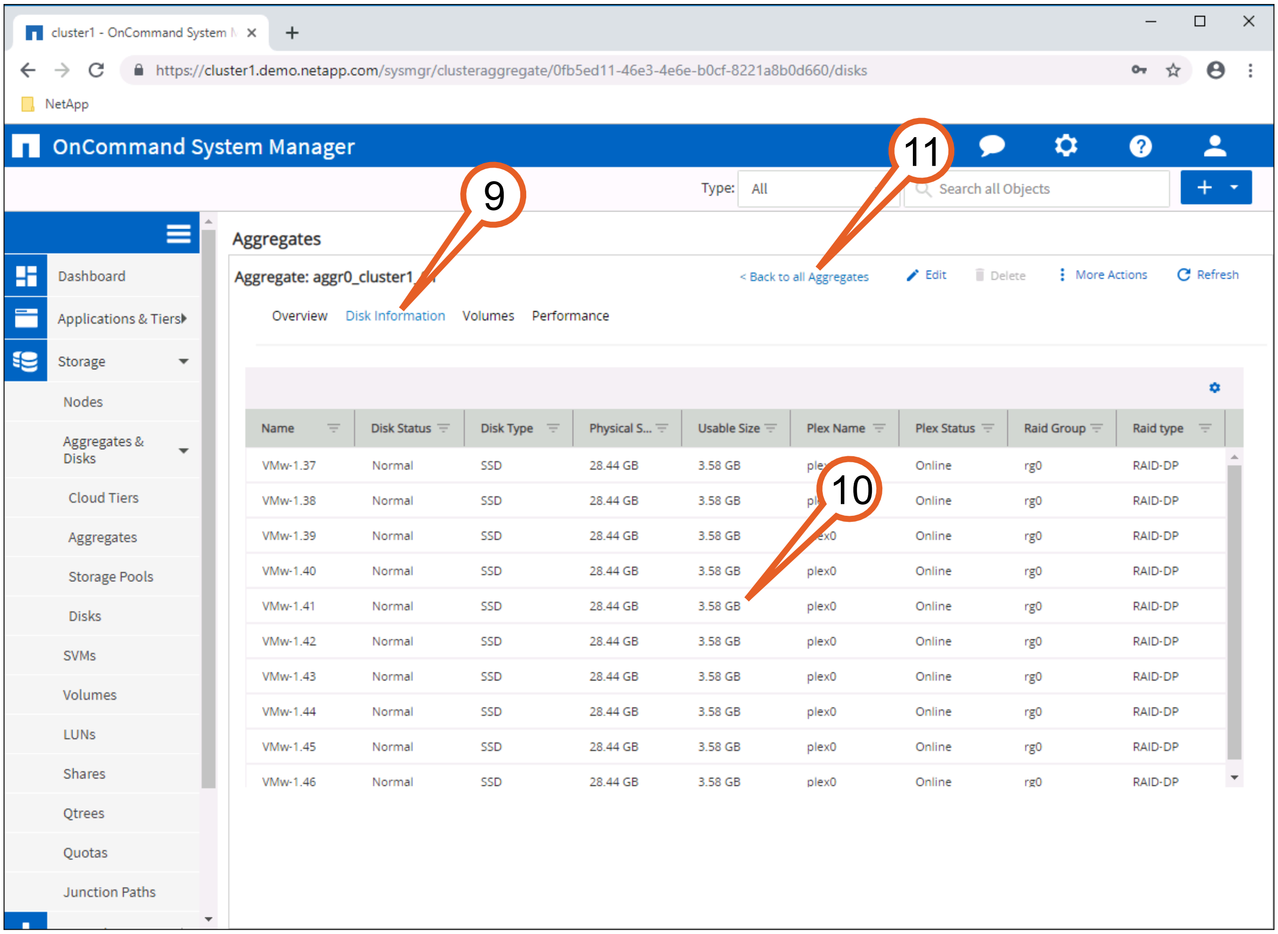

Figure 3-7:

System Manager displays the “Aggregates” page.

The ONTAP CLI includes a diagnostic level command that provides a more comprehensive single view of a system's partitioned disks.

12. If you do not already have a PuTTY session established to cluster1, launch PuTTY as described in the “Accessing the Command Line” section at the beginning of this guide, and connect to the host cluster1 with username **admin** and password **Netapp1!**.
13. The following commands shows all the disk partitions on the disks that belong to the node cluster1-01.

```
cluster1::> set -priv diag

Warning: These diagnostic commands are for use by NetApp personnel only.
Do you want to continue? {y|n}: y

cluster1::*> disk partition show -owner-node-name cluster1-01
                          Usable  Container     Container
Partition                 Size    Type          Name              Owner
------------------------- ------- ------------- ----------------- ----------------
VMw-1.37.P1               12.41GB spare         Pool0             cluster1-01
VMw-1.37.P2               12.41GB spare         Pool0             cluster1-01
VMw-1.37.P3                3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
                                                                  cluster1-01
VMw-1.38.P1               12.41GB spare         Pool0             cluster1-01
VMw-1.38.P2               12.41GB spare         Pool0             cluster1-01
VMw-1.38.P3                3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
                                                                  cluster1-01
VMw-1.39.P1               12.41GB spare         Pool0             cluster1-01
VMw-1.39.P2               12.41GB spare         Pool0             cluster1-01
VMw-1.39.P3                3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
```

```
                                                                cluster1-01
VMw-1.40.P1                12.41GB spare         Pool0            cluster1-01
VMw-1.40.P2                12.41GB spare         Pool0            cluster1-01
VMw-1.40.P3                 3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
                                                                cluster1-01
VMw-1.41.P1                12.41GB spare         Pool0            cluster1-01
VMw-1.41.P2                12.41GB spare         Pool0            cluster1-01
VMw-1.41.P3                 3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
                                                                cluster1-01
VMw-1.42.P1                12.41GB spare         Pool0            cluster1-01
VMw-1.42.P2                12.41GB spare         Pool0            cluster1-01
VMw-1.42.P3                 3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
                                                                cluster1-01
VMw-1.43.P1                12.41GB spare         Pool0            cluster1-01
VMw-1.43.P2                12.41GB spare         Pool0            cluster1-01
VMw-1.43.P3                 3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
                                                                cluster1-01
VMw-1.44.P1                12.41GB spare         Pool0            cluster1-01
VMw-1.44.P2                12.41GB spare         Pool0            cluster1-01
VMw-1.44.P3                 3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
                                                                cluster1-01
VMw-1.45.P1                12.41GB spare         Pool0            cluster1-01
VMw-1.45.P2                12.41GB spare         Pool0            cluster1-01
VMw-1.45.P3                 3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
                                                                cluster1-01
VMw-1.46.P1                12.41GB spare         Pool0            cluster1-01
VMw-1.46.P2                12.41GB spare         Pool0            cluster1-01
VMw-1.46.P3                 3.58GB aggregate     /aggr0_cluster1_01/plex0/rg0
                                                                cluster1-01
VMw-1.47.P1                12.41GB spare         Pool0            cluster1-01
VMw-1.47.P2                12.41GB spare         Pool0            cluster1-01
VMw-1.47.P3                 3.58GB spare         Pool0            cluster1-01
VMw-1.48.P1                12.41GB spare         Pool0            cluster1-01
VMw-1.48.P2                12.41GB spare         Pool0            cluster1-01
VMw-1.48.P3                 3.58GB spare         Pool0            cluster1-01
36 entries were displayed.

cluster1::*> set -priv admin

cluster1::>
```

3.1.4 Create a New Aggregate on Each Cluster Node

3.1.4.1 Aggregate Concepts

An aggregate is a group of disks on a node. A node can host multiple aggregates depending on the data sizing, performance, and isolation needs of the storage workloads that it will be hosting. When you create a Storage Virtual Machine (SVM) you assign it to use one or more specific aggregates to host the SVM's volumes. You can assign multiple SVMs to use the same aggregate, which offers greater flexibility in managing storage space, whereas dedicating an aggregate to just a single SVM provides greater workload isolation.

Aggregates utilize RAID to span storage across multiple disks. Although ONTAP supports several different RAID configuration options, NetApp recommends using RAID-DP, which is a double-parity RAID-6 implementation that prevents data loss when two disks fail in the RAID group.

The only aggregates that exist on a newly created cluster are the node root aggregates. The root aggregate should not be used to host user data, so in this section you will create a new aggregate on each of the nodes in cluster1 so they can host any storage virtual machines, volumes, and LUNs that you create later in this lab.

3.1.4.2 Create Aggregate Exercise

In this lab activity, you create a data aggregate on each node in the cluster.

If you completed the preceding exercise then System Manager should still be displaying the contents of the Aggregates page. If you skipped that exercise then, starting from the Dashboard view, you can navigate to the Aggregates view by going to **Storage** > **Aggregates & Disks** > **Aggregates**.

1. Click **Create** to launch the Aggregates: Create Aggregate Wizard.

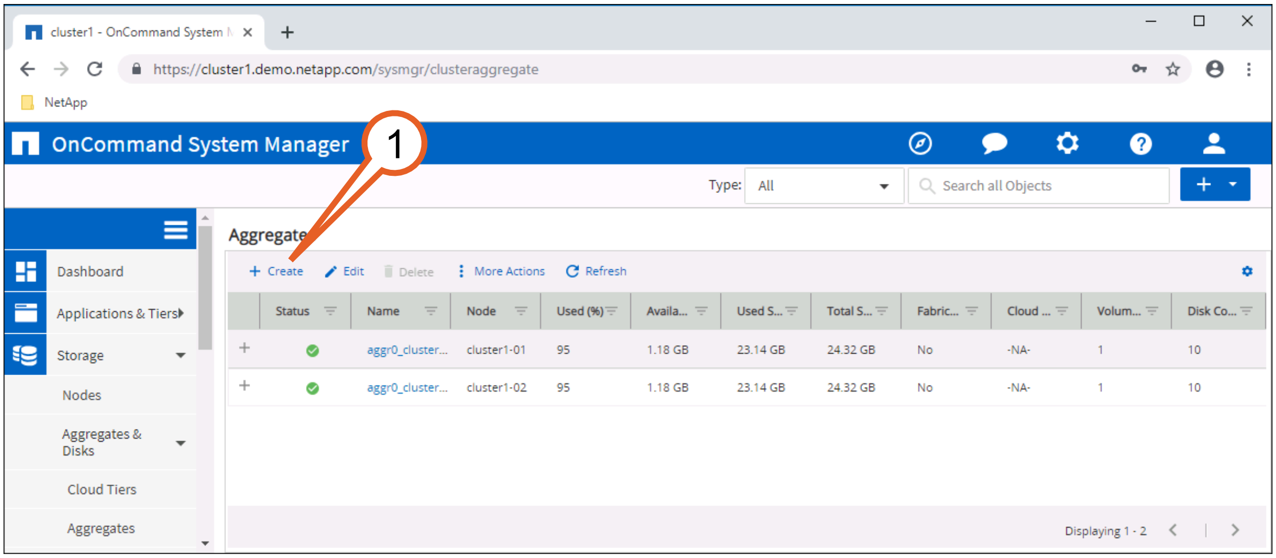

Figure 3-8:

The “Aggregates: Create Aggregate” page opens.

2. ONTAP will offer to automatically create a maximally sized aggregate on each node. For the purpose of this lab a minimally sized aggregate is sufficient, but you must create it manually, so activate the **Manually Create Aggregate** toggle switch.
3. In the “Name” field enter **`aggr1_cluster1_01`**.
4. Click **Browse**.

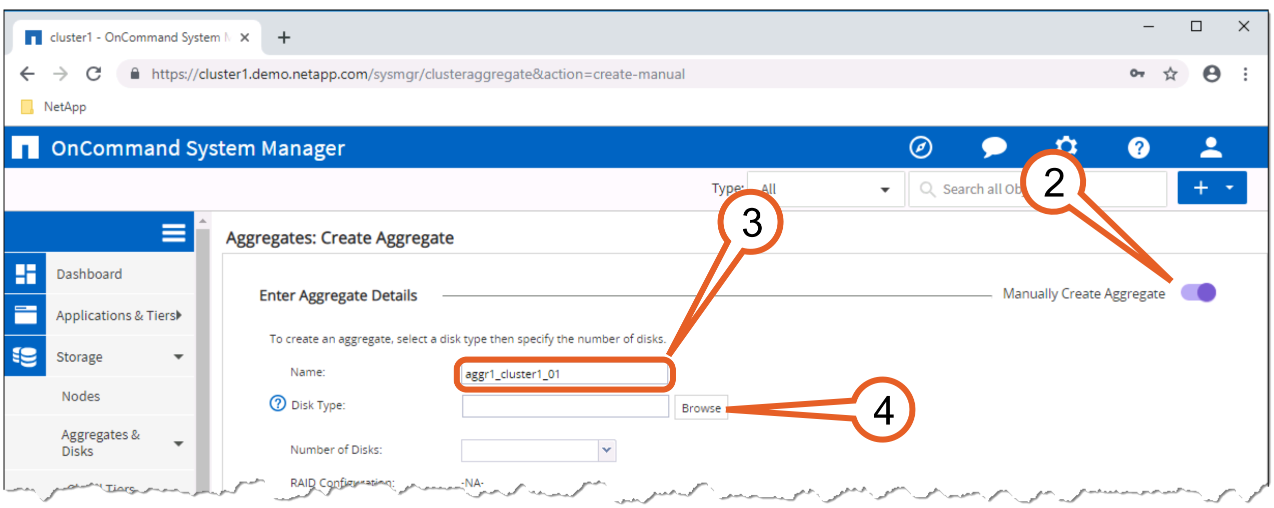

Figure 3-9:

The “Select Disk Type” dialog opens.

5. Select the Disk Type entry for the node **cluster1-01**.

6. Click **OK**.

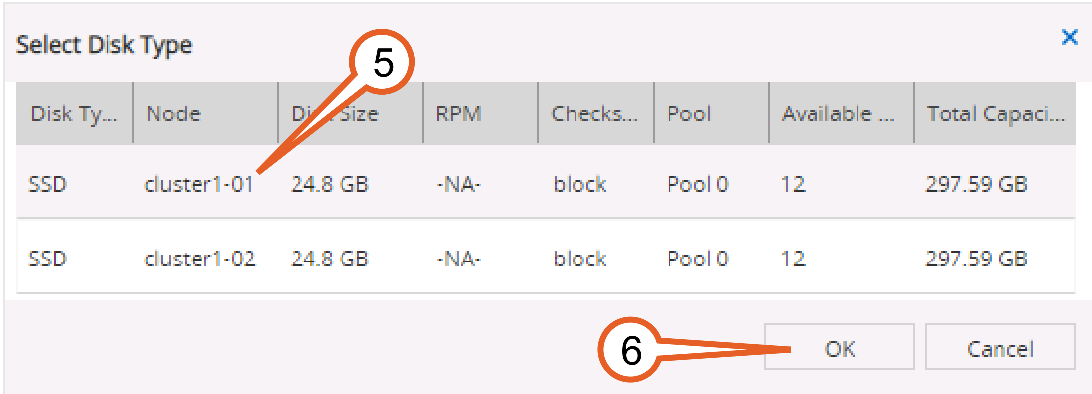

Figure 3-10:

The “Select Disk Type” dialog closes, and focus returns to the “Aggregates: Create Aggregate” page.

7. The “Disk Type” should now display as “SSD”.
8. Set the “Number of Disks” to **5**.
9. Note that the RAID configuration defaults to RAID-DP, which offers protection against double-disk failures. The default value is acceptable for this lab.
10. Click **Submit** to create the new aggregate, and to close the wizard.

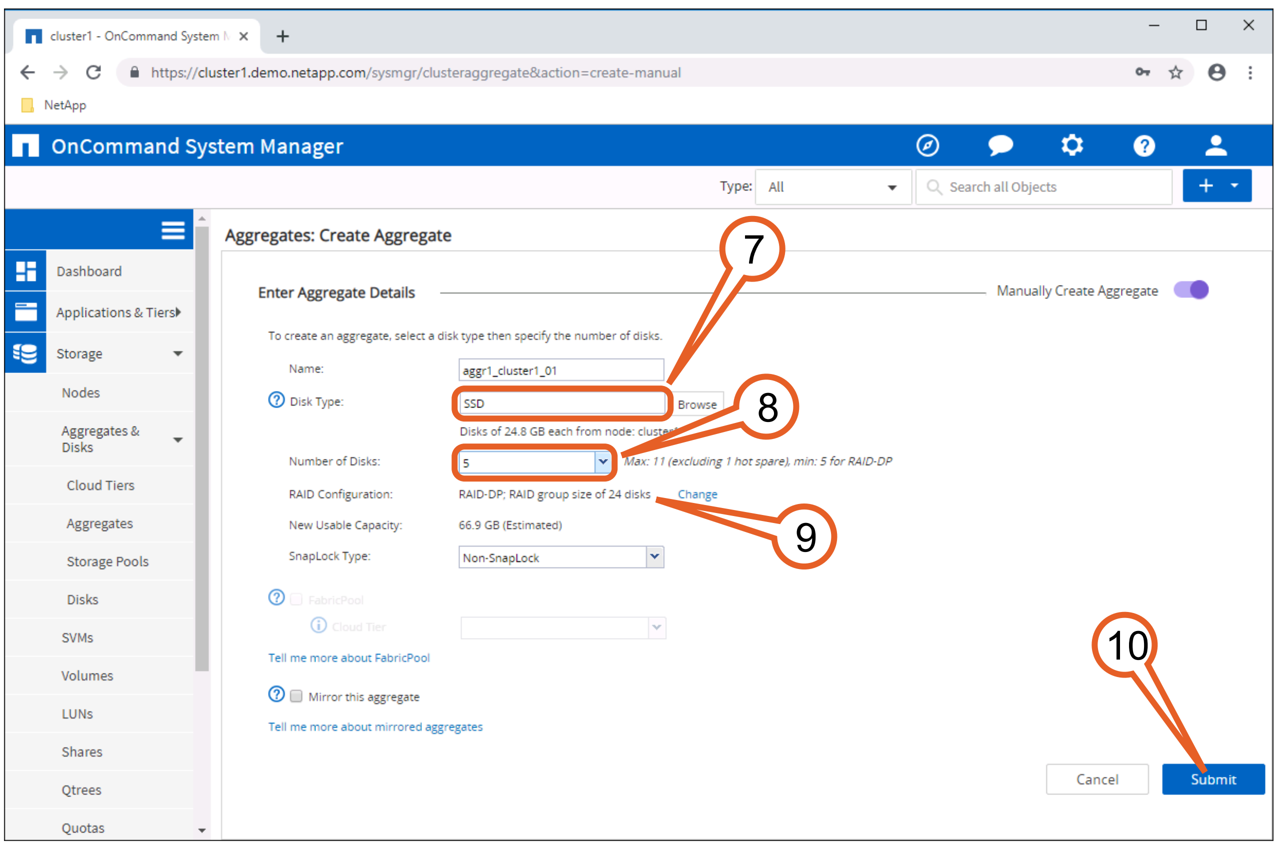

Figure 3-11:

The “Create Aggregate” window closes, and focus returns to the “Aggregates” page. You will see a green box display at the top of the page stating “SUCCESS: The aggregate has been created”. You can close the green box to dismiss the message. The newly created aggregate will also be visible in the Aggregates list.

11. Expand the entry for the aggregate **aggr1_cluster1_01**.
12. The expanded "Overview" section presents a summary of this aggregate's configuration. If you scroll down the page you can also view graphical metrics for the aggregates space allocation, storage efficiency, and performance characteristics (IOPS and Throughput). Since this is a newly created aggregate, there is little data for these metrics to report, but that will change when you start populating volumes and workloads on this aggregate.

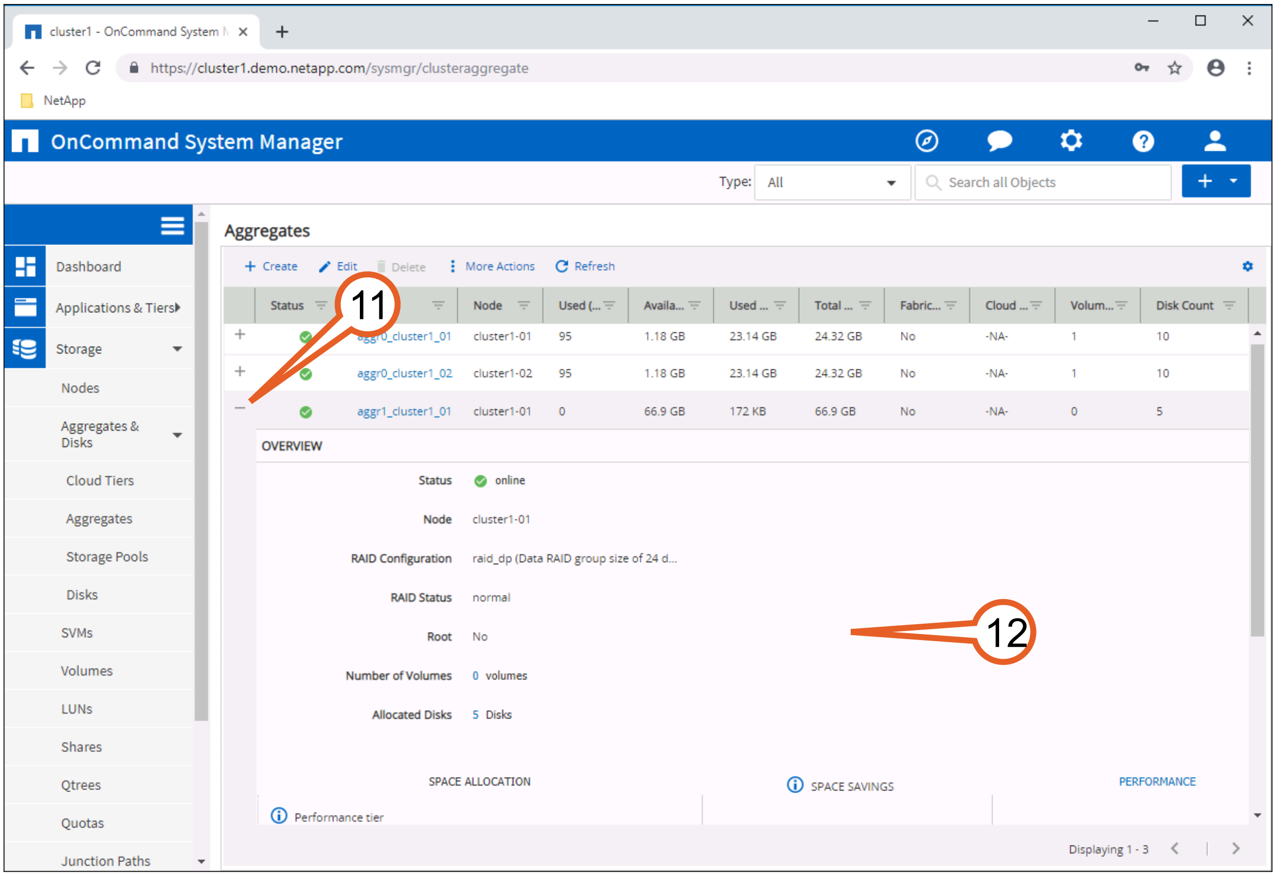

Figure 3-12:

Now repeat the process to create a new aggregate on the node "cluster1-02".

13. Click **Create** again.

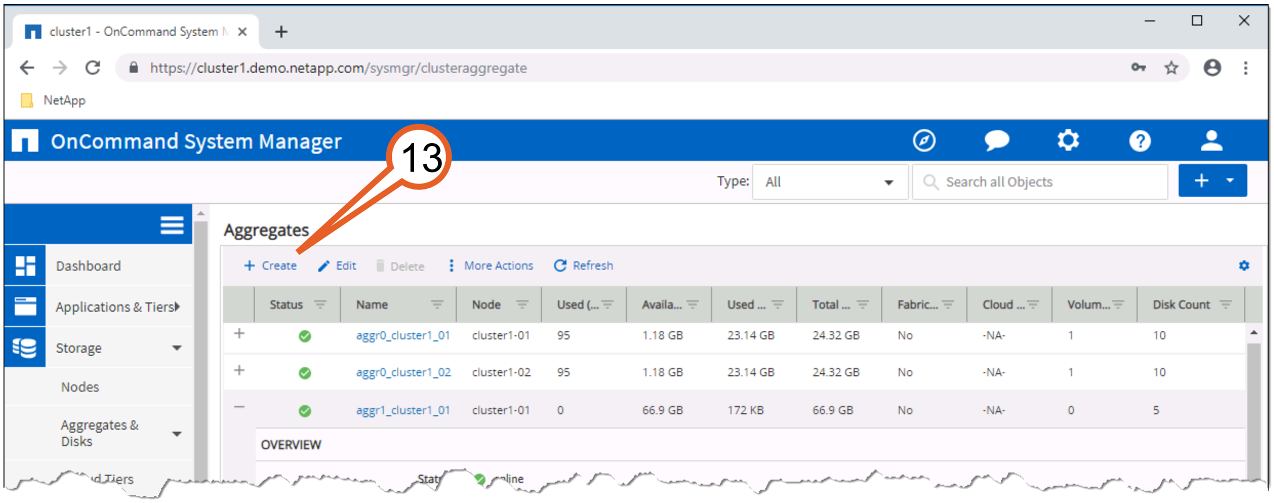

Figure 3-13:

The “Aggregates: Create Aggregate” page opens.

14. Activate the **Manually Create Aggregate** toggle switch.
15. Specify the fields on this page as follows:

- “Name”: **`aggr1_cluster1_02`**
- “Disk Type”: Use the **Browse** button to select the **SSD** disk type for the disks on node **`cluster1-02`**.
- “Number of Disks”: **5**

16. Click **Submit** to create the new aggregate.

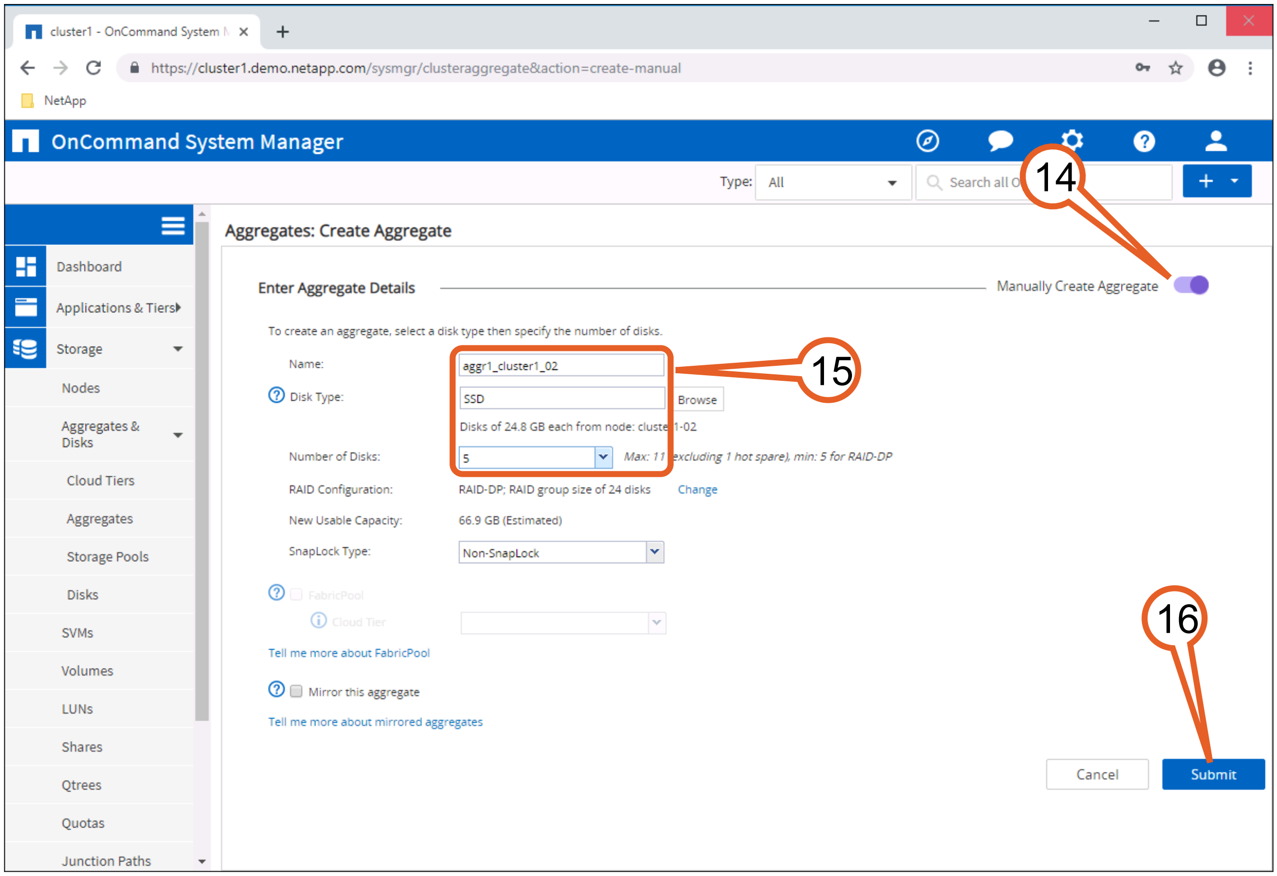

Figure 3-14:

The “Aggregates: Create Aggregate” page closes, and focus returns to the “Aggregates” page where you will once again see a green box display at the top of the page stating “SUCCESS: The aggregate has been created”. Dismiss the message.

17. The new aggregate, “aggr1_cluster1_02” now appears in the cluster's aggregate list.

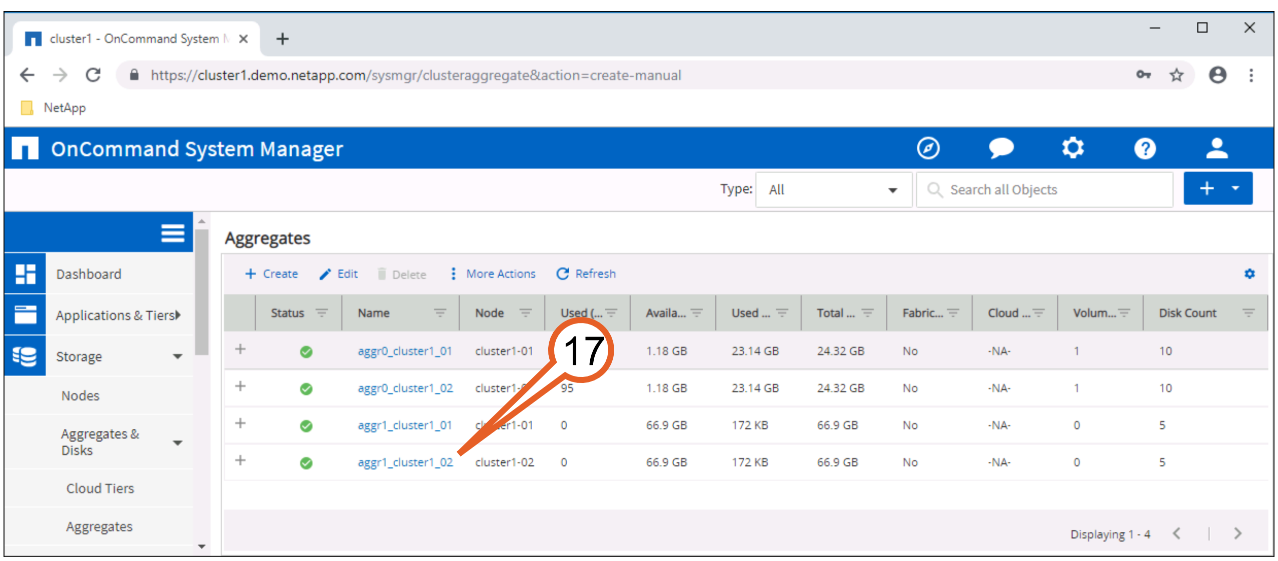

Figure 3-15:

3.1.5 Networks

3.1.5.1 Network Concepts

This section discusses the network components that ONTAP provides to manage your cluster.

Ports are the physical Ethernet and Fibre Channel connections on each node, the interface groups (ifgrps) you can create to aggregate those connections, and the VLANs you can use to subdivide them.

A logical interface (LIF) is essentially an IP address that is associated with a port, and has a number of associated characteristics such as an assigned home node, an assigned physical home port, a list of physical ports it can fail over to, an assigned SVM, a role, a routing group, and so on. A given LIF can only be assigned to a single SVM, and since LIFs are mapped to physical network ports on cluster nodes this means that an SVM runs, in part, on all nodes that are hosting its LIFs.

Routing tables in ONTAP are defined for each Storage Virtual Machine. Since each SVM has its own routing table, changes to one SVM's routing table do not have impact on any other SVM's routing table.

IPspaces allow you to configure an ONTAP cluster to logically separate one IP network from another, even if those two networks are using the same IP address range. IPspaces are a multi-tenancy feature that allow storage service providers to share a cluster between different companies while still separating storage traffic for privacy and security. Every cluster includes a default IPspace to which ONTAP automatically assigns new SVMs, and that default IPspace is usually sufficient for NetApp customers who deploy a cluster within a single company or organization that uses a non-conflicting IP address range.

Broadcast Domains are collections of ports that all have access to the same layer 2 networks, both physical and virtual (i.e., VLANs). Every IPspace has its own set of Broadcast Domains, and ONTAP provides a default broadcast domain to go along with the default IPspace. Broadcast domains are used by ONTAP to determine what ports an SVM can use for its LIFs.

Subnets in ONTAP are a convenience feature, intended to make LIF creation and management easier for ONTAP administrators. A subnet is a pool of IP addresses that you can specify by name when creating a LIF. ONTAP will automatically assign an available IP address from the pool to the LIF, along with a subnet mask and a gateway. A subnet is scoped to a specific broadcast domain, so all the subnet's addresses belong to the same layer 3 network. ONTAP manages the pool automatically as you create or delete LIFs, and if you manually configure a LIF with an address from the pool, it will detect that the address is in use and mark it as such in the pool.

DNS Zones allow an SVM to manage DNS name resolution for its own LIFs. Since multiple LIFs can share the same DNS name, this allows the SVM to load balance traffic by IP address across a set of LIFs. To use DNS Zones you must configure your DNS server to delegate DNS authority for the subdomain to the SVM.

3.1.5.2 Create Subnet Exercise

In this lab activity, you use System Manager to create a Subnet that you will leverage in later exercises to assign IP addresses while provisioning SVMs and LIFs. You will not create IPspaces or Broadcast Domains, as the system defaults are sufficient for this lab.

1. In System Manager, navigate to **Network** > **Broadcast Domains**.

2. In the “Broadcast Domains” pane, select the **Default** broadcast domain.

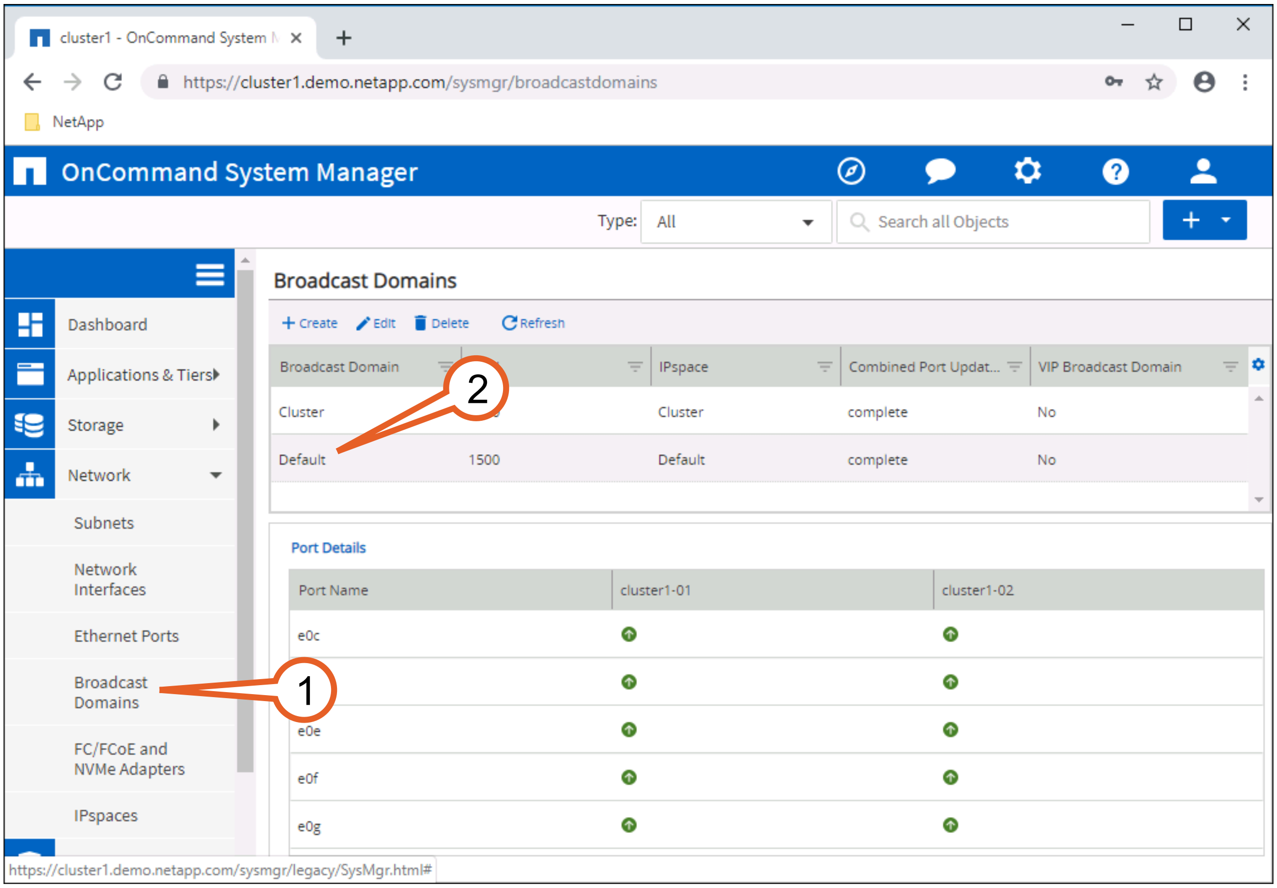

Figure 3-16:

Review the “Port Details” section at the bottom of the Network pane, and note that the e0c – e0g ports on both cluster nodes are all part of this broadcast domain. These are the network ports that you will use in this lab.

Now create a new Subnet for this lab.

3. Navigate to **Network** > **Subnets**.
4. There are currently no subnets listed in the “Subnets” pane. Unlike Broadcast Domains and IPSpaces, ONTAP does not provide a default Subnet.

