NetApp Element Software

User Guide

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NetApp®

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About this guide

The NetApp Element Software User Guide provides information about how to configure, manage, and use storage systems running Element data management software. This guide is intended for IT professionals, software developers, and others who install, administer, or troubleshoot NetApp SolidFire storage solutions.

This guide makes the following assumptions:

- You have a background as a Linux system administrator.
- You are familiar with server networking and networked storage, including IP addresses, netmasks, and gateways.

SolidFire storage system

The SolidFire storage system contains hardware and software designed for complete system automation and management.

Using the NetApp Element user interface (Element UI), you can set up and monitor SolidFire cluster storage capacity and performance, and manage storage activity across a multi-tenant infrastructure. The Element UI is built on the NetApp Element software API, which enables you to see system adjustments almost immediately.

Clusters

A cluster is the hub of a SolidFire storage system and is made up of a collection of nodes. You must have at least four nodes in a cluster for SolidFire storage efficiencies to be realized. A cluster appears on the network as a single logical group and can then be accessed as block storage.

Creating a new cluster initializes a node as communications owner for a cluster and establishes network communications for each node in the cluster. This process is performed only once for each new cluster. You can create a cluster by using the Element UI or the API.

You can scale out a cluster by adding additional nodes. When you add a new node, there is no interruption of service and the cluster automatically uses the performance and capacity of the new node.

Administrators and hosts can access the cluster using virtual IP addresses. Any node in the cluster can host the virtual IP addresses. The management virtual IP (MVIP) enables cluster management through a 1GbE connection, while the storage virtual IP (SVIP) enables host access to storage through a 10GbE connection. These virtual IP addresses enable consistent connections regardless of the size or makeup of a SolidFire cluster. If a node hosting a virtual IP address fails, another node in the cluster begins hosting the virtual IP address.

Note: Beginning in Element version 11.0, nodes can be configured with IPv4, IPv6, or both addresses for their management network. This applies to both storage nodes and management nodes. When creating a cluster, only a single IPv4 or IPv6 address can be used for the MVIP and the corresponding address type must be configured on all nodes.

Nodes

Nodes are the individual hardware components that are grouped into a cluster to be accessed as block storage. There are two types of nodes in a SolidFire storage system: storage nodes and Fibre Channel nodes.

Related concepts

Storage nodes on page 9
Fibre Channel nodes on page 10
Drives on page 10

Storage nodes

A SolidFire storage node is a server containing a collection of drives that communicate with each other through the Bond10G network interface. Drives in the node contain block and metadata space for data storage and data management.

Storage nodes have the following characteristics:

- Each node has a unique name. If a node name is not specified by an administrator, it defaults to SF-XXXX, where *XXXX* is four random characters generated by the system.
- Each node has its own high-performance non-volatile random access memory (NVRAM) write cache to improve overall system performance and reduce write latency.
- Each node is connected to two networks, storage and management, each with two independent links for redundancy and performance. Each node requires an IP address on each network.
- You can create a cluster with new storage nodes, or add storage nodes to an existing cluster to increase storage capacity and performance.
- You can add or remove nodes from the cluster at any time without interrupting service.

Fibre Channel nodes

SolidFire Fibre Channel nodes provide connectivity to a Fibre Channel switch, which you can connect to Fibre Channel clients. Fibre Channel nodes act as a protocol converter between the Fibre Channel and iSCSI protocols; this enables you to add Fibre Channel connectivity to any new or existing SolidFire cluster.

Fibre Channel nodes have the following characteristics:

- Fibre Channel switches manage the state of the fabric, providing optimized interconnections.
- The traffic between two ports flows through the switches only; it is not transmitted to any other port.
- Failure of a port is isolated and does not affect operation of other ports.
- Multiple pairs of ports can communicate simultaneously in a fabric.

Drives

A storage node contains one or more physical drives that are used to store a portion of the data for the cluster. The cluster utilizes the capacity and performance of the drive after the drive has been successfully added to a cluster.

A storage node contains two types of drives:

Volume metadata drives

These drives store compressed information that defines each volume, clone, or snapshot within a cluster. The total metadata drive capacity in the system determines the maximum amount of storage that can be provisioned as volumes. The maximum amount of storage that can be provisioned is independent from how much data is actually stored on the block drives of the cluster. Volume metadata drives store data redundantly across a cluster using Double Helix data protection.

Note: Some system event log and error messages refer to volume metadata drives as slice drives.

Block drives

These drives store the compressed, de-duplicated data blocks for server application volumes. Block drives make up a majority of the storage capacity of the system. The majority of read requests for data already stored on the SolidFire cluster, as well as requests to write data, occur on the block drives. The total block drive capacity in the system determines the maximum amount of data that can be stored, taking into account the effects of compression, thin provisioning, and de-duplication.

Networking

The network setup for a SolidFire system consists of switch and port requirements. The implementation of these depends on your system.

Related concepts

Switch configuration for clusters running Element software on page 11

Related references

Network port requirements on page 11

Switch configuration for clusters running Element software

The NetApp Element software system has certain switch requirements and best practices for optimal storage performance.

