Abstract
This document discusses the virtualization features and integration points between the Dell EMC™ PowerStore™ platform and VMware® vSphere®.

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Executive summary

Virtualization offers many benefits such as consolidation, performance, availability, business continuity, load balancing, and ease of maintenance. Because of these advantages, more applications are being virtualized today. It is important for data-center components to not only support, but also provide integration with hypervisors and virtualized applications. This document details the many virtualization features and integration points that are available on Dell EMC™ PowerStore™.

Audience

This document is intended for IT administrators, storage architects, partners, and Dell Technologies™ employees. This audience also includes any individuals who may evaluate, acquire, manage, operate, or design a Dell EMC networked storage environment using PowerStore systems.
1 Introduction

Dell EMC PowerStore achieves new levels of operational simplicity and agility. It uses a container-based microservices architecture, advanced storage technologies, and integrated machine learning to unlock the power of your data. PowerStore is a versatile platform with a performance-centric design that delivers multidimensional scale, always-on data reduction, and support for next-generation media.

PowerStore brings the simplicity of public cloud to on-premises infrastructure, streamlining operations with an integrated machine-learning engine and seamless automation. It also offers predictive analytics to easily monitor, analyze, and troubleshoot the environment. PowerStore is highly adaptable, providing the flexibility to host specialized workloads directly on the appliance and modernize infrastructure without disruption. It also offers investment protection through flexible payment solutions and data-in-place upgrades.

1.1 PowerStore virtualization integration

PowerStore features multiple integration points with VMware® vSphere® virtualization technology that is used in data centers today. Many of these powerful integration points are embedded in the system and are designed with the end-user experience in mind. They can be easily managed directly from the HTML5-based PowerStore Manager user interface. In addition to the integration points that are built into the system, off-array software and plug-ins are available. These plug-ins enable PowerStore to be used with existing tools and fit the specific requirements of each organization. Storage and virtualization administrators can use these features to create simple, modern, flexible, and affordable solutions.

PowerStore is offered as a PowerStore T model or PowerStore X model appliance. Both models are designed to have deep integration with VMware vSphere. These integrations include VAAI and VASA support, event notifications, snapshot management, storage containers for VMware vSphere Virtual Volumes™ (vVols), and virtual machine discovery and monitoring in PowerStore Manager.

PowerStore X models provide flexibility and agility by providing AppsON functionality. This ability enables administrators to run applications directly on the storage system. Due to the embedded VMware ESXi™ hypervisor on the PowerStore X model nodes, other virtualization features and automation for the configuration process are available on this model. The vSphere hypervisor is embedded on each of the PowerStore X model nodes to allow running applications. Simultaneously, it can also be used as a standard external storage array, providing block-volume access to servers over Fibre Channel or iSCSI.

1.2 Terminology

**Fibre Channel (FC) protocol**: Transfer protocol used to communicate IP and SCSI commands over an FC network.

**Internet SCSI (iSCSI)**: Provides a mechanism for accessing block-level data storage over network connections.

**PowerStore Manager**: An HTML5 user interface used to manage Dell EMC PowerStore systems.

**Storage container**: A VMware term for a logical entity that consists of one or more capability profiles and their storage limits. This entity is known as a VMware vSphere Virtual Volumes™ (vVol) datastore once it is mounted in vSphere.

**Storage Policy Based Management (SPBM)**: Using policies to control storage-related capabilities for a VM and ensure compliance throughout its life cycle.
**Virtual machine (VM):** An operating system running on a hypervisor, which is used to emulate physical hardware.

**vCenter:** VMware vCenter® server that provides a centralized platform for managing VMware vSphere environments.

**VMware vSphere Virtual Volumes (vVols):** A VMware storage framework which allows VM data to be stored on individual Virtual Volumes. This ability allows for data services to be applied at a VM-level of granularity and according to SPBM. Virtual Volumes can also refer to the individual storage objects that are used to enable this functionality.

**vSphere API for Array Integration (VAAI):** A VMware API that improves ESXi host utilization by offloading storage-related tasks to the storage system.

**vSphere API for Storage Awareness (VASA):** A VMware vendor-neutral API that enables vSphere to determine the capabilities of a storage system. This feature requires a VASA provider on the storage system for communication.
vCenter connection

To enable virtual machine (VM) discovery, monitoring, and snapshot management, the vCenter server must be registered in PowerStore Manager. This enables PowerStore to monitor the VM attributes, capacity, storage and compute performance, and virtual volumes. It also enables PowerStore to subscribe to event notifications, alleviating the need for PowerStore to continuously poll for new information.

On PowerStore X models, a vCenter server connection is required as part of the initial configuration process. This connection enables the VASA provider registration and vVol datastore creation to happen automatically. This ability allows users to begin using vVols immediately after deploying the system without any additional setup. For PowerStore X models, the vCenter must be hosted on an external server.

On PowerStore T models, a vCenter server connection is optional so it is not configured by default. In order to connect a vCenter server, go to **Compute > vCenter Server Connection**. You can connect a vCenter by entering in the **vCenter Server IP Address** (or FQDN), **User Name**, and **Password** for an existing vCenter server. The vCenter requirements are:

- **PowerStore T models**
  - vCenter version 6.0 Update 2 or newer

- **PowerStore X models**
  - vCenter version 6.7 or newer
    - Any vCenter releases that support vSphere 6.7 can be used for PowerStore X models
  - vCenter Foundation or Standard license

The vCenter Server Connection page is shown in Figure 1.

![Registering a vCenter server](image-url)
After a successful vCenter server connection is made, the IP address or hostname of the connected vCenter is displayed and the status changes to **Connected**. Buttons to **Launch vSphere**, **Update Connection**, and **Disconnect** (PowerStore T model only) also become available, as shown in Figure 2.