5. Click **+ Create**.

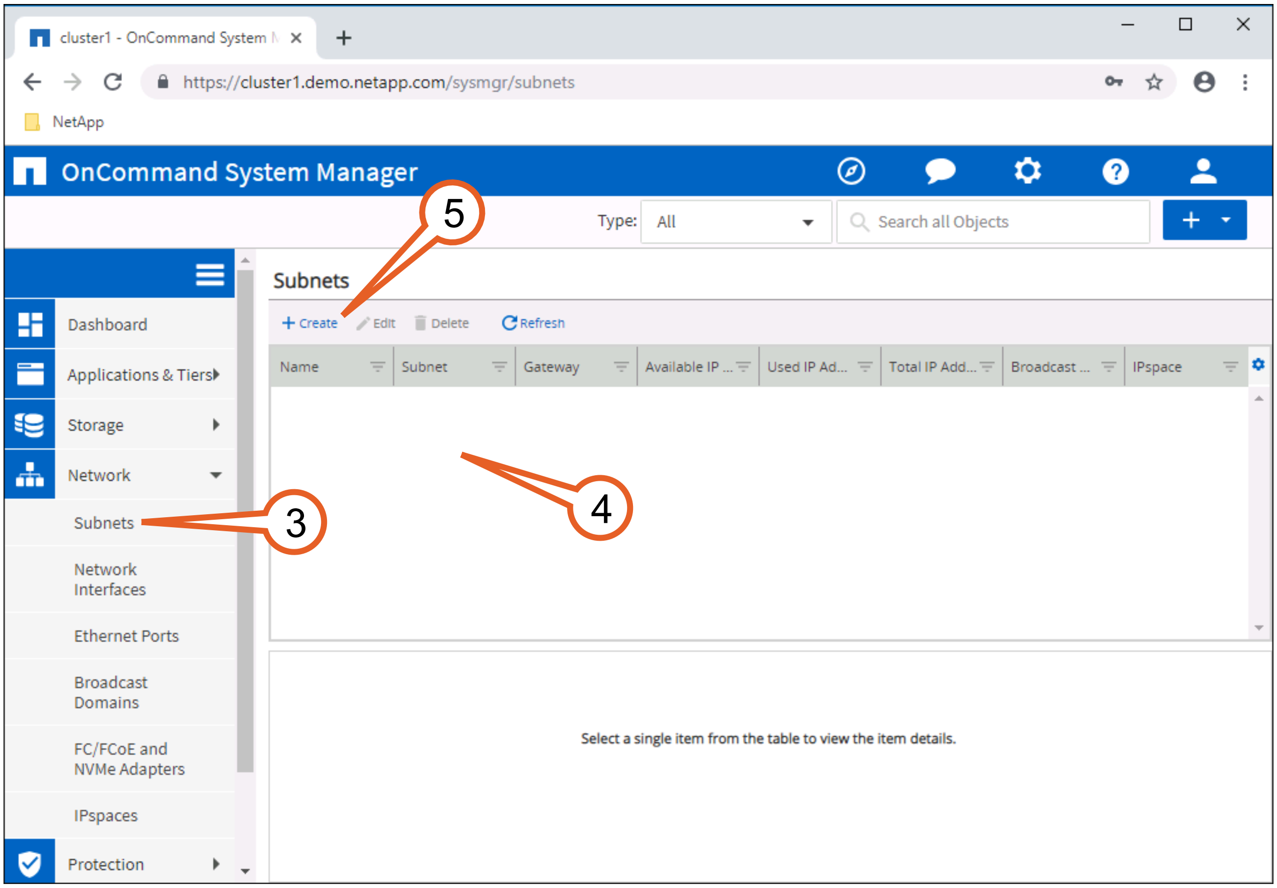

Figure 3-17:

The “Create Subnet” dialog opens.

6. Set the fields in this window as follows:

- “Name”: **`Demo`**
- “Subnet IP/Subnet mask”: **`192.168.0.0/24`**
- “IP Addresses”: The values you enter in the “IP address” field depend on which lab guide(s) you intend to complete in this lab instance.

  Important: It is important that you choose the right values here so that the values in your lab will correctly match up with the values used in this lab guide.

  - If you plan to complete only the NAS lab guide, or both the NAS and SAN lab guides, then enter **`192.168.0.131-192.168.0.139`**.
  - If you plan to complete just the SAN lab guide then enter **`192.168.0.133-192.168.0.139`**.
- “Gateway”: **`192.168.0.1`**

7. Click **Browse**.

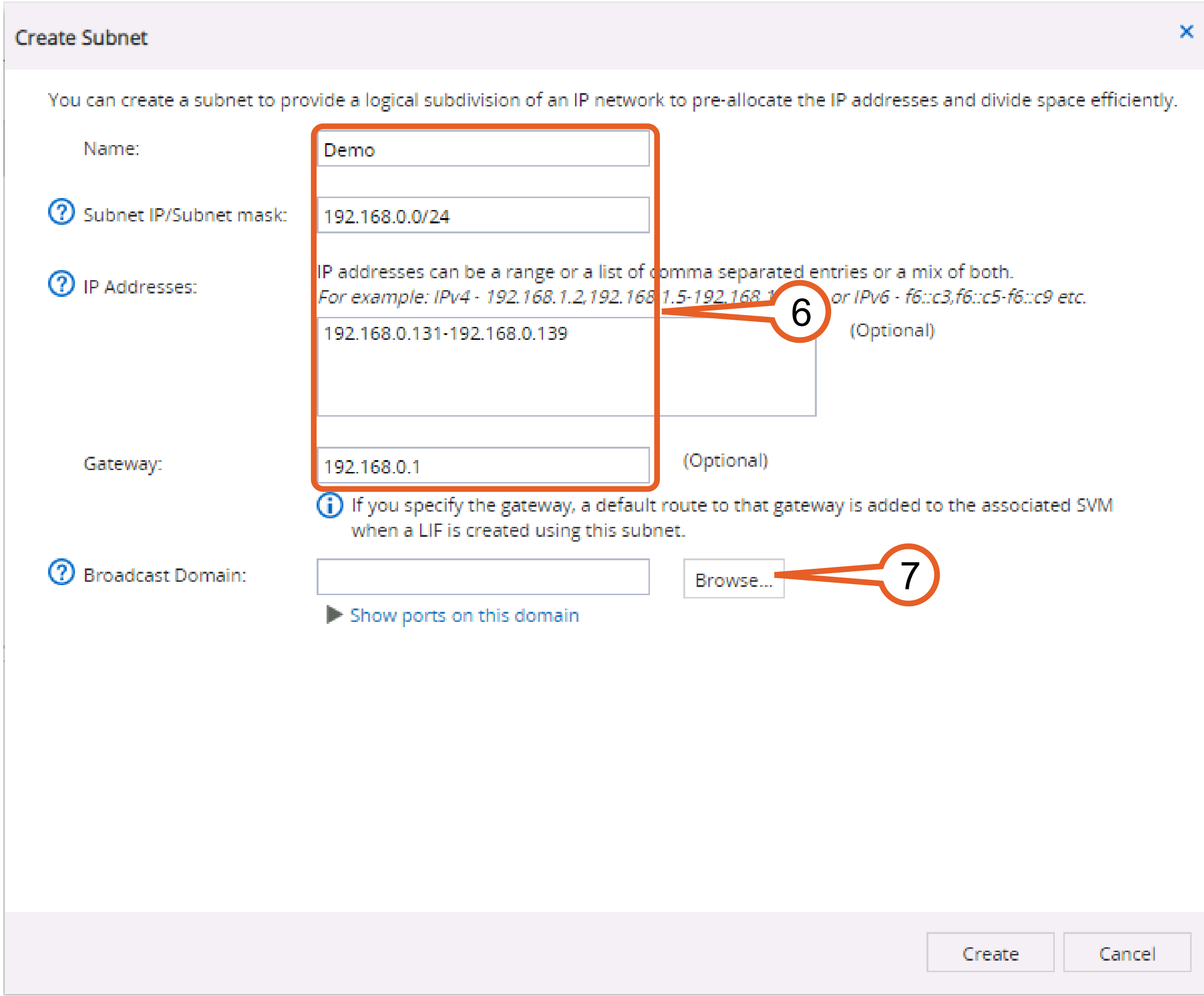

Figure 3-18:

The “Select Broadcast Domain” dialog opens.

8. Select the **Default** entry from the list.

9. Click **OK**.

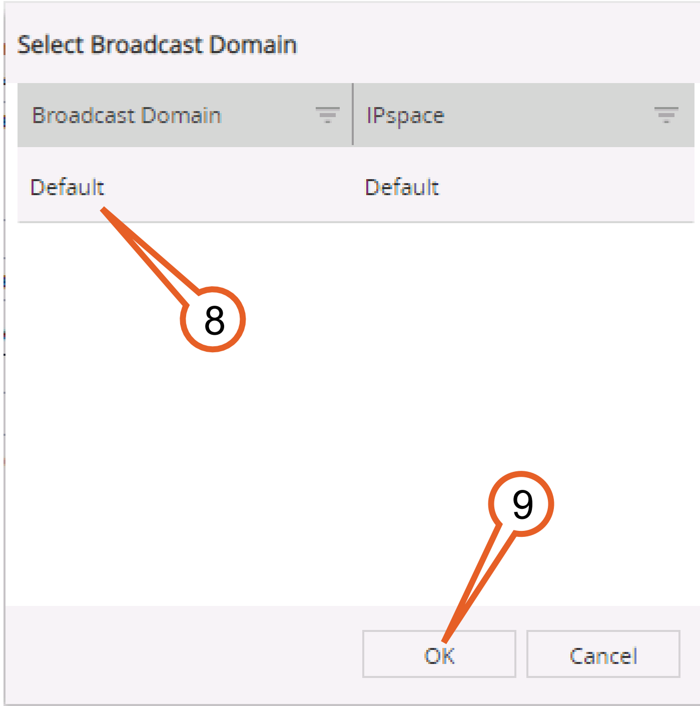

Figure 3-19:

The “Select Broadcast Domain” dialog closes, and focus returns to the “Create Subnet” dialog.

10. The values in your “Create Subnet” dialog should now match those shown in the following screenshot. The only possible exception would be the value you entered in the “IP Addresses” field, since that value depends on the range you entered to support the lab guide(s) (NAS vs. SAN) that you are using.
11. If it is not already displayed, click the **Show ports on this domain** link under the Broadcast Domain textbox to see the list of ports that this broadcast domain includes.

12. Click **Create**.

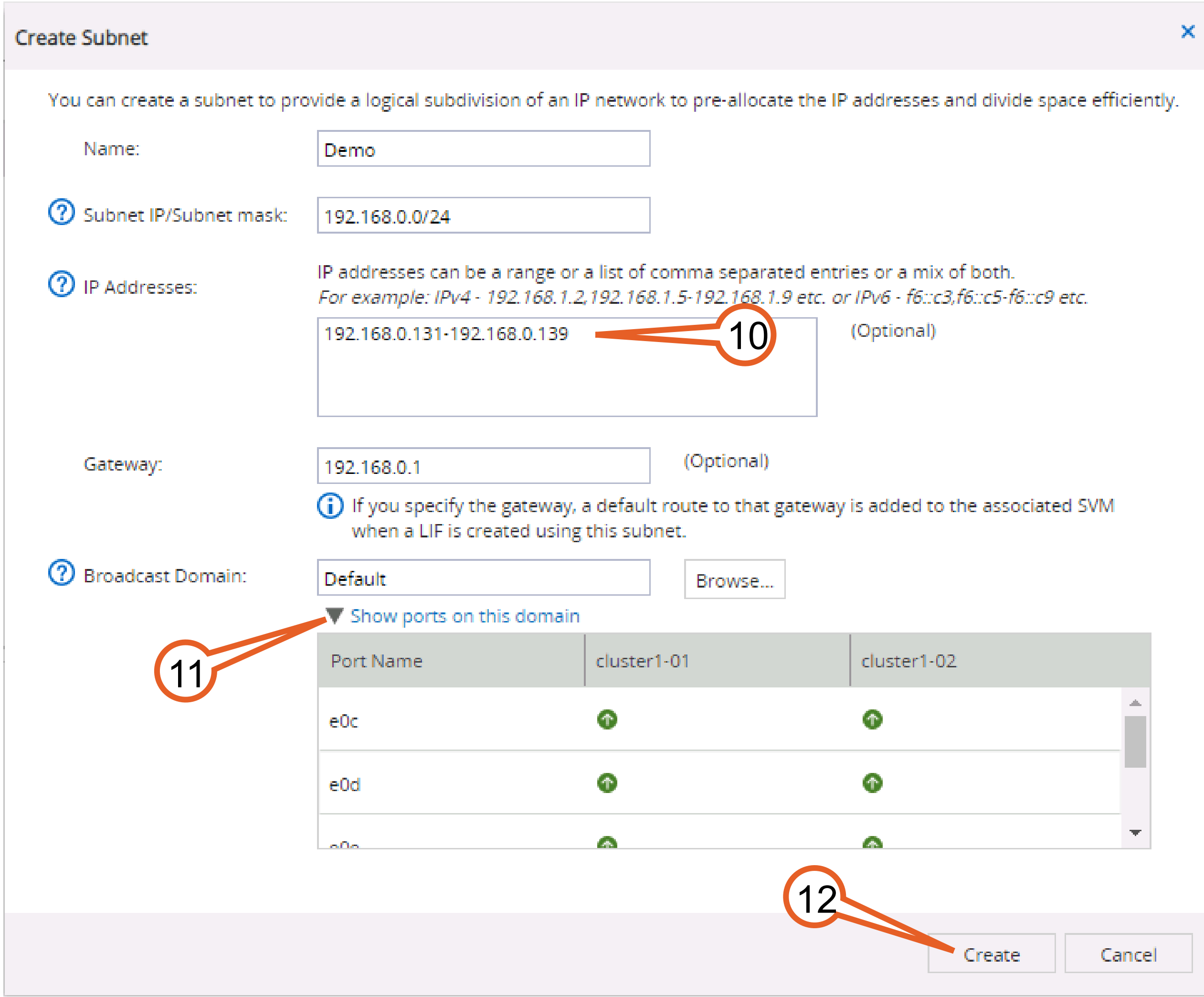

Figure 3-20:

The “Create Subnet” dialog closes, and focus returns to the “Subnets” tab in System Manager.

13. Notice that the main pane of the “Subnets” tab now includes an entry for your newly created subnet, and that the lower portion of the pane includes metrics that track the consumption of the IP addresses that belong to this subnet.

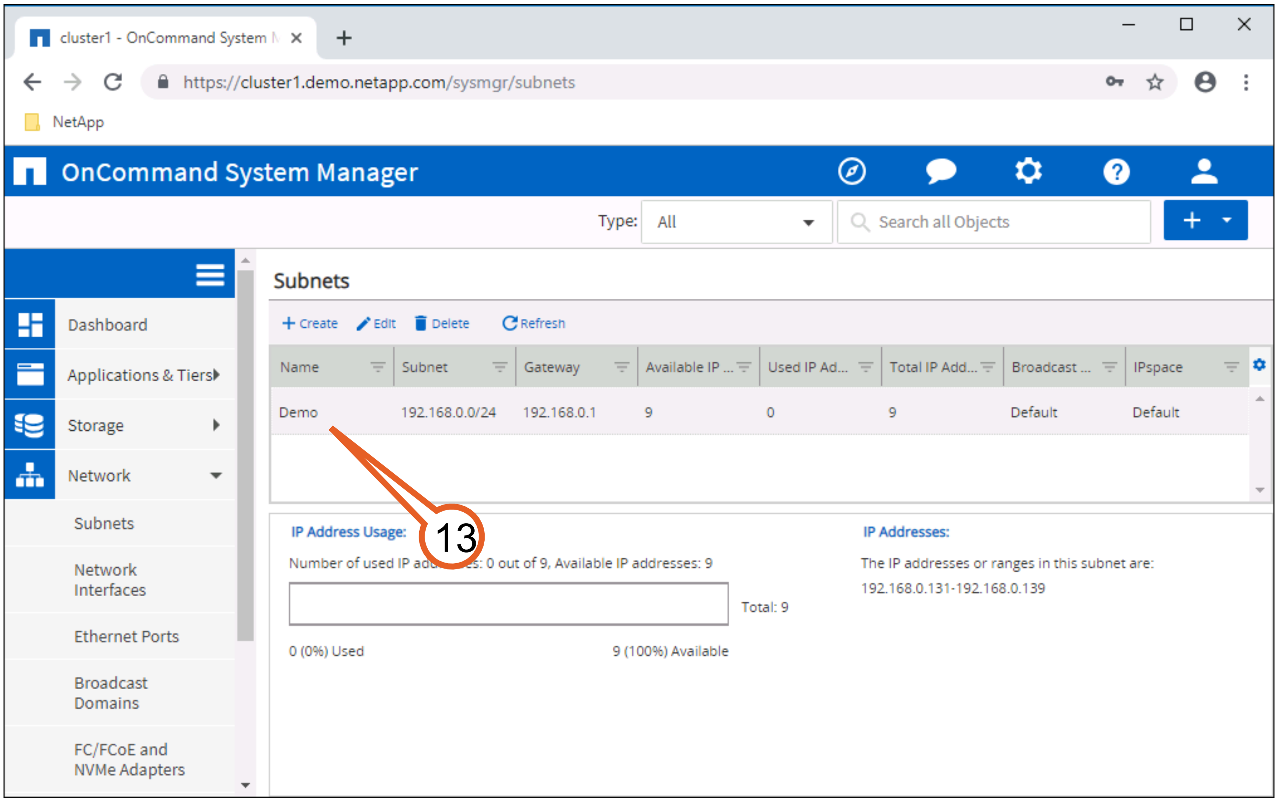

Figure 3-21:

Feel free to explore the contents of the other tabs available in the navigation pane under the “Network” section. Here is a brief summary of the information available on those tabs.

- The “Network Interfaces” tab displays a list of all of the LIFs on your cluster.
- The “Ethernet Ports” tab displays the physical NICs on your controller. These include the NICs that you previously saw listed as belonging to the default broadcast domain. The other NICs you see listed on the Ethernet Ports tab include the node's cluster network NICs.
- The “FC/FCoE and NVMe Adapters” tab lists all the WWPNs for all the controller’s NICs in the event they will be used for iSCSI or FCoE connections. The NetApp controllers you are using in this lab do not include FC adapters, and this lab does not make use of FCoE.
- The “IPspaces” tab lists the network spaces used to segregate networks for tenants in multi-tenant systems. This allows different tenants to use the same IP address ranges without mixing traffic. A multi-node cluster contains two IPspaces by default; the “Cluster” IPspace segregates IP addresses for the cluster NICs, while the “Default” IPspace is used for everything else.

3.2 Create Storage for NFS and CIFS

Expected Completion Time: 40 Minutes

You must have completed the Clusters exercises before you can proceed.

3.2.1 Create a Storage Virtual Machine

3.2.1.1 General SVM Concepts

Storage Virtual Machines (SVMs), previously known as Vservers, are the logical storage servers within a cluster that serve data out to storage clients. A single cluster can host hundreds of SVMs, with each SVM managing its own set of volumes (FlexVols), Logical Network Interfaces (LIFs), storage access protocols (e.g., NFS/CIFS/iSCSI/FC/FCoE), and for NAS clients, its own namespace.

A single SVM can host any combination of the supported storage protocols. You explicitly configure which storage protocols you want a given SVM to support at the time you create the SVM. You can later add or remove protocols as desired.

The ability to support many SVMs in a single cluster is a key feature in ONTAP, and NetApp encourages customers to embrace this feature in order to take full advantage of a cluster's capabilities. A cluster that utilizes multiple SVMs will scale signficantly better than a cluster that only has a single SVM, and provides administrators with much greater flexibility when managing workloads and access controls. The number of ONTAP storage controller nodes in a cluster determines the total number of SVMs that can run in the cluster. Each storage controller node can host a maximum of 125 SVMs, so you can calculate the cluster's effective SVM limit by multiplying the number of nodes by 125. As cluster size gets larger, the maximum number of SVMs a cluster can support approaches 1000 SVMs.

An SVM's assigned aggregates and LIFs determine which cluster nodes handle processing for that SVM. As you saw earlier, an aggregate is directly connected to the specific node hosting its disks, which means that an SVM runs in part on any nodes whose aggregates are hosting volumes for the SVM. An SVM also has a direct relationship to any nodes that are hosting its LIFs. LIFs are essentially an IP address with a number of associated characteristics, such as an assigned home node, an assigned physical home port, a list of physical ports it can fail over to, an assigned SVM, a role, a routing group, and so on. You can only assign a given LIF to a single SVM, and since LIFs map to physical network ports on cluster nodes, this means that an SVM runs in part on all the nodes that are hosting its LIFs.

The most efficient client access path to a volume's data is through a LIF that is mapped to a physical network port located on the same node as the aggregate that hosts the volume's storage. However, clients can also access volume data through LIFs bound to physical network ports on other nodes in the cluster; in these cases ONTAP uses the high speed cluster network to bridge communication between the node hosting the LIF and the node hosting the volume.

When you configure an SVM with multiple data LIFs, clients can use any of those LIFs to access volumes hosted by the SVM. The specific LIF IP address (and by extension, which LIF) a client will choose is a function of the storage protocol and of name resolution.

3.2.1.2 Additional SVM Concepts For NAS

For NAS, the mapping of a hostname to an IP address is a function of name resolution services. Under NetBIOS, CIFS Servers have the responsibility for resolving requests from clients for their hostnames, and in so doing can perform some load balancing by responding to different clients with different LIF addresses. However, this distribution is not sophisticated and requires external NetBIOS name servers in order to deal with clients that are not on the local network. NFS Servers do not handle name resolution on their own.

DNS provides basic name resolution load balancing by advertising multiple IP addresses for the same hostname. DNS is supported by both NFS and CIFS clients, and works equally well with clients on local area and wide area networks. Since DNS is an external service that resides outside of ONTAP, this architecture creates the potential for service disruptions if the DNS server is advertising IP addresses for LIFs that are temporarily offline. To compensate for this condition you can configure DNS servers to delegate the name resolution responsibility for the SVM's hostname records to the SVM itself, so that it can directly respond to name resolution requests involving its LIFs. This allows the SVM to consider LIF availability and LIF utilization levels when deciding what LIF address to return in response to a DNS name resolution request.

A NAS LIF (a LIF supporting only NFS and/or CIFS) can automatically failover from one cluster node to another in the event of a component failure. Any existing connections to that LIF from NFS and SMB 2.0 (and later) clients can non-disruptively tolerate the LIF failover event. When a LIF failover happens the NAS LIF migrates to a different physical NIC, potentially to a NIC on a different node in the cluster, and continues servicing network requests from that new node/port. Throughout this operation the NAS LIF maintains its IP address. Clients connected to the LIF may notice a brief delay while the failover is in progress, but as soon as it completes the clients resume any in-process NAS operations without any loss of data.

NetApp best practice is to create at least one NAS LIF for a given SVM on each cluster node that has an aggregate that is hosting volumes for that SVM. If you desire additional resiliency you can also create a NAS LIF on nodes not hosting aggregates for the SVM.

There is no limit on the number of LIFs that an SVM can host, but there is a limit on the number of LIFs that can run on a given node. For low-to-mid range controllers that limit is 256 LIFs per node, and high-end controllers can support 512 LIFs per node. If the node in question is part of an HA pair configured for failover, then this limit is half the usual per-node value so that the node can accommodate its HA partner's LIFs in the event of an HA failover event.

3.2.1.3 Create SVM Exercise

In this lab activity you create a new SVM named “svm1” on the cluster, and configure it to serve out a volume over NFS and CIFS. You will configure two NAS data LIFs on the SVM, one per node in the cluster.

Start by creating the storage virtual machine.

1. In the left pane of System Manager, navigate to **Storage** > **SVMs**.
2. Click **Create** to launch the Storage Virtual Machine Setup wizard.

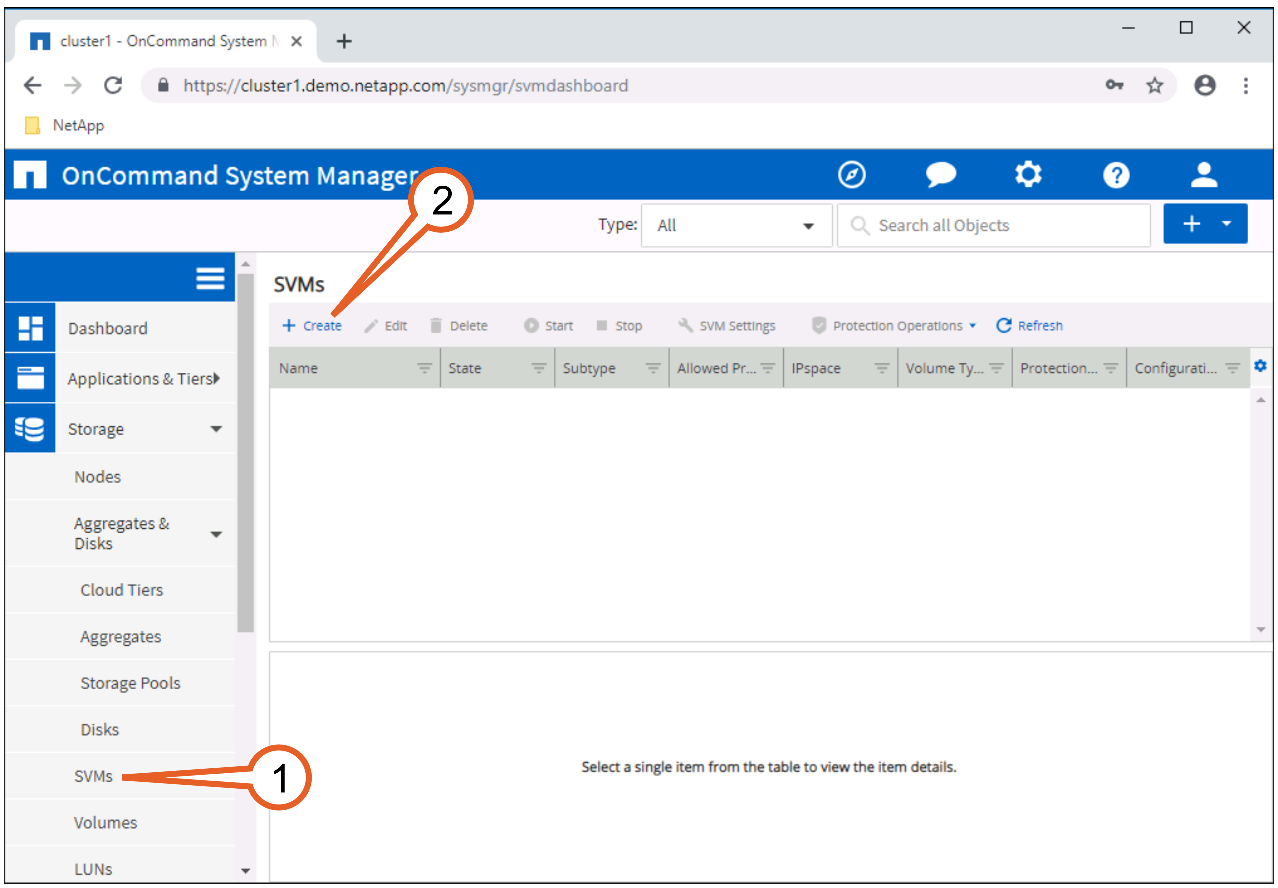

Figure 3-22:

The “Storage Virtual machine (SVM) Setup” dialog opens.

3. Set the fields in this window as follows:

- “SVM Name”: `svm1`
- “Data Protocols”: check **CIFS** and **NFS**.

  Tip: The list of available Data Protocols is dependent upon which protocols are licensed on your cluster; if a given protocol is not listed, it is because you are not licensed for it. (In this lab all the protocols are licensed.)
- “Security Style”: **NTFS**.

  Note: NetApp recommends the “NTFS” security style for SVMs that serve CIFS or CIFS plus NFS. If a NAS SVM only serves NFS, then we recommend the “UNIX” security style.
- “Root Aggregate”: **aggr1_cluster1_01**.

4. Click **Submit & Continue**.

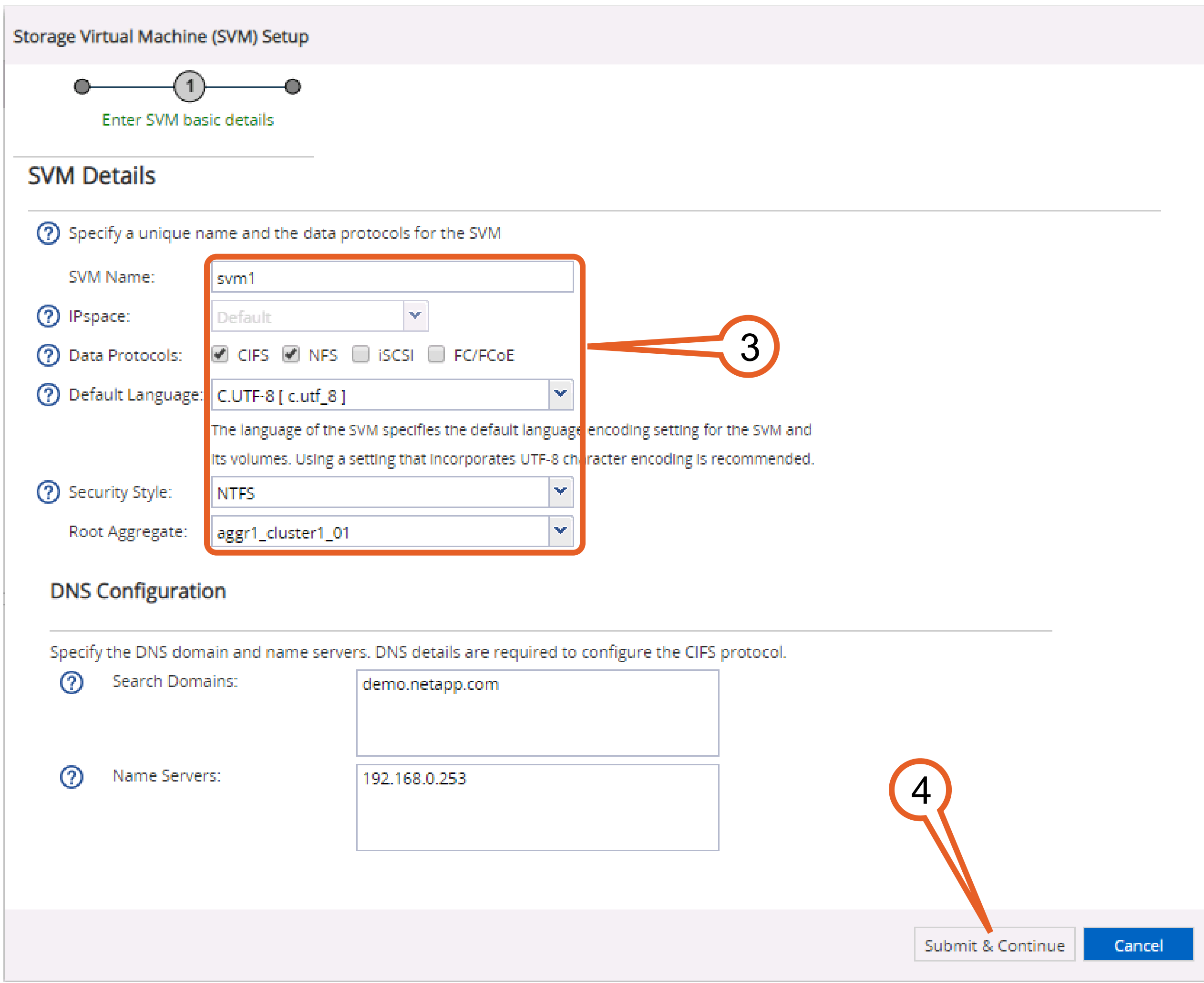

Figure 3-23:

The “Storage Virtual Machine (SVM) Setup” wizard advances to the “Configure CIFS/NFS protocol” step.

5. Set the **Assign IP Address** dropdown to **Using a subnet**.

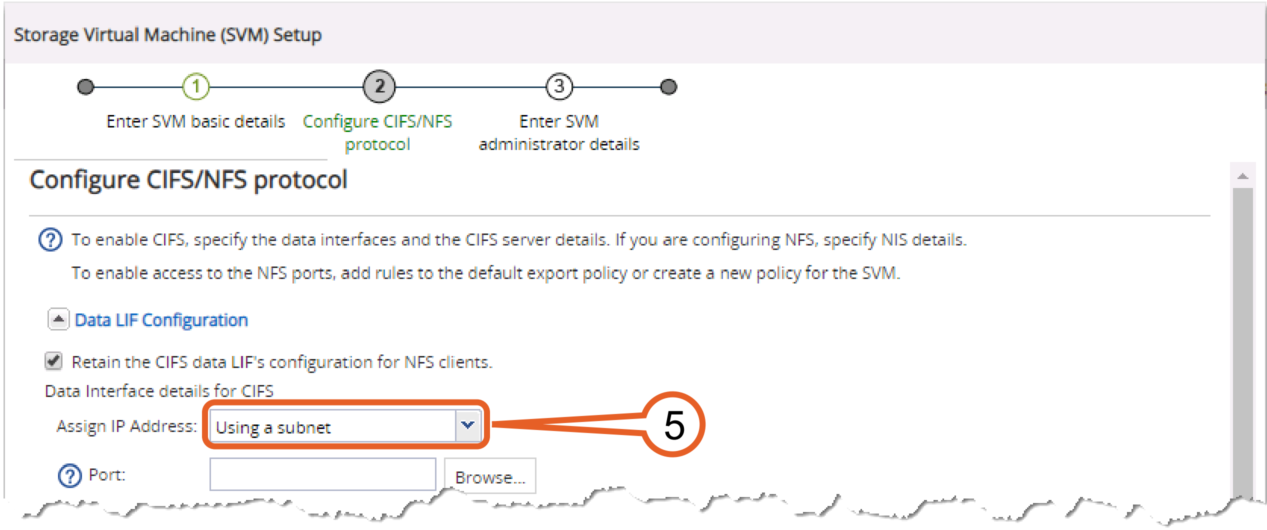

Figure 3-24:

The “Add Details” dialog opens.

6. The **Subnet chosen:** dropdown should be pre-populated with **Demo**, the name of the subnet you created in an earlier exercise. Recall that “Demo” is the only subnet defined on the cluster.
7. Click **OK**.

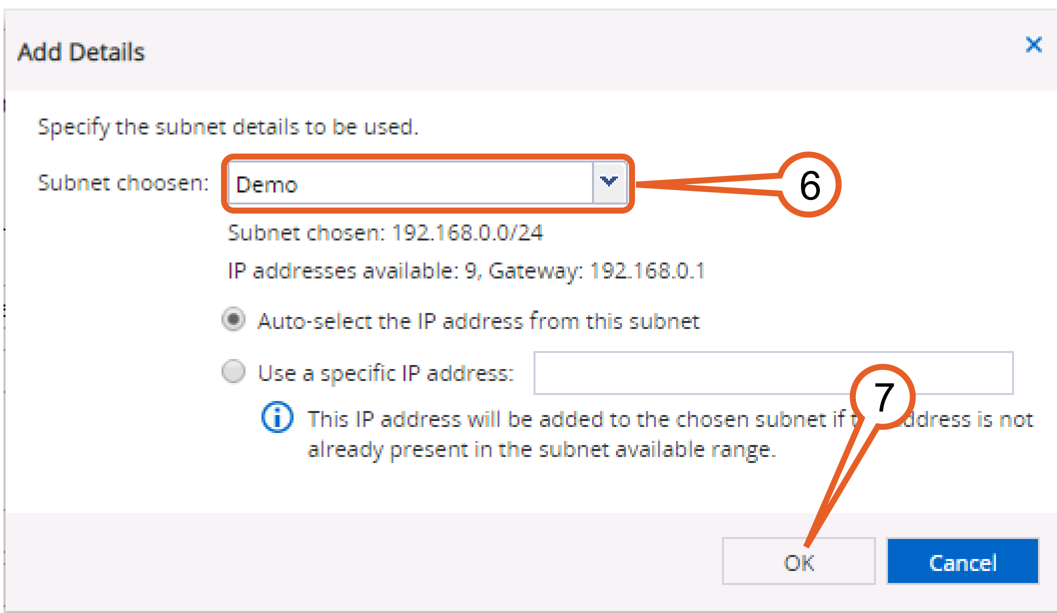

Figure 3-25:

The “Add Details” dialog closes, and focus returns to the “Storage Virtual Machine (SVM) Setup” wizard.

8. Click **Browse** next to the “Port” text box.

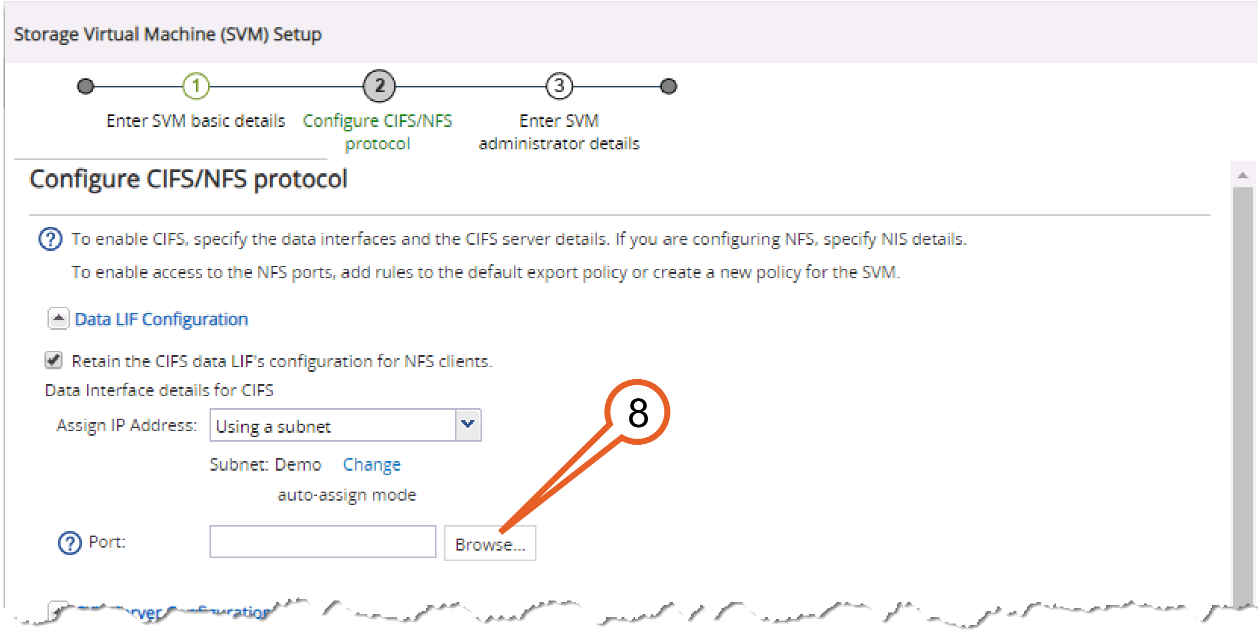

Figure 3-26:

The “Select Network Port or Adapter” dialog opens.

9. Expand the list of ports for the node **cluster1-01**.
10. Select port **e0c**.

11. Click **OK**.

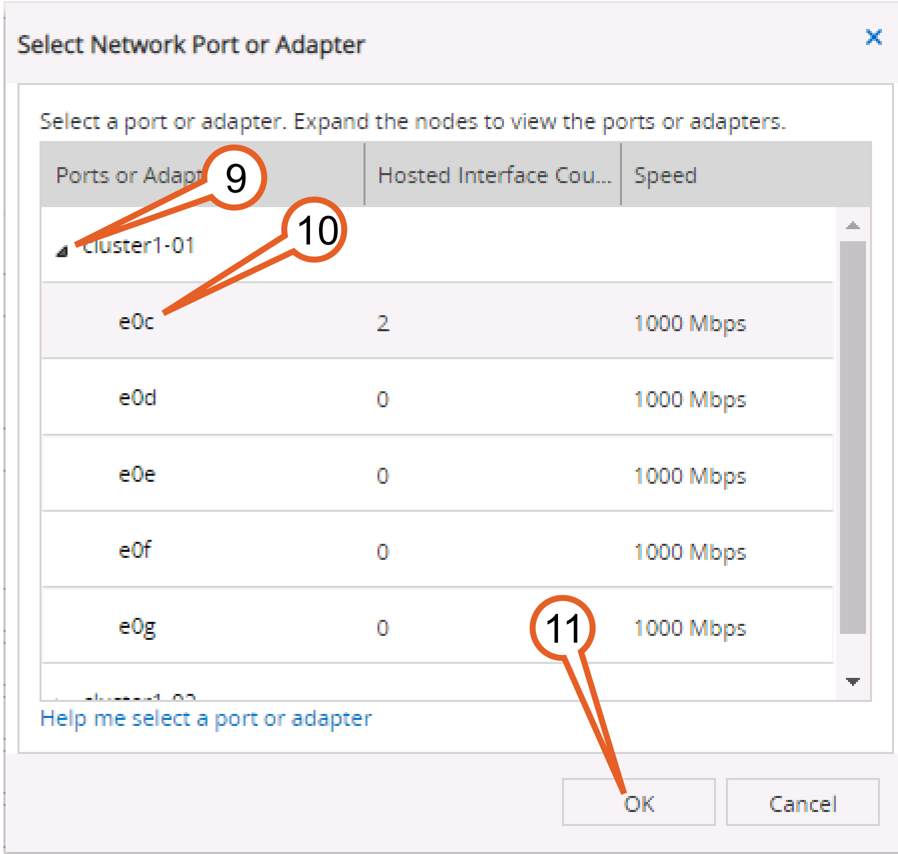

Figure 3-27:

The “Select Network Port or Adapter” dialog closes, and focus returns to the protocols portion of the Storage Virtual Machine (SVM) Setup wizard.