Storage nodes require 10 or 25GbE Ethernet switches, depending on specific node hardware, for iSCSI storage services and node intra-cluster services communication. 1GbE switches can be used for these types of traffic:

- Management of the cluster and the nodes
- Intra-cluster management traffic between the nodes
- Traffic between the cluster nodes and the management node virtual machine

You should implement the following best practices when configuring Ethernet switches for cluster traffic:

- Deploy a pair of 1GbE switches to provide high availability and load sharing for non-storage traffic in the cluster.
- Configure and utilize jumbo frames (an MTU size of 9216 bytes) on the storage network switches. This ensures a successful installation and eliminates storage network errors due to fragmented packets.

Network port requirements

You might need to allow the following TCP ports through your datacenter's edge firewall so that you can manage the system remotely and allow clients outside of your datacenter to connect to resources. Some of these ports might not be required, depending on how you use the system.

All ports are TCP unless stated otherwise, and should permit bi-directional communications between the NetApp Support Server, management node, and nodes running Element software.

Tip:

Enable ICMP between the management node, nodes running Element software, and cluster MVIP.

The following abbreviations are used in the table:

- MIP: Management IP address
- SIP: Storage IP address
- MVIP: Management virtual IP address
- SVIP: Storage virtual IP address

Source	Destination	Port	Description
iSCSI clients	Storage cluster MVIP	443	(Optional) UI and API access
iSCSI clients	Storage cluster SVIP	3260	Client iSCSI communications
iSCSI clients	Storage node SIP	3260	Client iSCSI communications
Management node	sfsupport.solidfire.com	22	Reverse SSH tunnel for support access
Management node	Storage node MIP	22	SSH access for support
Management node	DNS servers	53 TCP/UDP	DNS lookup
Management node	Storage node MIP	442	UI and API access to storage node and Element software upgrades
Management node	monitoring.solidfire.com	443	Storage cluster reporting to Active IQ
Management node	Storage cluster MVIP	443	UI and API access to storage node and Element software upgrades
SNMP server	Storage cluster MVIP	161 UDP	SNMP polling
SNMP server	Storage node MIP	161 UDP	SNMP polling
Storage SIP	Compute node SIP	8888	(NetApp HCI only) Compute node API; configuration and validation; access to software inventory
Storage node MIP	DNS servers	53 TCP/UDP	DNS lookup
Storage node MIP	Management node	80	Element software upgrades
Storage node MIP	S3/Swift endpoint	80	(Optional) HTTP communication to S3/Swift endpoint for backup and recovery
Storage node MIP	NTP server	123 TCP/UDP	NTP
Storage node MIP	Management node	162 UDP	SNMP traps
Storage node MIP	SNMP server	162 UDP	SNMP traps
Storage node MIP	LDAP server	389 TCP/UDP	LDAP lookup
Storage node MIP	Remote storage cluster MVIP	443	Remote replication cluster pairing communication
Storage node MIP	Remote storage node MIP	443	Remote replication cluster pairing communication
Storage node MIP	S3/Swift endpoint	443	(Optional) HTTPS communication to S3/Swift endpoint for backup and recovery

Source	Destination	Port	Description
Storage node MIP	Management node	10514 TCP/UDP 514 TCP/UDP	Syslog forwarding
Storage node MIP	Syslog server	10514 TCP/UDP 514 TCP/UDP	Syslog forwarding
Storage node MIP	LDAPS server	636 TCP/UDP	LDAPS lookup
Storage node MIP	Remote storage node MIP	2181	Intercluster communication for remote replication
Storage node SIP	S3/Swift endpoint	80	(Optional) HTTP communication to S3/Swift endpoint for backup and recovery
Storage node SIP	S3/Swift endpoint	443	(Optional) HTTPS communication to S3/Swift endpoint for backup and recovery
Storage node SIP	Remote storage node SIP	2181	Intercluster communication for remote replication
Storage node SIP	Storage node SIP	3260	Internode iSCSI
Storage node SIP	Remote storage node SIP	4000 through 4020	Remote replication node-to-node data transfer
System administrator PC	Storage node MIP	80	(NetApp HCI only) Landing page of NetApp HCI Deployment Engine
System administrator PC	Management node	442	HTTPS UI access to management node
System administrator PC	Storage node MIP	442	HTTPS UI and API access to storage node
			(NetApp HCI only) Configuration and deployment monitoring in NetApp HCI Deployment Engine
System administrator PC	Management node	443	HTTPS UI and API access to management node
System administrator PC	Storage cluster MVIP	443	HTTPS UI and API access to storage cluster
System administrator PC	Storage node MIP	443	HTTPS storage cluster creation, post-deployment UI access to storage cluster
vCenter Server	Storage cluster MVIP	443	vCenter Plug-in API access

Source	Destination	Port	Description
vCenter Server	Management node	8080/8443	(Optional) vCenter Plug-in QoSSIOC service. 8080 redirects to 8443.
vCenter Server	Storage cluster MVIP	8444	vCenter VASA provider access (VVols only)
vCenter Server	Management node	9443	vCenter Plug-in registration. The port can be closed after registration is complete.