![vCenter Server Connection](image)

**Figure 2** vCenter connected

The **Launch vSphere** button opens a new tab to the connected vCenter. This feature enables the administrator to easily open the connected vCenter.

The **Update Connection** button is used to update the connection with new information if the vCenter IP address, hostname, or credentials changes. Each PowerStore cluster can only be registered to a single vCenter instance at a time. The update button should not be used to connect the PowerStore cluster to a separate vCenter instance. On PowerStore T models, the vCenter connection can be disconnected and then connected to the new vCenter instance. On PowerStore X models, the vCenter connection cannot be changed to another vCenter instance. This limitation is due to the existence of the objects such as the datacenter, cluster, PowerStore X model ESXi nodes, virtual distributed switches, and other configurations.
The Update Connection page is displayed in Figure 3.

![Update Connection page](image)

**Figure 3**  Update Connection page

The **Disconnect** button is used to remove a vCenter connection. This feature is only available on PowerStore T models since the vCenter connection is mandatory on PowerStore X models. A confirmation dialog is displayed when disconnecting the vCenter server, as shown in Figure 4.

![Disconnect vCenter Server confirmation dialog](image)

**Figure 4**  Disconnect vCenter Server confirmation dialog
3 Virtual Volumes

PowerStore supports the VMware vSphere Virtual Volumes (vVols) framework through the VASA 3.0 protocol. This feature enables VM-granular data services and Storage Policy Based Management (SPBM). In traditional storage environments, volumes or file systems are formatted as VMFS or NFS datastores for VMs. Data services are applied at the volume or file-system level, which means all VMs that reside on that datastore are also affected.

With vVols, VM data is stored on dedicated storage objects that are called storage containers, which become vVol datastores in vSphere. A VM consists of multiple vVols depending on its configuration and status. PowerStore works with vSphere to track which vVols belong to which VM.

Data services, such as VM snapshots and clones, can be applied at a VM-level of granularity since they are only applied to the relevant vVols. These data services are offloaded to PowerStore to maximize efficiency. Also, policies and profiles can be leveraged to ensure VMs are provisioned with the desired storage capabilities.

3.1 VASA provider

vSphere API for Storage Awareness (VASA) is a VMware-defined and vendor-neutral API that enables vSphere to determine the capabilities of a storage system. The API requests basic storage information from PowerStore, which is used for monitoring and reporting storage details to the user in vSphere.

PowerStore includes a native VASA 3.0 provider, which enables the vVols storage framework. The VASA provider must be registered in vSphere in order to use vVols. On PowerStore X models, the storage provider is registered in vSphere automatically as part of the initial configuration process. On PowerStore T models, the storage provider must be manually registered in vSphere to enable vVols functionality. In order to register storage provider, go to the vSphere page vCenter > Storage Providers > Configure. Click Add and provide the following information:

- Name: <name>
- URL: https://<Cluster_IP>:8443/version.xml
- Username: User with administrator or VM administrator privileges
- Password: <password>
The New Storage Provider page in vSphere is displayed in Figure 5.

![New Storage Provider page](image)

Figure 5  New Storage Provider page

After a storage provider is successfully registered, additional details about the provider are displayed, as shown in Figure 6.

![Registered storage provider](image)

Figure 6  Registered storage provider
3.2 Storage containers

A storage container is used to present vVol storage from PowerStore to vSphere. vSphere mounts the storage container as a vVol datastore and makes it available for VM storage. When using PowerStore for VM storage, user VMs should be provisioned on the vVol datastores. User VMs should never be provisioned on the PowerStore X model private datastores since those datastores are reserved for the controller VMs. PowerStore includes a default storage container that is named PowerStore <Cluster_Name>, as shown in Figure 7.

![Storage Containers](image)

**Figure 7** Default storage container

On PowerStore X models, the default storage container is mounted automatically on the internal ESXi nodes. PowerStore can also expose its storage containers to external ESXi hosts, enabling VM provisioning on external compute with PowerStore vVol storage. Enable this ability using the following steps:

1. Registering the PowerStore VASA provider in vSphere (PowerStore T models only)
2. Establishing iSCSI or Fibre Channel connectivity between the external ESXi host and PowerStore
3. Registering the ESXi host and selecting its initiators
4. Initiating a rescan
5. Adding the storage container as a vVol datastore

All registered ESXi hosts are automatically granted access to all the storage containers on PowerStore. Figure 8 shows the vVol datastore mounted in vSphere.

![PowerStore vVol datastore](image)

**Figure 8** PowerStore vVol datastore

In addition to the default storage container, additional storage containers can also be created. On PowerStore X models, these additional storage containers are mounted automatically to the internal ESXi nodes. On PowerStore T models, these additional storage containers can be mounted as vVol datastores in vSphere.
By default, a storage container exposes all the free capacity available on the cluster. Storage containers can be configured with a quota to expose less or more storage to vSphere. When configuring a quota on an existing storage container, a high-water mark can also be configured. When the utilization of the storage container exceeds the high-water mark, the system generates a notification. If the utilization falls below the high-water mark, the notification clears automatically. By default, the high-water mark is set to 85% and this is user configurable. Figure 9 shows setting a quota of 5 TB and a high-water mark of 85%.

If a quota is set on an existing storage container, the size is not immediately updated in vSphere. To force a refresh, right-click the datastore and click Refresh Capacity Information. Alternatively, the capacity refreshes automatically every 15 minutes. Figure 10 shows the updated capacity on the vVol datastore after the quota is applied.
With a multi-appliance cluster, the cluster exposes a single storage container that includes all the appliances within the cluster. When a VM is provisioned on the storage container, resource balancer determines which appliance within the cluster its vVols are stored on. You can determine which appliance a vVol resides on by looking at the Virtual Volumes card within the VM or storage container properties page.