12. Set the fields in this window as follows:

    - “CIFS Server Name”: **`svm1`**

      Note: The CIFS Server Name value does not need to match the name of the SVM, but in this lab they are the same.
    - “Port”: Populated with the cluster and port value you just selected.
    - “Active Directory”: **`demo.netapp.com`**
    - “Administrator Name”: **`Administrator`**

      Note: This is the Active Directory administrator account user name.
    - “Password”: **`Netapp1!`**

13. The optional “Provision a volume for CIFS storage” text boxes offer a quick way to provision a simple volume and CIFS share at SVM creation time, with the caveat that this share will not be multi-protocol. In most cases when you create a share it is for an existing SVM. Instead of creating a share here, this lab guide will show the more full-featured volume creation procedure in the following sections.

14. Scroll down the window to continue.

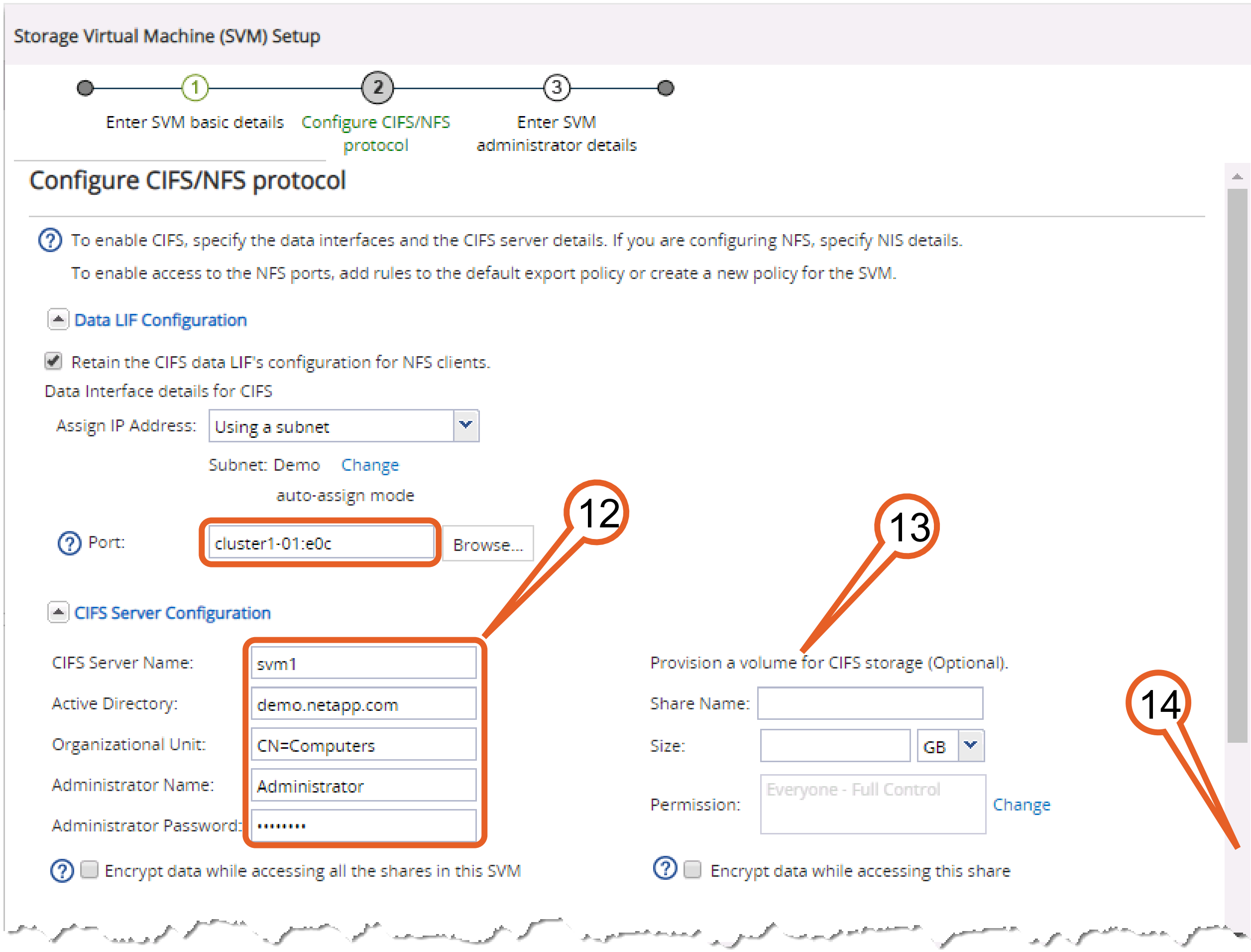

Figure 3-28:

15. In the NIS section, the “Domain Name” and “IP Addresses” fields are blank. In a NFS environment where you are running NIS, you would configure these values, but this lab environment does not utilize NIS, and populating these fields will create a name resolution problem later in the lab.
16. As was the case with CIFS, the “Provision a volume for NFS storage” text boxes offer a quick way to provison a volume and create an NFS export for that volume. Once again, the volume will not be inherently multi-protocol, and will be a completely separate volume from the CIFS share volume that you could have selected to create in the CIFS section. For the purpose of this lab, you will create NFS storage using the more full featured volume creation process described later in the guide.

17. Click **Submit & Continue** to advance the wizard to the next screen.

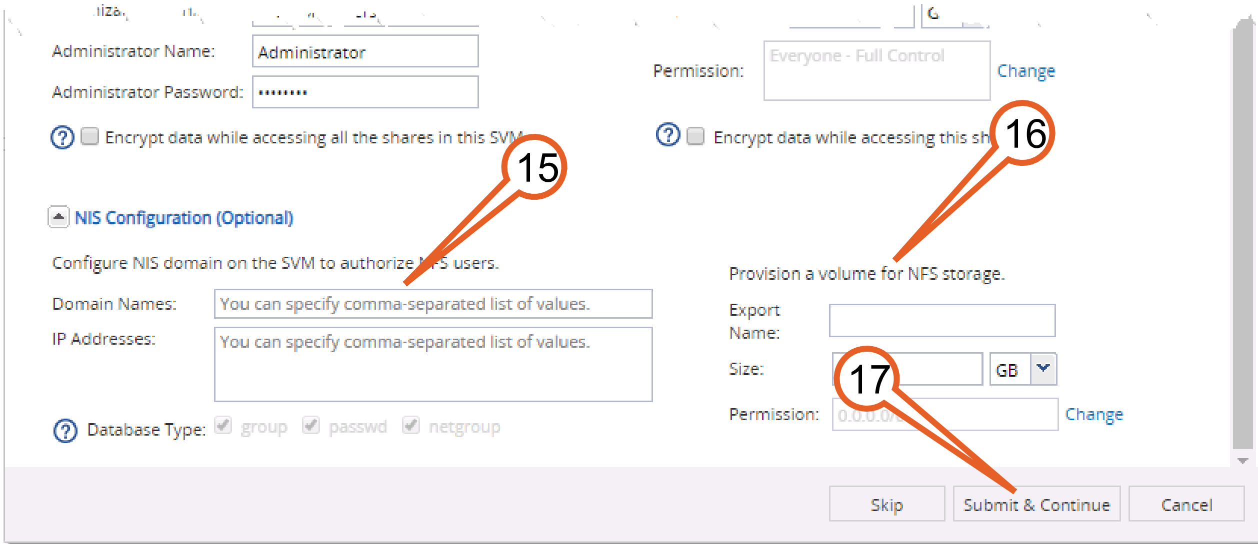

Figure 3-29:

The SVM Administration step of the Storage Virtual Machine (SVM) Setup wizard opens. This window allows you to set up an administrative account for this specific SVM so you can delegate administrative tasks to an SVM-specific administrator without giving that administrator cluster-wide privileges.

18. The web browser may prompt if you want to save the password for the “Administrator” account. Click **Never**.

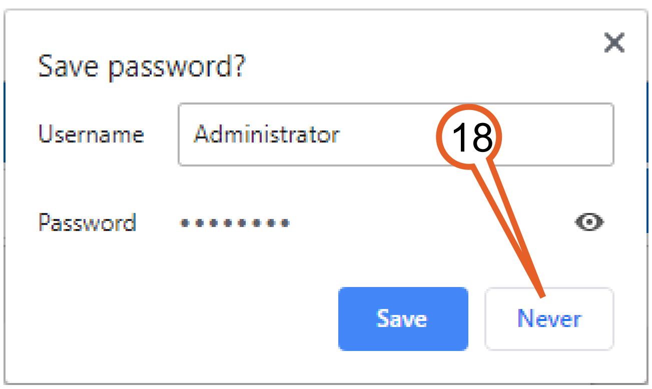

Figure 3-30:

The web browser “Save Password” dialog closes, and focus returns to the Storage Virtual machine (SVM) Setup wizard. This stage of the setup wizard allows you to create an additional administrator account whose privileges are scoped to only this storage virtual machine.

19. Enter `netapp123` in both the “Password” and “Confirm Password” text boxes.

20. When finished, click **Submit & Continue**.

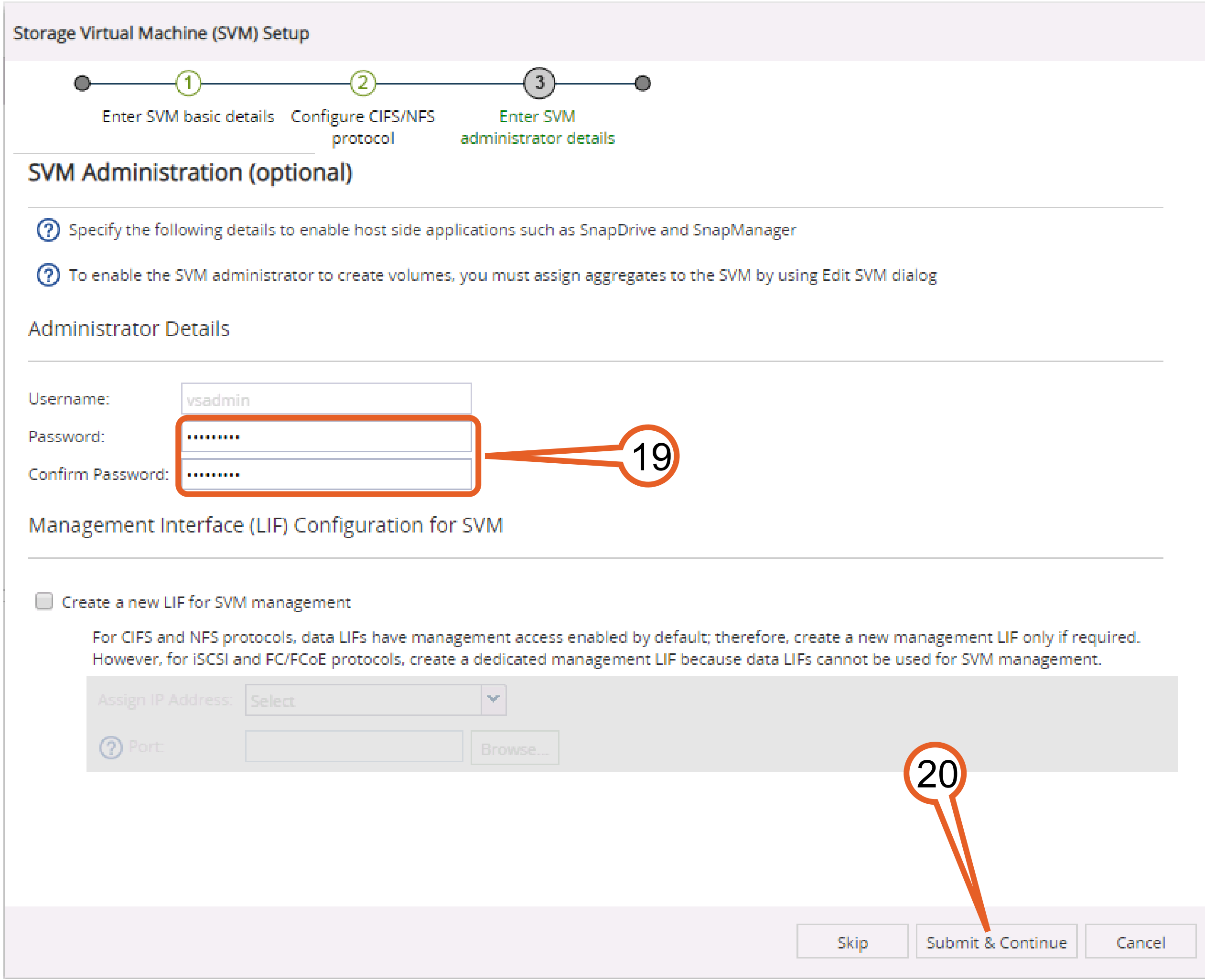

Figure 3-31:

The "New Storage Virtual Machine (SVM) Summary" window opens.

21. The web browser may prompt you to ask if you want to save the password for the “admin” account. Click **Nope**.

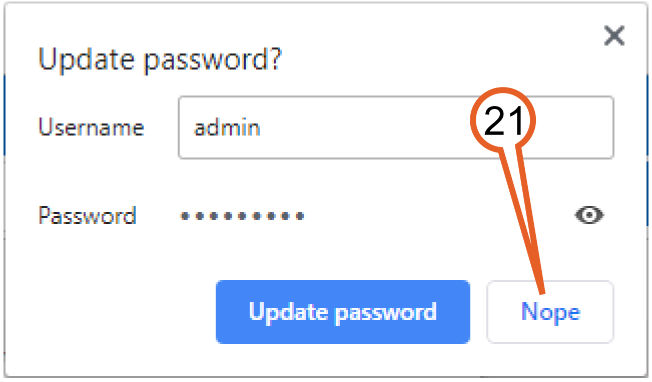

Figure 3-32:

The web browser “Save Password” dialog closes, and focus returns to the Storage Virtual machine (SVM) Setup wizard.

22. Review the settings for the new SVM, taking note of the IP Address listed in the “CIFS/NFS Configuration” section. ONTAP allocated this address from the Subnets pool that you created earlier in the lab. Make sure you use the scrollbar on the right to see all the available information in the window.

23. When finished, click **OK** .

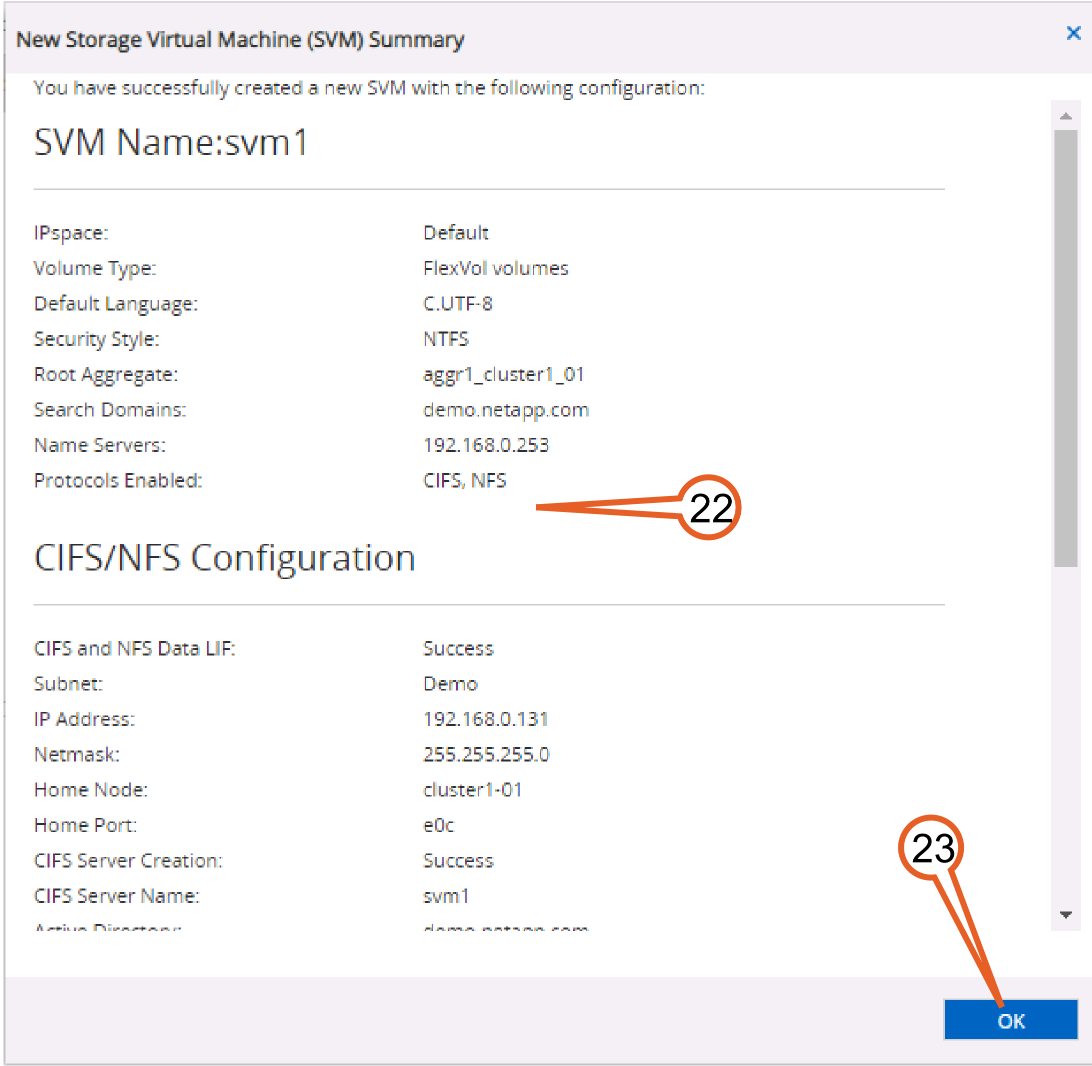

Figure 3-33:

The wizard closes, and focus returns to the System Manager “SVMs” page, that now displays a summary page for your newly created “svm1” SVM.

24. The SVMs page now displays an entry for your newly created “svm1” SVM.

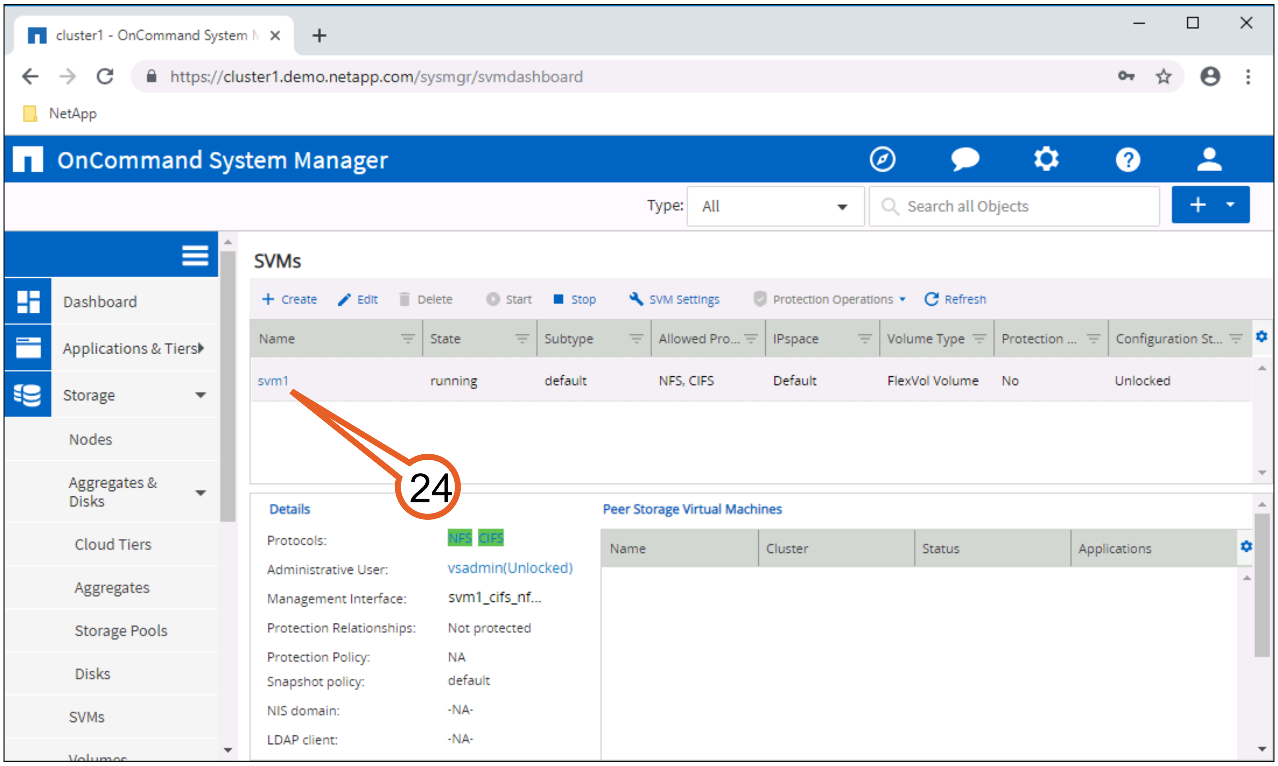

Figure 3-34:

The New Storage Virtual Machine Setup wizard only provisions a single NAS LIF when creating a new SVM. NetApp best practice is to configure a NAS LIF on both nodes in an HA pair so that a client can access the SVM's shares through either node. To comply with that best practice you will now create a second NAS LIF hosted on the other node in the cluster.

25. In the left pane, navigate to **Network** > **Network Interfaces**.

26. Select the only LIF listed for the svm1 SVM (you may have to scroll down in the list to see it). Notice that this LIF is named “svm1_cifs_nfs_lif1”. Follow this same naming convention for the new LIF that you are creating.

27. Click **Create** to launch the Create Network Interface Wizard.

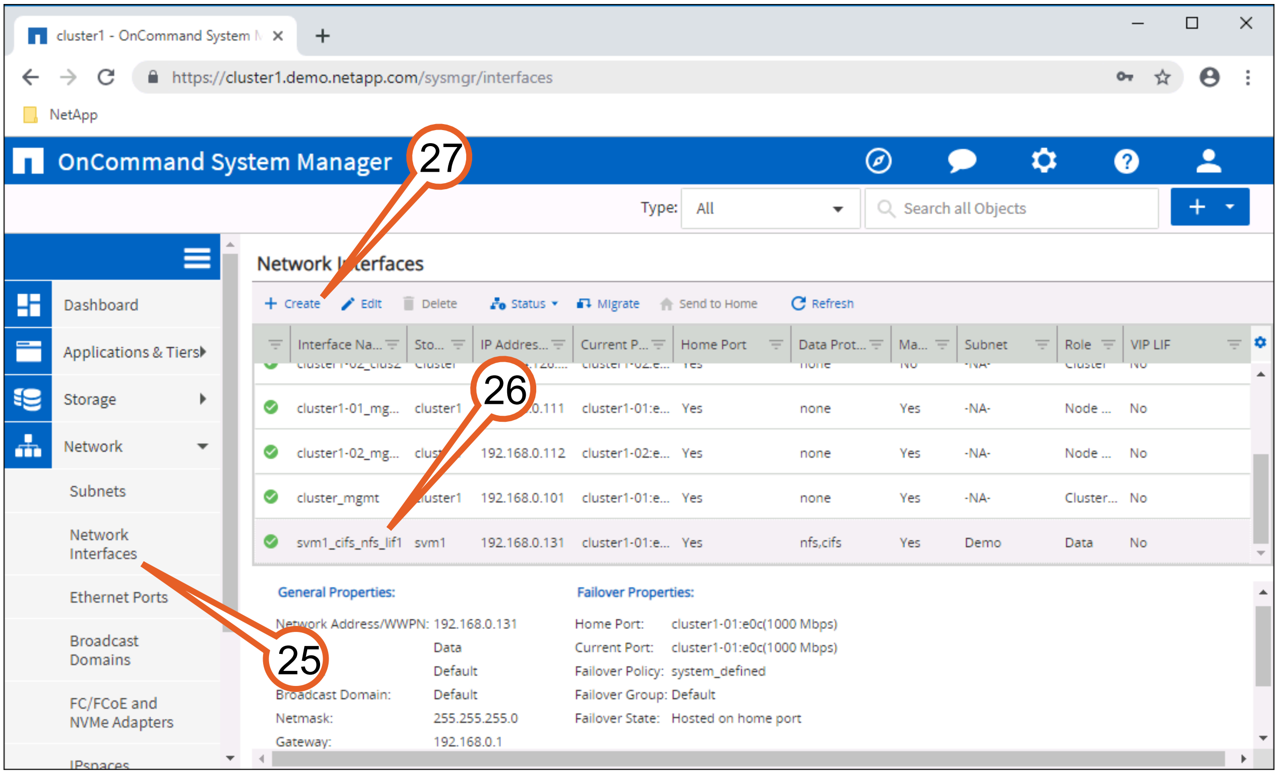

Figure 3-35:

The "Create Network Interface" dialog opens.

28. Set the fields in this wizard as follows:

- Enter **`svm1_cifs_nfs_lif2`** in the “Name” field.
- Click the **Serves Data** radio button in the “Interface Role” field.
- Enter **`svm1`** in the “SVM” field.
- Check **CIFS** and **NFS** in the “Protocol Access” field.
- Check **Enable Management Access**in the “Management Access” field.
- Select **Using a subnet** in the “Assign IP Address” field.

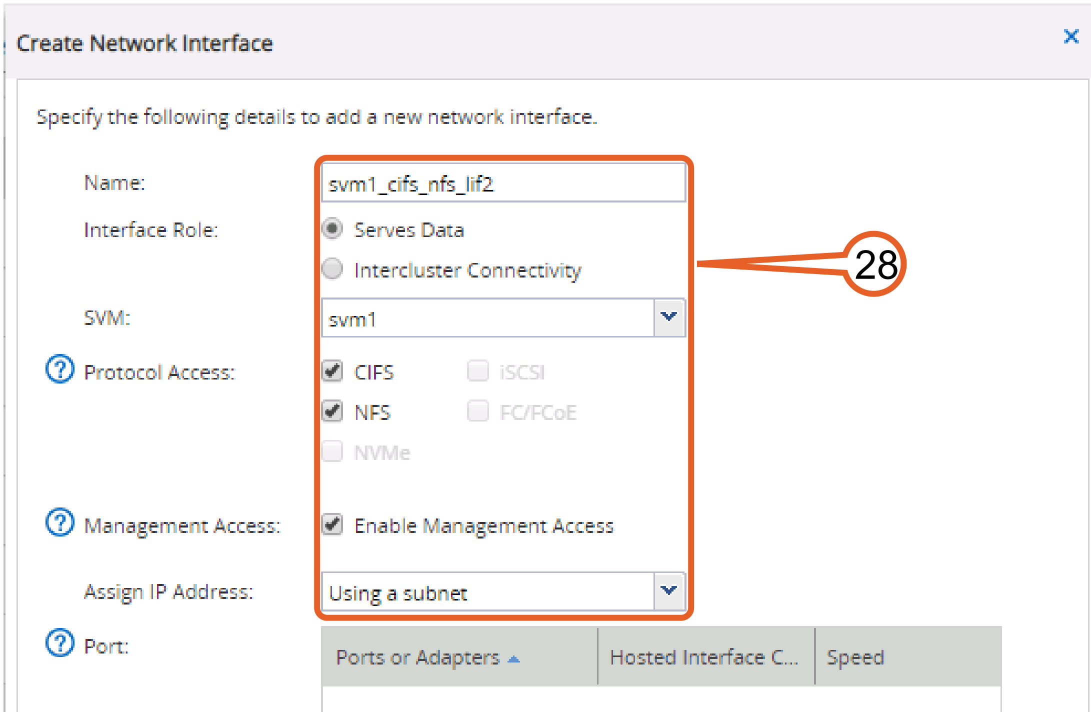

Figure 3-36:

The “Add Details” dialog opens.

29. The “Subnet Chosen” drop-down menu should be pre-set to **Demo**.

30. Click **OK**.

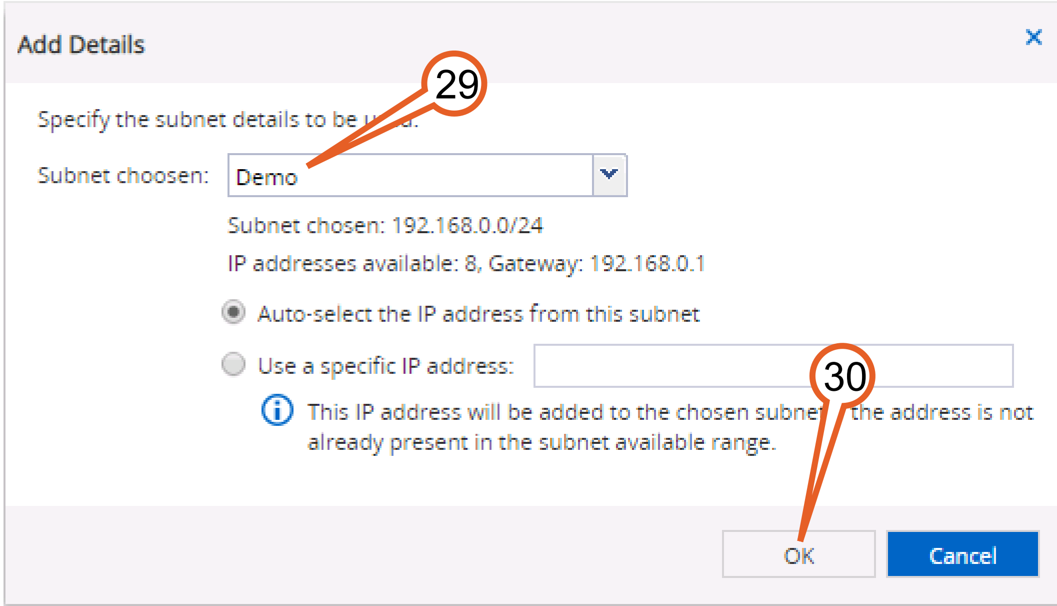

Figure 3-37:

The “Add Details” dialog closes, and focus returns to the “Create Network Interface” dialog.

31. Expand the “Ports or Adapters” entry for**cluster1-02** list.
32. Select the entry for port **e0c**.

33. Click **Create** to continue.

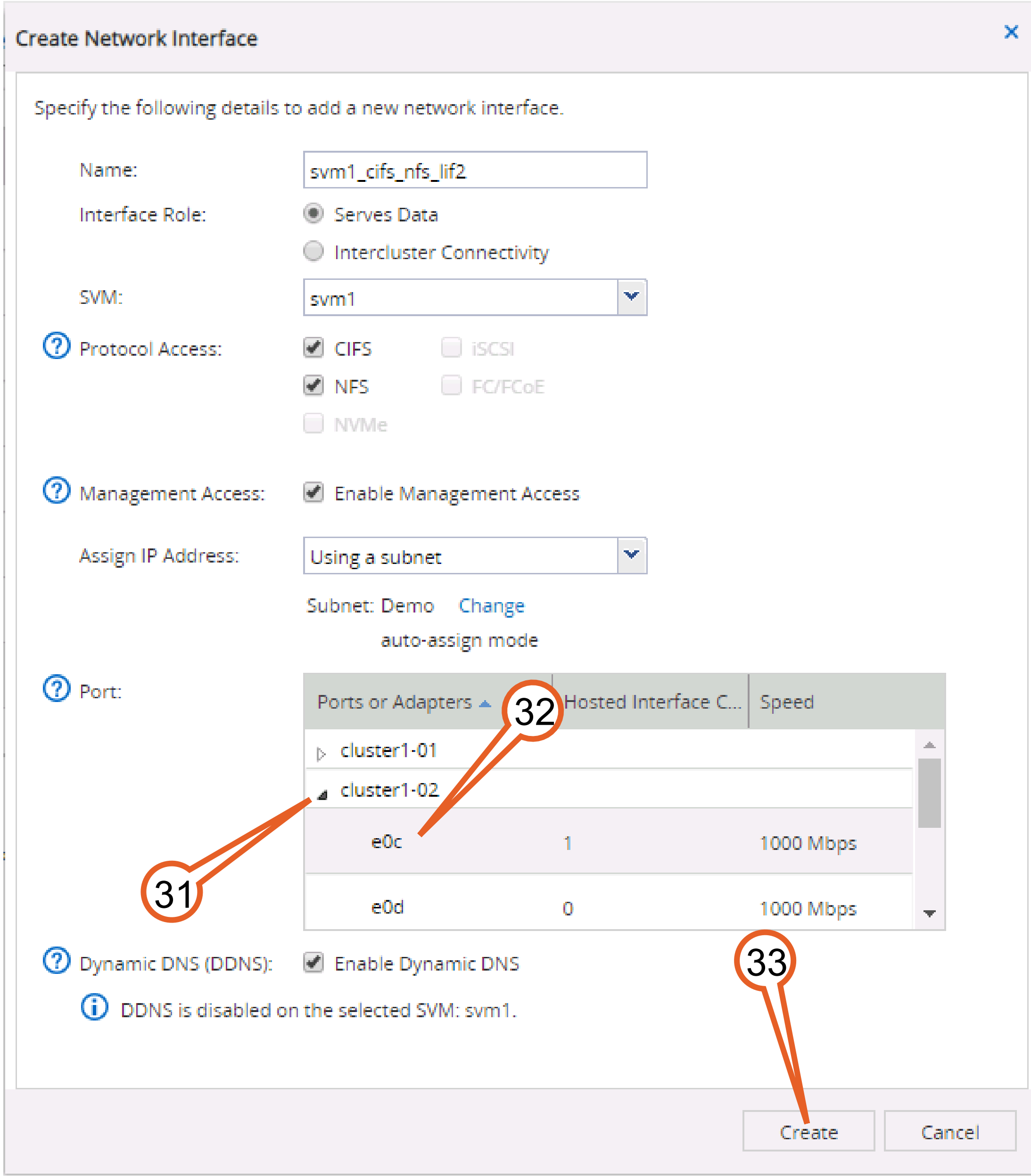

Figure 3-38:

The “Create Network Interface” window closes, and focus returns to the “Network Interfaces” page in System Manager.

34. Notice that a new entry for the **svm1_cifs_nfs_lif2** LIF is now present in the Network Interfaces list. Select this entry and review the LIF's properties in the lower pane.

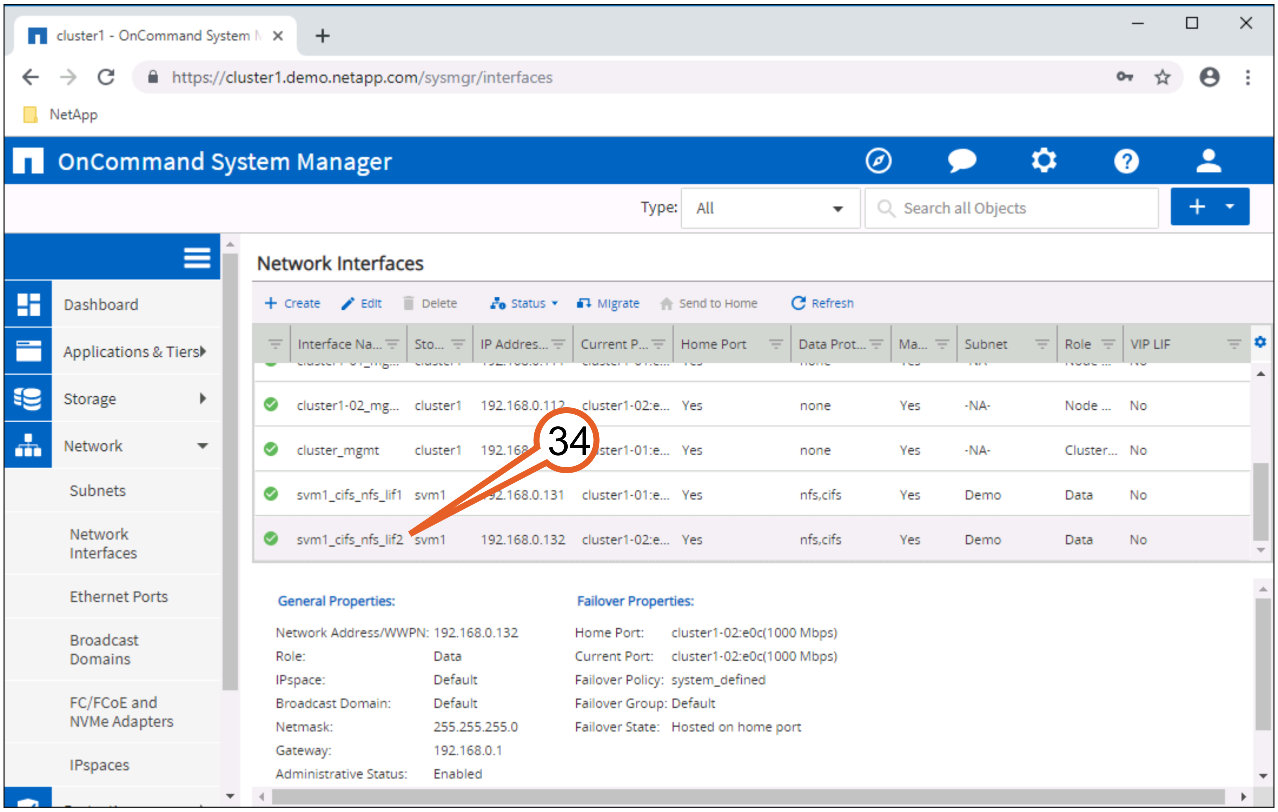

Figure 3-39:

Lastly, you need to configure DNS delegation for the SVM so that Linux and Windows clients can intelligently utilize all of svm1's configured NAS LIFs. For this to work, the DNS server must delegate the responsibility of a DNS zone for the SVM's hostname ("svm1.demo.netapp.com") to svm1. The lab's DNS server already contains a DNS zone for this delegation, but you must also configure svm1 to accept it. System Manager does not currently include the capability to configure DNS delegation for the SVM so you will need to use the CLI for this purpose.

35. Open a PuTTY connection to cluster1 using the instructions in the "Accessing the Command Line" section at the beginning of this guide. Log in with username **admin**, and the password **Netapp1!**.

36. Configure svm1 for the delegation.

```
cluster1::> network interface modify -vserver svm1 -lif svm1_cifs_nfs_lif1
 -dns-zone svm1.demo.netapp.com
cluster1::> network interface modify -vserver svm1 -lif svm1_cifs_nfs_lif2
 -dns-zone svm1.demo.netapp.com
cluster1::> network interface show -vserver svm1 -fields dns-zone,address
vserver lif                address       dns-zone
------- ------------------ ------------- --------------------
svm1    svm1_cifs_nfs_lif1 192.168.0.131 svm1.demo.netapp.com
svm1    svm1_cifs_nfs_lif2 192.168.0.132 svm1.demo.netapp.com
2 entries were displayed.
cluster1::>
```

37. Launch **PowerShell** on the Jumphost.

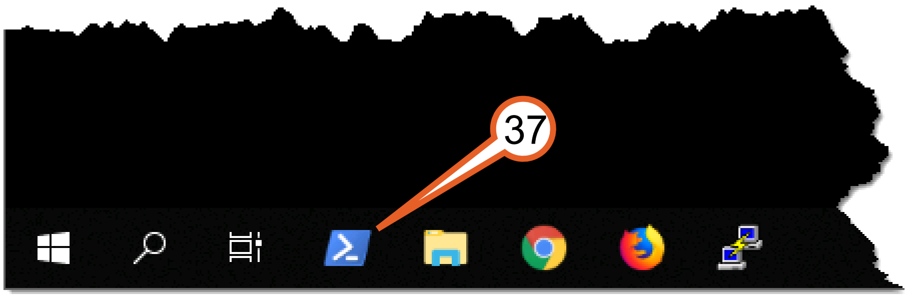

Figure 3-40:

38. Validate that DNS delegation is working correctly by using the `nslookup` command as shown in the following CLI output. If the `nslookup` command returns different IP addresses on different lookup attempts then delegation is working correctly. If the `nslookup` command returns a “Non-existent domain” error, then delegation is not working correctly, and you will need to review the ONTAP commands you entered for any errors. Also notice in the following CLI output that different executions of the `nslookup` command return different addresses, demonstrating that DNS load balancing is working correctly.