Related information

VMware documentation

System setup

Before you can use your SolidFire storage system, you must install and configure the management node, configure the individual nodes, create a cluster, and add drives to the cluster.

The SolidFire storage system provisions storage using volumes. Volumes are block devices accessed over the network by iSCSI or Fibre Channel clients. Accounts enable clients to connect to volumes on a node. You must create accounts to be able to access the volumes on a node.

Your hardware must be racked, cabled, and powered on before you perform the system setup tasks. Instructions for setting up the hardware are included in the hardware shipment. When setting up the SolidFire storage system, you must follow a specific order of operations to ensure that your nodes and clusters are configured correctly.

Steps

1. Installing a management node on page 15
2. Setting up the connection.json file for Active IQ on page 16
3. Configuring a storage node on page 18
4. Configuring a Fibre Channel node on page 20
5. Creating a new cluster on page 21
6. Adding drives to a cluster on page 22
7. Changing the Element software default SSL certificate on page 23

Related concepts

Using the Element software web UI on page 24
Working with accounts on page 57
Working with volumes on page 59

Installing a management node

You can install the management node using the appropriate image for your configuration. A management node is a virtual machine-based node used to upgrade the system software, connect to Active IQ for system monitoring, and allow NetApp Support to access your nodes if you need help troubleshooting a problem.

Before you begin

You have identified the management node image type that is correct for your platform. See the following table for guidance:

Platform	Installation image type
Microsoft Hyper-V	`.iso`
KVM	`.iso`
VMware vSphere	`.iso`, `.ova`
Citrix XenServer	`.iso`
OpenStack	`.iso`

About this task

You must use a minimum screen resolution of 1024 x 768 at 16-bit color.

Steps

1. Create a new 64-bit virtual machine with the following configuration:
   - Two virtual CPUs
   - 8GB RAM
   - 400GB virtual disk, thin provisioned
   - One virtual network interface with internet access
   - (Optional) One virtual network interface with management network access to the storage cluster
2. Attach the `solidfire-fdva-xxxx-xxxx.iso` to the virtual machine, and boot to the `.iso` install image.

   Note:
   - Access the NetApp Support Site for the latest version of the management node `.iso` image.
   - Installing a management node removes all data from the virtual machine (VM).
3. Power on the management node after the installation completes.
4. Create a management node admin user using the terminal user interface (TUI).

   Tip: To enter text, press **Enter** on the keyboard to open edit mode. After you enter text, press **Enter** again to close the edit mode. To navigate between fields, use the arrow keys.
5. Configure the management node network using the TUI.

Related concepts

Working with the management node on page 149

Related tasks

Accessing a management node on page 150
Configuring the node using the TUI on page 20

Setting up the connection.json file for Active IQ

You must configure the `connection.json` file when connecting to SolidFire Active IQ from behind a proxy server.

About this task

You might choose to leave out the proxy and certificates steps of this procedure if they are not required in your environment. The proxyUsername and proxyPassword are optional even if you specify a proxy server. If you specify a proxyIP, you must also specify a proxyPort.

Note: The certificates option might be required if the collector is installed on something other than a management node. By default, the certificates option looks for the `/etc/ssl/certs/ca-certificates.crt` file to get the set of trusted root certificates to validate the remote support server SSL certification. If that file does not exist, you can use the certificates file that is

maintained by the cURL project. The certificates file is located at: http://curl.haxx.se/ca/cacert.pem. Save the `cacert.pem` file in a desired location, and point the certificates option to that file.

Steps

1. Open a terminal window and use Secure Shell (SSH) to connect to your management node.
2. Become root with the following command:

   ```
   sudo su
   ```

3. Change to the following directory: cd / solidfire/collector
4. Change the permissions for the `collector.py` file to 775 with the following command:

   ```
   sudo chmod 775 collector.py
   ```

5. View the help to see the options that you can use to configure the `connection.json` file.

   ```
   sudo ./manage-collector.py --help
   ```

6. Set the user name and MVIP for the collection configuration in the `connection.json` file.

   See the following sample input command:

   ```
   ./manage-collector.py  --set-username <username>  --set-mvip <mvip>
   ```

   The script automatically saves the `connection.json` file.

7. Set the password using the set-password command.

   See the following sample input command:

   ```
   ./manage-collector.py  --set-password <password>
   ```

   Note: When you enter a password using the set-password command, you are prompted to enter the password and reenter it to confirm the password.

8. Restart the collector service with the following command:

   ```
   sudo restart sfcollector
   ```

9. Verify the connection is working with the following command:

   ```
   tail -f /var/log/sf-collector.log
   ```

Related references

Help options for the manage-collector.py utility on page 17

Help options for the manage-collector.py utility

You can view the full list of help options that can be used to configure the `connection.json` file.

-h --help

Show help message and exit.

--config CONFIG

Collector configuration file to manage (default: ./connection.json).