You can also migrate individual vVols to another appliance within the cluster on these pages. Although this practice is not enforced, it is recommended to keep all vVols for each VM on the same appliance for best performance. The vVol migration option is shown in Figure 11.

Figure 10  vVol datastore capacity with quota

Figure 11  Migrate vVol
3.3 Storage Policy Based Management

vVols leverage Storage Policy Based Management (SPBM) to ensure VMs have the appropriate storage capabilities through their entire life cycle. VM storage policies can be optionally created after the storage provider is registered. These policies are used to determine the desired storage capabilities when a VM is being provisioned. To create a storage policy, go to the Policies and Profiles > VM Storage Policies page in vSphere. Click Create VM Storage Policy and check the box to Enable rules for “DELLEMC.POWERSTORE.VVOL” storage.

The QoS Priority rule determines the relative performance prioritization for the VM if the system experiences resource contention. Figure 12 shows the available options when creating a new storage policy.

![Create VM Storage Policy](image)

Figure 12 Create VM Storage Policy page
4 Virtual machines

VMs that are stored on PowerStore vVol datastores are automatically discovered and displayed in PowerStore Manager. All VMs stored on the vVol datastores are displayed. This listing includes VMs using internal compute on PowerStore X and external compute on an ESXi server. This page includes a list of VMs including the name, operating system, CPUs, memory, and more, as shown in Figure 13.

![Virtual Machines page](image)

Figure 13  Virtual Machines page

Click each VM to view more details such as capacity, compute and storage performance, alerts, protection, and virtual volumes for that VM. See Figure 14.

![VM storage performance](image)

Figure 14  VM storage performance

4.1 Protection

The Protection card enables administrators to manage snapshots and configure protection policies for a VM. This page enables creating a new manual snapshot or modifying and deleting existing snapshots. A protection policy can also be applied to the VM to take snapshots automatically, like for volumes and file systems.
The VM protection page where snapshots and protection policies are configured is shown in Figure 15.

![Virtual Machines](image)

**Figure 15  VM protection**

VM snapshots are visible in both PowerStore Manager and vCenter, regardless of where they are created. You can view information about VM snapshots in the Manage Snapshots page in vCenter. You can also initiate a revert operation from here in order to restore the VM using the snapshot. You can revert to any snapshot in the snapshot tree.

Snapshots that are taken from PowerStore do not include the guest VM memory. This behavior means that the VM memory contents and power state are not preserved, but the snapshot is crash consistent. After the snapshot restore operation completes, the VM reverts to a powered-off state and can be powered back on. A VM with manual and scheduled snapshots that are created from PowerStore is shown in Figure 16.

![Manage Snapshots](image)

**Figure 16  VM snapshots**
vSphere enforces a limit of 31 snapshots for each VM, but it is possible to apply a protection policy that exceeds this limit. If this limit is reached, the oldest snapshot is automatically deleted chronologically starting with the oldest when the next snapshot is created by the policy. Although manually created snapshots count towards this limit, they are never automatically deleted since they do not have an expiration date.

In large environments, it is possible to initiate many snapshots requests to vCenter at once. In order to prevent overloading vCenter, PowerStore sends a maximum of five simultaneous create snapshot operations to vCenter. The remaining operations are queued and started as each create snapshot operation completes. PowerStore also sends a maximum of five simultaneous delete snapshot operations to vCenter. Although the create snapshot operations are sent individually, delete snapshot operations can be sent in batches, up to a limit of five. Since these two limits are different, it is possible to have a total of five create and five delete snapshot operations simultaneously on different VMs.

For more information about snapshots and protection policies, see the document *Dell EMC PowerStore: Snapshots and Thin Clones* on Dell.com/StorageResources.

### 4.2 Virtual Volumes

The type of vVol provisioned depends on the type of data that is being stored:

- **Data**: Stores data such as VMDKs, snapshots, full clones, and fast clones. At least one data vVol is required per VM to store its hard disk.
- **Config**: Stores standard VM configuration data such as .vmx files, logs, and NVRAM. At least one config vVol is required per VM to store its .vmx configuration file.
- **Swap**: Stores a copy of the VM memory pages when the VM is powered on. Swap vVols are automatically created and deleted when VMs are powered on and off. The swap vVol size matches the VM memory size.
- **Memory**: Stores a complete copy of VM memory on disk when suspended, or for a with-memory snapshot.

At a minimum, three vVols are required for each powered-on VM: **data** for the hard disk, **config** for the configuration, and **swap** for the memory pages.

The Virtual Volumes card provides details about the vVols used for the VM. PowerStore uses the VASA protocol to communicate with vSphere to create, bind, unbind, and delete vVols automatically as needed. Manual management of these vVols is not required. This page provides options to migrate vVols, manage the Watchlist, and collect support materials also.
Virtual machines

Information such as the vVol name, type, capacity, storage container, appliance, and IO priority are displayed, as shown in Figure 17.

Figure 17  Virtual Volumes
5 PowerStore X models

Each PowerStore X model node has VMware ESXi 6.7 Update 2 installed on it. Each node requires a VMware vSphere Enterprise Plus license, which can be applied after the appliance is installed. You can provide your own license or purchase one along with the PowerStore X model appliance.

5.1 Performance best practices

When configuring a new PowerStore X model appliance, it is highly recommended to apply these best practices to enable maximum performance. These settings should be changed before provisioning any resources on the appliance to avoid interruptions.

The details below provide step-by-step instructions on how to set these best practices manually in your environment. If you prefer to leverage a script to set these best practices automatically, reference KB article HOW17288 on Dell Support.