Tip: You may need to run the `nslookup` command more than two times before you see it report different addresses for the hostname, as ONTAP's delegated DNS load balancing algorithm is more sophisticated than a simple round-robin scheme.

```
Windows PowerShell
Copyright (C) 2013 Microsoft Corporation. All rights reserved.
PS C:\Users\Administrator.DEMO> nslookup svm1.demo.netapp.com
Server:  dc1.demo.netapp.com
Address:  192.168.0.253
Non-authoritative answer:
Name:    svm1.demo.netapp.com
Address:  192.168.0.132
PS C:\Users\Administrator.DEMO> nslookup svm1.demo.netapp.com
Server:  dc1.demo.netapp.com
Address:  192.168.0.253
Non-authoritative answer:
Name:    svm1.demo.netapp.com
Address:  192.168.0.131
PS C:\Users\Administrator.DEMO
```

3.2.2 Configure CIFS and NFS

3.2.2.1 CIFS and NFS Concepts

ONTAP configures CIFS and NFS on a per SVM basis. When you created the “svm1” SVM in the previous section, you set up and enabled CIFS and NFS for that SVM. However, clients cannot yet access the SVM using CIFS and NFS. That is partially because you have not yet created any volumes on the SVM, but also because you have not told the SVM what to share, and who to share it with.

Each SVM has its own NAS namespace, a logical grouping of the SVM's CIFS and NFS volumes into a single logical filesystem view. Clients can access the entire namespace by mounting a single share or NFS export that references the top of the namespace tree. This means that SVM administrators can maintain a single, centrally managed, consistent, real-time view of the SVM's data for all clients rather than having to reproduce that view structure on each individual client. As an administrator maps and unmaps volumes from the namespace, those volumes instantly become visible or disappear from clients that have mounted CIFS and NFS volumes higher in the SVM's namespace. Administrators can also create NFS exports at individual junction points within the namespace, and can create CIFS shares at any directory path in the namespace.

The root of an SVM’s namespace is hosted on the SVM's root volume (“svm1_root” in the case of the “svm1” SVM). The SVM's other volumes are junctioned (i.e., mounted) within that root volume, or within other volumes that are already junctioned into the namespace. A key point to remember is that CIFS and NFS clients cannot access a volume that has not been junctioned into the namespace.

When you create an SVM, ONTAP automatically creates a root volume to hold that SVM's namespace. An SVM always has a root volume, whether or not it is configured to support NAS protocols.

Once CIFS is enabled for an SVM, clients still cannot use SMB to access data on your SVM until you create a share. Share creation on ONTAP works very similarly to how it works on Windows; you specify the directory you want to share, name the share, and assign share permissions. As you saw in the previous exercise, ONTAP supports Active Directory integration, so you can leverage your existing Active Directory groups and users when configuring share access rules. Although NetApp recommends using Active Directory integration for your CIFS SVMs (as that provides the best user experience), you can also set up CIFS services without using Active Directory.

CIFS and NFS clients can access the entire namespace by mounting a single NFS export or CIFS share that references the top of the root volume directory hierarchy. While this is a very powerful capability, there is no requirement to make the whole namespace accessible. You can create CIFS shares at any directory level in the namespace, and you can create different NFS export rules at junction boundaries for individual volumes, and for individual qtrees within a junctioned volume.

ONTAP does not utilize an /etc/exports file to export NFS volumes; instead it uses a policy model that dictates the NFS client access rules for the associated volumes. An NFS-enabled SVM implicitly exports the root of its namespace and automatically associates that export with the SVM's default export policy, but that default policy is initially empty, and until it is populated with access rules no NFS clients is able to access the namespace.

The SVM's default export policy applies to the root volume, and also to any volumes that an administrator junctions into the namespace, but an administrator can optionally create additional export policies in order to implement different access rules within the namespace. You can apply export policies to a volume as a whole and to individual qtrees within a volume, but a given volume or qtree can only have one associated export policy. While you cannot create NFS exports at any other directory level in the namespace, NFS clients can mount from any level in the namespace by leveraging the namespace's root export.

3.2.2.2 Configure CIFS and NFS Exercise

In this lab activity, you configure a default export policy for your SVM so that any volumes you junction into its namespace will automatically pick up the same NFS export rules. You will also create a single CIFS share at the top of the namespace so that all the volumes you junction into that namespace are accessible through that one share.

Before you configure NFS and CIFS for your newly created SVM, take a quick look at its root volume.

1. In the left pane of System Manager, navigate to **Storage** > **Volumes**.
2. In the right pane, make sure the “Volumes on SVM” dropdown is set to **svm1** so the view will only display the volumes that belong to the selected SVM.

   Tip: A number of different pages in System Manager use this type of dropdown menu to filter a view’s context. We encourage you to look for these menus on each System Manager page you visit, which can help you avoid potential confusion when you otherwise wouldn’t see expected entries listed in a view.
3. There is only a single volume listed, “svm1_root”. Expand the entry for this volume.

4. Observe that the “svm1_root” volume is small, only 20 MB.

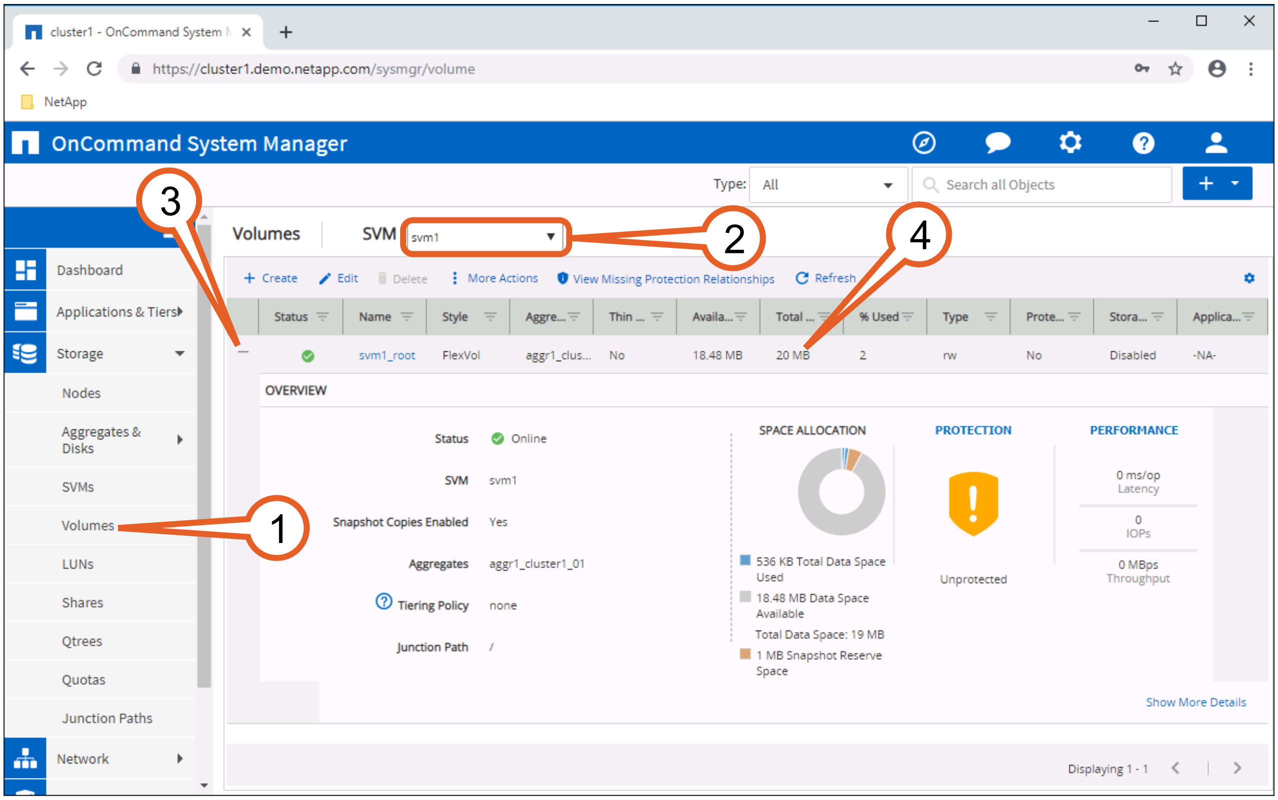

Figure 3-41:

The root volume hosts the namespace for the SVM. Root volumes are small because they are only intended to house the junctions that organize the SVM's volumes. All of the files hosted on the SVM should reside inside other volumes that are junctioned into the namespace, rather than directly in the SVM's root volume.

Confirm that CIFS and NFS are running for the svm1 SVM.

5. In the left pane of System Manager, navigate to **Storage** > **SVMs** .

6. In the right pane, click the link for **svm1**.

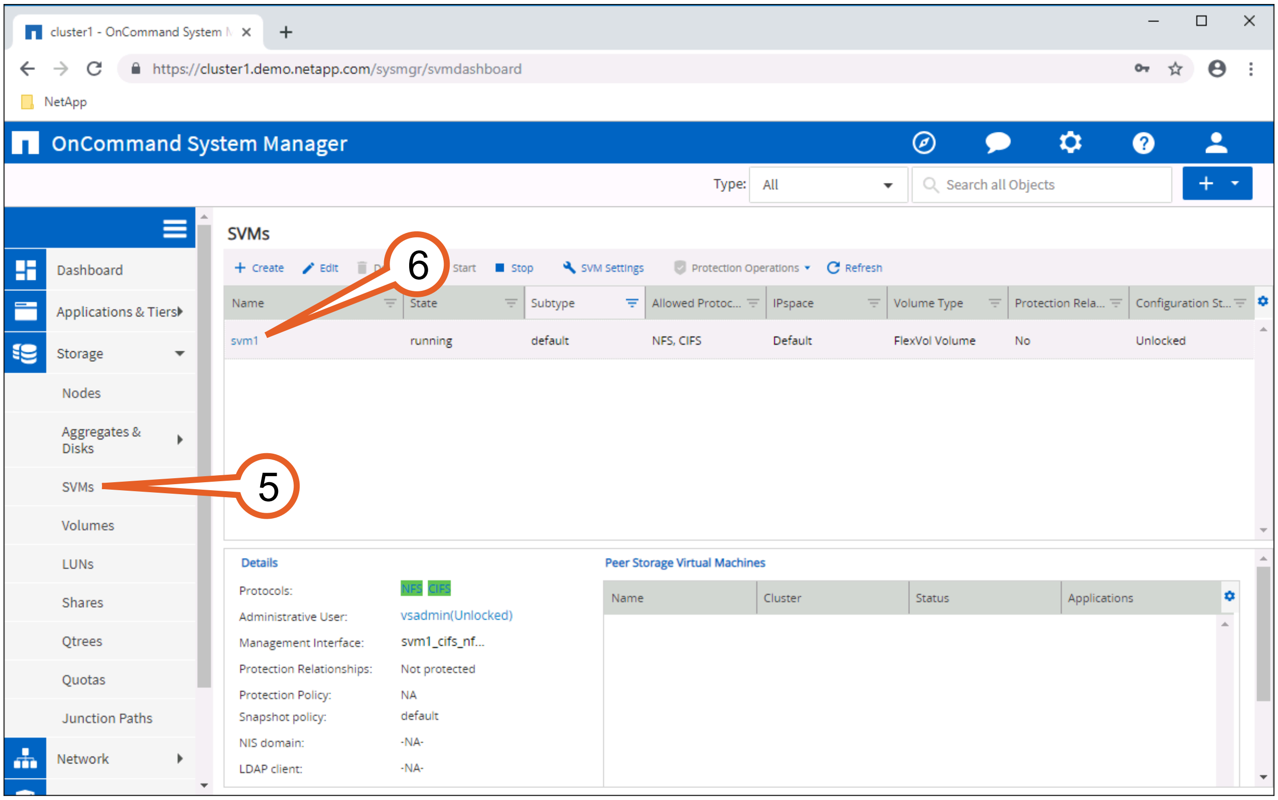

Figure 3-42:

System Manager displays the dashboard for the “svm1” SVM.

7. In the “Protocol Status” pane, observe the green check marks above the NFS and CIFS links. These green check marks indicate that the NFS and CIFS servers for this SVM are running.

8. Click the **CIFS** link.

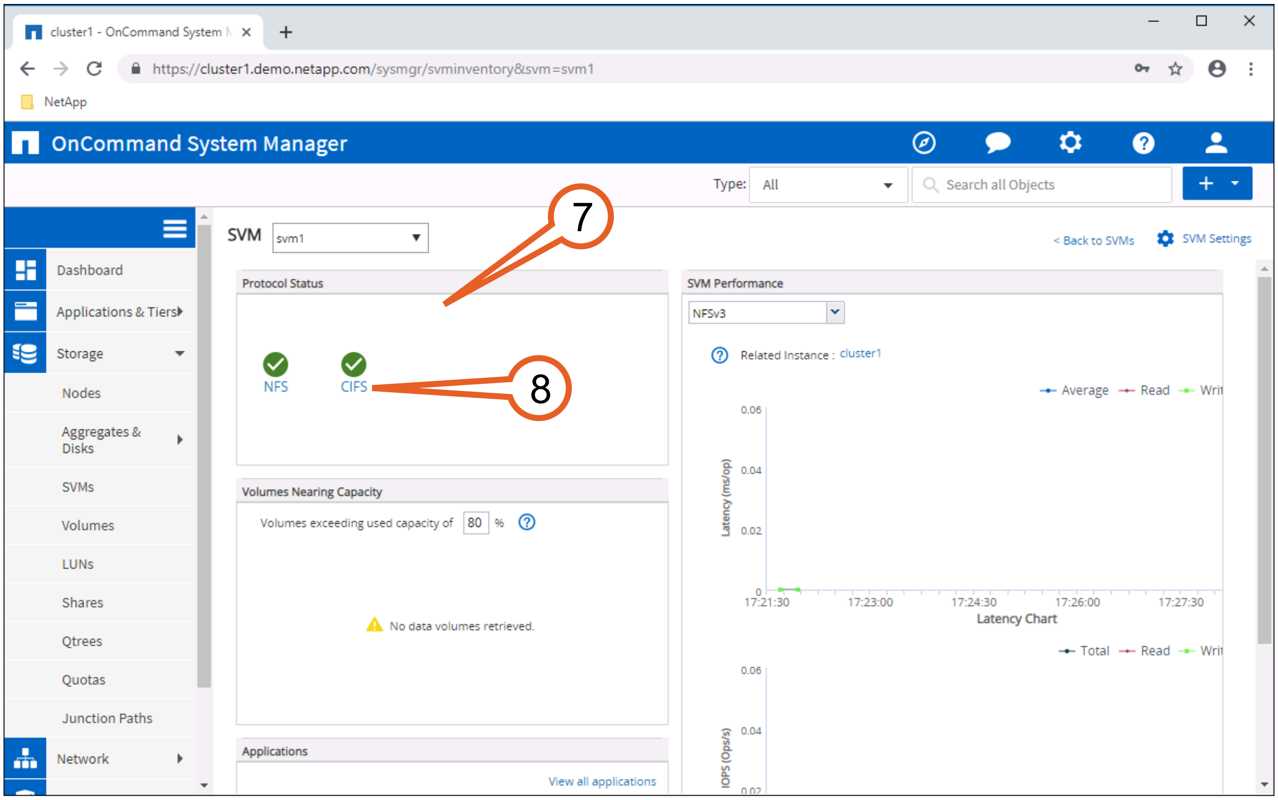

Figure 3-43:

The “SVM Settings” view opens, and displays the “Configuration” tab for the CIFS protocol.

9. Note that the Service Status field is listed as “Started”, which indicates that there is a running CIFS server for this SVM. If CIFS was not already running for this SVM, you could configure and start it using the **Setup** button found under the “Configuration” tab.

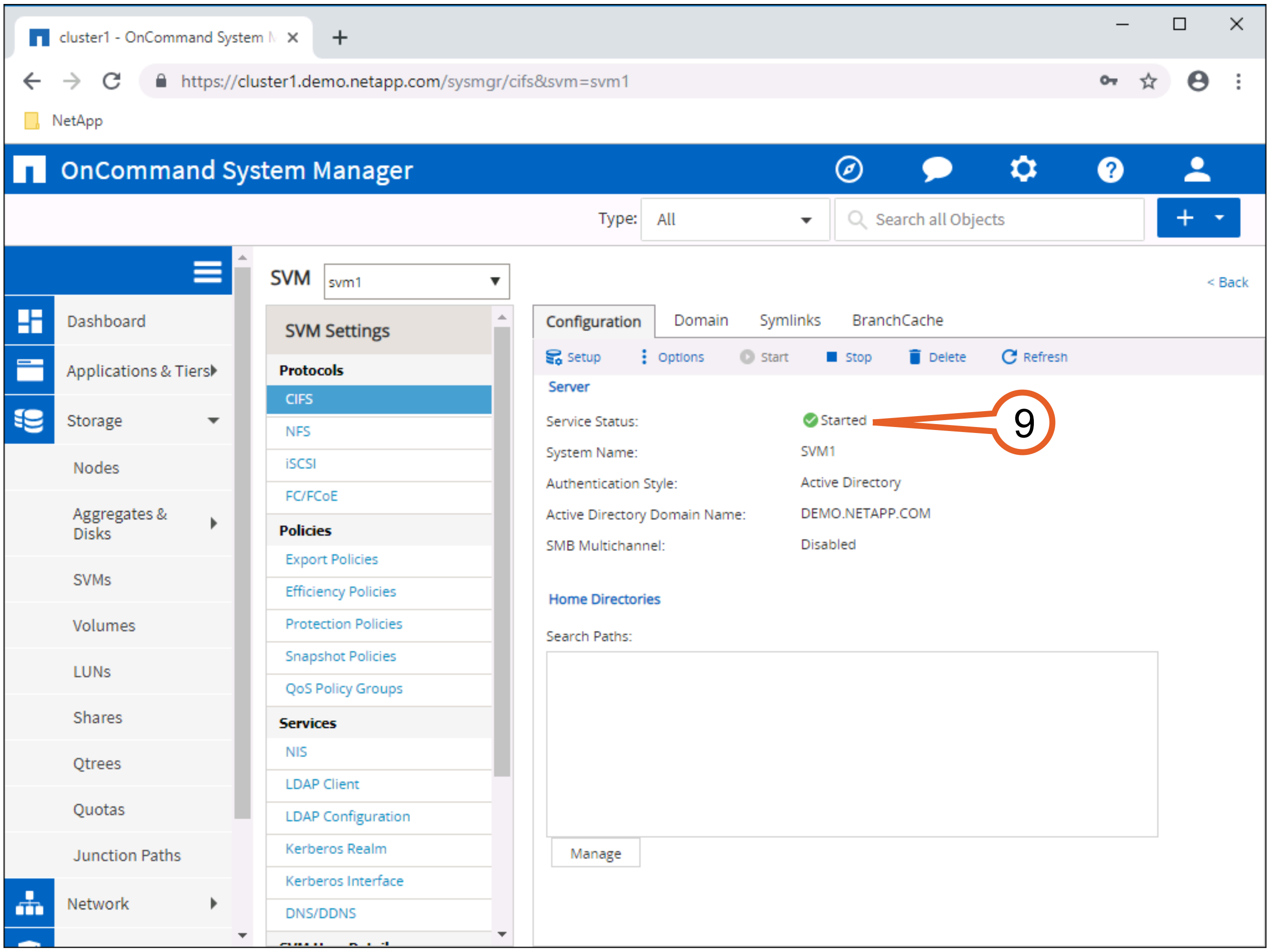

Figure 3-44:

Now check that NFS is enabled for your SVM.

10. In the “SVM Settings” pane, under the “Protocols” section, select **NFS**.
11. Notice that the NFS Server Status field shows as “Enabled”. You can use the **Enable** and **Disable** buttons on the pane's menu bar to place the NFS server online and offline if needed. Please leave NFS enabled for this lab.

12. NFS version 3 is enabled, but versions 4 and 4.1 are not. If you wanted to change this use the **Edit** button to do so, but for this lab NFS version 3 is sufficient.

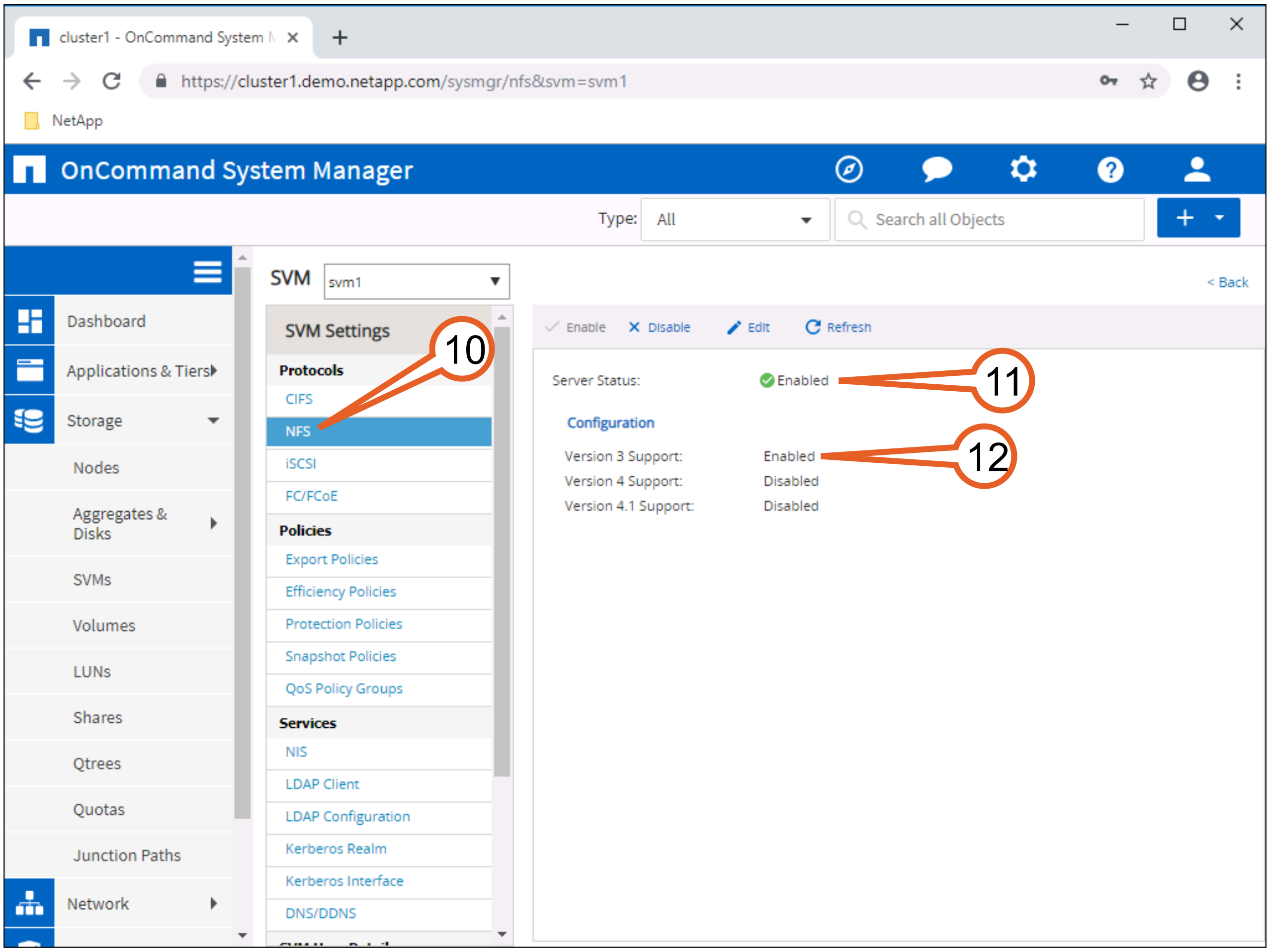

Figure 3-45:

At this point, you have confirmed that your SVM has a running CIFS server and a running NFS server. However, you have not yet configured those two servers to actually serve any data. The first step is to configure the SVM's default NFS export policy.

When you create an SVM that supports NFS, ONTAP automatically creates a default NFS export policy for that SVM. That default export policy contains an empty list of access rules, and without any access rules the policy will not allow clients to access any of the SVM’s exports. If you create an access rule in the default export policy now, then when you create and junction in new volumes later in this lab they will automatically be accessible to NFS clients. If any of this seems a bit confusing, don’t worry; the concept should become clearer as you work through this section and the next one.

13. In the “SVM Settings” pane, under the “Policies” section, select **Export Policies**.
14. In the “Policy” pane that now displays on the right, select the **default** policy.
15. Make sure the **Export Rules** tab at the bottom of the lower pane is selected.

16. In that lower pane, click **Add**.

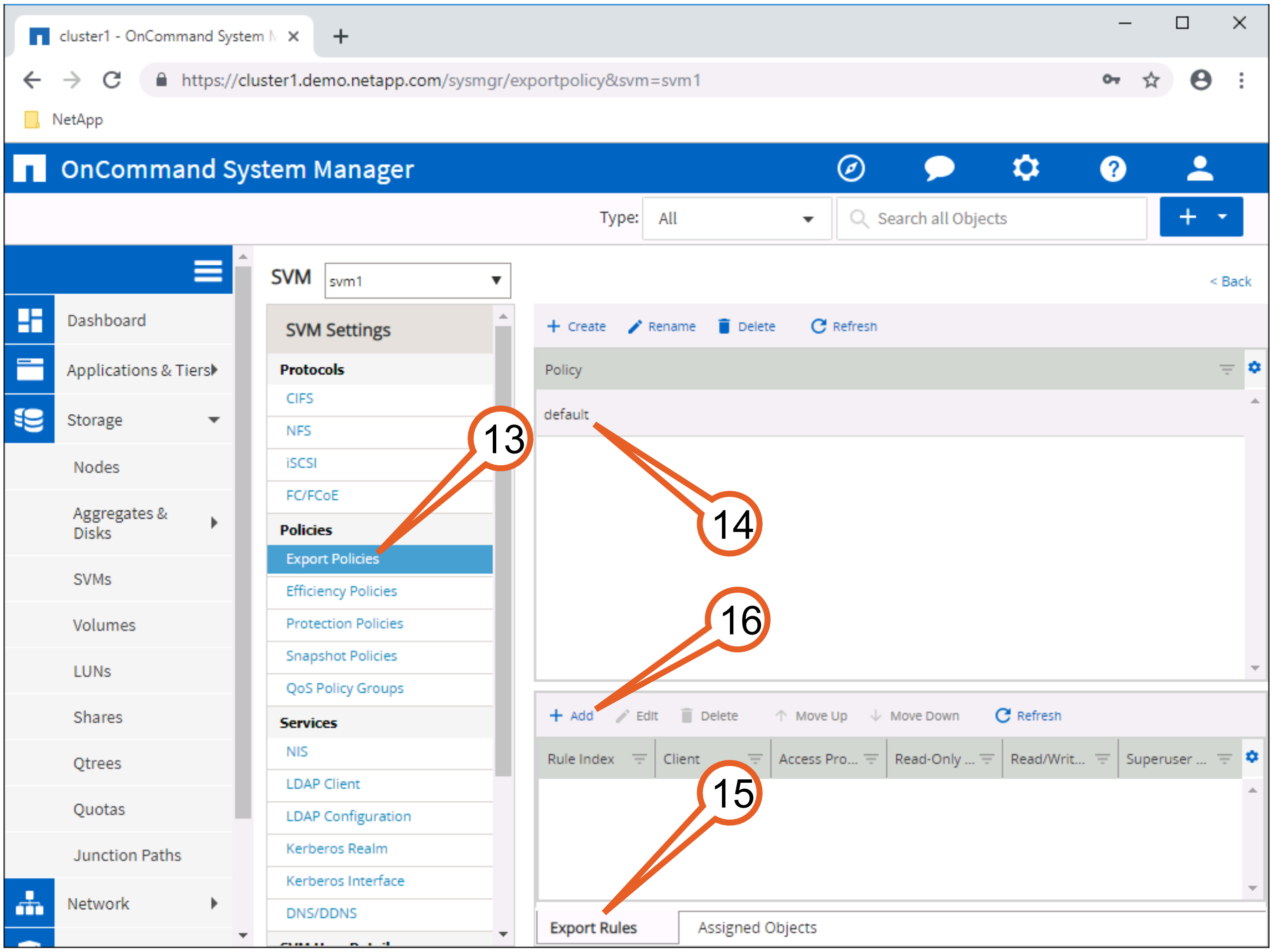

Figure 3-46:

The “Create Export Rule” dialog opens. Using this dialog you can create any number of rules that provide fine grained client access control, and specify their application order. For this lab, you are going to create a single rule that grants unfettered access to any host on the lab's private network.

17. Set the fields in this window as follows:

- “Client Specification”: `0.0.0.0/0`, which is equivalent to all clients.
- “Rule Index”: **1**
- “Access Protocols”: Check the **CIFS** and **NFS** checkboxes.

  The other defaults in this window grant clients full read/write access across all of the supported authentication mechanisms, and also permit UNIX superuser access.

18. Click **OK**.

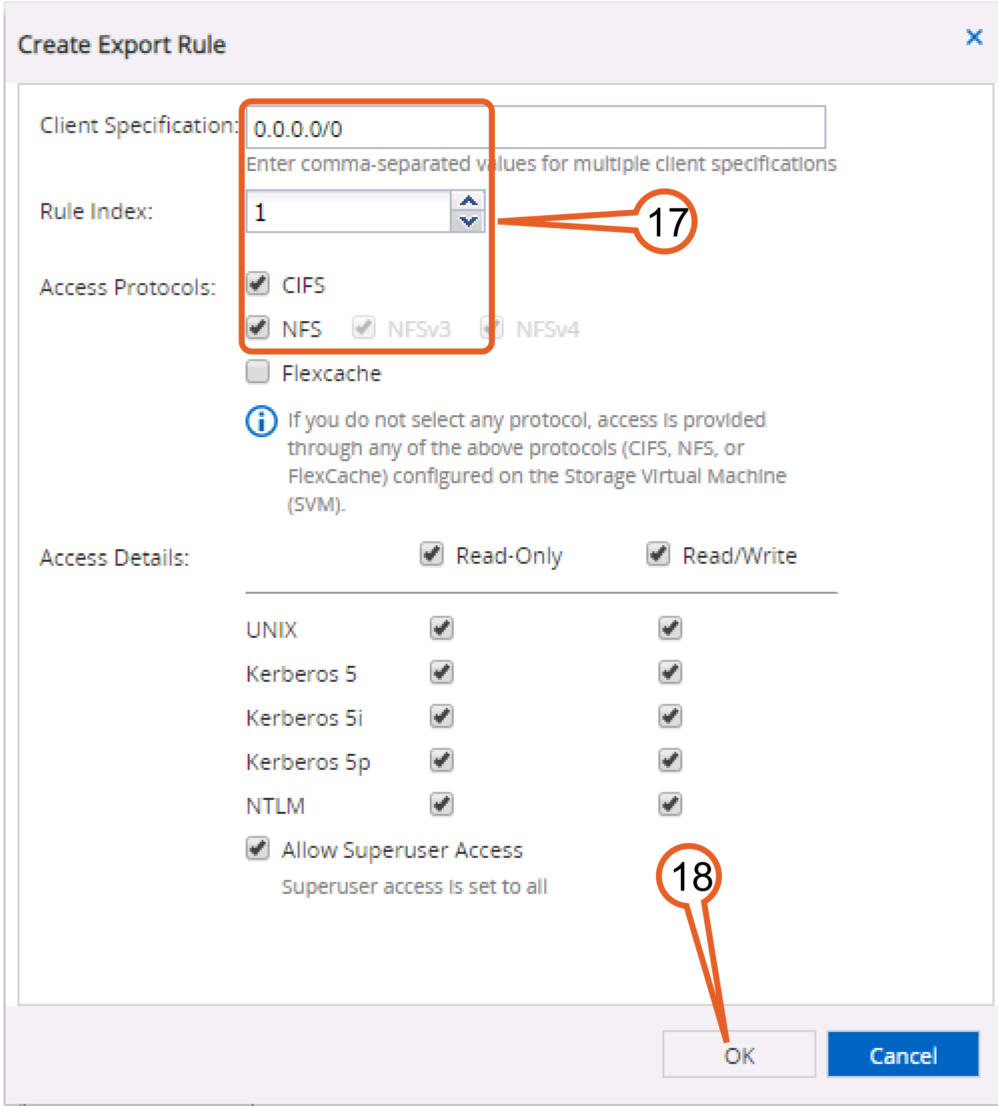

Figure 3-47:

The “Create Export Policy” dialog closes and focus returns to the “Export Policies” pane in System Manager.

19. The new access rule you created now appears in the bottom portion of the pane.

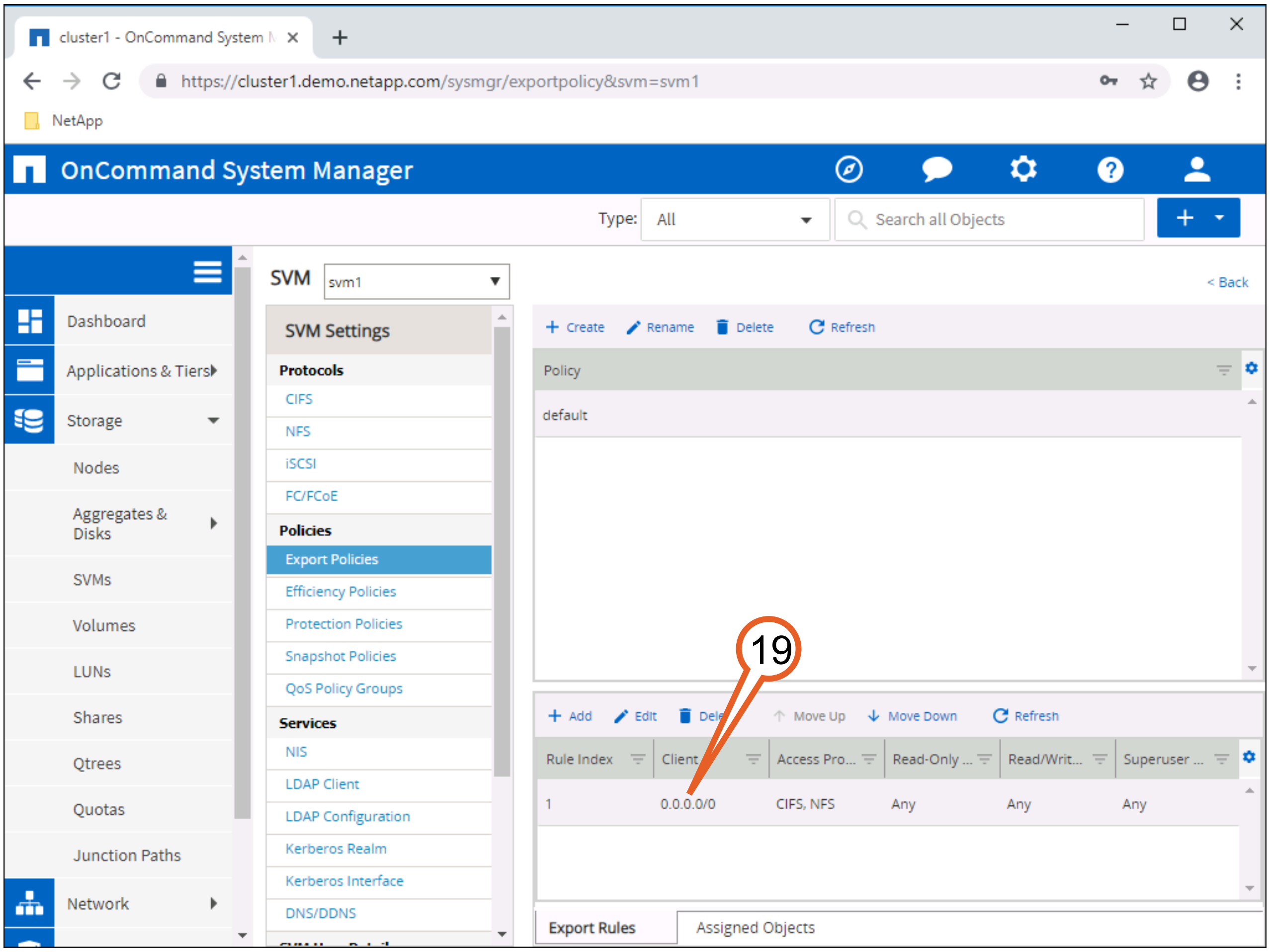

Figure 3-48:

With this updated default export policy in place, NFS clients are now able to mount the root of the svm1 SVM's namespace, and use that mount to access any volumes that you junction into the namespace.

Now create a CIFS share for the svm1 SVM. You are going to create a single share named “nsroot” at the root of the SVM's namespace.

20. In the left pane of System Manager, navigate to **Storage** > **Shares**.
21. In the right pane, make sure the “Shares on SVM” dropdown is set to **svm1**.

22. Click **Create Share**.

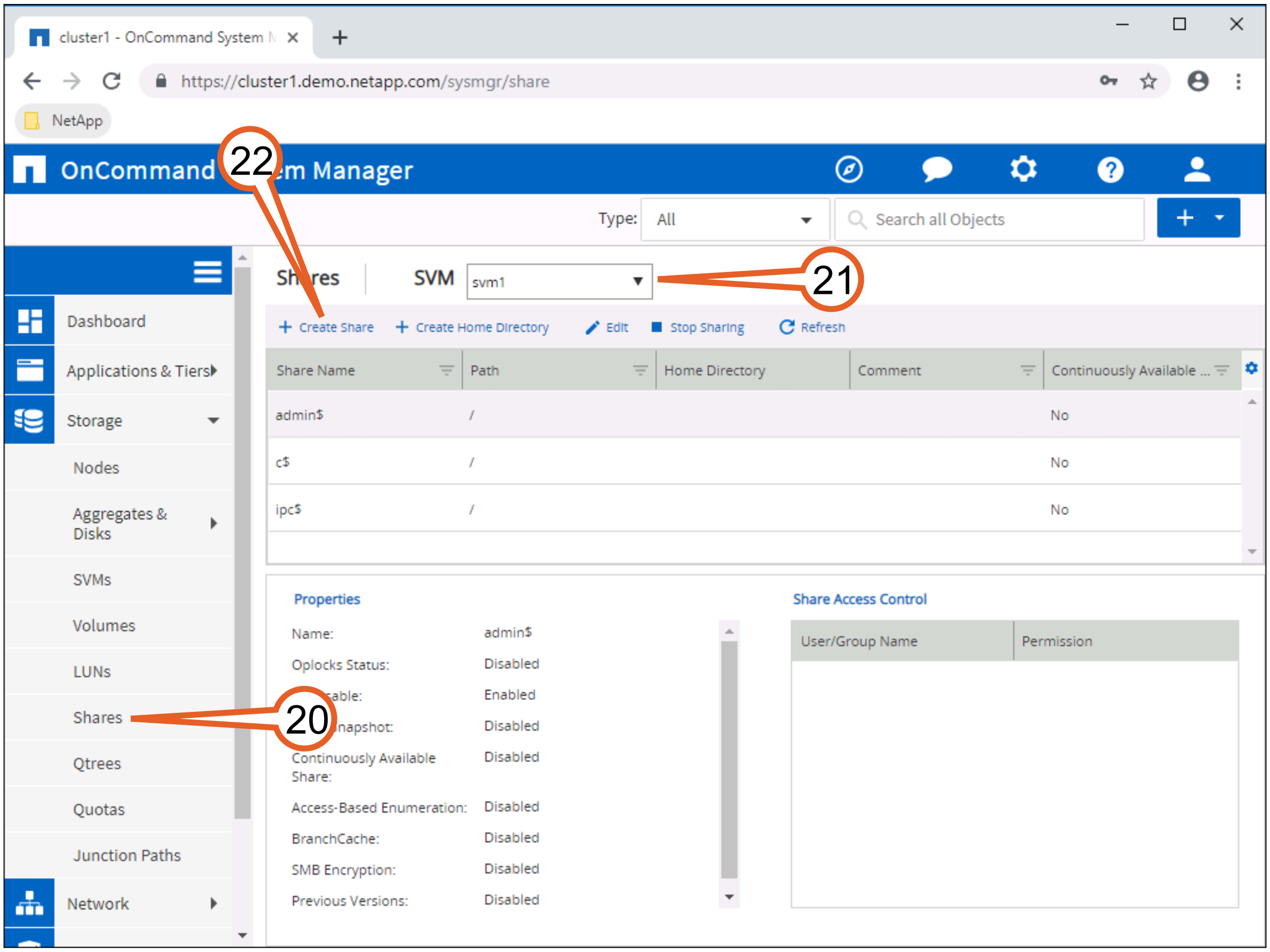

Figure 3-49:

The “Create Share” dialog box opens.