--save-config

Save the configuration to the collector configuration file. This option is not necessary when calling any of the set commands; the configuration is saved automatically when using those commands.

--set-username USERNAME

Set the cluster user name in the collector configuration file.

--set-password

Set the cluster password in the collector configuration file.

Note: The new password will be captured at the prompt.

--set-mvip MVIP

Set the cluster management virtual IP (MVIP) address in the collector configuration file.

--set-remoteHost REMOTEHOST

Set the remote host in the collector configuration file.

--get-all

Get all the parameters from the collector configuration file.

--get-username

Get the cluster user name from the collector configuration file.

--get-password

Get the cluster password from the collector configuration file.

--get-mvip

Get the cluster MVIP from the collector configuration file.

--get-remoteHost

Get the remote host from the collector configuration file.

--debug

Enable debug messages.

Related tasks

Setting up the connection.json file for Active IQ on page 16

Configuring a storage node

You must configure individual nodes before you can add them to a cluster. When you install and cable a node in a rack unit and power it on, the terminal user interface (TUI) displays the fields necessary to configure the node. Ensure that you have the necessary configuration information for the node before proceeding.

Alternatively, you can configure these settings by accessing the node via the Element UI using the Dynamic Host Configuration Protocol (DHCP) 1G management IP address displayed in the TUI. The DHCP address is located in the menu bar at the top of the TUI.

You cannot add a node with DHCP assigned IP addresses to a cluster. You can use the DHCP IP address to initially configure the node in the Element UI, TUI, or API. During this initial configuration, you can add the static IP address information so that you can add the node to a cluster.

After initial configuration, you can access the node using the node's management IP address. You can then change the node settings, add it to a cluster, or use the node to create a cluster. You can also configure a new node using Element software API methods.

Note: Beginning in Element version 11.0, nodes can be configured with IPv4, IPv6, or both addresses for their management network. This applies to both storage nodes and management nodes. When creating a cluster, only a single IPv4 or IPv6 address can be used for the MVIP and the corresponding address type must be configured on all nodes.

Related concepts

Configuring iDRAC on each new node on page 20

Related tasks

Configuring the node using the node UI on page 19
Configuring the node using the TUI on page 20
Creating a new cluster on page 21

Related references

Node states on page 41

Related information

NetApp SolidFire Installation

Configuring the node using the node UI

You can configure nodes using the Node Configuration user interface.

About this task

- You can configure the node using IPv4 or IPv6 addressing.
- You need the DHCP address displayed in the TUI to access a node. You cannot use DHCP addresses to add a node to a cluster.

  Attention: You should configure the Bond1G and Bond10G interfaces for separate subnets. Bond1G and Bond10G interfaces configured for the same subnet causes routing problems when storage traffic is sent via the Bond1G interface. If you must use the same subnet for management and storage traffic, manually configure management traffic to use the Bond10G interface. You can do this for each node using the Cluster Settings page of the Element UI.

Steps

1. In a browser window, enter the DHCP IP address of a node.

   You must add the extension `:442` to access the node; for example, `https://172.25.103.6:442`.

   The Network Settings tab opens with the Network Settings – Bond1G section.
2. Enter the 1G network settings.
3. Click **Save Changes**.
4. Click **Bond10G** to display the settings for the 10G network settings.
5. Enter the 10G network settings.
6. Click **Save Changes**.

7. Click **Cluster Settings**.
8. Enter the hostname for the 10G network.
9. Click **Save Changes**.

Configuring the node using the TUI

You can use the terminal user interface (TUI) to perform initial configuration for new nodes.

About this task

Attention: You should configure the Bond1G and Bond10G interfaces for separate subnets. Bond1G and Bond10G interfaces configured for the same subnet causes routing problems when storage traffic is sent via the Bond1G interface. If you must use the same subnet for management and storage traffic, manually configure management traffic to use the Bond10G interface. You can do this for each node using the Cluster Settings page of the Element UI.

Steps

1. Attach a keyboard and monitor to the node and then power on the node.

   The TUI appears on the tty1 terminal with the Network Settings tab. If a DHCP server is running on the network with available IP addresses, the 1GbE address appears in the Address field.

   Note: If the node cannot reach your configuration server, the TUI displays an error message. Check your configuration server connection or the networking connection to resolve the error.

2. Use the on-screen navigation to configure the 1G and 10G network settings for the node.

   Tip: To enter text, press **Enter** on the keyboard to open edit mode. After you enter text, press **Enter** again to close the edit mode. To navigate between fields, use the arrow keys.

3. Enter **s** to save the settings, and then enter **y** to accept the changes.
4. Enter **c** to navigate to the **Cluster** tab.
5. Use the on-screen navigation to configure the cluster settings for the node.

   All the nodes in a cluster must have identical cluster names. Cluster names are case-sensitive.

6. Enter **s** to save the settings, and then enter **y** to accept the changes.

   The node is put in a pending state and can be added to an existing cluster or a new cluster.