When implementing the best practices in this document, it is also recommended to review and apply the VMware vSphere settings that are described in the PowerStore Host Configuration Guide on the PowerStore Info Hub and the Dell EMC PowerStore: Best Practices Guide on Dell.com/StorageResources. The Dell EMC Virtual Storage Integrator (VSI) can also be leveraged to apply these best practices to your host automatically.

5.1.1 iSCSI targets

The Initial Configuration Wizard (ICW) requires a minimum of six IP addresses for the storage network, but it is highly recommended to supply additional IP addresses to maximize performance. These additional IP addresses are used to enable additional iSCSI targets and sessions, which significantly increase performance. The number of additional IP addresses depends on the model:

- PowerStore 1000X: No additional IP addresses and configuration needed
- PowerStore 3000X – 9000X: two additional IP addresses (one per node)

Note: If these additional IP addresses are not added in the ICW, they can be added in the Settings > Network IPs > Storage page in PowerStore Manager.

Follow these instructions to configure additional iSCSI targets:

1. Go to the Hardware > Appliance > Ports > Virtual Ports page.
2. Select the NodeA-vFEPort2 and NodeB-vFEPort2 virtual ports and click Map Storage Network.
3. Open vSphere and go to Hosts and Clusters > PowerStore X model ESXi node > Configure > Storage Adapters.
4. Click vmba64 > Static Discovery and confirm that two targets are listed.
5. Click Rescan Storage and then confirm that the additional targets are listed.
6. Repeat steps 4 through 6 on the other PowerStore X model ESXi node.
5.1.2 Queue depth
The iSCSI queue depth setting controls the number of outstanding IOs on each PowerStore X model ESXi node. For maximum performance, this setting should be modified as follows depending on the model:

- PowerStore 1000X: No changes needed
- PowerStore 3000X – 9000X: 256

Follow these instructions to configure the queue depth setting:

1. Log in to the PowerStore X model ESXi node through SSH using the credentials below:
   - Username: root
   - Password: <Dell_Service_Tag>_123!

2. Gather a list of the iSCSI devices:
   - [root@H7047-host-1:~] esxcfg-scsidesvs -c | awk '{print $1}' | grep naa.68ccf09800
   - naa.68ccf098003627e45222d0b308a6486d
   - naa.68ccf09800c15b9b1c9afe443a367359

3. Verify the queue depth setting for each iSCSI device:
   - [root@H7047-host-1:~] esxcli storage core device list -d naa.68ccf098003627e45222d0b308a6486d | grep "competing"
     - No of outstanding IOs with competing worlds: 128
   - [root@H7047-host-1:~] esxcli storage core device list -d naa.68ccf09800c15b9b1c9afe443a367359 | grep "competing"
     - No of outstanding IOs with competing worlds: 128

4. Change the queue depth to the appropriate value on each iSCSI device:
   - [root@H7047-host-1:~] esxcli storage core device set -d naa.68ccf098003627e45222d0b308a6486d -O 256
   - [root@H7047-host-1:~] esxcli storage core device set -d naa.68ccf09800c15b9b1c9afe443a367359 -O 256
5. Confirm the new queue depth values for each device:

- [root@H7047-host-1:~] esxcli storage core device list -d naa.68ccf098003627e45222d0b308a6486d | grep "competing"
- No of outstanding IOs with competing worlds: 256
- [root@H7047-host-1:~] esxcli storage core device list -d naa.68ccf09800c15b9b1c9afe443a367359 | grep "competing"
- No of outstanding IOs with competing worlds: 256

6. Repeat these steps on the other PowerStore X model ESXi node.

5.1.3 Jumbo frames

By default, the Maximum Transmission Unit (MTU) is set to 1500. Using jumbo frames (9000 MTU) increases performance and network efficiency by sending larger payloads in the Ethernet frame. In order to use jumbo frames, all equipment on the network must also be configured for jumbo frames. Follow these instructions to enable jumbo frames:

1. In PowerStore Manager, go to the Settings > Cluster MTU page.
2. Change the cluster network MTU size to 9000.
3. Go to Network IPs > Storage.
4. Click Reconfigure.
5. Confirm that there are no resources in use or actively being migrated.
6. Change the storage network MTU size to 9000.
7. Open vSphere and go to Hosts and Clusters > PowerStore X model ESXi node > Configure > Storage Adapters.
8. Click Rescan Storage.
9. The iSCSI sessions must be restarted for this change to take effect. This update can be forced on all sessions by putting the node in to maintenance mode. Right-click one of the PowerStore X model ESXi nodes > Maintenance Mode > Enter Maintenance Mode. This process may take some time to complete due to the Maintenance Mode Service.
10. After the node enters maintenance mode, wait a few minutes to ensure all services failover completely before proceeding.
11. Right-click the PowerStore X model ESXi node > Maintenance Mode > Exit Maintenance Mode.
12. After the node exits maintenance mode, allow time for the Controller VM to completely boot before proceeding.
13. Repeat steps 9 through 12 on the other PowerStore X model ESXi node.

5.2 Initial configuration

The ICW prompts for the vCenter server details on PowerStore X model appliances. You must provide the details for an existing vCenter server that is hosted on an external server. This page is not displayed when configuring a PowerStore T model appliance.

The vCenter information enables automation during the initial configuration process such as establishing the vCenter connection, creating the vSphere cluster, configuring objects such as virtual distributed switches, and registering the VASA storage provider. If an existing datacenter name is specified, the cluster is created
underneath that datacenter. Otherwise, a new datacenter with the specified name is automatically created for this cluster.

On PowerStore X models, the vCenter connection cannot be changed to another vCenter instance due to the existence of the objects such as the datacenter, cluster, PowerStore X model ESXi nodes, virtual distributed switches, and other configurations.