23. Set the fields in this window as follows:

- “Folder to Share”: `/`

  Tip: Alternately, If you opt to use the **Browse** button, in the “Browse For Folder” dialog, make sure you select the **“/”** folder.

- “Share Name”: **`nsroot`**

24. Click the **Create** button.

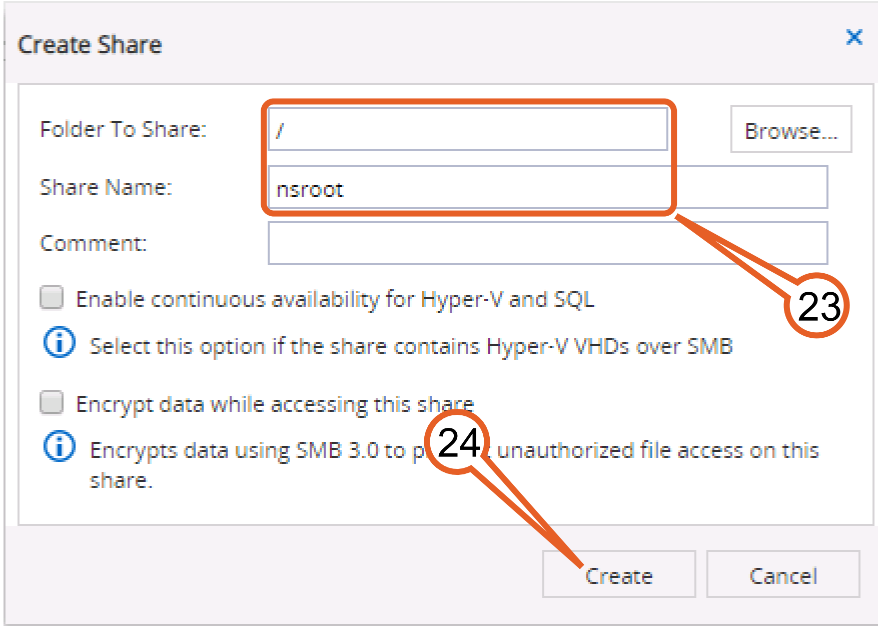

Figure 3-50:

The “Create Share” dialog closes, and focus returns to “Shares” pane in System Manager. The new “nsroot” share now shows up in the list of shares, but you must also set the share permissions.

25. Select **nsroot** from the list of shares.

26. Click the **Edit** button to edit the share's settings.

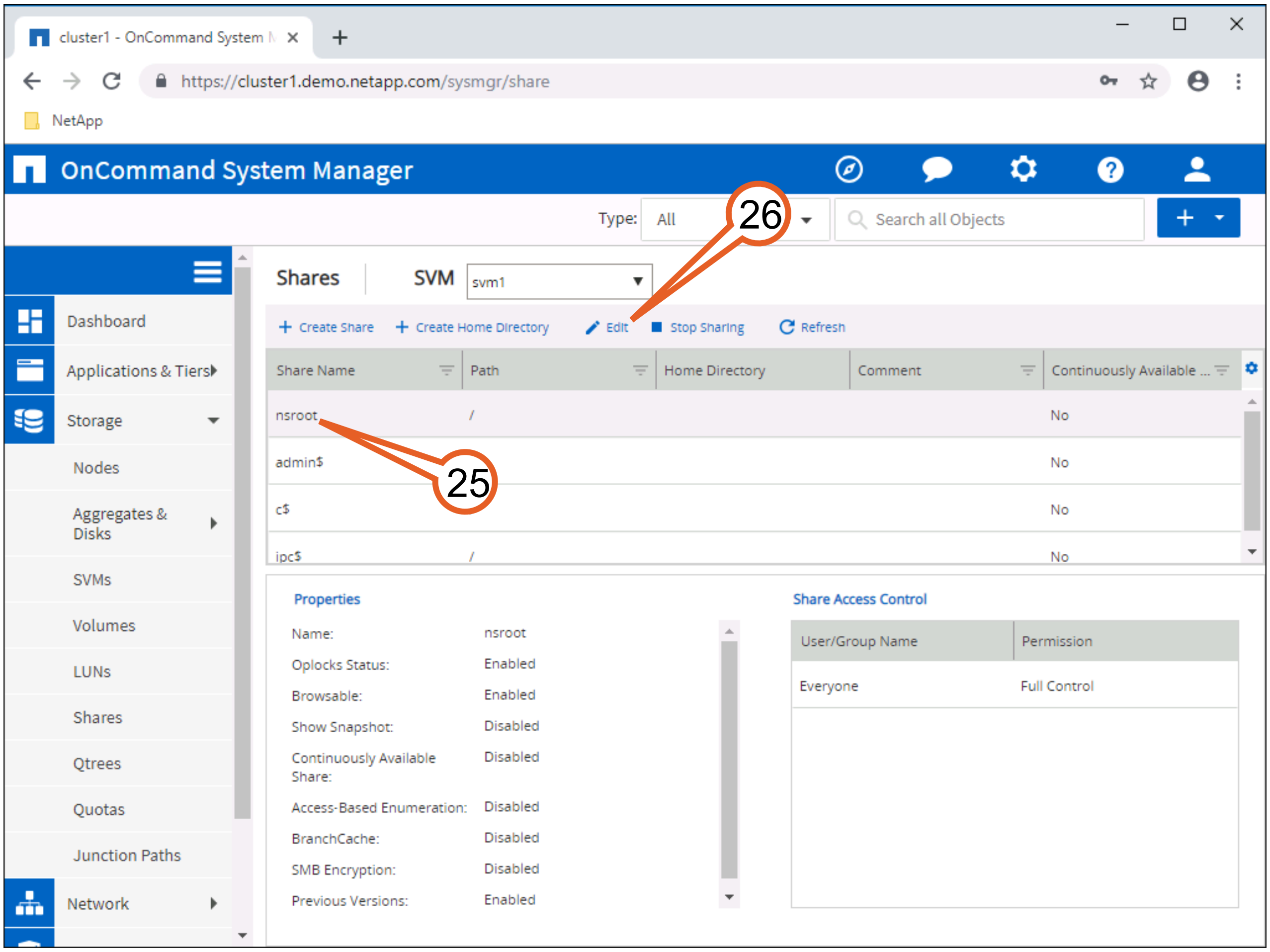

Figure 3-51:

The “Edit nsroot Settings” dialog opens.

27. Select the **Permissions** tab.

28. When you create a share, the default permissions are set to grant “Everyone” **Full Control**. You can set more detailed permissions on the share from this tab, but this configuration is sufficient for the exercises in this lab.

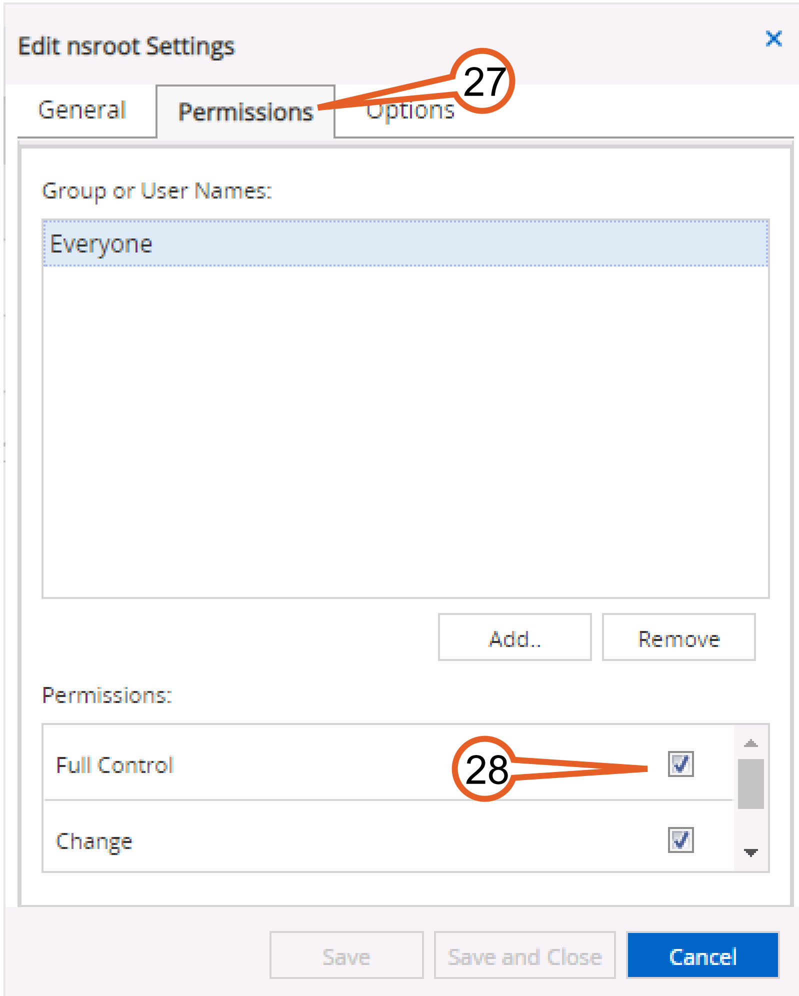

Figure 3-52:

There are other settings to check in this window, so do not close it yet.

29. Click the **Options** tab.
30. Set the radio button in the “Symbolic Links” section to **Symlinks**. This setting enables SMB clients to follow UNIX symbolic links that point within the share.
31. Ensure that the following checkboxes are selected: **Enable Oplocks**, **Browsable**, **Notify Change**, and **Show previous versions**. All other check boxes should be cleared.

32. If you had to change any of the settings listed on the previous screen then the **Save and Close** button will become active, and you should click it. Otherwise, click the **Cancel** button.

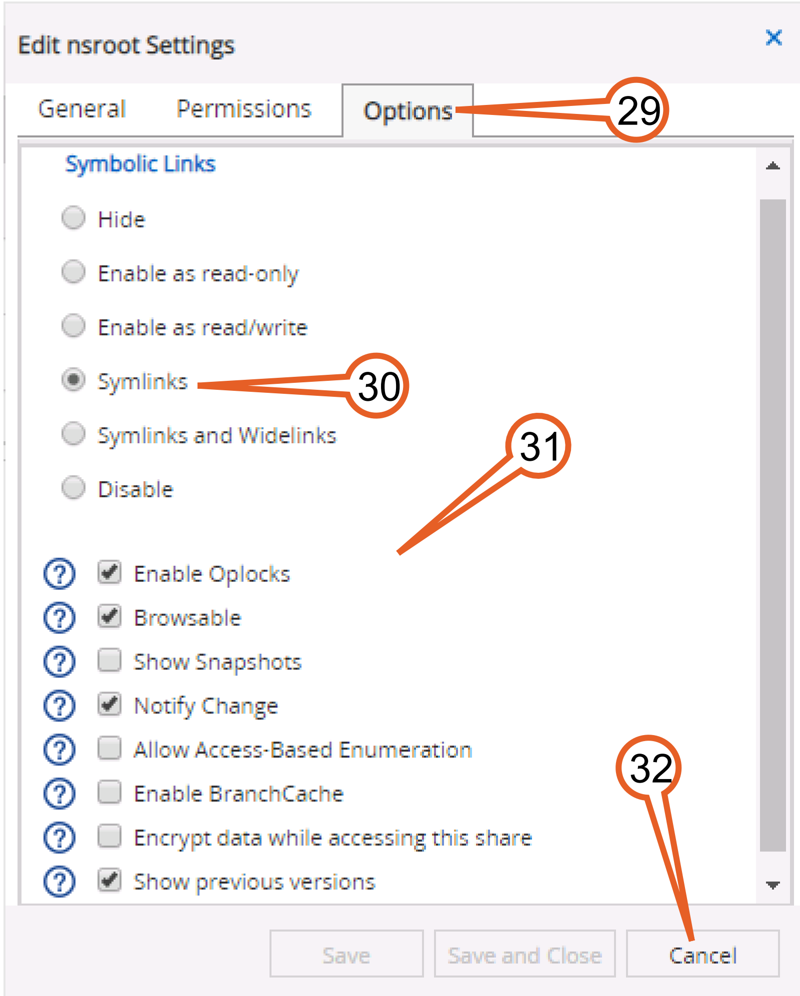

Figure 3-53:

The “Edit nsroot Settings” dialog closes, and focus returns to the “Shares on svm1” pane in System Manager. Setup of the “\\svm1\nsroot” CIFS share is now complete.

For this lab you have created just one share at the root of your namespace that allows clients to access through that share to any volume mounted in the namespace in ONTAP. The advantage of this approach is that it reduces the number of mapped drives that you have to manage on your clients; any changes you make to the namespace, such as adding/removing volumes or changing junction locations, become instantly visible to your clients. If you prefer to use multiple shares then ONTAP allows you to create additional shares rooted at any directory level within the namespace.

3.2.2.3 Username Mapping Exercise

Since you have configured your SVM to support both NFS and CIFS, you next need to set up username mapping so that the UNIX “root” accounts and the Windows “DEMO\Administrator” account will have synonymous access to each other's files. Setting up such a mapping may not be desirable in all environments, but it will simplify data sharing for this lab (since these are the two primary accounts you are using in this lab).

1. In the left pane of System Manager, navigate to **Storage** > **SVMs**.
2. Select the entry for **“svm1”**.

3. Click **SVM Settings**.

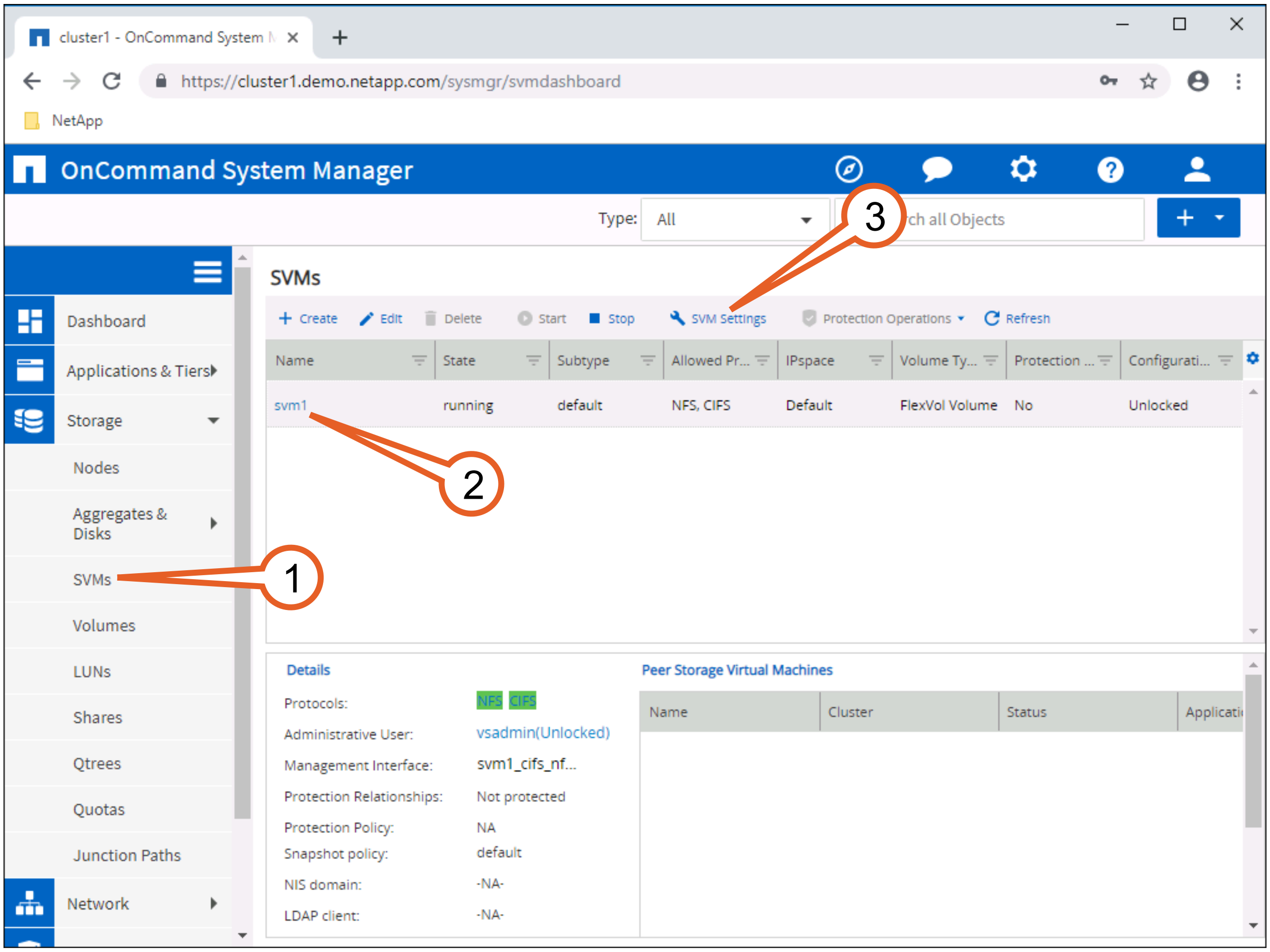

Figure 3-54:

The “SVM Settings” pane appears.

4. Make sure you are viewing the correct “SVM Settings” context by verifying that the SVM dropdown menu at the top of the pane is set to **svm1**.
5. In the “SVM Settings” navigation pane, scroll down to the “Host Users and Groups” section.
6. Click **Name Mapping**.

7. In the right pane, click **Add**.

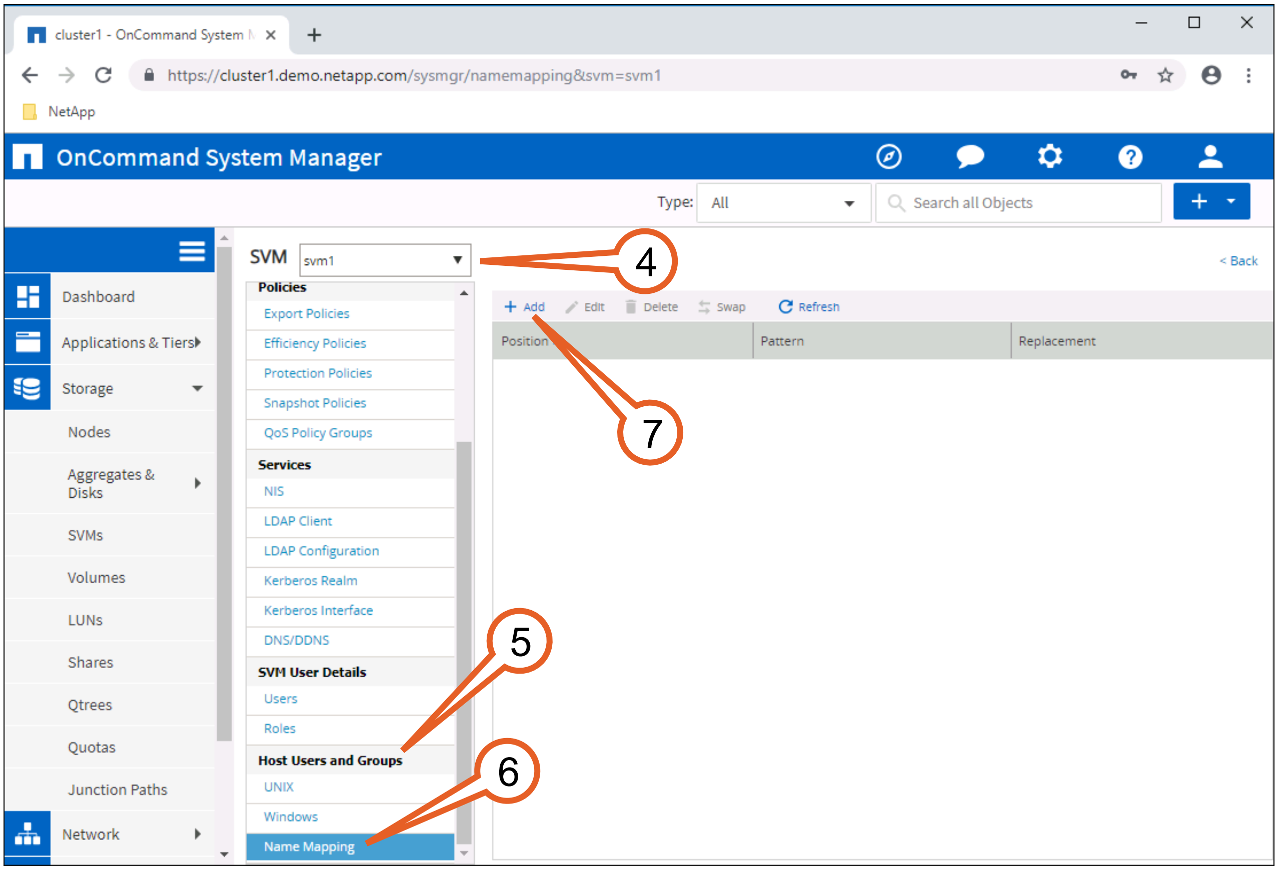

Figure 3-55:

The “Add Name Mapping Entry” dialog opens.

8. Set the fields in this window as follows:

- “Direction”: **Windows to UNIX**
- “Position”: **1**
- “Pattern”: **`demo\\administrator`**

Note: The two backslashes listed here is not a typo, and “administrator” should be lower case.

- “Replacement”: **`root`**

9. Click **Add**.

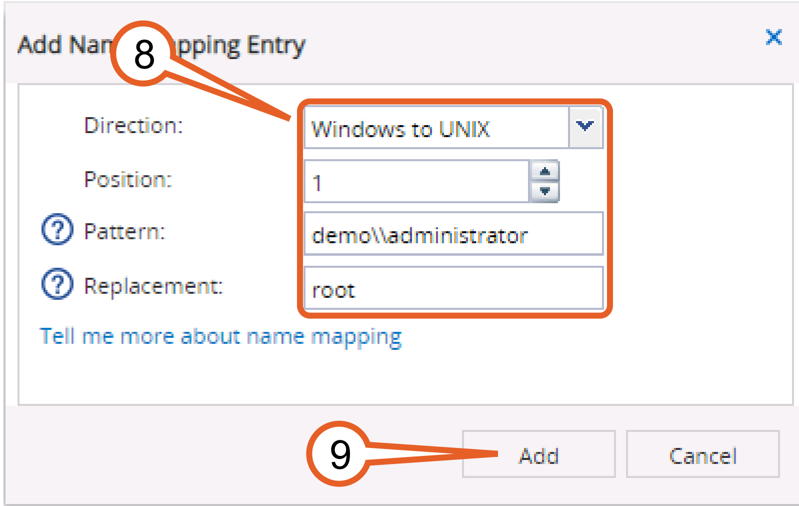

Figure 3-56:

The “Add Name Mapping Entry” dialog closes and focus returns to the “Name Mapping” pane in System Manager.

10. Click the **Add** button again to create another mapping rule.

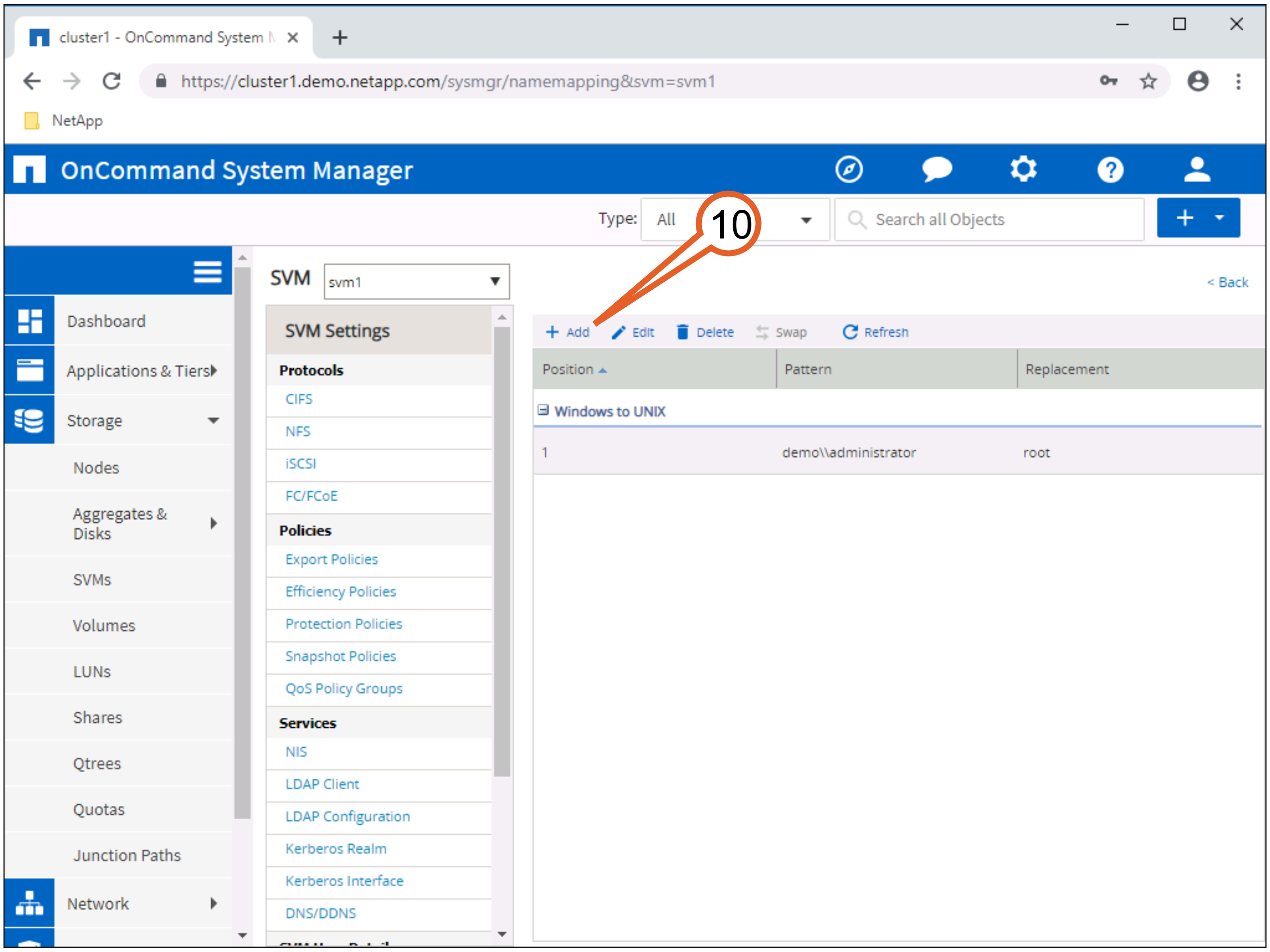

Figure 3-57:

The “Add Name Mapping Entry” dialog opens.

11. Set the fields in this window as follows:

- “Direction”: **UNIX to Windows**
- “Position”: **1**
- “Pattern”: **`root`**
- “Replacement”: **`demo\\administrator`**

Note: The two backslashes listed here is not a typo, and “administrator” should be lower case.

12. Click **Add**.

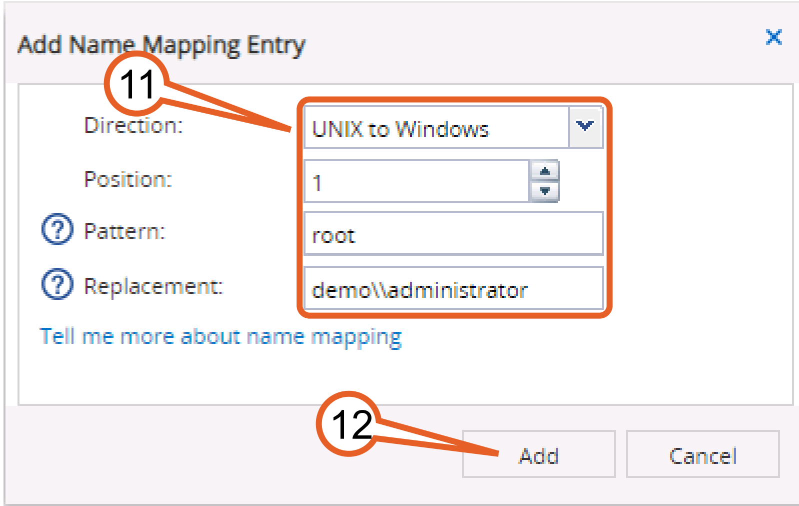

Figure 3-58:

The second “Add Name Mapping Entry” dialog closes, and focus again returns to the “Name Mapping” pane in System Manager.

13. You should now see two mappings listed in this pane that together make the “root” and “DEMO \Administrator” accounts equivalent to each other for the purpose of file access within the SVM.

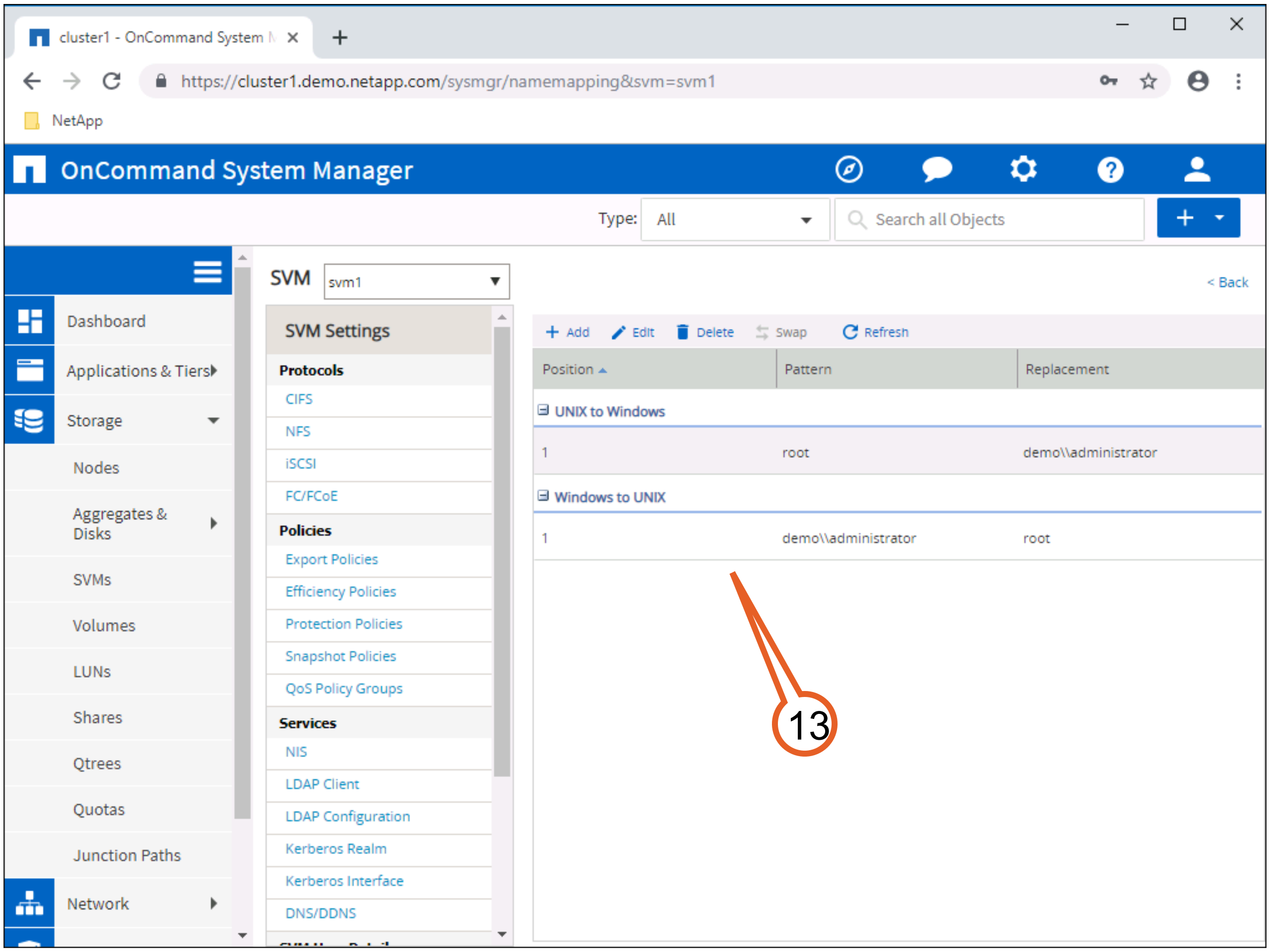

Figure 3-59:

3.2.3 Create a Volume and Map It to the Namespace

The Configure CIFS and NFS section discussed the concepts related to namespaces, so that information will not be repeated here.

3.2.3.1 Volume Concepts

Volumes, or FlexVols, are the dynamically sized containers used by ONTAP to store data. A volume only resides in a single aggregate at a time, but any given aggregate can host multiple volumes. Unlike an aggregate, which can associate with multiple SVMs, a volume can only associate to a single SVM. The maximum size of a volume can vary depending on what storage controller model is hosting it.

An SVM can host multiple volumes. While there is no specific limit on the number of FlexVols that can be configured for a given SVM, each storage controller node is limited to hosting no more than 1000 FlexVols, and there are higher cluster-wide maximums as well. Depending on the number of nodes in your cluster, the controller models, and the protocol mix (NAS vs. SAN) of the volumes, a given cluster will have a supported maximum of 1000 to 12,000 FlexVols.

Each storage controller node has a root aggregate (e.g., aggr0_<nodename>) that contains the node's ONTAP operating system.

Important: Do not use the node's root aggregate to host any other volumes or user data; always create additional aggregates and volumes for that purpose.

ONTAP FlexVols support a number of storage efficiency features including thin provisioning, deduplication, and compression. One specific storage efficiency feature you will see in this section of the lab is thin provisioning, which dictates how space for a FlexVol is allocated in its containing aggregate.

When you create a FlexVol with a volume guarantee of type “volume” you are thickly provisioning the volume, pre-allocating all of the space for the volume on the containing aggregate, which ensures that the volume will never run out of space unless the volume reaches 100% capacity.

When you create a FlexVol with a volume guarantee of “none” you are thinly provisioning the volume, which directs ONTAP to only allocate space in the aggregate for the volume as data is added to the volume. Thin provisioning allows you to increase your overall space utilization, and even oversubscribe an aggregate by allocating more volumes on it than the aggregate could actually accommodate if all those volumes reached their full size at the same time. If an oversubscribed aggregate does fill up, then all of its volumes will run out of space before they reach their maximum volume size, likely resulting in a service disruption. If you choose to oversubscribe an aggregate you should regularly monitor aggregate and volume space utilization so you can head off unanticipated growth before it might cause a problem.

3.2.3.2 Create and Map a Volume Exercise

In this lab activity you create a new volume for the “svm1” SVM. That volume will be thinly provisioned, hosted on the “aggr1_cluster1_01” aggregate, named “engineering”, and mounted in the namespace as “/engineering”. You will also create a volume named “eng_users” and mount it in the namespace as “/engineering/users”.

1. In the left pane of System Manager, navigate to **Storage** > **Volumes**.
2. Make sure the “Volumes on SVM” dropdown is set to **svm1**.

3. Click **Create** > **Create FlexVol** to launch the Create Volume wizard.

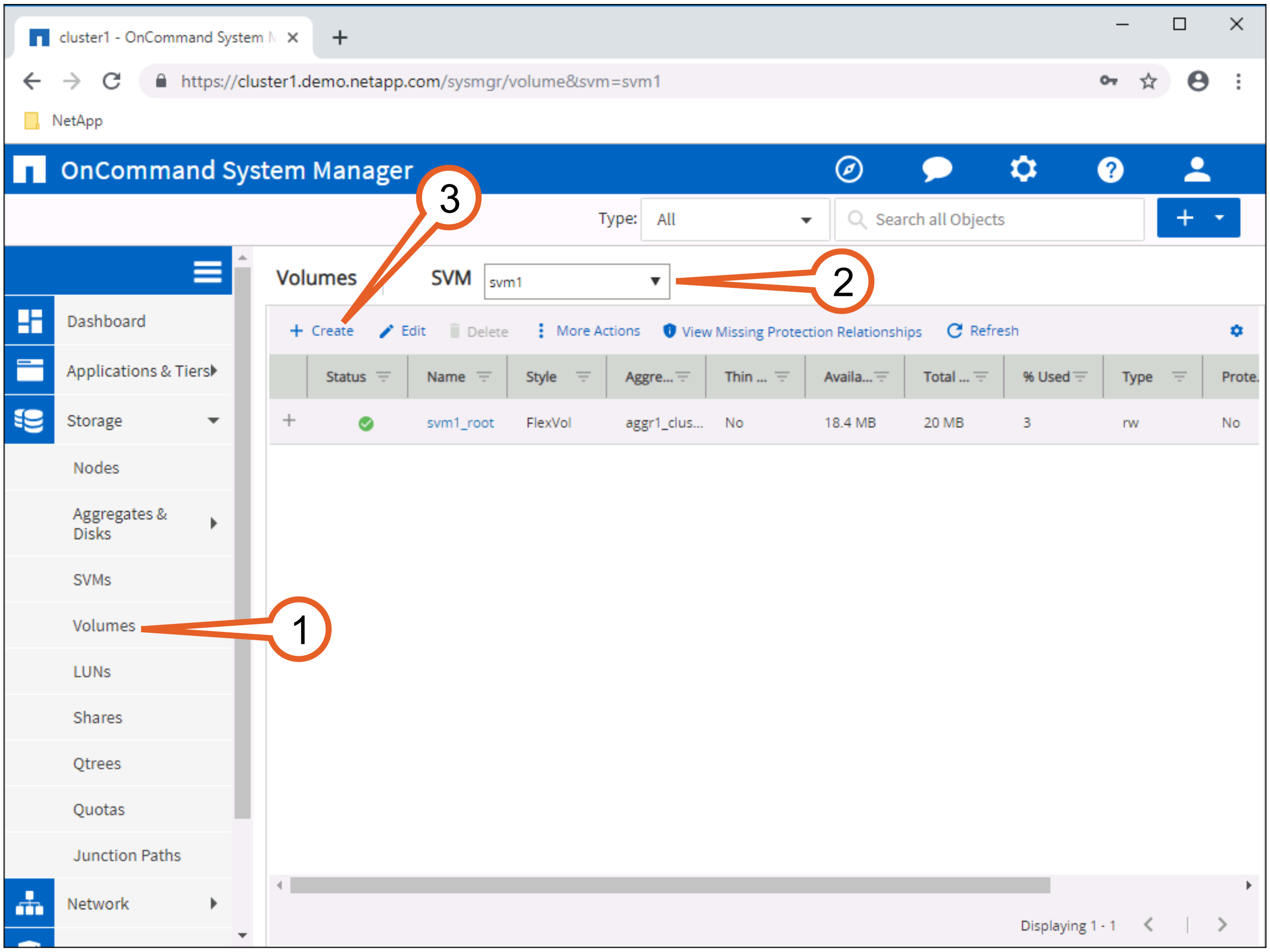

Figure 3-60:

The “Create Volume” dialog opens.

4. Populate the fields in the window as follows:
   - "Name": **`engineering`**
   - "Aggregate": Click **Choose**

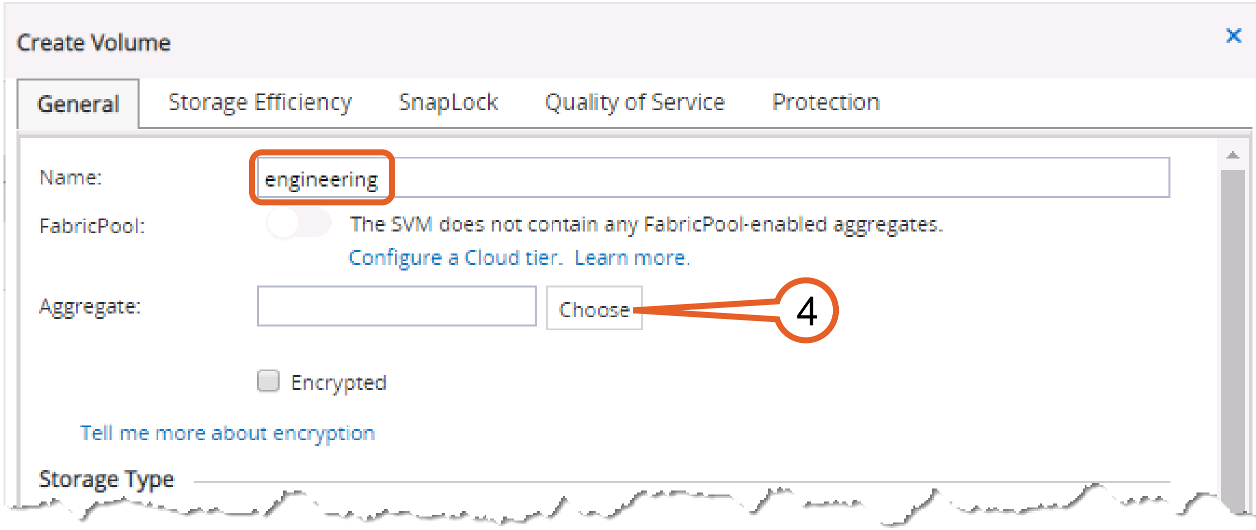

Figure 3-61:

The "Select Aggregate" dialog opens.