Configuring iDRAC on each new node

NetApp installs Dell iDRAC Enterprise on each node. iDRAC enables you to remotely manage and monitor the underlying hardware of each node in the cluster.

Related information

How to configure iDRAC on a SolidFire storage node

Configuring a Fibre Channel node

Fibre Channel nodes enable you to connect the cluster to a Fibre Channel network fabric. Fibre Channel nodes are added in pairs, and operate in active-active mode (all nodes actively process traffic for the cluster). Clusters running Element software version 9.0 and later support up to four nodes; clusters running previous versions support a maximum of two nodes.

You must ensure that the following conditions are met before you configure a Fibre Channel node:

- At least two Fibre Channel nodes are connected to Fibre Channel switches.
- All SolidFire Fibre Channel ports should be connected to your Fibre Channel fabric. The four SolidFire Bond10G network connections should be connected in one LACP bond group at the switch level. This will allow for the best overall performance from the Fibre Channel systems.

Network and cluster configuration steps are the same for Fibre Channel nodes and storage nodes.

When you create a new cluster with Fibre Channel nodes and SolidFire storage nodes, the worldwide port name (WWPN) addresses for the nodes are available in the Element UI. You can use the WWPN addresses to zone the Fibre Channel switch.

WWPNs are registered in the system when you create a new cluster with nodes. In the Element UI, you can find the WWPN addresses from the WWPN column of the FC Ports tab, which you access from the Cluster tab.

Related concepts

Configuring iDRAC on each new node on page 20

Related tasks

Configuring the node using the node UI on page 19
Configuring the node using the TUI on page 20
Creating a new cluster on page 21

Related information

SolidFire Fibre Channel Configuration Guide

Creating a new cluster

You can create a new cluster after you have configured individual nodes. When you create a cluster, a cluster administrator user account is automatically created for you. The cluster administrator has permission to manage all cluster attributes and can create other cluster administrator accounts.

Before you begin

- You have installed the management node.
- You have configured individual nodes.

About this task

During new node configuration, 1G or 10G Management IP (MIP) addresses are assigned to each node. You must use one of the node IP addresses created during configuration to open the Create a New Cluster page. The IP address you use depends on the network you have chosen for cluster management.

Note: When creating a new cluster, if you are using storage nodes that reside in a shared chassis, you might want to consider designing for chassis-level failure protection using the protection domains feature.

Steps

1. In a browser window, enter a node MIP address.
2. In **Create a New Cluster**, enter the following information:

- Management VIP: Routable virtual IP on the 1GbE or 10GbE network for network management tasks.

  Note: You can create a new cluster using IPv4 or IPv6 addressing.

- iSCSI (storage) VIP: Virtual IP on the 10GbE network for storage and iSCSI discovery.

  Note: You cannot change the SVIP after you create the cluster.

- User name: The primary cluster administrator user name for authenticated access to the cluster. You must save the user name for future reference.

  Note: You can use uppercase and lowercase letters, special characters, and numbers for the user name.

- Password: Password for authenticated access to the cluster. You must save the user name for future reference.

Two-way data protection is enabled by default. You cannot change this setting.

3. Read the End User License Agreement, and click **I Agree**, if you approve.
4. Optional: In the Nodes list, ensure that the check boxes for nodes that should not be included in the cluster are not selected.
5. Click **Create Cluster**.

   The system might take several minutes to create the cluster depending on the number of nodes in the cluster. On a properly configured network, a small cluster of five nodes should take less than one minute. After the cluster is created, the Create a New Cluster window is redirected to the MVIP URL address for the cluster and displays the Element UI.

Adding drives to a cluster

When you add a node to the cluster or install new drives in an existing node, the drives automatically register as available. You must add the drives to the cluster using either the Element UI or API before it can participate in the cluster.

About this task

Drives are not displayed in the Available Drives list when the following conditions exist:

- Drives are in Active, Removing, Erasing, or Failed state.
- The node of which the drive is a part of is in Pending state.

Steps

1. Select **Cluster > Drives**.
2. Click **Available** to view the list of available drives.
3. Choose one of the following options to add drives:

Option	Steps
To add individual drives	**a.** Click the **Actions** button for the drive you want to add. **b.** Click **Add**.

Option	Steps
To add multiple drives	**a.** Select the check boxes of the drives to add, and click **Bulk Actions**. **b.** Click **Add**.

Related information

How to calculate max provisioned space in a SolidFire cluster

Changing the Element software default SSL certificate

You can change the default SSL certificate and private key of the storage node in the cluster using the NetApp Element API.

When a NetApp Element software cluster is created, the cluster creates a unique self-signed Secure Sockets Layer (SSL) certificate and private key that is used for all HTTPS communication via the Element UI, per-node UI, or APIs. Element software supports self-signed certificates as well as certificates that are issued and verified by a trusted Certificate Authority (CA).

You can use the following API methods to get more information about the default SSL certificate and make changes. For information about each method, see the *NetApp Element Software API Reference Guide* in the Element product library.

GetSSLCertificate

You can use this method to retrieve information about the currently installed SSL certificate including all certificate details.