The PowerStore X model ICW Hypervisor page is shown in Figure 18.

![Initial Configuration](image)

Figure 18   PowerStore X model Initial Configuration > Hypervisor page

5.3 **AppsON**

Integration of the PowerStore container-based architecture with the onboard VMware ESXi results in a new level of consolidation for enterprise storage. This ability combines the benefits of a local on-array application environment with unmatched integration with the vSphere management environment and server resources. This integration allows users to bring applications closer to storage, by running applications as virtual machines running directly on PowerStore.

Benefits of the AppsON capability include a new level of agility for application deployments. This feature enables seamless movement between the PowerStore appliances and VMware ESXi servers, and the ability to shrink the stack by eliminating server and networking footprint for space-efficient edge and remote deployments. AppsON is ideal for data-intensive applications that require low latency or a storage-heavy imbalance of compute and storage.
5.4 vCenter

Due to the embedded VMware ESXi hypervisor on PowerStore X model appliances, these nodes can be managed and monitored in vCenter, along with other ESXi hosts. For PowerStore X models, the vCenter must be hosted on an external server. Standard vSphere concepts such as datacenter, cluster, hosts, and virtual distributed switches are applied to the PowerStore X model objects. Figure 19 shows these objects along with the controller VMs in vSphere.

Figure 19  PowerStore X model objects in vSphere

5.5 Controller VMs

Each PowerStore X model appliance includes two controller VMs, one for each node. These VMs run a virtualized version of the PowerStore operating system. Each controller VM reserves 50% of the available CPU and memory on the appliance, leaving the other 50% for user VMs. Resources are guaranteed for the controller VMs, so that there is no resource contention between user VMs and controller VMs. It is normal for high CPU and memory alerts to be generated for these controller VMs in vCenter due to the nature of guaranteeing resources for the Controller VMs.

Each controller VM resides on a private datastore, which is provisioned on the internal M.2 device on each physical node. These private datastores are reserved for the controller VMs and should never be used for user VMs. The controller VM must always reside on its associated node and can never be migrated. Since these VMs are fully dedicated and vital to the PowerStore X model storage operations, it is crucial to never make changes to the controller VMs. Also, do not replicate or take snapshots of the controller VMs.

The controller VMs are named PSTX-<DST>-<A/B>, where DST is the Dell Service Tag for the appliance. They are stored on a private local VMFS6 datastore that is named PRIVATE-<DST>-<A/B>.INTERNAL. These private datastores are reserved only for the controller VMs and should not be used to store any user VMs. All user VMs should be stored on the vVol datastore instead.
5.6 Networking

PowerStore X model appliances have a vSphere Distributed Virtual Switch (DVS), multiple port groups, and NIC teaming that is configured automatically as part of the initial configuration process. The DVS has a naming convention of **DVS-<Cluster_Name>**. The DVS name is then prepended to each port group name along with a dash.

The DVS has the following port groups created, by default:

- **PG_MGMT**: PowerStore management
- **PG_MGMT_ESXi**: ESXi management
- **PG_Storage_INIT1 - 2**: VMkernel adapters for iSCSI connectivity from ESXi to the controller VM
- **PG_Storage_TGT1 - 4**: iSCSI targets on the controller VM for internal and external connectivity
- **PG_vMotion1**: vMotion network used for VM mobility

The vSphere DVS groups the physical adapters from both nodes together into uplinks. The uplinks are used on each of the port groups to indicate which ports are active, standby, or unused. Table 1 shows the mapping between the vSphere uplink, vSphere physical adapter, and PowerStore Manager port names.

<table>
<thead>
<tr>
<th>vSphere Uplink</th>
<th>vSphere Physical Adapter</th>
<th>PowerStore Manager Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uplink1</td>
<td>vmnic8</td>
<td>4PortCard-hFEPort1</td>
</tr>
<tr>
<td>Uplink2</td>
<td>vmnic9</td>
<td>4PortCard-hFEPort0</td>
</tr>
<tr>
<td>Uplink3</td>
<td>vmnic6</td>
<td>4PortCard-hFEPort3</td>
</tr>
<tr>
<td>Uplink4</td>
<td>vmnic7</td>
<td>4PortCard-hFEPort2</td>
</tr>
</tbody>
</table>

Table 2 shows the management port groups that are used for the controller VM and ESXi management. Both management networks are configured with Uplink1 and Uplink2 as active for high availability. Uplink3 and Uplink4 are configured as standby in case the primary uplinks become unavailable.

The PowerStore X model ESXi node management interface is configured on a VMkernel adapter named **vmk0**. Since the PowerStore management interface resides on the controller VM, it does not require a VMkernel adapter.

<table>
<thead>
<tr>
<th>vSphere VMkernel Adapter</th>
<th>vSphere Port Group</th>
<th>vSphere Active Uplinks</th>
<th>vSphere Standby Uplinks</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>PG_MGMT</td>
<td>Uplink2</td>
<td>Uplink3 Uplink4</td>
</tr>
<tr>
<td>vmk0</td>
<td>PG_MGMT_ESXi</td>
<td>Uplink2</td>
<td>Uplink3 Uplink4</td>
</tr>
</tbody>
</table>
Table 3 shows the VMkernel adapters that are created for storage connectivity. These VMkernel adapters are used by the PowerStore X model ESXi nodes to connect to the iSCSI targets on the controller VMs. There are two VMkernel adapters on each node for multipathing purposes. The VMkernel adapters are active on one uplink and there are no standby uplinks.

The communication between the node and controller VM is used to establish iSCSI sessions, create protocol endpoints, and run I/O to the vVol datastore. Since the controller VM runs on the node itself, the traffic on these networks remains local to the node.