5. In the aggregate list, select **aggr1_cluster1_01**.
6. Click **OK**.

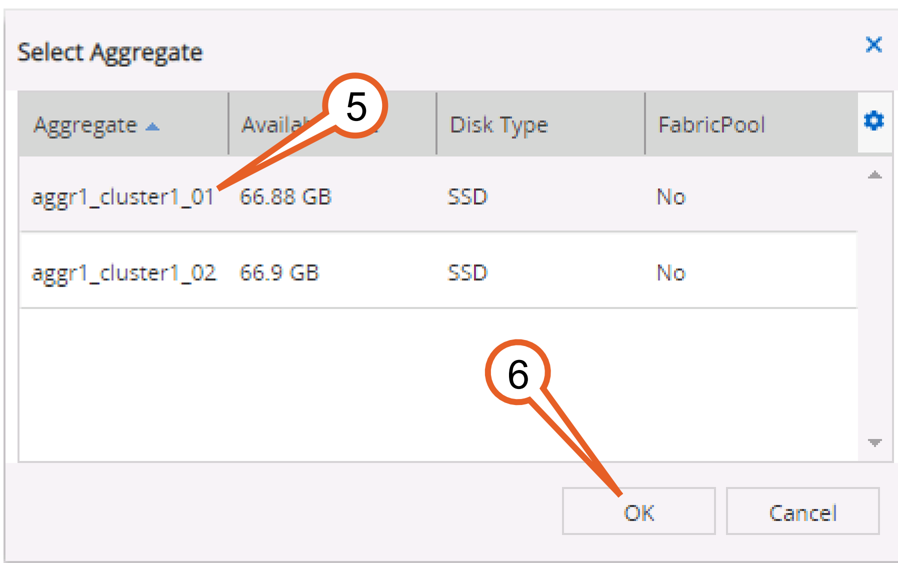

Figure 3-62:

The "Select Aggregate"dialog closes, and focus returns to the "Create Volume" dialog.

7. Set the fields in this window as follows:
   - "Storage Type": **NAS**
   - "Total Size:" **`10 GB`**
   - "Space Reserve (optional)": **Thin Provisioned**.

Leave the other values at their defaults.

8. Click **Create** .

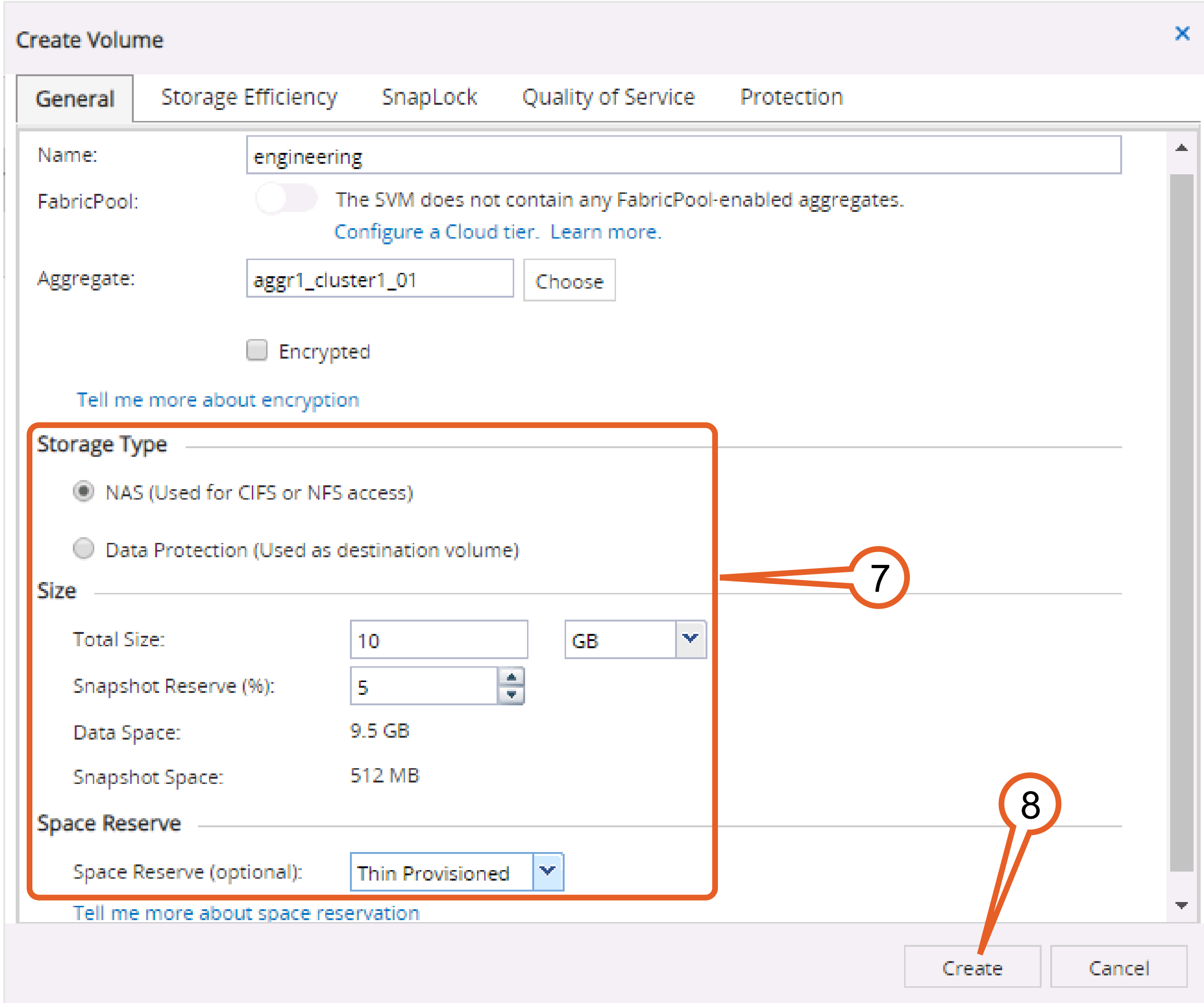

Figure 3-63:

The “Create Volume” dialog closes, and focus returns to the “Volumes” pane in System Manager.

9. The newly created engineering volume now appears in the Volumes list. Expand the entry for the volume.
10. The volume is 10 GB in size.
11. The volume is thin provisioned.

12. The graphics in the “Overview” section provide a visual summary of the volume’s space utilization, data protection status, and performance metrics.

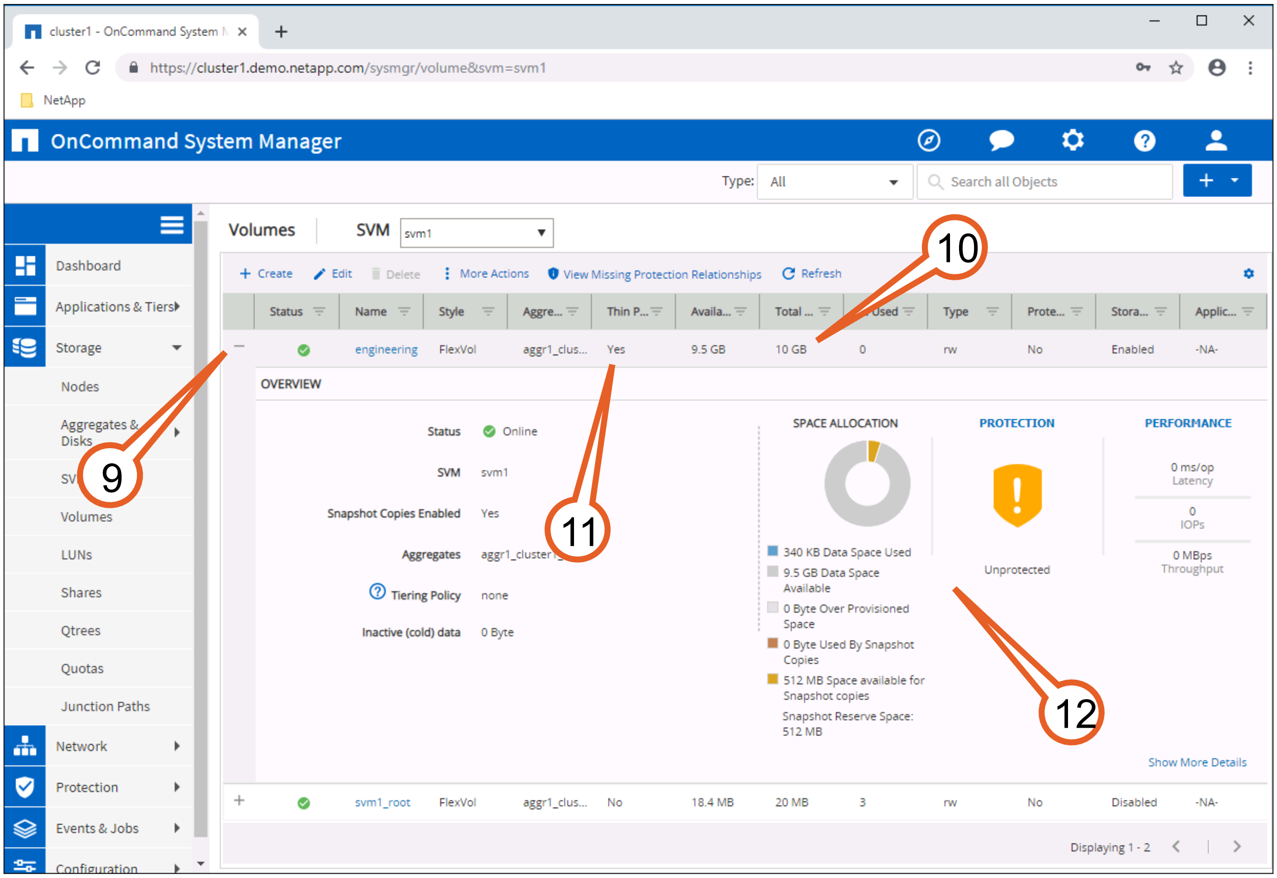

Figure 3-64:

13. In the left pane, navigate to **Storage** > **Junction Paths**.
14. Select **svm1** from the “Junction Path on SVM” drop-down menu.
15. Select the entry for the **engineering** Storage Object..

16. Notice that ONTAP automatically junctioned in the engineering volume under the root of the SVM's namespace, and that this volume has inherited the default NFS Export Policy.

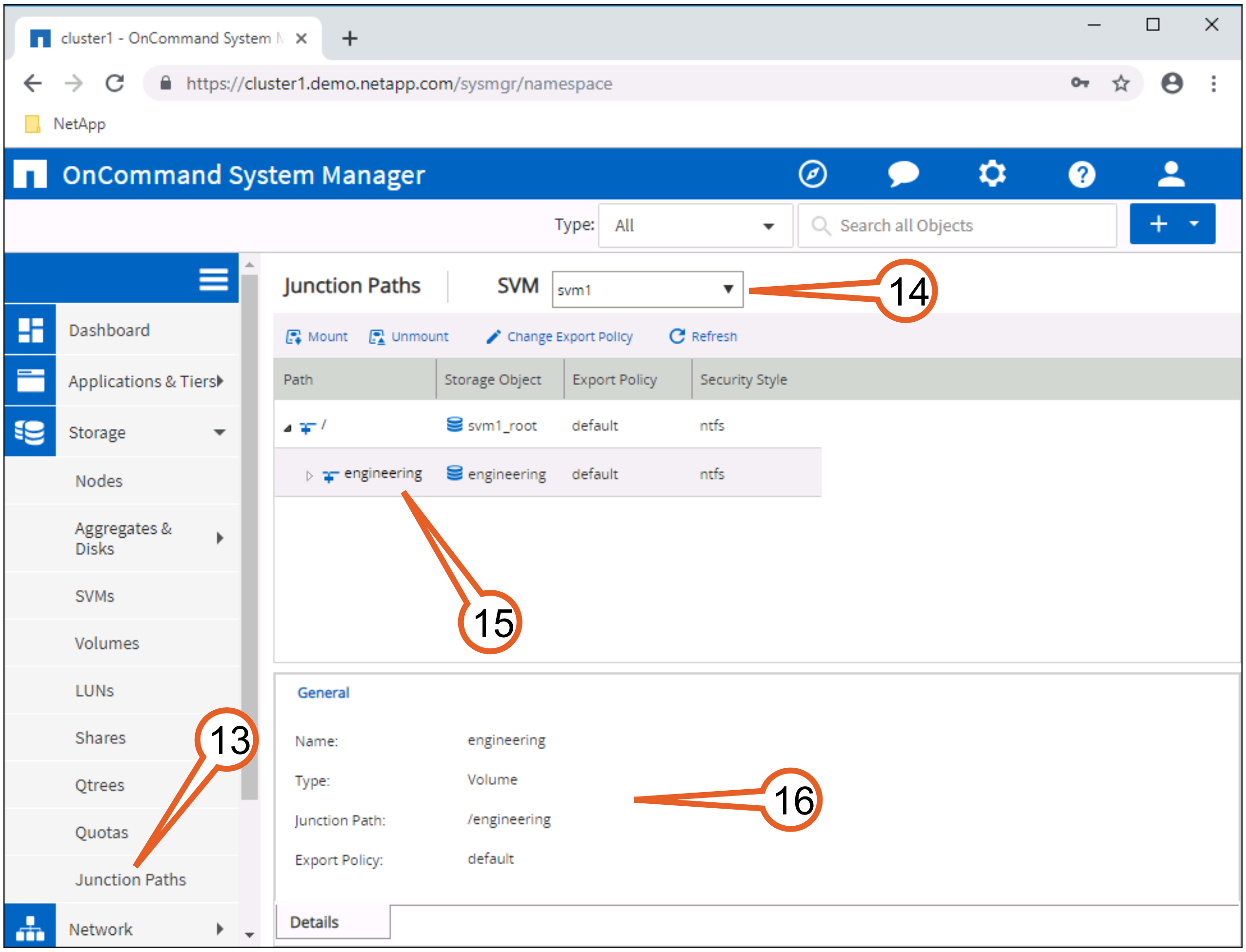

Figure 3-65:

Since you have already configured the access rules for the default policy, the volume was instantly accessible to NFS clients as soon as it was junctioned in. As you can see in the preceding screenshot, the engineering volume was junctioned as “/engineering”, meaning that any client that had mapped a share to \\svm1\nsroot or NFS mounted svm1:/ would now instantly see the engineering directory in the respective share and NFS mount.

Now create a second volume.

17. In the left pane, navigate back to **Storage** > **Volumes**.
18. Verify that **svm1** is selected in the “Volumes on SVM” drop-down menu.

19. Click **Create** > **Create FlexVol** to launch the Create Volume wizard.

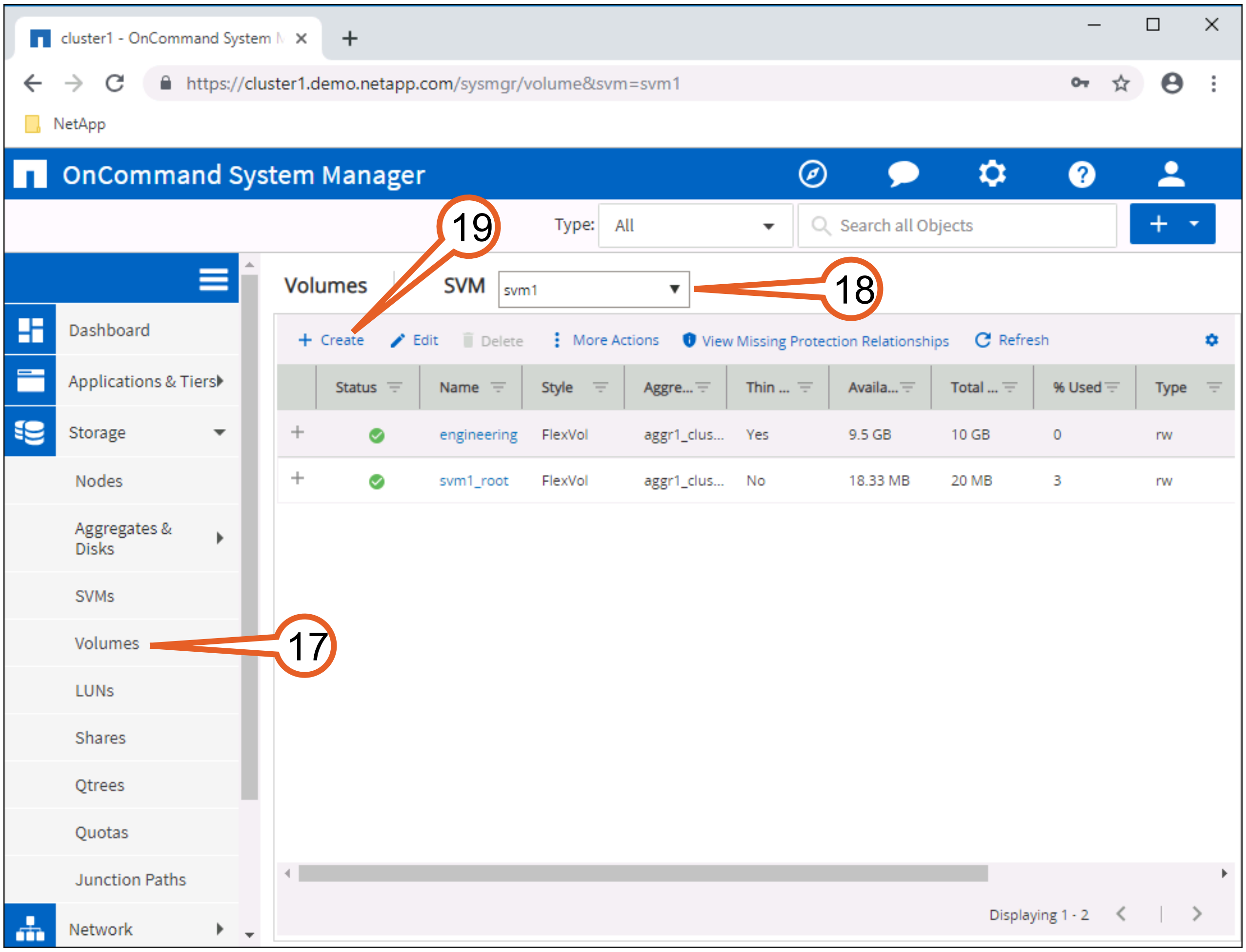

Figure 3-66:

The “Create Volume” window opens.

20. Populate the following values into the data fields in the window:

- “Name:” **`eng_users`**
- “Aggregate”: **`aggr1_cluster1_01`**
- “Storage Type”: **NAS**
- “Total Size”: **`10 GB`**
- “Space Reserve (optional)”: **Thin Provisioned** .

Leave the other values at their defaults.

21. Click **Create**.

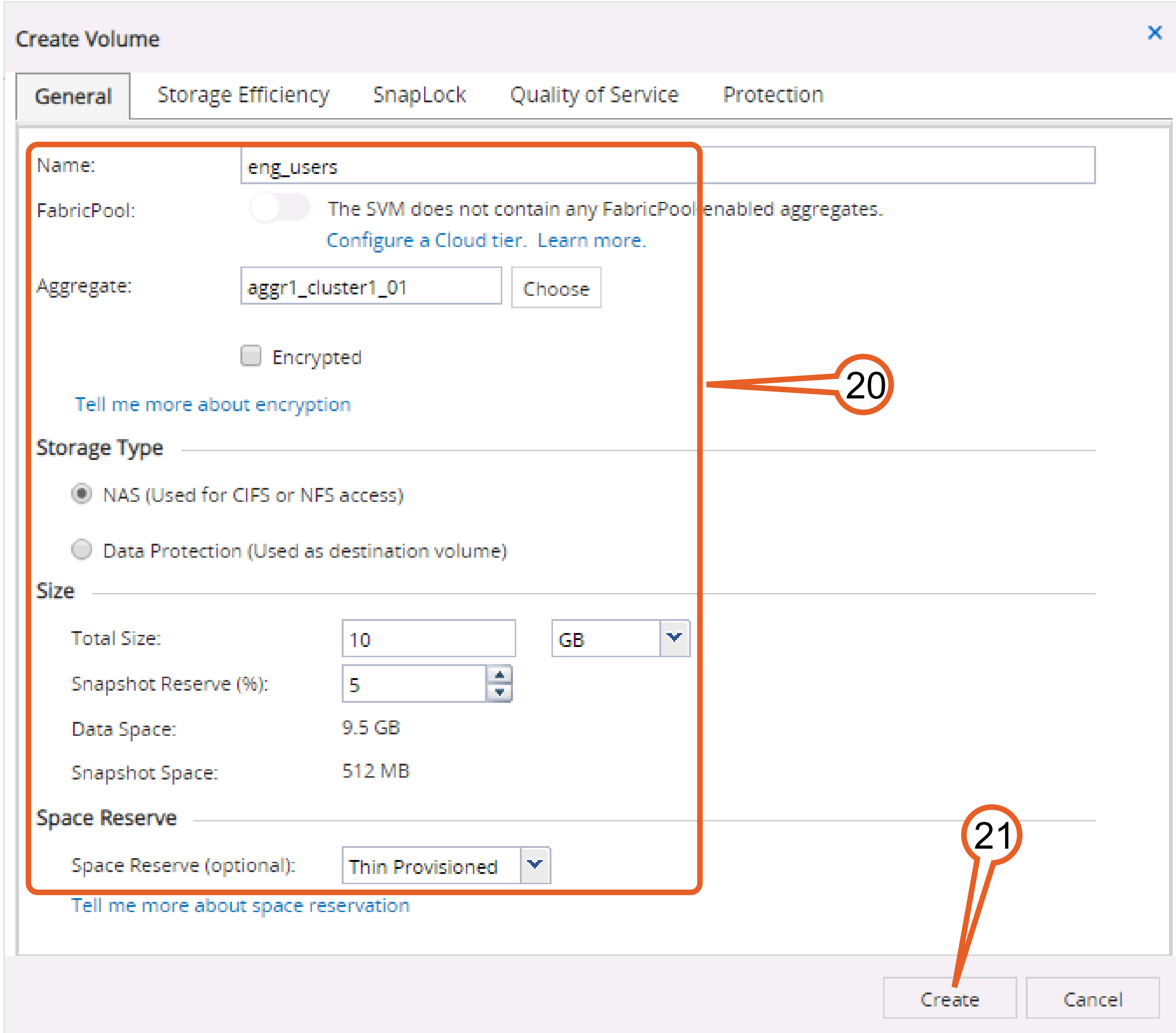

Figure 3-67:

The “Create Volume” dialog closes, and focus returns again to the “Volumes” pane in System Manager. The newly created “eng_users” volume should now appear in the Volumes list.

22. Expand the entry for the **eng_users** volume in the volumes list.

23. In the “OVERVIEW” section, click **Show More Details**.

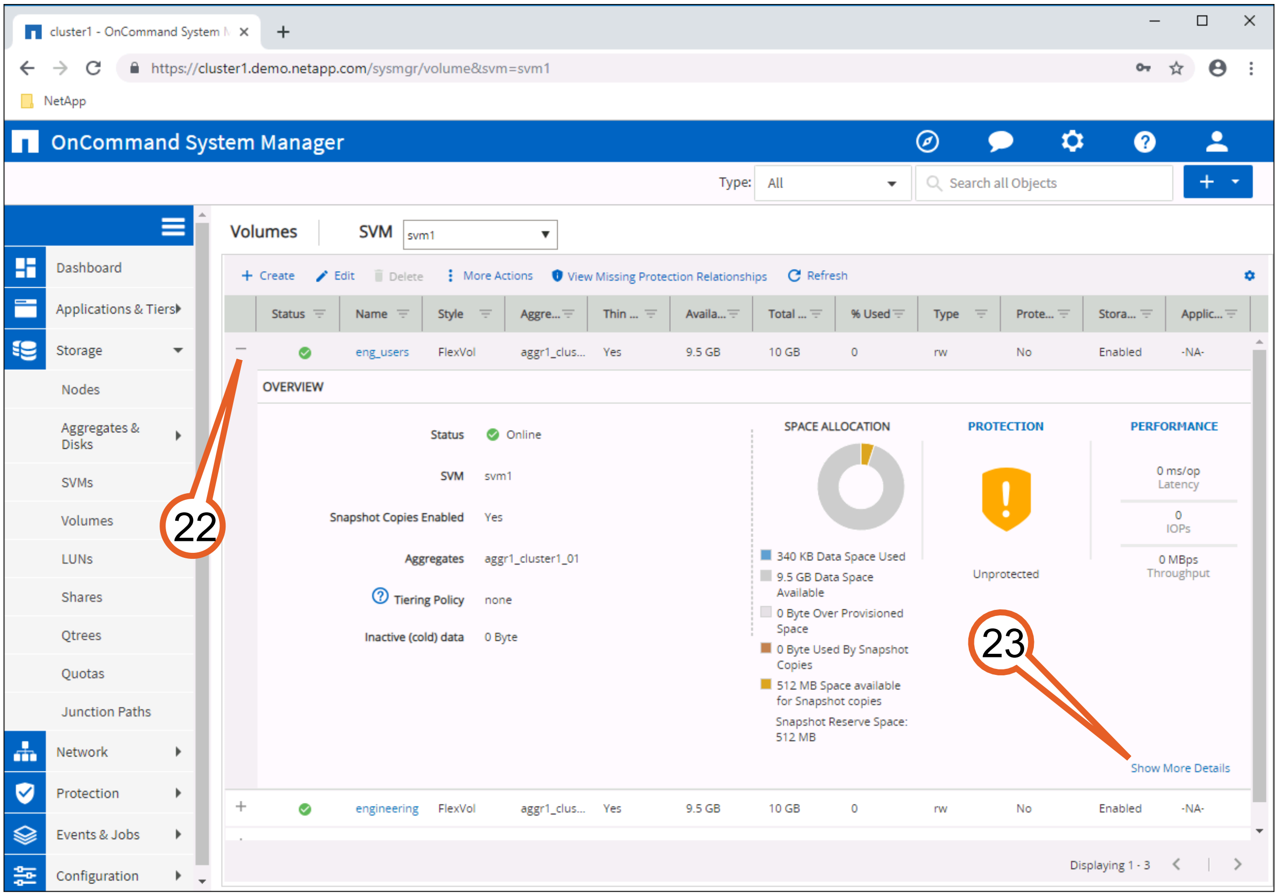

Figure 3-68:

The “Volume: eng_users” page displays.

24. Click the **Overview** tab.

25. Examine the details for this volume shown on this tab. Specifically, note that this volume has a “Junction Path” value of “/eng_users”.

26. Click **< Back to All Volumes** to return to the Volumes summary page.

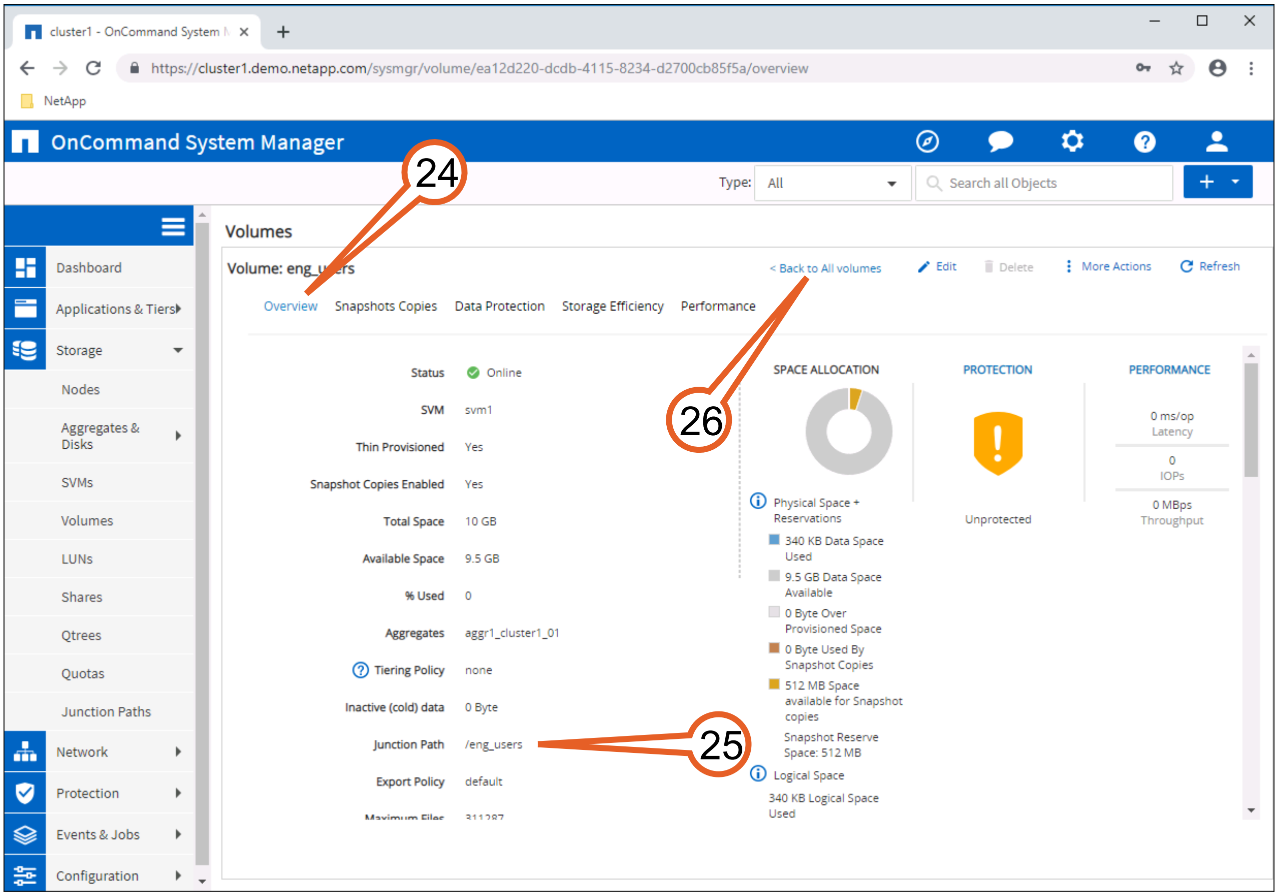

Figure 3-69:

You do have more options for junctioning than just placing your volumes into the root of your namespace. In the case of the eng_users volume, you will re-junction that volume underneath the engineering volume, and shorten the junction name to take advantage of an already intuitive context.

27. In the left pane, navigate to **Storage** > **Junction Paths**.

28. Verify that the “Junctions Path on SVM” drop-down menu is set to **svm1**.

29. Select the **eng_users** junction point.

30. Click **Unmount**.

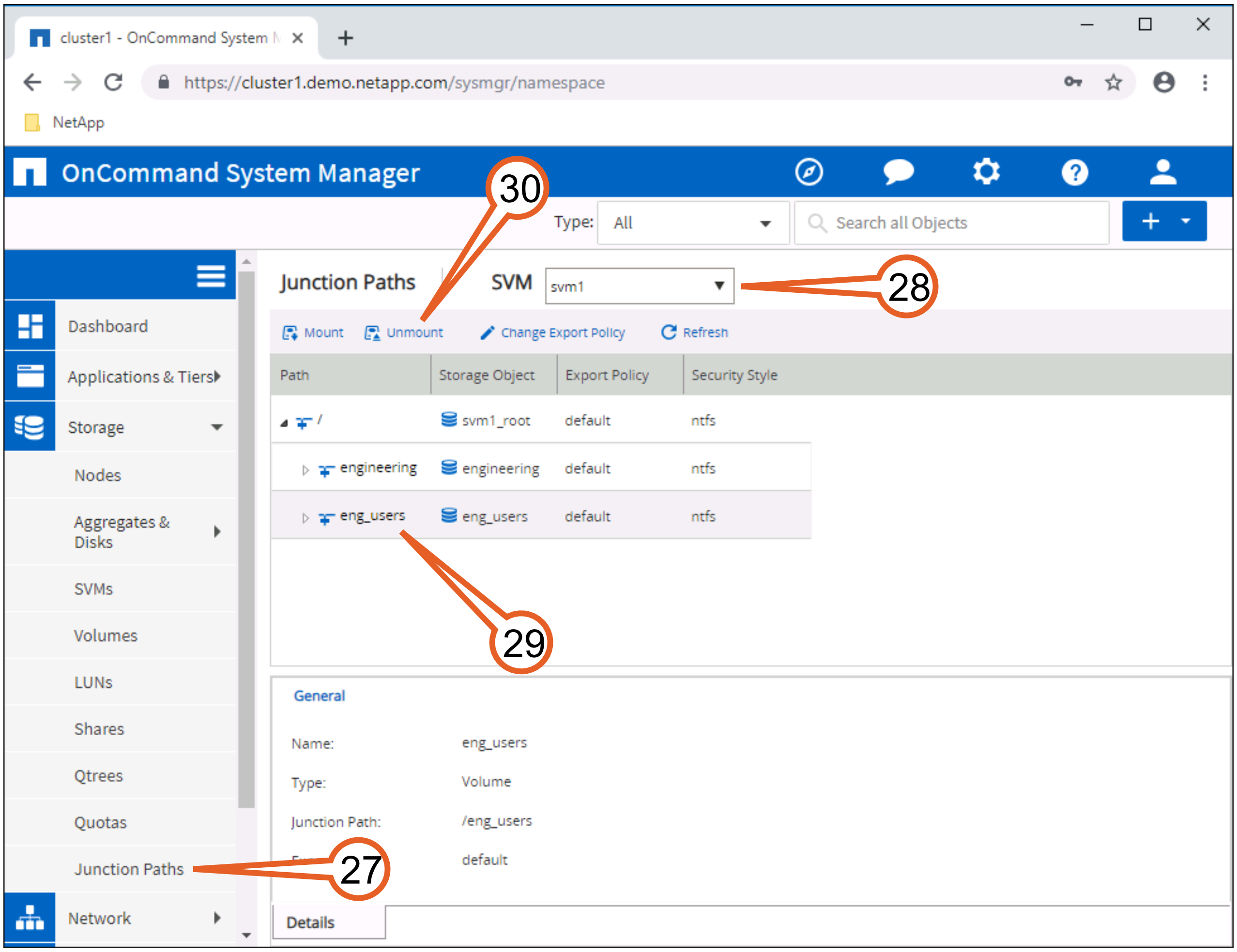

Figure 3-70:

The “Unmount Volume” dialog opens asking for confirmation that you really want to unmount the volume.

31. Click **Unmount**.

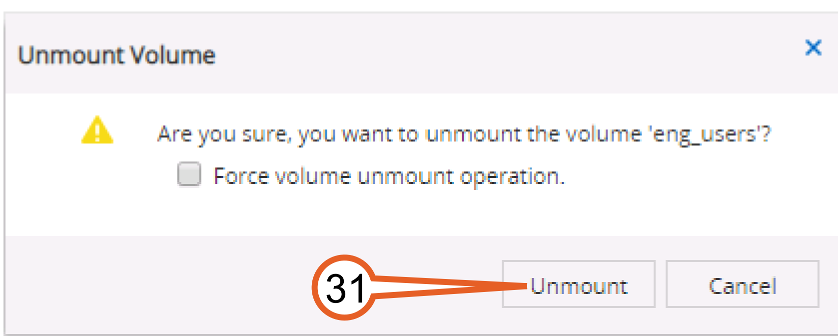

Figure 3-71:

The “Unmount Volume” dialog closes, and focus returns to the “Junction Paths on SVM” pane.

32. The “eng_users” volume no longer appears in the junction list for the namespace, and since it is no longer junctioned in the namespace, clients can no longer access it or even see it.

33. Junction the volume in at another location in the namespace by clicking **Mount**.

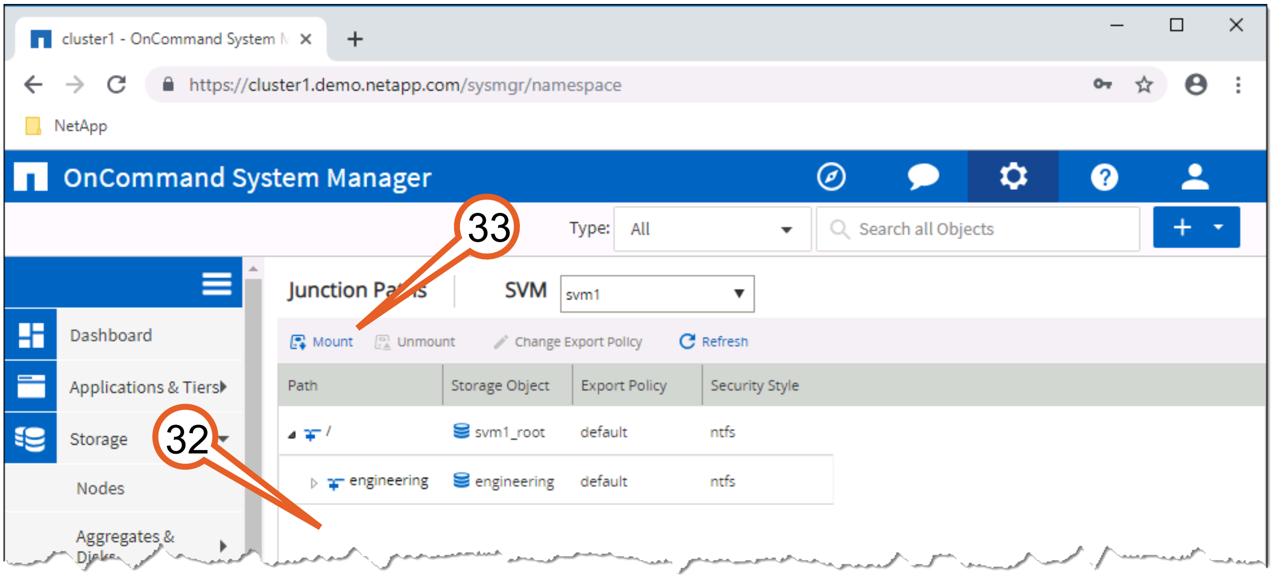

Figure 3-72:

The “Mount Volume” dialog opens.

34. Set the fields in the window as follows.

- “Volume Name”: **eng_users**
- “Junction Name”: **`users`**

35. Click **Browse**.

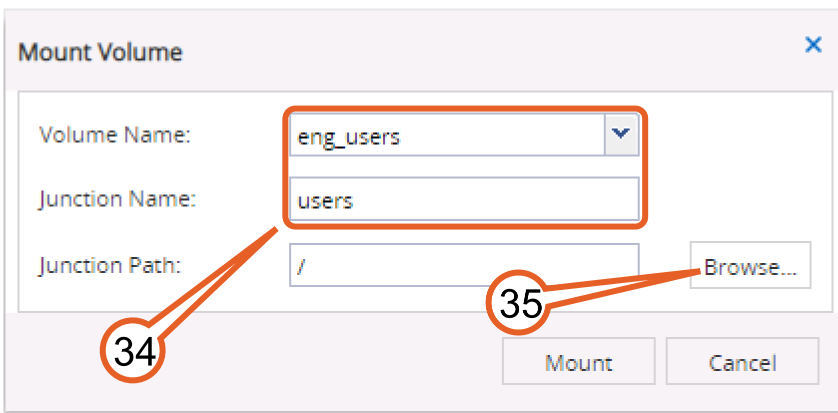

Figure 3-73:

The “Browse For Junction Path” dialog opens.

36. Select **engineering**, which will populate “/engineering” into the textbox above the list.

37. Click **Select** to accept the selection.

Figure 3-74:

The “Browse For Junction Path” dialog closes, and focus returns to the “Mount Volume” dialog.