SetSSLCertificate

You can use this method to set the cluster and per-node SSL certificates to the certificate and private key you supply. The system validates the certificate and private key to prevent an invalid certificate from being applied.

RemoveSSLCertificate

This method removes the currently installed SSL certificate and private key. The cluster then generates a new self-signed certificate and private key.

Note: The cluster SSL certificate is automatically applied to all new nodes added to the cluster. Any node removed from the cluster reverts to a self-signed certificate and all user-defined certificate and key information is removed from the node.

Related information

NetApp Element Product Library

Using the Element software web UI

You can use the NetApp Element software web user interface (Element UI) to monitor and perform common tasks on your SolidFire system. You can access the UI by using the management virtual IP (MVIP) address of the primary cluster node.

Before you access the UI, you must ensure that popup blockers and NoScript settings are disabled in your browser.

You can access the UI using IPv4 or IPv6 addressing.

IPv4

Enter `https://<IPv4 MVIP address>`. For example, https://10.123.456.789/

IPv6

Enter `https://[IPv6 MVIP address]`. For example, https://[fd20:8b1e:b256:45a::1234]/

For DNS

Enter the host name.

You should click through any authentication certificate messages.

Related tasks

Using filters on page 24
Using the API log on page 25
Sorting lists on page 25
Providing feedback on page 27

Related references

Icons in the Element UI on page 26

Using filters

You can sort and filter list information on pages in the Element UI. When viewing lists (such as volumes, snapshots, and so on), you can use filter functionality to focus the information and make it more easily fit on the screen.

Steps

1. When viewing list information, click **Filter**.
2. Expand the **Filter By** field.
3. Choose a column to filter by from the leftmost element in the field.
4. Choose a constraint for the column.
5. Enter text to filter by.
6. Click **Add**.

   The system runs the new filter on the information in the list, and temporarily stores the new filter in the Filter By field.
7. Optional: To add another filter, perform the following steps:

a. Click **Add**.

b. Follow Steps 3 through 6 to add another filter.

8. Optional: Click **Clear All** to remove the list of filters and display the unfiltered list information.

Sorting lists

You can sort list information by one or more criteria on certain pages in the Element UI. This helps you arrange the information you need on the screen.

Steps

1. To sort on a single column, click the column heading until the information is sorted in the desired order.
2. To sort using multiple columns, click the column heading for each column you want to sort by until the information in each column is sorted in the desired order.

   The Sort button appears when you sort using multiple columns.
3. To reorder the sort criteria, perform the following steps:

   a. Click **Sort**.

      The system populates the Sort By field with your column selections.

   b. Arrange the columns in the Sort By field in the order you want the list to be sorted.

      The system sorts the list information.
4. To remove a single sort criterion, click the **Remove** icon next to the name of a sort criteria.
5. Optional: To remove all sort criteria, click **Clear All**.

Using the API log

The Element system uses the NetApp Element API as the foundation for its features and functionality. The Element UI enables you to view various types of real-time API activity on the system as you use the interface. With the API log, you can view user-initiated and background system API activity, as well as API calls made on the page you are currently viewing.

About this task

You can use the API log to identify what API methods are used for certain tasks, and see how to use the API methods and objects to build custom applications. For information about each method, see the *NetApp Element Software API Reference Guide* in the Element product library

Steps

1. From the Element UI navigation bar, click **API Log**.
2. To modify the type of API activity displayed in the **API Log** window, perform the following steps:

   a. Select **Requests** to display API request traffic.

   b. Select **Responses** to display API response traffic.

   c. Filter the types of API traffic by selecting one of the following:

- **User Initiated**: API traffic by your activities during this web UI session.
- **Background Polling**: API traffic generated by background system activity.
- **Current Page**: API traffic generated by tasks on the page you are currently viewing.

Related information

NetApp Element Product Library

Element UI and cluster load

Depending on API response times, the cluster might automatically adjust the data refresh interval for certain portions of the page you are viewing.

The refresh interval is reset to the default when you reload the page in your browser. You can see the current refresh interval by clicking the cluster name in the upper-right of the page. Note that the interval controls how often API requests are made, not how quickly the data comes back from the server.

When a cluster is under heavy load, it might queue API requests from the Element UI. In rare circumstances, when system response is significantly delayed, such as a slow network connection combined with a busy cluster, you might be logged out of the Element UI if the system does not respond to queued API requests quickly enough. If you are redirected to the logout screen, you can log in again after dismissing any initial browser authentication prompt. Upon returning to the overview page, you might be prompted for cluster credentials if they are not saved by your browser.

Icons in the Element UI

You can find information about the icons in the Element UI.

The following table provides a quick reference:

Icon	Description
	Actions
	Backup to
	Clone or copy
	Delete or purge
	Edit
	Filter
	Pair
	Refresh
	Restore
	Restore from
	Rollback

Icon	Description
	Snapshot

Providing feedback

You can help improve the Element software web user interface and address any UI issues by using the feedback form that is accessible throughout the UI.