<table>
<thead>
<tr>
<th>vSphere VMkernel Adapter</th>
<th>vSphere Port Group</th>
<th>vSphere Active Uplink</th>
</tr>
</thead>
<tbody>
<tr>
<td>vmk1</td>
<td>PG_Storage_INIT1</td>
<td>Uplink1</td>
</tr>
<tr>
<td>vmk2</td>
<td>PG_Storage_INIT2</td>
<td>Uplink2</td>
</tr>
</tbody>
</table>

Table 4 shows the controller VM iSCSI targets that are created. These targets enable both the PowerStore X model ESXi node and external hosts to establish iSCSI connectivity. A minimum of one per node is required, which is configured automatically as part of the initial configuration process. By default, this target is active on Uplink1 on each node. The remaining uplinks are configured in standby mode.

<table>
<thead>
<tr>
<th>vSphere Port Group</th>
<th>vSphere Active Uplink</th>
<th>vSphere Standby Uplinks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG_Storage_TGT1</td>
<td>Uplink1</td>
<td>Uplink2, Uplink3, Uplink4</td>
</tr>
<tr>
<td>PG_Storage_TGT2</td>
<td>Uplink2</td>
<td>Uplink1, Uplink3, Uplink4</td>
</tr>
<tr>
<td>PG_Storage_TGT3</td>
<td>Uplink3</td>
<td>Uplink1, Uplink2, Uplink4</td>
</tr>
<tr>
<td>PG_Storage_TGT4</td>
<td>Uplink4</td>
<td>Uplink1, Uplink2, Uplink3</td>
</tr>
</tbody>
</table>

The storage network can be scaled out to enable connectivity on the remaining ports on the four-port card. When this action is done, the additional uplinks become active as shown in Table 4. Depending on the model appliance, this action may be a best practice for maximum performance. For details about how to scale out the storage network, see section 5.1.1.
Table 5 shows information about the virtual ports that are available on the appliance. The virtual ports page can be used to map additional ports for the storage network or tag additional ports for the replication network. By default, vFEP0rt1 is tagged for both storage and replication.

Table 5  PowerStore virtual ports

<table>
<thead>
<tr>
<th>PowerStore Manager Virtual Port</th>
<th>vSphere Network Adapter</th>
<th>vSphere Port Group</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>vFEP0rt0</td>
<td>Network adapter 1</td>
<td>PG_MGMT</td>
<td>PowerStore management</td>
</tr>
<tr>
<td>vFEP0rt1</td>
<td>Network adapter 2</td>
<td>PG_Storage_TGT1</td>
<td>Storage and replication network</td>
</tr>
<tr>
<td>vFEP0rt2</td>
<td>Network adapter 3</td>
<td>PG_Storage_TGT2</td>
<td>Storage and replication network scaling</td>
</tr>
<tr>
<td>vFEP0rt3</td>
<td>Network adapter 4</td>
<td>PG_Storage_TGT3</td>
<td>Storage and replication network scaling</td>
</tr>
<tr>
<td>vFEP0rt6</td>
<td>Network adapter 5</td>
<td>PG_Storage_TGT4</td>
<td>Storage and replication network scaling</td>
</tr>
<tr>
<td>vFEP0rt7</td>
<td>Network adapter 6</td>
<td>PG_Internal</td>
<td>Internal system use</td>
</tr>
</tbody>
</table>

Table 6 shows the VMkernel adapters that are created for vMotion operations. This network is used when moving VMs between the two PowerStore X model ESXi nodes and from external hosts.

Table 6  vMotion port group uplink

<table>
<thead>
<tr>
<th>vSphere VMkernel Adapter</th>
<th>vSphere Port Group</th>
<th>vSphere Active Uplinks</th>
<th>vSphere Standby Uplinks</th>
</tr>
</thead>
<tbody>
<tr>
<td>vmk3</td>
<td>PG_vMotion1</td>
<td>Uplink3</td>
<td>Uplink1, Uplink2, Uplink4</td>
</tr>
</tbody>
</table>
Figure 20 shows these networks as they appear in vCenter.

![Figure 20 vSphere networks](image)

Before deploying a user VM on the internal ESXi nodes, a new port group should be created for the external network. This process is completed by right-clicking the **DVS > Distributed Port Group > New Distributed Port Group**. Provide the information for the new port group and configure a VLAN, if necessary. Once the new port group is configured, user VMs can be deployed and they can use this port group for network connectivity.

If the PowerStore X model ESXi node, iSCSI, or vMotion interfaces must change, they must be updated in PowerStore Manager. This action updates the configuration and propagates the necessary changes to vSphere automatically. Changing these interfaces directly in vSphere is not supported.

### 5.7 Volumes

PowerStore X model appliances can provision volumes and volume groups to external hosts. For example, you can provision volumes to external ESXi nodes for Virtual Machine File System (VMFS) datastores or Raw Disk Mappings (RDMs). It is not supported to present volumes from a PowerStore X model appliance to its own ESXi nodes. These nodes already have access to the storage through the storage container, which is configured and mounted by default. More storage containers can be created if needed.

### 5.8 Distributed Resource Scheduler Monitoring Service

PowerStore X model ESXi nodes are designed to work with VMware Distributed Resource Scheduler (DRS). During initial configuration of the PowerStore X model appliance, the appliance automatically enables DRS in partially automated mode. Partially automated mode automatically applies DRS for initial VM placement and makes suggestions for load balancing, which can be initiated by the administrator.