38. The fields in the “Mount Volume” dialog should now all contain values as follows:

- “Volume Name”: **eng_users**
- “Junction Name”: **`users`**
- “Junction Path”: **`/engineering`**

39. When ready, click **Mount**.

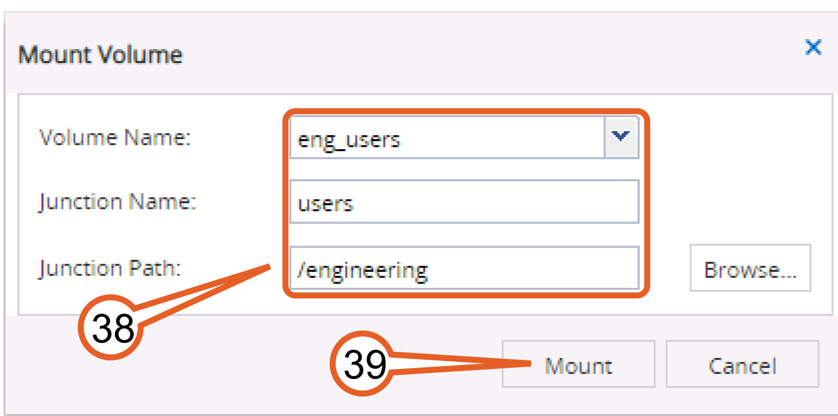

Figure 3-75:

The “Mount Volume” dialog closes, and focus returns to the “Junction Path on SVM” pane.

40. The “eng_users” volume is now mounted in the namespace as “/engineering/users”.

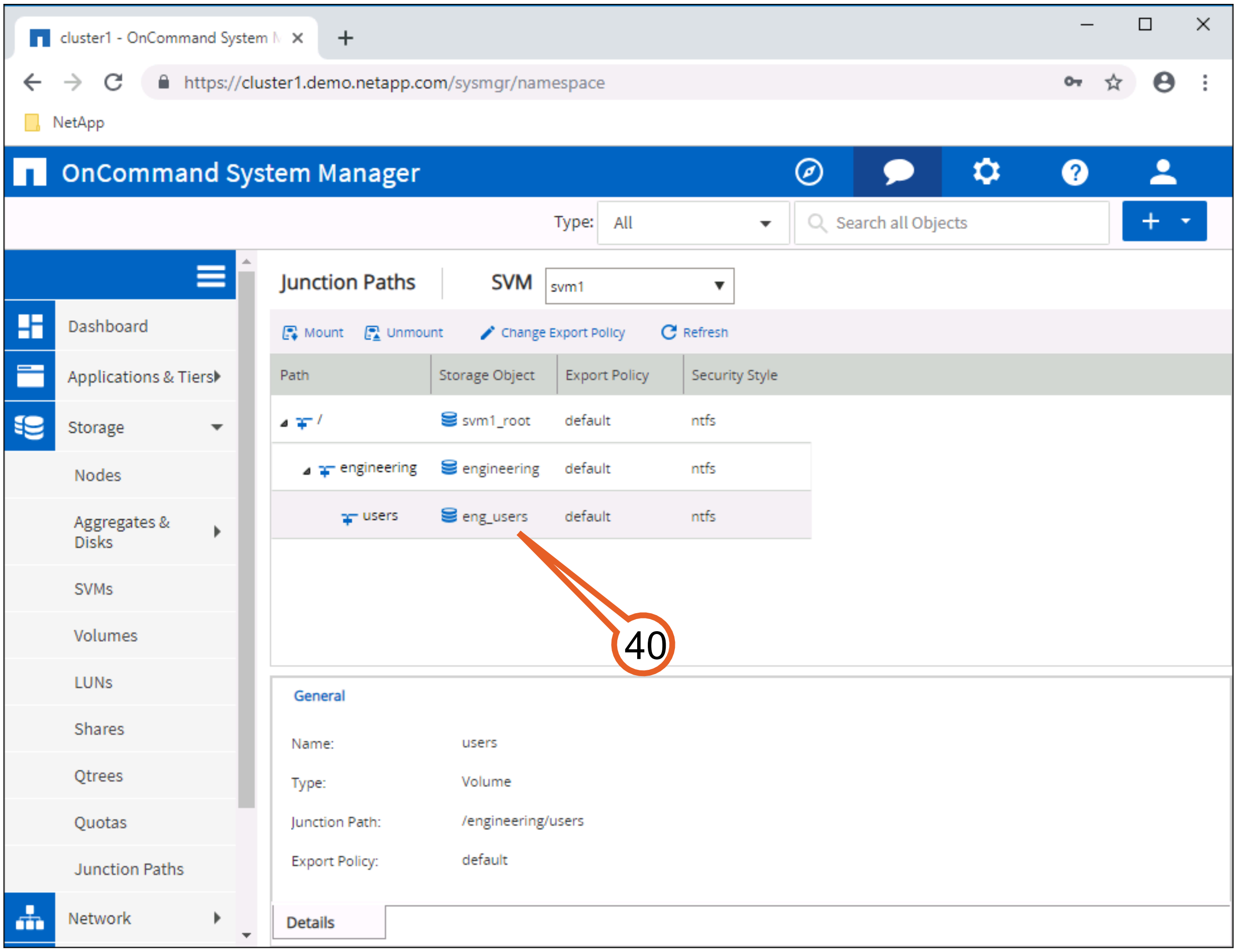

Figure 3-76:

You can also create a junction within user created directories. For example, from a CIFS or NFS client you could create a folder named “Projects” inside the engineering volume, and then create a “widgets” volume that junctions in under the projects folder. In that scenario, the namespace path to the “widgets” volume contents would be “/engineering/projects/widgets”.

3.2.4 Connect NAS Clients

The “svm1” SVM is up and running and is configured for NFS and CIFS access, so it's time to validate that everything is working properly by mounting the NFS export on a Linux host, and the CIFS share on a Windows host. You should complete the exercises for both clients so you can see that they are both able to seamlessly access the volume and its files.

3.2.4.1 Windows Client

This lab activity demonstrates how to connect the Windows client Jumphost to the CIFS share “\\svm1\nsroot” using the Windows GUI.

1. On the Windows host Jumphost, open Windows Explorer by clicking on the **folder icon** on the task bar.

Figure 3-77:

A Windows Explorer window opens.

2. In the left pane of Windows Explorer click on **This PC**.
3. On the menu bar, click on **Computer**.
4. Click on **Map network drive** to launch the Map Network Drive wizard.

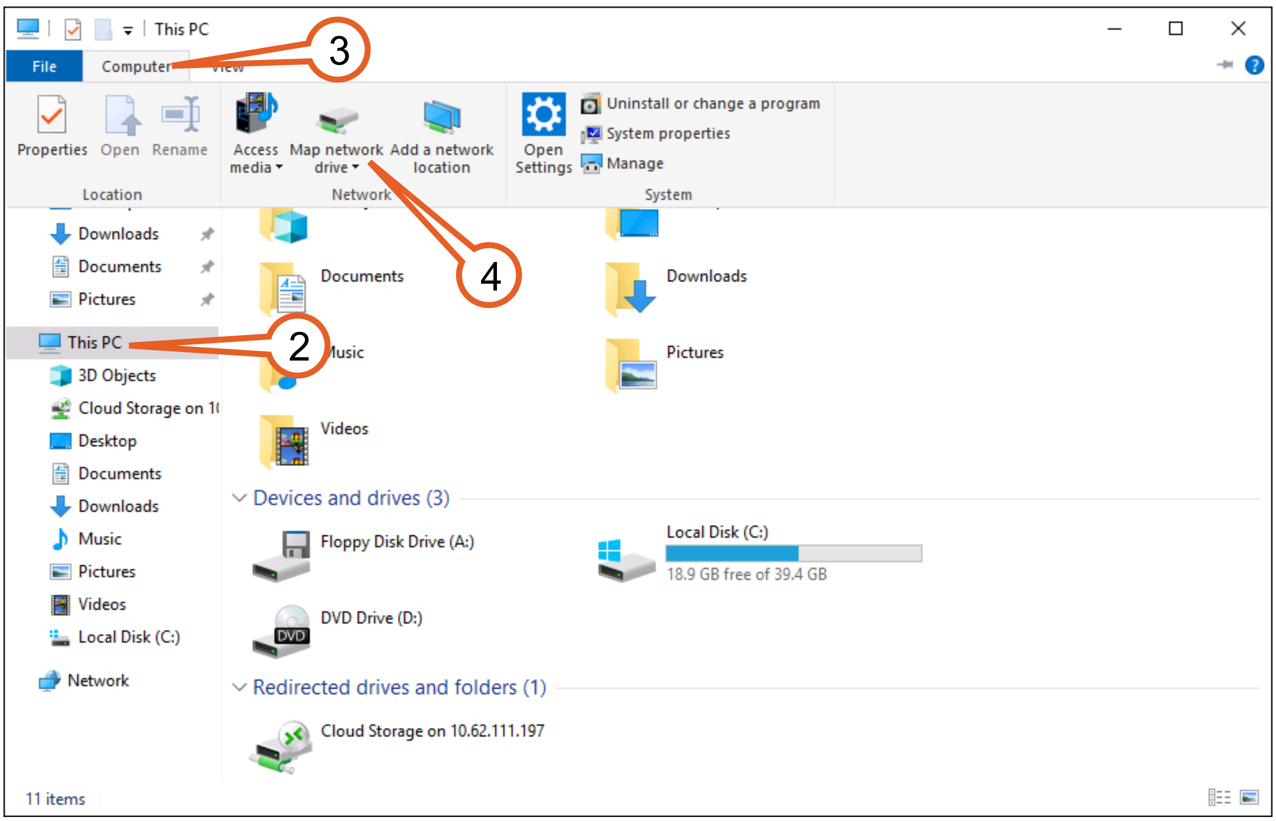

Figure 3-78:

The “Map Network Drive” wizard opens.

5. Set the fields in the window to the following values.
   - “Drive”: **S:**.
   - “Folder”: **\\svm1\nsroot**.
   - Check the **Reconnect at sign-in** check box.

6. When finished click **Finish**.

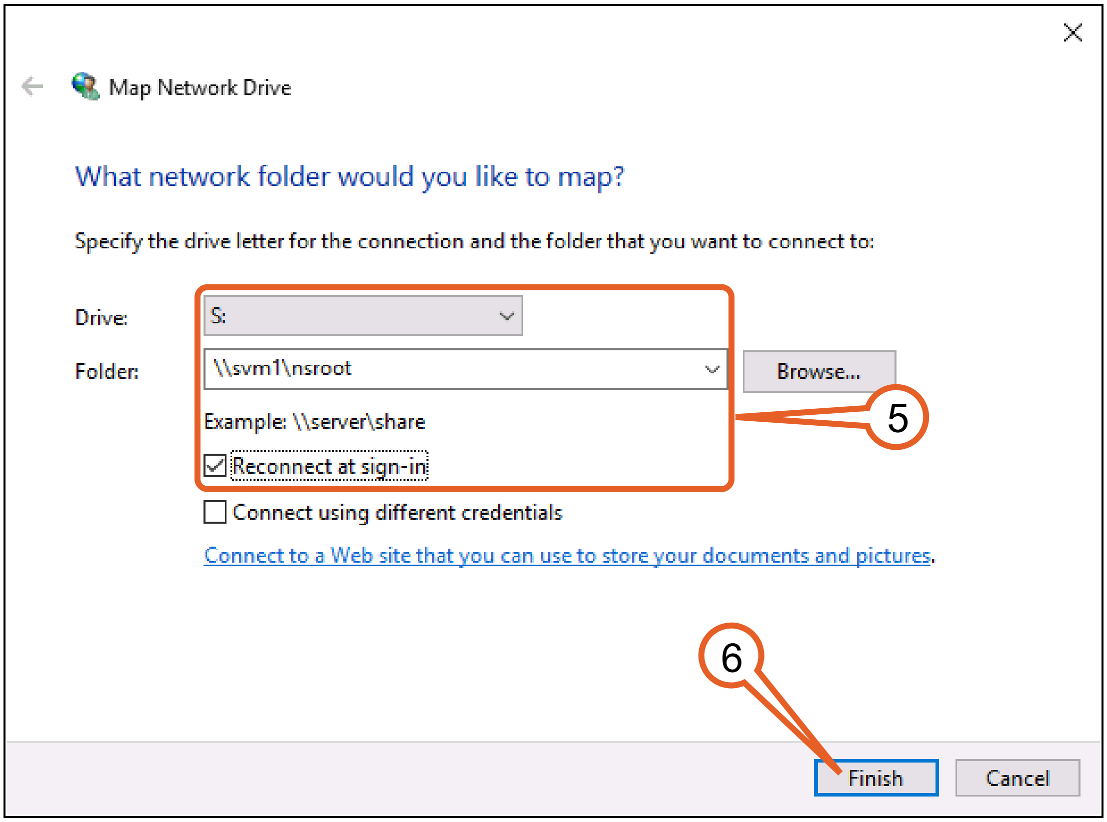

Figure 3-79:

A new Windows Explorer window opens.

7. The engineering volume you previously junctioned into the svm1's namespace is visible at the top of the nsroot share that points to the root of the namespace. If you created another volume on svm1 right now and mounted it under the root of the namespace, that new volume would instantly become visible

in this share, and to clients like Jumphost that have already mounted the share. Double-click on the **engineering** folder to open it.

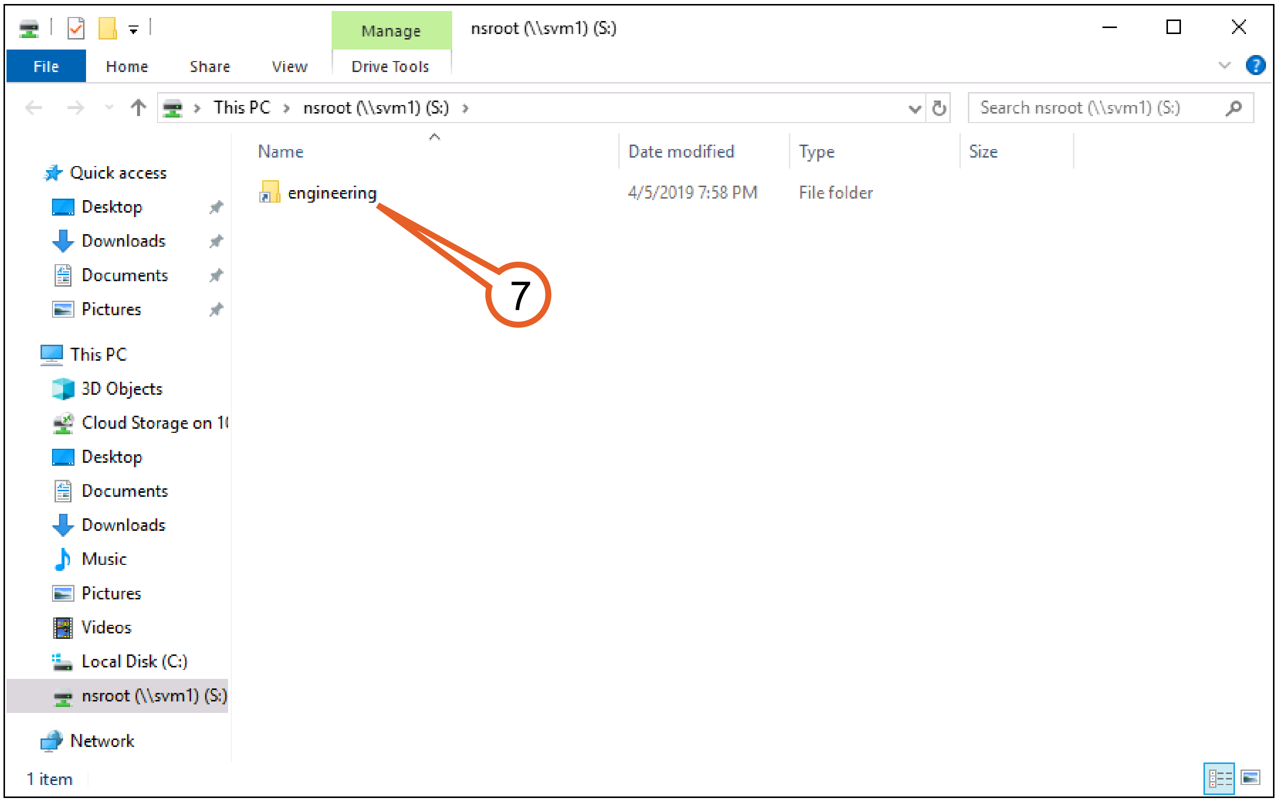

Figure 3-80:

File Explorer displays the contents of the engineering folder. Now create a file in this folder to confirm that you can write to it.

8. Notice that the “eng_users” volume that you junctioned in as “users” is visible inside this folder.

9. Right-click in the empty space in the right pane of File Explorer, and select **New** > **Text Document** from the context menu.

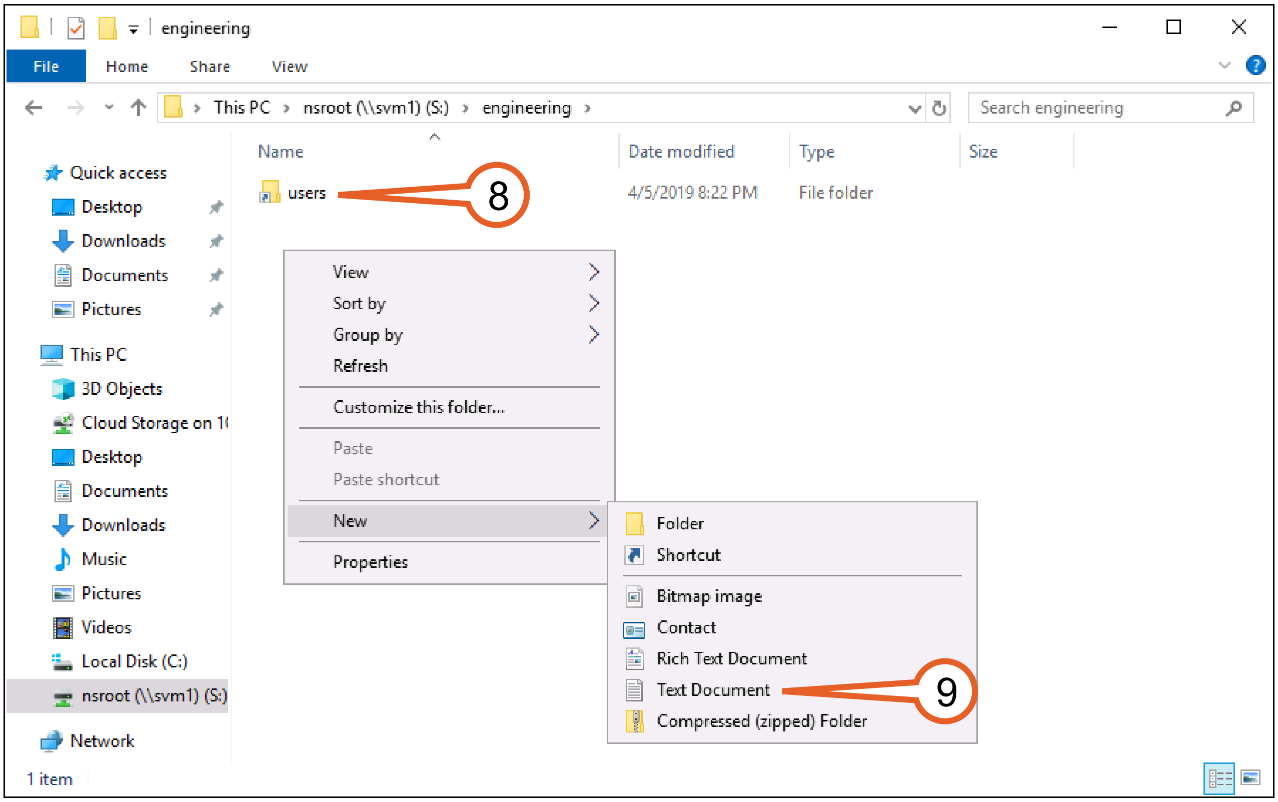

Figure 3-81:

10. Name the resulting file **`cifs.txt`**.
11. Double-click the **cifs.txt** file to open it with Notepad.

    Tip: If you do not see file extensions in your lab, you can enable them by going to the **View** menu at the top of Windows Explorer and checking the **File Name Extensions** check box.
12. In Notepad, enter some text. Ensure that you put a carriage return at the end of the line, otherwise when you later view the contents of this file on Linux, the command shell prompt will appear on the same line as the file contents.
13. Use the **File** > **Save** menu in Notepad to save the file's updated contents to the share. If write access is working properly then the save operation will complete silently (i.e., you will not receive an error message).
14. Close the Notepad window.

15. Close the File Explorer window.

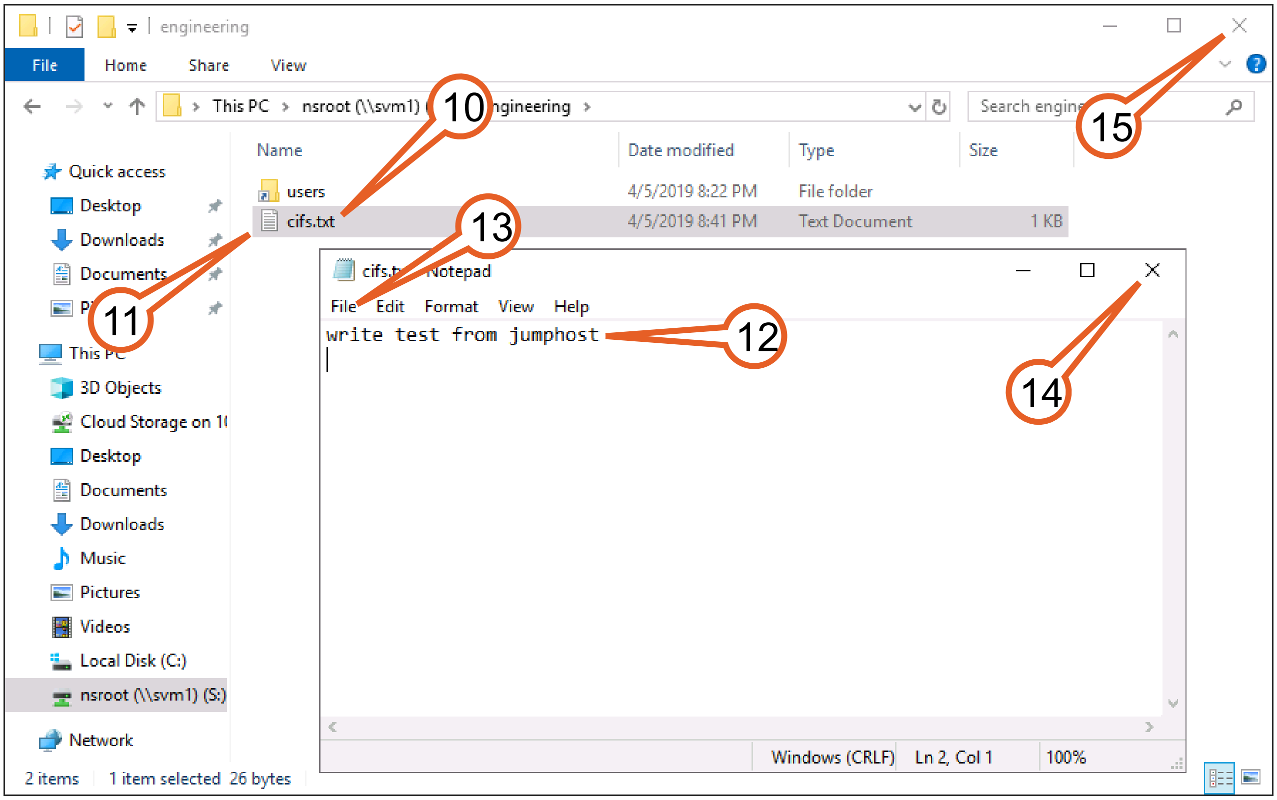

Figure 3-82:

3.2.4.2 Linux Client

This section demonstrates how to connect a Linux client to the NFS volume svm1:/ using the Linux command line.

1. Follow the instructions in the "Accessing the Command Line" section at the beginning of this lab guide to open PuTTY and connect to the system **rhel1**. Log in as the user **`root`** with the password **`Netapp1!`**.
2. Verify that there are no NFS volumes currently mounted on rhel1.

```
[root@rhel1 ~]# df
Filesystem             1K-blocks    Used Available Use% Mounted on
/dev/mapper/rhel-root   39265556 2810364  36455192   8% /
devtmpfs                  930956       0    930956   0% /dev
tmpfs                     941996       0    941996   0% /dev/shm
tmpfs                     941996   98820    843176  11% /run
tmpfs                     941996       0    941996   0% /sys/fs/cgroup
/dev/sda1                 508588  129304    379284  26% /boot
tmpfs                     188400       0    188400   0% /run/user/0
[root@rhel1 ~]#
```

3. Create the /svm1 directory to serve as a mount point for the NFS volume you will be mounting.

```
[root@rhel1 ~]# mkdir /svm1
[root@rhel1 ~]#
```

4. Add an entry for the NFS mount to the fstab file.

```
[root@rhel1 ~]# echo "svm1:/ /svm1 nfs rw,defaults 0 0" >> /etc/fstab
[root@rhel1 ~]#
```

5. Verify the fstab file contains the new entry you just created.

```
[root@rhel1 ~]# grep svm1 /etc/fstab
svm1:/ /svm1 nfs rw,defaults 0 0
```

```
[root@rhel1 ~]#
```

6. Mount all the file systems listed in the fstab file.

```
[root@rhel1 ~]# mount -a
[root@rhel1 ~]#
```

7. View a list of the mounted file systems.

```
[root@rhel1 ~]# df
Filesystem            1K-blocks    Used Available Use% Mounted on
/dev/mapper/rhel-root  39265556 2810304  36455252   8% /
devtmpfs                 930956       0    930956   0% /dev
tmpfs                    941996       0    941996   0% /dev/shm
tmpfs                    941996   98828    843168  11% /run
tmpfs                    941996       0    941996   0% /sys/fs/cgroup
/dev/sda1                508588  129304    379284  26% /boot
tmpfs                    188400       0    188400   0% /run/user/0
svm1:/                    19456     576     18880   3% /svm1
[root@rhel1 ~]#
```

The NFS file system svm1:/ now shows as mounted on /svm1.

8. Navigate into the /svm1 directory.

```
[root@rhel1 ~]# cd /svm1
[root@rhel1 svm1]#
```

9. Notice that you can see the engineering volume that you previously junctioned into the SVM's namespace.

```
[root@rhel1 svm1]# ls
engineering
[root@rhel1 svm1]#
```

10. Navigate into engineering and list its contents.

    Attention: The following command output assumes that you have already performed the Windows client connection steps found earlier in this lab guide, including creating the cifs.txt file.

```
[root@rhel1 svm1]# cd engineering
[root@rhel1 engineering]# ls
cifs.txt  users
[root@rhel1 engineering]#
```

11. Display the contents of the cifs.txt file you created earlier.

    Tip: When you `cat` the cifs.txt file, if the shell prompt winds up on the same line as the file output, that indicates that you forgot to include a new line at the end of the file when you created the file on Windows.

```
[root@rhel1 engineering]# cat cifs.txt
write test from jumphost
[root@rhel1 engineering]#
```

12. Verify that you can create file in this directory.

```
[root@rhel1 engineering]# echo "write test from rhel1" > nfs.txt
[root@rhel1 engineering]# cat nfs.txt
write test from rhel1
[root@rhel1 engineering]# ls -l
total 4
-rwxrwxrwx 1 root bin    26 Sep 22 16:15 cifs.txt
-rwxrwxrwx 1 root root   22 Sep 22 19:59 nfs.txt
drwxrwxrwx 4 root root 4096 Sep 22 04:54 users
[root@rhel1 engineering]#
```

3.2.5 Creating and NFS Exporting Qtrees (Optional)

This is an optional exercise for customers with very large NFS environments who need more NFS exports than can be supported by volumes alone in ONTAP.

3.2.5.1 Qtree Concepts

Qtrees had many capabilities in Data ONTAP 7-mode that are no longer present in cluster mode. Qtrees do still exist, but their purpose is now mostly limited to quota management, with most other 7-mode qtree features, including NFS exports, now taken over by volumes. This functionality change created challenges for 7-mode customers with large numbers of NFS qtree exports who were trying to transition to cluster mode and could not convert those qtrees to volumes because they would exceed ONTAP's maximum limit for the number of supported volumes.

To address this problem, ONTAP introduced qtree NFS. NetApp continues to recommend that customers favor volumes over qtrees in cluster mode whenever practical, but customers who require a larger numbers of exports than can be supported by volumes alone can now use qtree NFS to meet those needs.

3.2.5.2 Creating Qtrees Exercise

This optional activity explains how to create qtrees. You will create a couple of qtrees within the “eng_users” volume, one for each of the users “bob” and “susan”.

1. In the left pane, navigate to **Storage** > **Qtrees**.
2. Make sure the "Qtrees on SVM" dropdown is set to "svm1".
3. Click **Create** to launch the Create Qtree wizard.

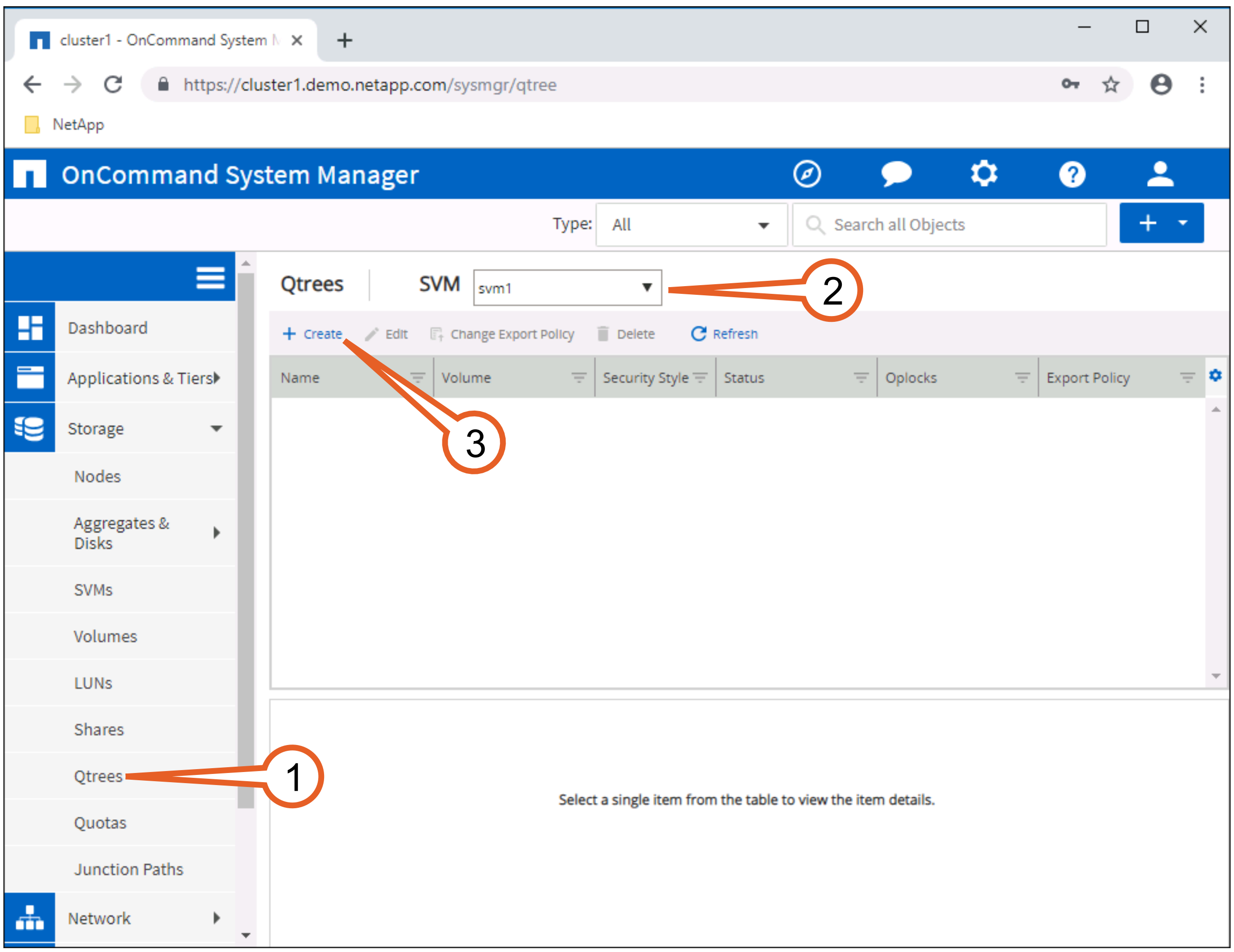

Figure 3-83:

The “Create Qtree” dialog opens.

4. Set the fields in this window as follows:
    - "Name": **bob**
    - "Volume": Click **Browse**.

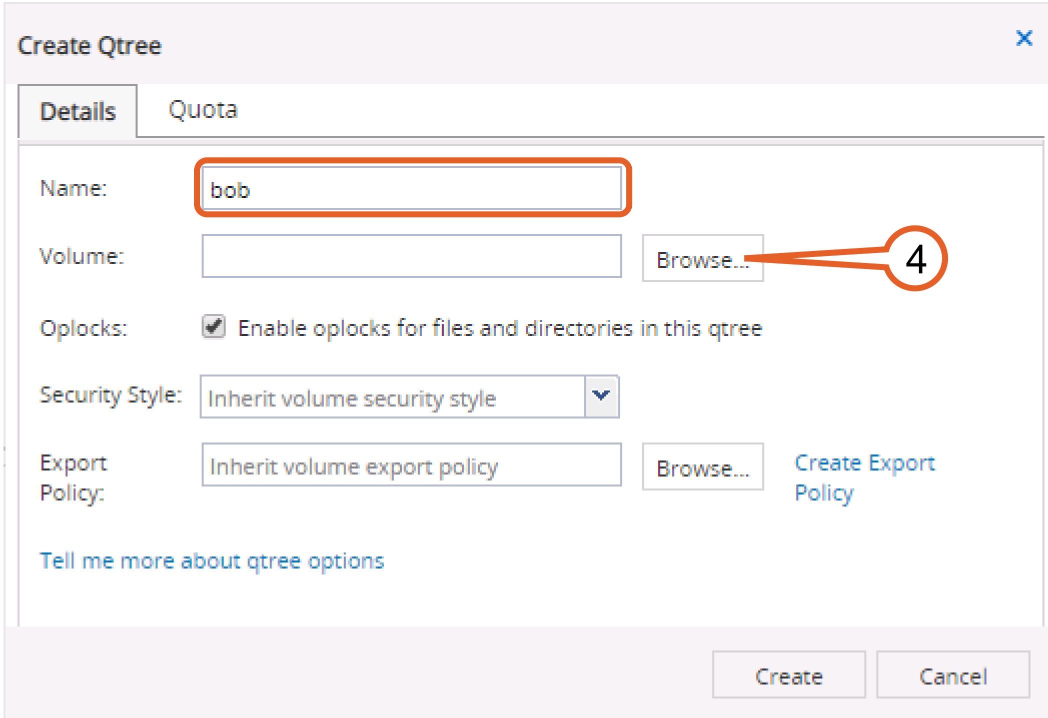

Figure 3-84:

The "Select a Volume" dialog opens.

5. Expand the **svm1** list.
6. Select the **eng_users** volume.

Tip: Remember, you are selecting the name of the volume that will host the qtree, not the path where that qtree will reside in the namespace.

7. Click **OK**.

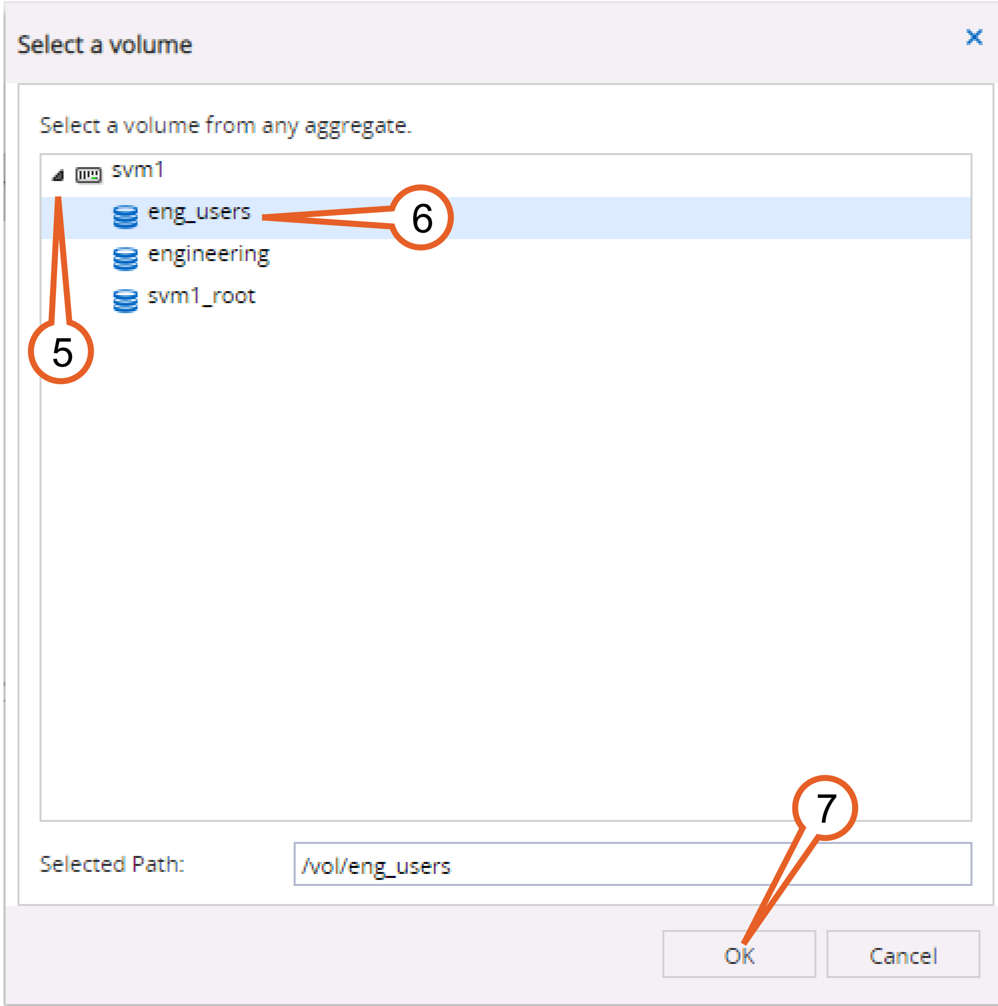

Figure 3-85:

The “Select a Volume” dialog closes, and focus returns to the “Create Qtree” dialog.

8. The “Volume” field is now populated with **`eng_users`**.

9. Select the **Quota** tab.

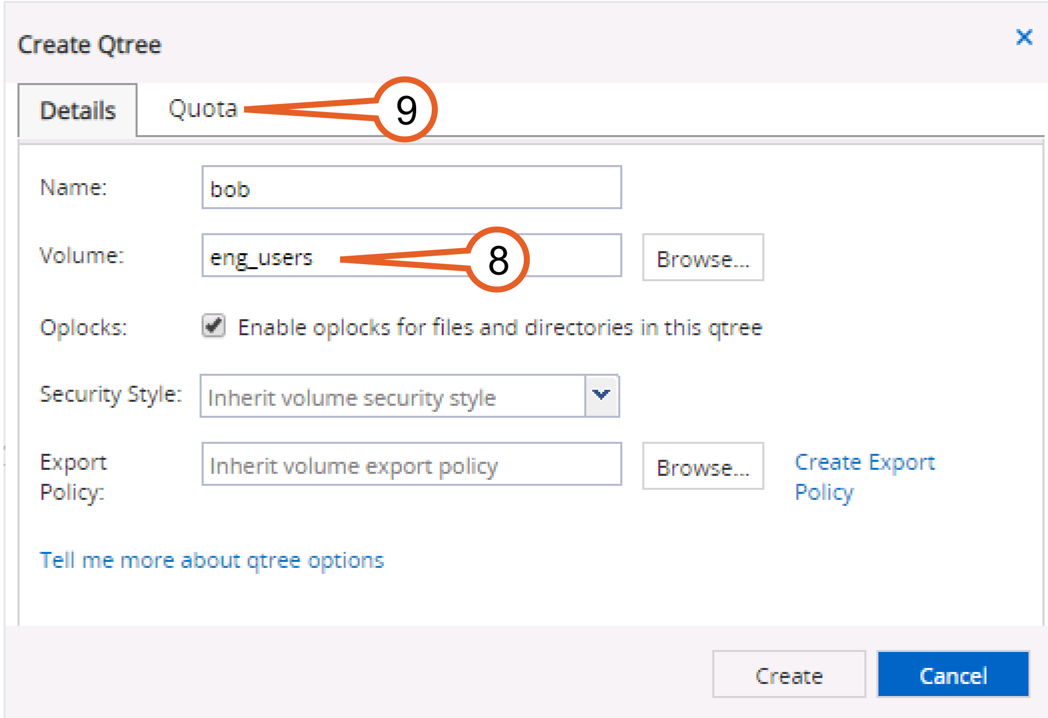

Figure 3-86:

The **Quota** tab is where you define any space usage limits you want to apply to the qtree.