Steps

1. From any page in the Element UI, click the **Feedback** button.
2. Enter relevant information in the Summary and Description fields.
3. Attach any helpful screenshots.
4. Enter a name and email address.
5. Select the check box to include data about your current environment.
6. Click **Submit**.

System management

You can manage your system in the Element UI. This includes creating and managing cluster administrators, managing cluster settings, and upgrading software.

Related concepts

Managing cluster administrator users on page 28
Configuring cluster settings on page 33
Upgrading storage nodes on page 47

Managing cluster administrator users

You can manage cluster administrators for a SolidFire storage system. Available cluster administrator management functions include creating, deleting, and editing cluster administrator accounts, changing the cluster administrator password, and configuring LDAP settings to manage system access for users.

Related concepts

Storage cluster user types on page 28

Related tasks

Creating a cluster administrator account on page 29
Editing cluster administrator permissions on page 30
Deleting a cluster administrator account on page 31
Changing passwords for cluster administrator accounts on page 31
Configuring LDAP on page 32
Disabling LDAP on page 33

Related references

Cluster Admins details on page 29

Storage cluster user types

There are two types of administrators that can exist in a storage cluster running Element software: the primary cluster administrator account and a cluster admin role.

The following types of administrators can exist in a cluster:

Primary cluster administrator account

This administrator account is created when the cluster is created. This account is the primary administrative account with the highest level of access to the cluster. This account is analogous to a root user in a Linux system. Two (or more) cluster administrators with administrator access permissions must exist before you can delete the primary cluster administrator account. You can change the password for this administrator account.

Cluster admin account

You can give a cluster admin account a limited range of administrative access to perform specific tasks within a cluster. The credentials assigned to each cluster admin account are used to authenticate API and Element UI requests within the storage system.

Note: A local (non-LDAP) cluster admin account is required to access active nodes in a cluster via the per-node UI. Account credentials are not required to access a node that is not yet part of a cluster.

Cluster Admins details

On the Cluster Admins page of the Users tab, you can view the following information.

ID

Sequential number assigned to the cluster admin account.

Username

The name given to the cluster admin account when it was created.

Access

Shows the user permissions assigned to the user account. Possible values:

- read
- reporting
- nodes
- drives
- volumes
- accounts
- clusterAdmins
- administrator

Note: All permissions are available to the administrator access type.

Type

Shows the type of cluster administrator. Possible values:

- Cluster
- Ldap

Attributes

If the cluster admin user was created using the Element API, this column shows any name-value pairs that were set using that method. See the *NetApp Element Software API Reference Guide* in the Element product library.

Related information

NetApp Element Product Library

Creating a cluster administrator account

You can create new cluster administrator accounts with permissions to allow or restrict access to specific areas of the storage system. When you set cluster administrator account permissions, the system grants read-only rights for any permissions you do not assign to the cluster administrator.

Before you begin

If you want to create an LDAP cluster administrator account, ensure that LDAP is configured on the cluster before you begin.

Steps

1. Click **Users > Cluster Admins**.
2. Click **Create Cluster Admin**.
3. To create a cluster-wide (non-LDAP) cluster administrator account, perform the following actions:
   a. Select the **Cluster** user type.
   b. Enter a user name.
   c. Enter a password for the account.
   d. Confirm the password.
   e. Select user permissions to apply to the account.
   f. Select the check box to agree to the End User License Agreement.
   g. Click **Create Cluster Admin**.
4. To create a cluster administrator account in the LDAP directory, perform the following actions:
   a. Select the **LDAP** user type.
   b. Follow the example in the text box to enter a full distinguished name for the user.
   c. Select user permissions to apply to the account.
   d. Select the check box to agree to the End User License Agreement.
   e. Click **Create Cluster Admin**.

Related tasks

Configuring LDAP on page 32

Editing cluster administrator permissions

You can change cluster administrator account privileges for reporting, nodes, drives, volumes, accounts, and cluster-level access. When you enable a permission, the system assigns write access for that level. The system grants the administrator user read-only access for the levels that you do not select.

Steps

1. Click **Users > Cluster Admins**.
2. Click the Actions icon for the cluster administrator you want to edit.
3. Click **Edit**.
4. Select user permissions to apply to the account.
5. Click **Save Changes**.

Deleting a cluster administrator account

You can remove any cluster administrator user account created by a system administrator. You cannot remove the primary cluster administrator account that was created when the cluster was created.

Steps

1. Click **Users > Cluster Admins**.
2. Click the Actions icon for the cluster administrator you want to delete.
3. In the resulting menu, select **Delete**.
4. Confirm the action.

Changing passwords for cluster administrator accounts

You can use the Element UI to change cluster administrator passwords.

Steps

1. Click **Users > Cluster Admins**.
2. Click the Actions icon for the cluster administrator you want to edit.
3. Click **Edit**.
4. In the Change Password field, enter a new password.
5. Confirm the password.
6. Click **Save Changes**.