Since the appliance is optimized for and expects this configuration, changing these settings is not supported. The DRS Monitoring Service polls vSphere every 15 seconds and confirms that the DRS configuration has not been changed by the administrator. If any changes are detected, it automatically heals by reverting the invalid changes back to the default configuration.
5.9 **Serviceability**

On a PowerStore T model appliance, a node can be rebooted or powered off in PowerStore Manager. On a PowerStore X model appliance, these operations are not available in PowerStore Manager. Instead, a reboot or power off of a PowerStore X model node should be initiated from vCenter after it is put into maintenance mode. This helps prevent accidental reboots of PowerStore X model ESXi nodes that have VMs running on them. Figure 21 shows that these operations are unavailable on a PowerStore X model appliance.

![PowerStore X model operations](image)

**Figure 21**  PowerStore X model operations

5.10 **Maintenance Mode Service**

Before shutting down or rebooting a PowerStore X model ESXi node, put the node into maintenance mode first. Entering maintenance mode ensures that there are no VMs running on this node before it is shut down or rebooted. When maintenance mode is entered, DRS migrates any running VMs to the other node in the vSphere cluster. Figure 22 shows the maintenance mode operations that are available in vCenter.

![Maintenance Mode](image)

**Figure 22**  Maintenance Mode
Since controller VMs cannot be migrated by DRS, PowerStore X model appliances include the Maintenance Mode Service (MMS) which manages the controller VMs during maintenance mode operations. Instead of moving the controller VM, it is gracefully powered off.

If maintenance mode is initiated on a PowerStore X model ESXi node, MMS automatically initiates a shutdown of the node controller VM. The shutdown of the controller VM is started after the migration of all the user VMs has completed. Once the controller VM successfully powers off, the ESXi node enters maintenance mode. Once maintenance mode is entered, the ESXi node can be rebooted or shutdown from vCenter without impact.

When one of the controller VMs is powered off or rebooted, the services fail over to the other controller VM. To avoid interruption, place only a single node of the appliance in maintenance mode at a time. To restore high availability, maintenance mode must be exited on the node. When the administrator initiates an exit maintenance mode operation, MMS automatically powers up the controller VM. Once the controller VM fully powers up, controller VM redundancy is restored.

After entering or exiting maintenance mode on a PowerStore X model ESXi node, wait a few minutes before issuing another maintenance mode operation. This period provides the controller VMs enough time to completely fail over all resources and services before starting the next operation.

### 5.11 Upgrades

The PowerStore X model upgrade image can be used to upgrade the PowerStore X model appliance to the latest software version. However, the PowerStore X model ESXi nodes can only use ESXi versions that are validated by Dell Technologies™ and available on Dell Support. Do not use ESXi update images that are obtained from VMware or any other source. When a new version is available for update, a notification is posted. For more information, follow the upgrade procedure in the document *Dell EMC PowerStore Virtualization Guide* on the PowerStore Info Hub.
VMware VAAI

vSphere API for Array Integration (VAAI) improves ESXi host utilization by offloading storage-related tasks to PowerStore. Since these tasks are processed by the array, the ESXi host CPU, memory, and network utilization is reduced. For example, an operation such as provisioning full clones from a template VM can be offloaded to PowerStore. PowerStore processes these requests internally, performs the write operations, and returns an update to the ESXi host once the requests are complete.

The following primitives are supported with PowerStore:

**Block:**

- **Atomic Test and Set (ATS):** This enables arrays to perform locking at the block level of a volume, instead of the whole volume. This enables multiple ESXi hosts to access a volume simultaneously. This is also known as Hardware-Assisted Locking.
- **Block Zero:** This enables arrays to zero out many blocks. This speeds up VM provisioning by accelerating the disk zeroing operation. This is also known as Hardware-Assisted Zeroing or Write Same.
- **Full Copy:** This enables arrays to make full copies of data within the array without the need for the ESXi host to read and write the data. This is useful when cloning VMs. This is also known as Hardware-Assisted Move or XCOPY.
- **Thin Provisioning – Unmap and Stun:** Unmap enables arrays to reclaim unused blocks on a thin LUN. Unmap is also known as Dead Space Reclamation. Stun limits the potential impact if a thin-provisioned datastore reaches 100% full by pausing only the VMs that require additional capacity, instead of all the VMs.

**File:**

- File VAAI primitives are not supported on PowerStore.
Migration

PowerStore is designed to easily and seamlessly integrate into an existing VMware vSphere environment. Native vSphere features and tools can be used between PowerStore and external ESXi hosts.

This ability enables performing quick and simple migrations by using tools such as vMotion and Storage vMotion. vMotion can be used to move VM compute off the current ESXi host and onto a PowerStore X model node. Storage vMotion can be used to move VM storage off the current datastore and onto the PowerStore vVol datastore. You also have the option of performing both a vMotion and Storage vMotion simultaneously as shown in Figure 23.

Figure 23  Compute and Storage vMotion
8 VMware plug-ins

Plug-ins are available for off-array software that further enhances the VMware integration that is built in to the system. These plug-ins provide flexibility and enable PowerStore to easily integrate into your environment using existing tools.

8.1 Virtual Storage Integrator

Virtual Storage Integrator (VSI) brings storage provisioning, management, and monitoring capabilities to the standard VMware vSphere Client interface. Viewing and performing common storage tasks can be accomplished directly from vSphere, without needing to launch PowerStore Manager. The VSI plug-in also provides visibility into the storage system, enabling administrators to see the underlying storage that their VMs are running on. When connecting external ESXi hosts to PowerStore, use VSI to scan the host and apply best practices for performance and availability. Figure 24 shows the datastore creation wizard in VSI.

8.2 vRealize Orchestrator

VMware vRealize® Orchestrator™ (vRO) enables creating automation workflows to streamline VMware and PowerStore tasks. The PowerStore plug-in includes many workflows such as provisioning storage, managing hosts, configuring protection, and viewing the details of the resources.