10. Review the available settings, but do not change them, as you are not actually implementing any quota limits in this lab.

11. Click the **Create** button to finish creating the qtree.

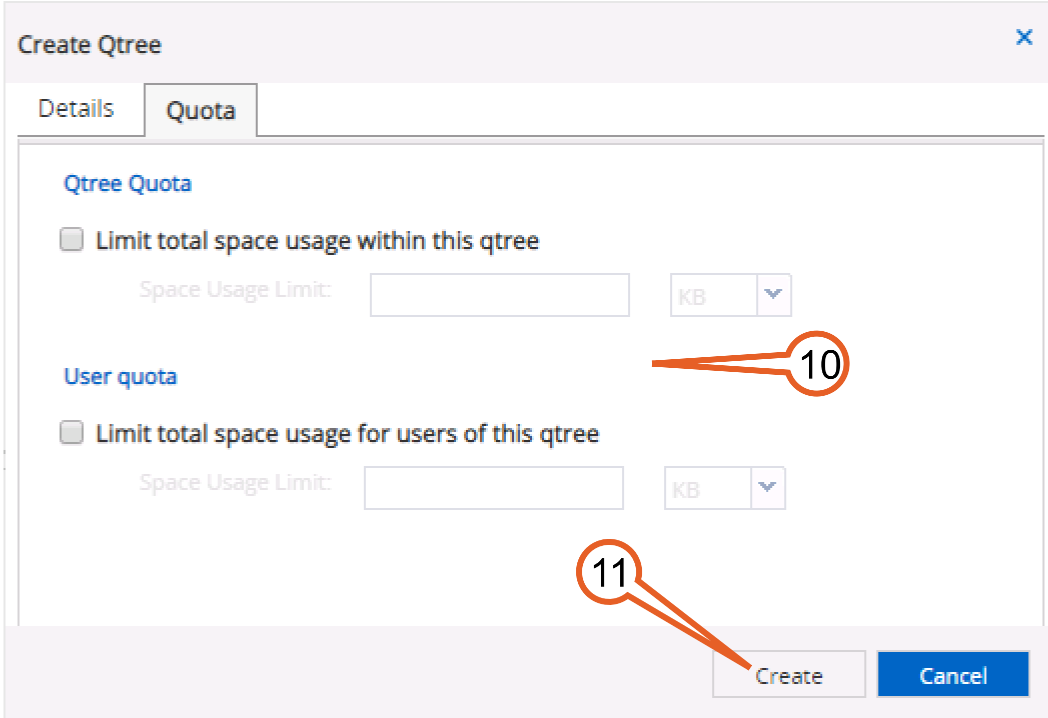

Figure 3-87:

The “Create Qtree” dialog closes, and focus returns to the “Qtrees” pane.

12. The new “bob” qtree is now present in the qtrees list.

13. Now create a qtree for the user account “susan” by clicking **Create**.

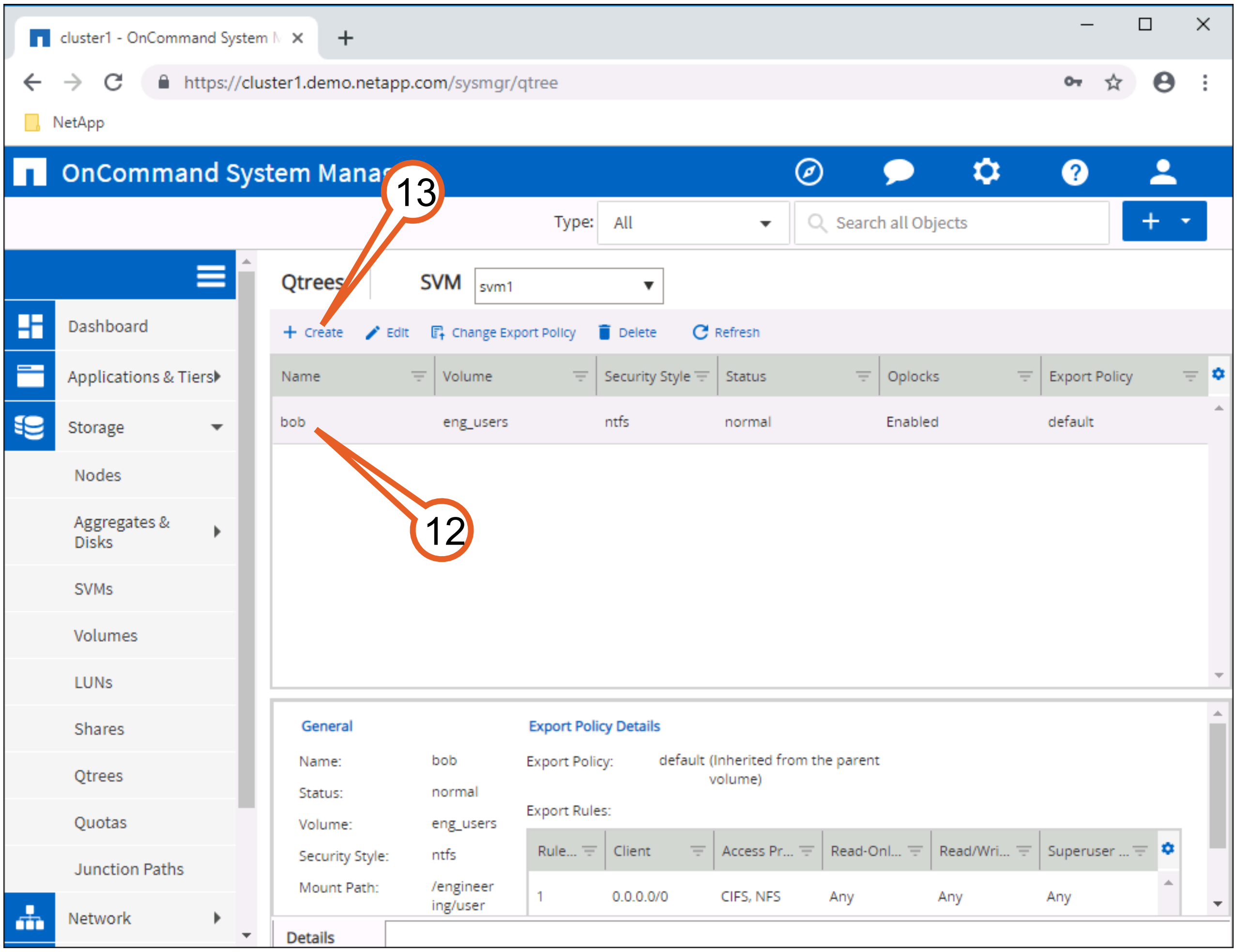

Figure 3-88:

The “Create Qtree” dialog opens.

14. Populate the fields on the “Details” tab as follows:

- “Name”: **susan**
- “Volume”: **eng_users**

15. Click **Create**.

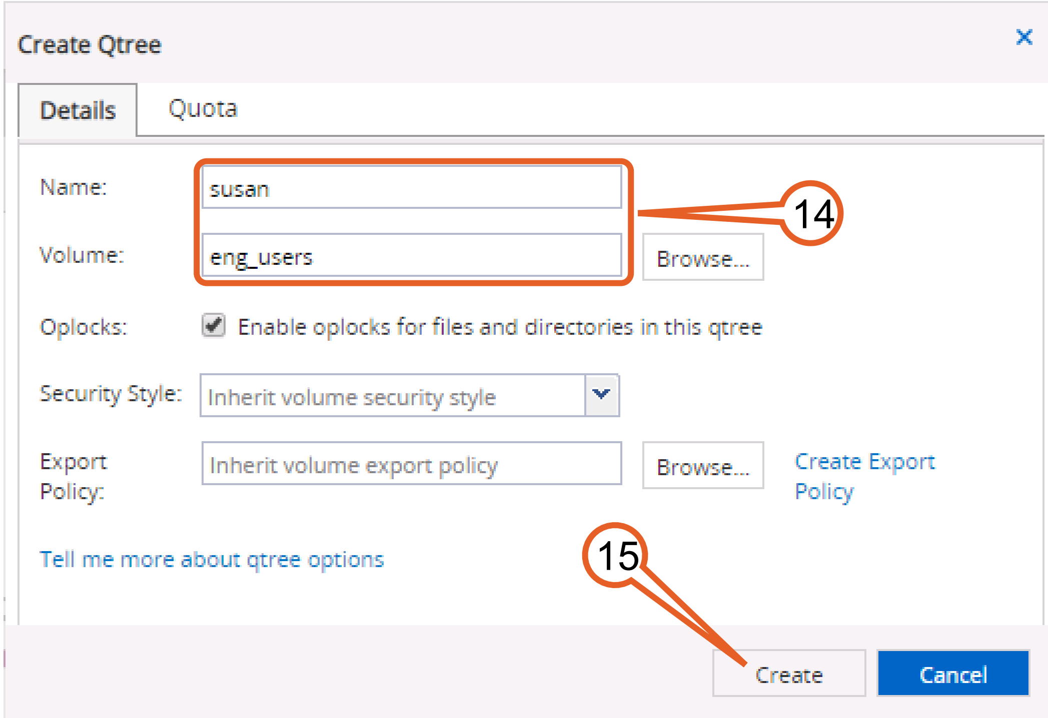

Figure 3-89:

The “Create Qtree” dialog closes, and focus returns to the “Qtrees” pane.

16. You should now see listings for both the “bob” and “susan” qtrees in the “Qtrees on SVM” pane.

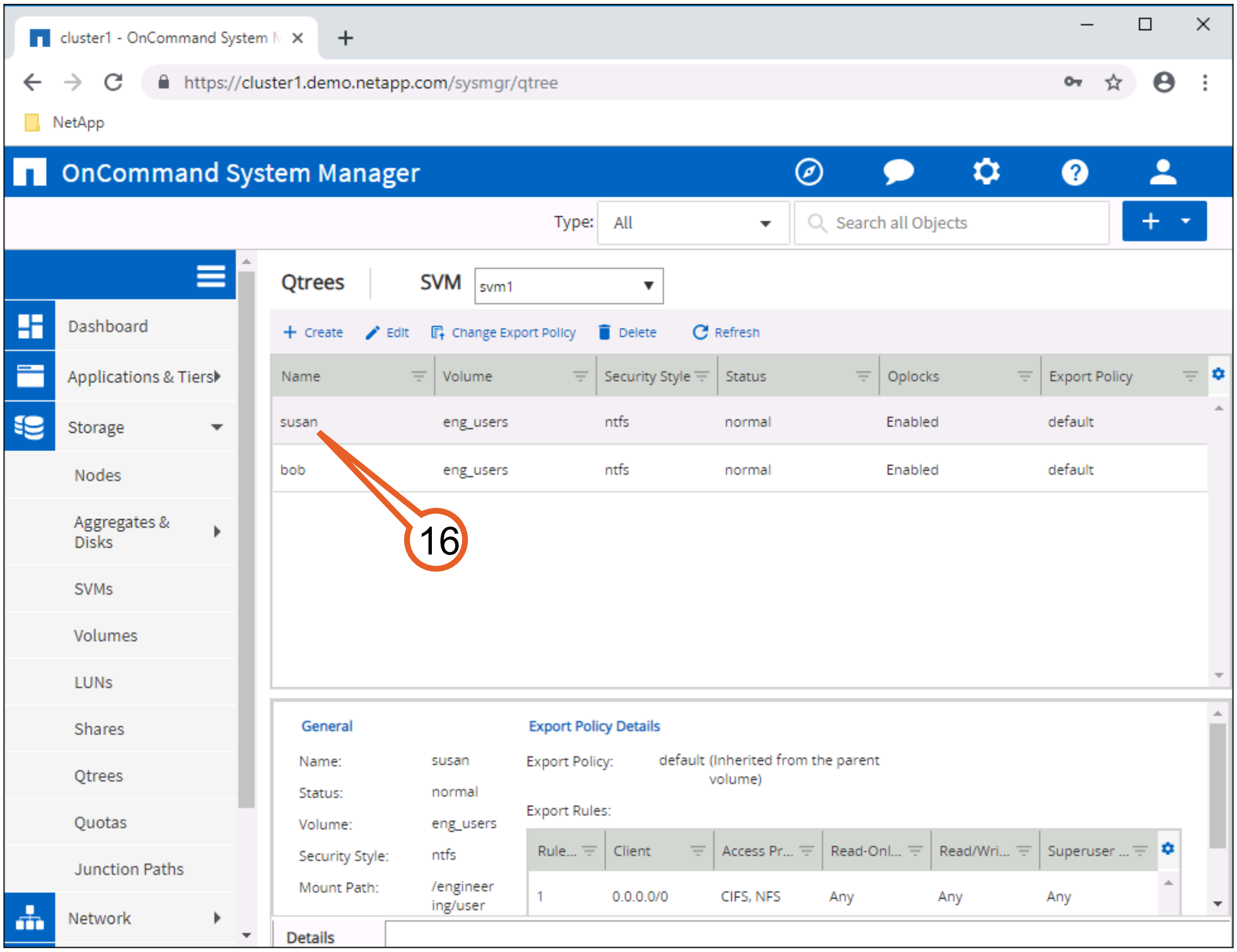

Figure 3-90:

3.2.5.3 NFS Exporting Qtrees Exercise

This optional activity explains how to configure qtree exports and create different export rules for a given qtree. You will be working with the qtrees you created in the preceding exercise, so you have to complete that exercise before you can proceed.

Note: While this section provides a graphical method to configure qtree NFS exports, you still need to use the command line to accomplish some configuration tasks.

In this exercise you will create a new export policy and export rules that permit NFS access from only the Linux host rhel1.

1. In the left pane of System Manager, navigate to **Storage** > **Qtrees**.
2. Select **svm1**from the “Qtrees on SVM” dropdown menu.
3. Select the entry for the **susan** qtree.

4. Click the **Change Export Policy** button.

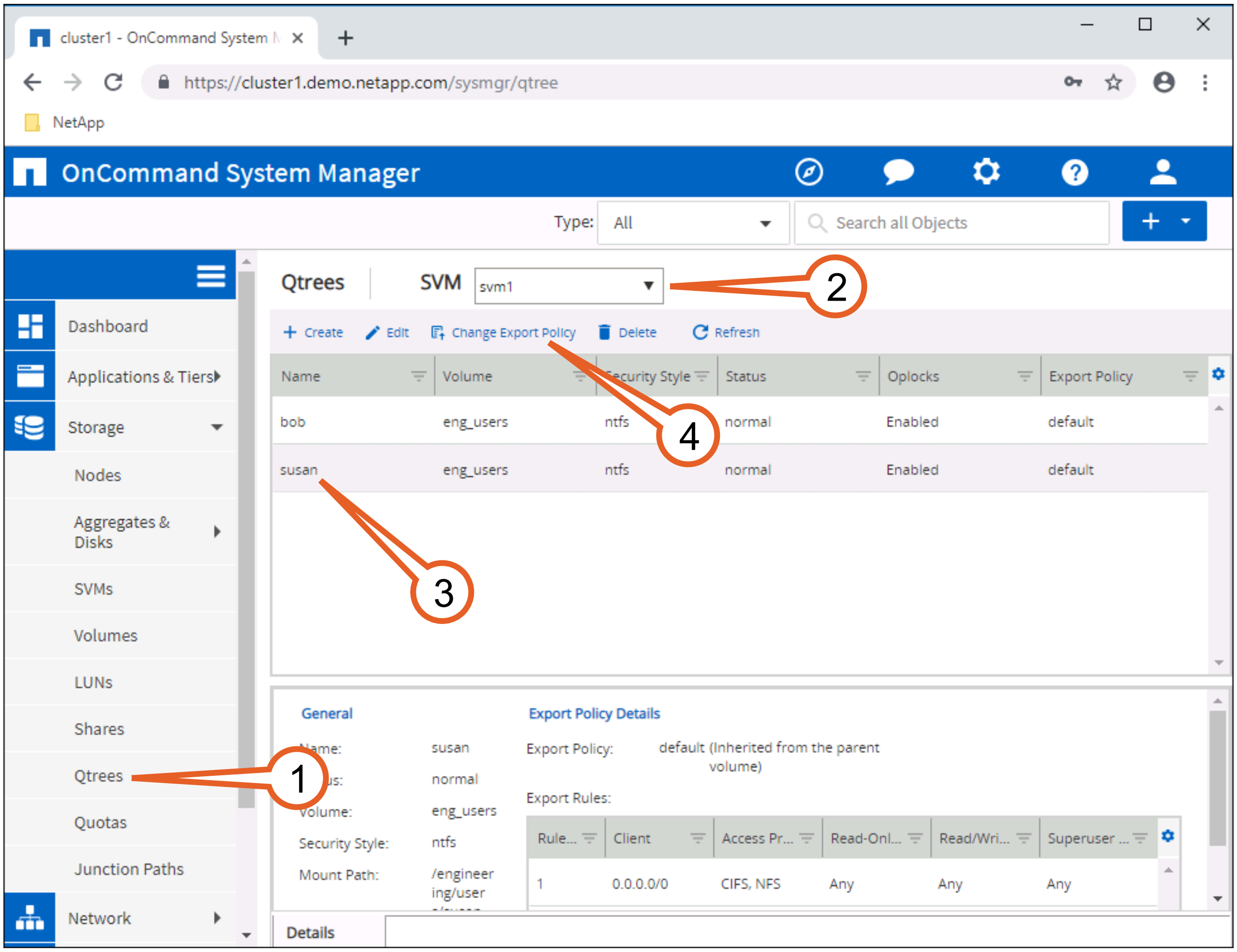

Figure 3-91:

The “Export Policy” dialog opens.

5. You will create a new export policy for this qtree, so click **Create Export Policy**.

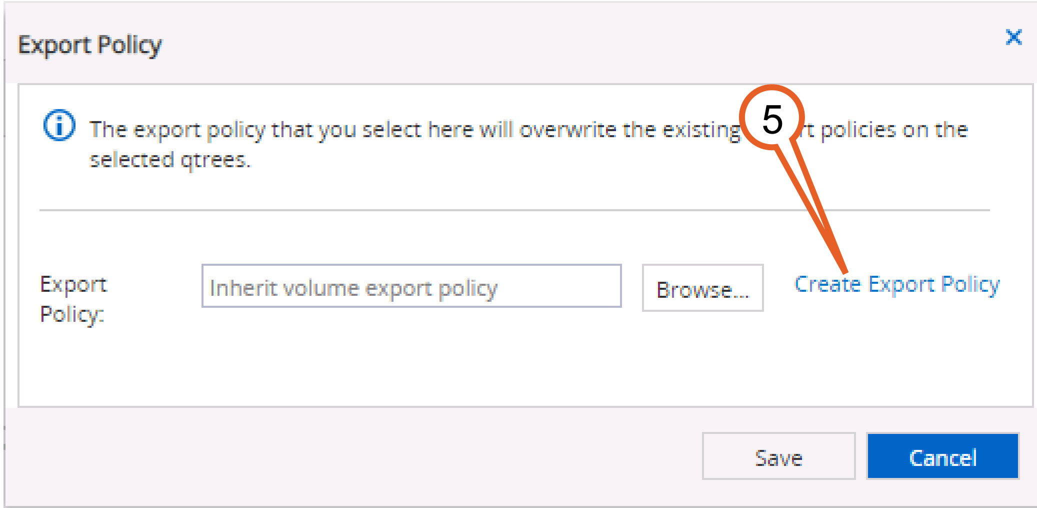

Figure 3-92:

The “Create Export Policy” dialog opens.

6. Set the “Policy Name” to **`rhel1-only`**.

7. Click **Add**.

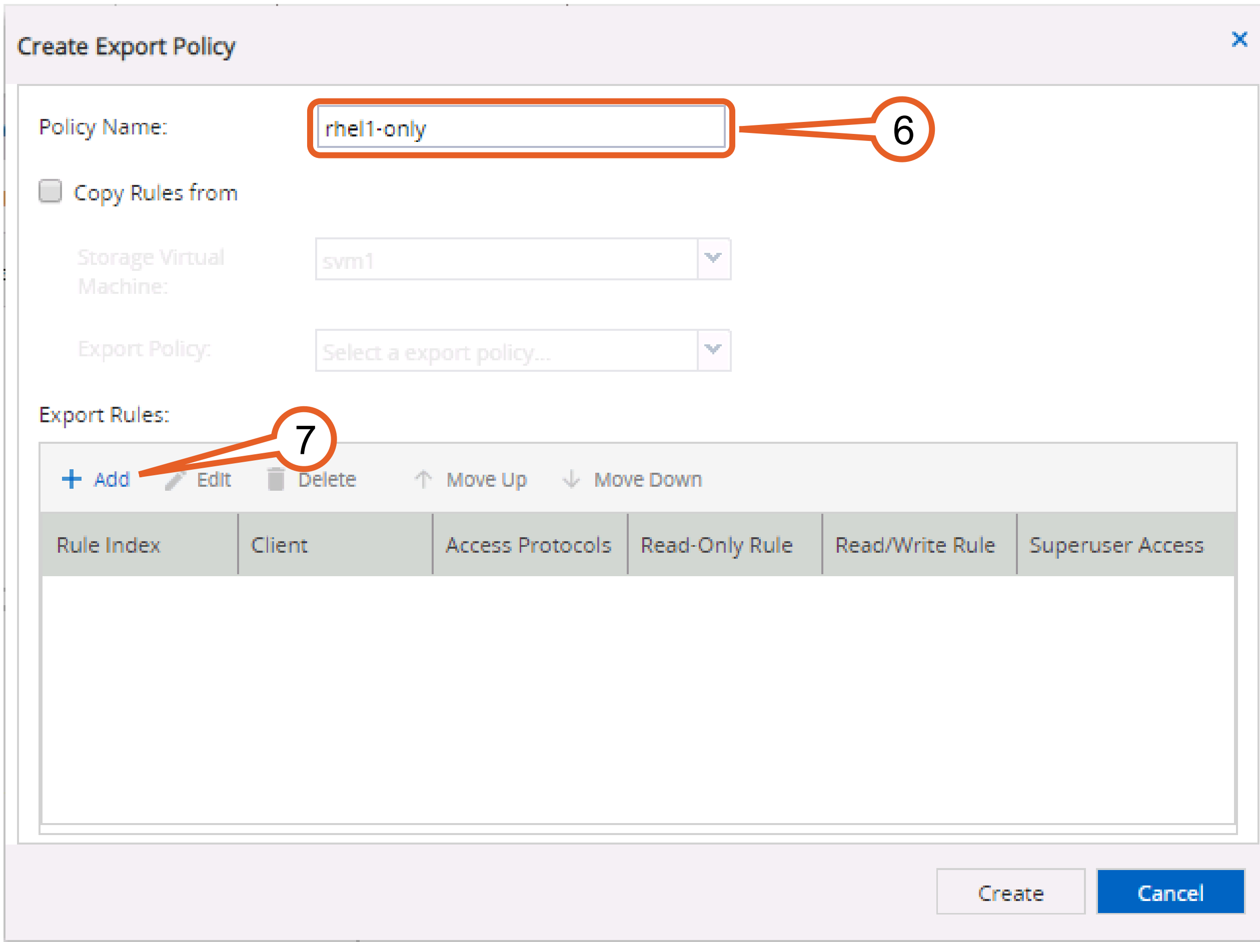

Figure 3-93:

The “Create Export Rule” dialog opens.

8. Set “Client Specification” to **`192.168.0.61`**.
9. Leave all of the “Access Protocol” checkboxes unchecked (see the information note below the checkboxes for an explanation why).

10. Click **OK**.

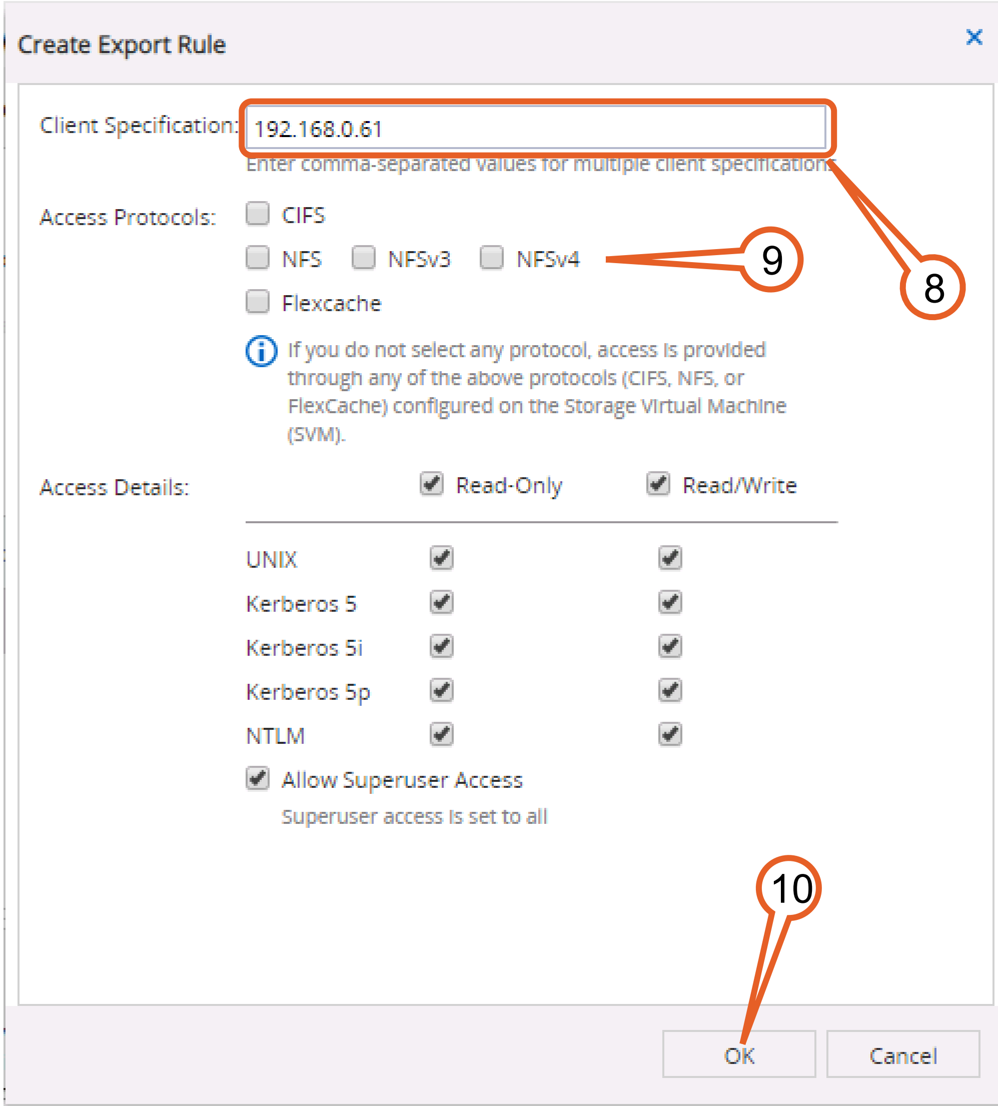

Figure 3-94:

The “Create Export Rule” dialog closes, and focus returns to the “Create Export Policy” dialog.

11. The new access rule now is now present in the rules window, and the rule's “Access Protocols” entry indicates that there are no protocol restrictions. If you had selected all the available protocol checkboxes when creating this rule, then each of those selected protocols would have been explicitly listed here.

12. Click **Create**.

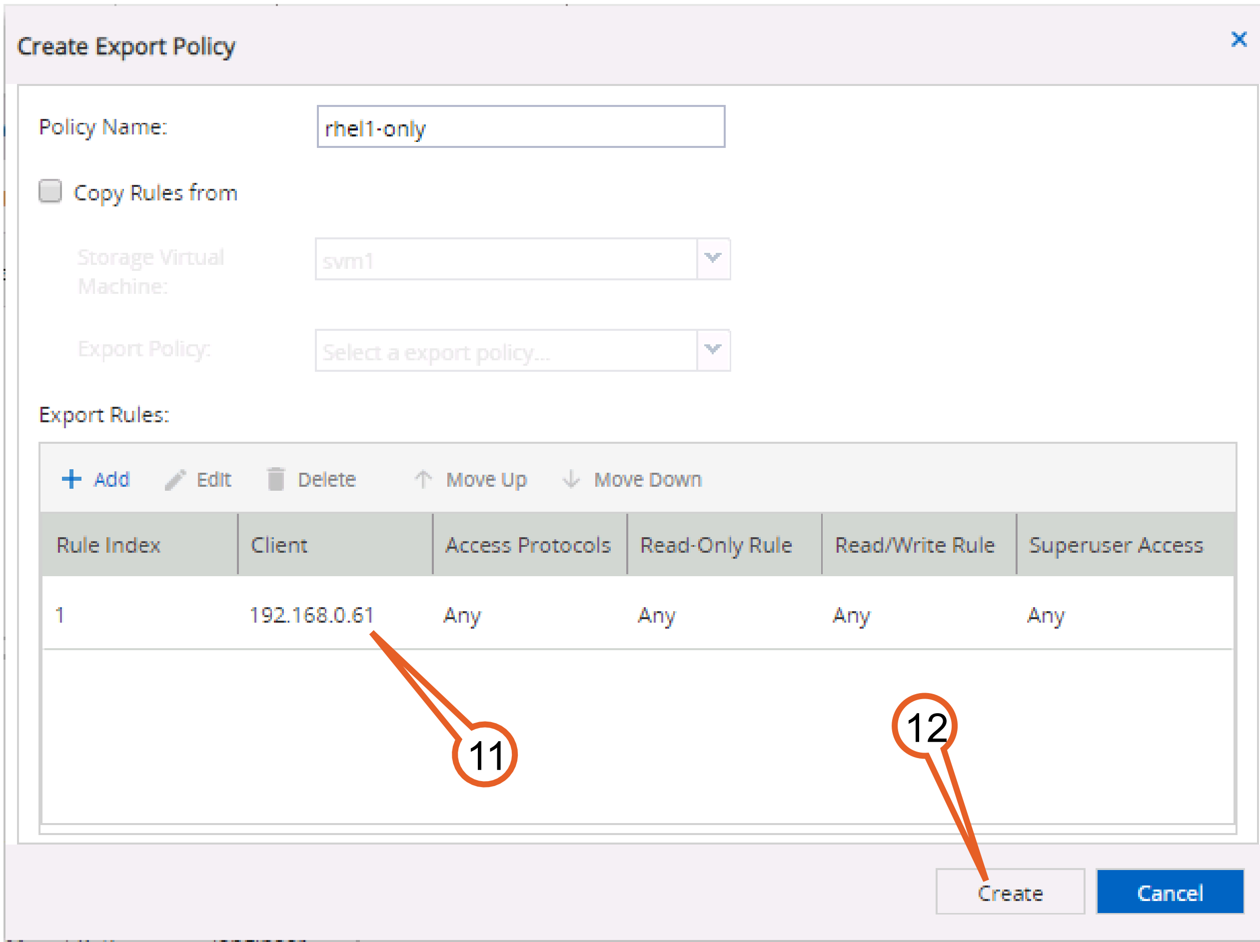

Figure 3-95:

The “Create Export Policy” dialog closes, and focus returns to the “Export Policy” dialog.

13. The “Export Policy:” textbox now displays “rhe1l-only”.

14. Click **Save**.

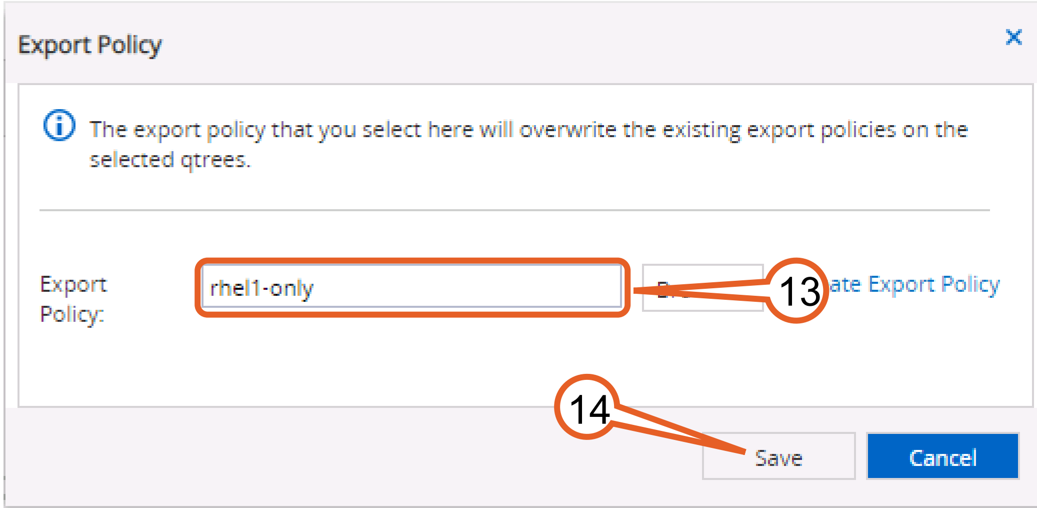

Figure 3-96:

The “Export Policy” window closes, and focus returns to the “Export Policies” pane in System Manager.

15. Make sure the “susan” qtree is selected in the qtree list.

16. The “rhel1-only” policy now shows up in the “Export Policy Details” list for the “susan” qtree.

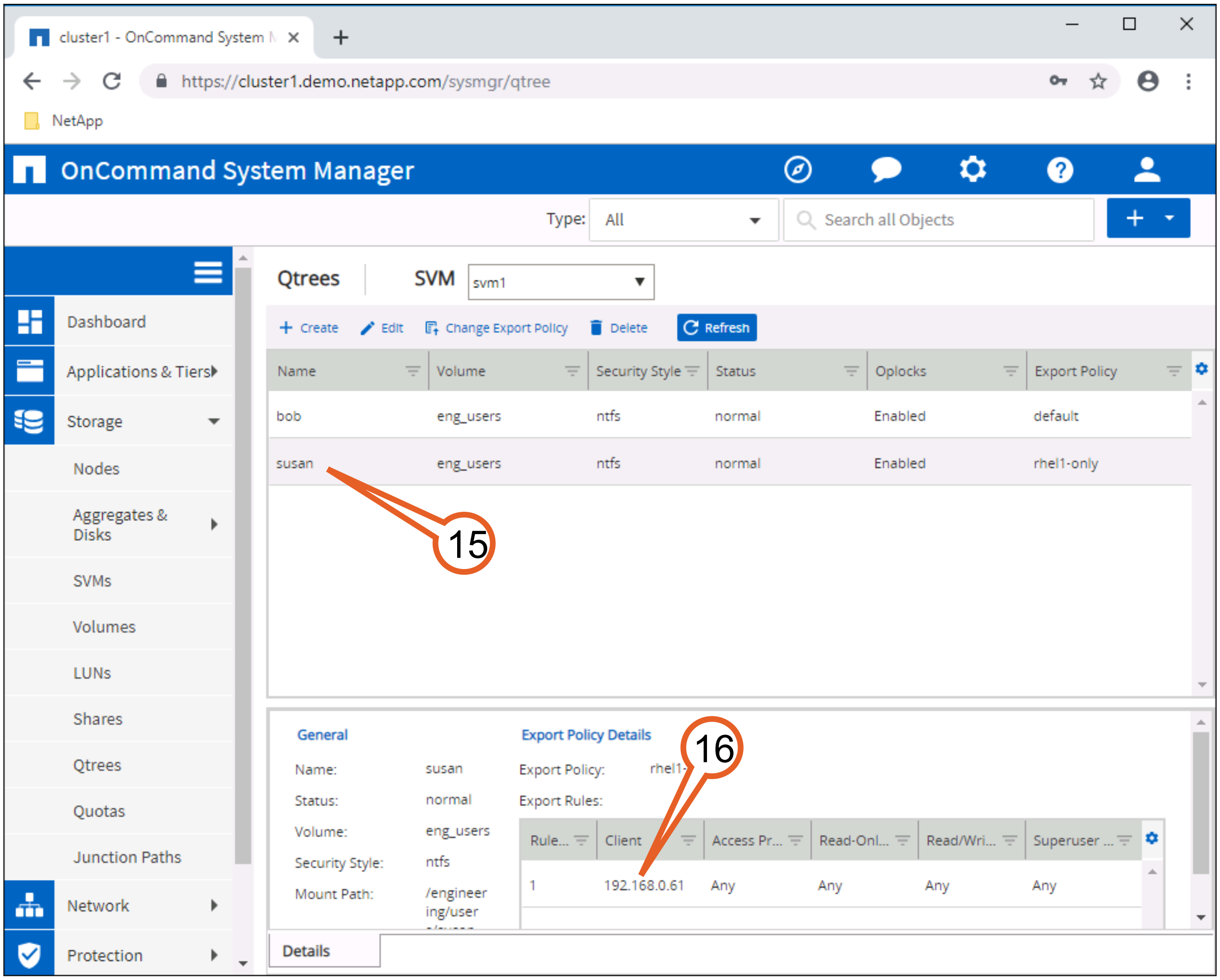

Figure 3-97:

17. Now you need to validate that the more restrictive export policy that you applied to the qtree “susan” is working as expected. If you still have an active PuTTY session open to the Linux host rhel1, bring that window up now, otherwise open a new PuTTY session to that host (username = `root`, password = `Netapp1!`). Issue the following commands to verify that you can still access the “susan” qtree from rhel1.

```
[root@rhel1 ~]# cd /svm1/engineering/users
[root@rhel1 users]# ls
bob susan
[root@rhel1 users]# cd susan
[root@rhel1 susan]# echo "hello from rhel1" > rhel1.txt
[root@rhel1 susan]# cat rhel1.txt
hello from rhel1
[root@rhel1 susan]#
```

18. Now open a PuTTY connection to the Linux host rhel2 (again, username = `root` and password = `Netapp1!`). This host should be able to access all the volumes and qtrees in the svm1 namespace *except* “susan”, which should give a permission denied error because that qtree's associated export policy only grants access to the host rhel1.

```
[root@rhel2 ~]# mkdir /svm1
[root@rhel2 ~]# mount svm1:/ /svm1
[root@rhel2 ~]# cd /svm1/engineering/users
[root@rhel2 users]# ls
bob susan
```

```
[root@rhel2 users]# cd susan
bash: cd: susan: Permission denied
[root@rhel2 users]# cd bob
[root@rhel2 bob]
```

4 References

The following references were used in writing this lab guide.

- TR-3982: NetApp Clustered Data ONTAP 8.3.X and 8.2.X – an Introduction, November 2015
- TR-4100: Nondisruptive Operations with SMB File Shares ONTAP 9.x, November 2016
- TR-4129: Namespaces in clustered Data ONTAP, July 2014
- TR-4523: DNS Load Balancing in ONTAP - Configuration and Best Practices, May 2020
- NetApp Hardware Universe: https://hwu.netapp.com/Home/Index, NetApp Support site login required.

5 Version History

Version	Date	Document Version History
Version 1.0	October 2014	Initial Release for Hands On Labs
Version 1.0.1	December 2014	Updates for Lab on Demand
Version 1.1	April 2015	Updated for Data ONTAP 8.3GA and other application software. NDO section spun out into a separate lab guide.
Version 1.2	October 2015	Updated for Data ONTAP 8.3.1GA and other application software.
Version 1.3	September 2016	Updated for ONTAP 9.0RC1 and other application software.
Version 1.3 Rev 1	November 2016	Updated for ONTAP 9.0P1, various errata.
Version 2.0	October 2018	Updated for ONTAP 9.4, created separate NAS and SAN lab guides.
Version 2.1	April 2019	Updated for ONTAP 9.5
Version 2.2	December 2020	Updated for ONTAP 9.7
Version 2.2.1	May 2023	Fixed typo

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