The vRO framework allows individual workflows to be put together to build a custom workflow. For example, you can create a custom vRO workflow that connects an ESXi host to the iSCSI target on the PowerStore appliance and then registers the host on the appliance. The vRO workflow engine can be used with vRealize Automation to create a policy-based self-service environment.
Figure 25 shows some of the workflows available in vRO with the PowerStore plug-in.

8.3 Storage Replication Adapter

A PowerStore Storage Replication Adapter (SRA) is available for customers that are leveraging array-based replication and VMware vCenter Site Recovery Manager (SRM) for disaster recovery. For SRM to properly manage PowerStore replication, the SRA must be installed on the SRM Server hosts at the recovery and protected sites. Figure 26 shows the PowerStore SRA in SRM.
8.3.1 Best Practices

Site Recovery Manager ships with a default configuration that is tuned for a large cross-section of environments. However, each environment is unique in terms of architecture, infrastructure, size, and recovery time objectives. Larger and more complex SRM environments may require tuning adjustments for SRM to work properly.

To customize storage settings for your environment, use the following procedure:

1. Click Sites in the Site Recovery Manager interface.
2. Right-click the site > Advanced Settings.
3. Click Storage Provider.
4. Modify the settings based on the parameters in Table 7.
5. Ensure you change the settings for both sites and restart the SRM service to take effect.

### Table 7: SRA best practices

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>storage.commandTimeout</td>
<td>0</td>
<td>300</td>
<td>This option specifies the timeout allowed (in seconds) for running SRA commands in array-based replication-related workflows. Increasing this value is typically required for larger environments. Recovery plans with many datastores to manage may fail if the storage-related commands take longer than five minutes to complete. For larger environments, increase this value (for example, to 3600 or higher) in the advanced SRM settings.</td>
</tr>
<tr>
<td>storageProvider.hostRescanRepeatCnt</td>
<td>0</td>
<td>1</td>
<td>This option specifies the number of additional host rescans during test, planned migration, and recovery workflows. This feature is not available in SRM 5.0 and is reintroduced in SRM 5.0.1. Increase this value (for example, to 2 or higher) in the advanced SRM settings.</td>
</tr>
<tr>
<td>storageProvider.hostRescanTimeoutSec</td>
<td>0</td>
<td>300</td>
<td>This option specifies the timeout allowed (in seconds) for host rescans during test, planned migration, and recovery workflows. Recovery plans with many datastores and/or hosts fail if the host rescans take longer than five minutes to complete. Increase this value (for example, to 600 or higher) in the advanced SRM settings.</td>
</tr>
</tbody>
</table>
### Parameter Table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>storageProvider.fixRecoveredDatastoreNames</td>
<td>0</td>
<td>0</td>
<td>During the execution of an SRM recovery plan, a re-signature operation is carried out on the recovered devices. This leads to the addition of a prefix like snap-xxxxxxx to the datastore name. Changing this option to 1 renames the datastore to its original name.</td>
</tr>
<tr>
<td>storageProvider.resignatureFailureRetryCount</td>
<td>0</td>
<td>0</td>
<td>During a recovery or test recovery plan, it may be necessary to change this value to allow SRM to retry a re-signature operation. Usually, keeping this value equal to the value of storageProvider.hostRescanRepeatCount works the best.</td>
</tr>
<tr>
<td>storageProvider.hostRescanDelaySec</td>
<td>0</td>
<td>0</td>
<td>SRAs can send responses to SRM before a promoted storage device on the recovery site becomes available to the ESXi hosts. When SRM receives a response from an SRA, it performs a rescan of the storage devices. If the storage devices are not fully available, ESXi Server does not detect them and SRM does not find the replicated devices when it performs the rescan. Datastores are not created, and recovered virtual machines cannot be found. In large-scale environments, you might experience problems with unavailable datastores, so SRM provides this setting to allow delaying the start of rescans after an SRA promotes a storage device.</td>
</tr>
<tr>
<td>storage.minDsGroupComputationInterval</td>
<td>0</td>
<td>600</td>
<td>By default, SRM checks arrays for changes to device configurations by rescanning arrays every 10 minutes. You can reconfigure the frequency for SRM to perform regular array scans by changing the value of this parameter.</td>
</tr>
</tbody>
</table>

### 8.4 RecoverPoint for VMs

Although PowerStore includes a native VASA 3.0 provider, vVol replication is not supported. If VM-granular replication services are required, RecoverPoint™ for Virtual Machines can be leveraged. RecoverPoint for VMs is a software-only replication solution that provides any-point-in-time asynchronous and synchronous protection on a per-VM basis. It is storage agnostic, working in the hypervisor layer with all storage types supported by VMware, including vVols. For more information about RecoverPoint for VMs, see the document *RecoverPoint for Virtual Machines Administrator’s Guide* on [Dell Support](https://www.dell.com/support).
PowerStore was designed to include a comprehensive set of integration points with VMware virtualization technology. Since many of these powerful integration points are embedded in the system, they can be managed through the HTML5-based PowerStore Manager and vCenter. PowerStore X model appliances feature deeper integration by allowing applications to run directly on the appliance and seamlessly integrate into the virtualized environment. Off-array software and plug-ins are also available to enable PowerStore to be used with your existing tools. Both storage and virtualization administrators can leverage PowerStore to create a solution that meets your requirements.
A Technical support and resources

Dell.com/support is focused on meeting customer needs with proven services and support.

Storage technical documents and videos provide expertise that helps to ensure customer success on Dell EMC storage platforms.

The PowerStore Info Hub provides detailed documentation on how to install, configure, and manage Dell EMC PowerStore systems.