Related concepts

Storage cluster user types on page 28

Managing LDAP

You can set up the Lightweight Directory Access Protocol (LDAP) to enable secure directory-based login functionality to SolidFire storage. You can configure LDAP at the cluster level and authorize LDAP users and groups.

You can configure LDAP at the cluster level and authorize LDAP users and groups.

Note: You can use both IPv4 and IPv6 addresses.

LDAP details

The LDAP page on the Cluster tab provides information about the following settings.

Note: You must enable LDAP to view these LDAP configuration settings.

LDAP Authentication Enabled

To configure LDAP, you must enable authentication.

LDAP Servers

Address of an LDAP or LDAPS directory server.

Auth Type

Identifies which user authentication method is used. Possible values:

- `DirectBind`
- `SearchAndBind`

Search Bind DN

A fully qualified DN to log in with to perform an LDAP search for the user (needs bind-level access to the LDAP directory).

Search Bind Password

Password used to authenticate access to the LDAP server.

User Search Base DN

The base DN of the tree used to start the user search. The system searches the subtree from the specified location.

Group Search Type

Controls the default group search filter used. Possible values:

- `ActiveDirectory`: Nested membership of all of a user's LDAP groups.
- `NoGroups`: No group support.
- `MemberDN`: MemberDN-style groups (single-level).

Group Search Base DN

The base DN of the tree used to start the group search. The system searches the subtree from the specified location.

Test User Authentication

After LDAP is configured, use this to test the user name and password authentication for the LDAP server.

Configuring LDAP

You can configure storage system integration with an existing LDAP server. This enables LDAP administrators to centrally manage storage system access for users.

Steps

1. Click **Cluster > LDAP**.
2. Click **Yes** to enable LDAP authentication.
3. Click **Add a Server**.
4. Enter the **Host Name/IP Address**.
5. Optional: Select **Use LDAPS Protocol**.
6. Enter the required information in **General Settings**.
7. Click **Enable LDAP**.
8. Click **Test User Authentication** if you want to test the server access for a user
9. Optional: Click **Save Changes** to save any new settings.

Related tasks

Creating a cluster administrator account on page 29

Related references

LDAP details on page 31

Disabling LDAP

You can disable LDAP integration using the Element UI.

Before you begin

You have made a note of all the configuration settings, because disabling LDAP erases all settings.

Steps

1. Click **Cluster** > **LDAP**.
2. Click **No**.
3. Click **Disable LDAP**.

Configuring cluster settings

You can view and change cluster-wide settings and perform cluster-specific tasks from the Cluster tab of the Element UI.

You can configure settings such as cluster fullness threshold, support access, encryption at rest, virtual volumes, SnapMirror, and NTP broadcast client.

Related concepts

Using SnapMirror replication between Element and ONTAP clusters on page 111
Working with virtual volumes on page 71
Managing Terms of Use on page 35
Managing SNMP on page 36
Managing drives on page 39
Managing nodes on page 40
Managing virtual networks on page 44

Related tasks

Setting cluster full threshold on page 33
Enabling and disabling support access on page 34
Enabling and disabling encryption for a cluster on page 34
Enabling a broadcast client on page 36
Viewing Fibre Channel ports details on page 43

Related information

How to calculate SolidFire system error alert percentage

Setting cluster full threshold

You can change the level at which the system generates a cluster fullness warning.

Before you begin

You have cluster administrator privileges.

Steps

1. Click **Cluster** > **Settings**.
2. In the Cluster Full Settings section, enter a percentage in **Raise a warning alert when _% capacity remains before Helix could not recover from a node failure**.
3. Click **Save Changes**.

Related information

How to calculate SolidFire system error alert percentage

Enabling and disabling support access

You can enable support access to temporarily allow NetApp support personnel access to storage nodes via SSH for troubleshooting.

Before you begin

You must have cluster admin privileges to change support access.

Steps

1. Click **Cluster** > **Settings**.
2. In the Enable / Disable Support Access section, enter the duration (in hours) that you want to allow support to have access.
3. Click **Enable Support Access**.
4. Optional: To disable support access, click **Disable Support Access**.

Encryption at rest

SolidFire clusters enable you to encrypt all data stored on the cluster.

All drives in storage nodes capable of encryption leverage AES 256-bit encryption at the drive level. Each drive has its own encryption key, which is created when the drive is first initialized. When you enable the encryption feature, a cluster-wide password is created, and chunks of the password are then distributed to all nodes in the cluster. No single node stores the entire password. The password is then used to password-protect all access to the drives and must then be supplied for every read and write operation to the drive.

Enabling the encryption at rest feature does not affect performance or efficiency on the cluster. Additionally, if an encryption-enabled drive or node is removed from the cluster with the Element API or Element UI, encryption at rest will be disabled on the drives. After the drive is removed, the drive can be secure erased by using the `SecureEraseDrives` API method. If a drive or node is forcibly removed from the cluster, the data remains protected by the cluster-wide password and the drive's individual encryption keys.

Enabling and disabling encryption for a cluster

You can enable and disable cluster-wide encryption at rest. This feature is not enabled by default.

Before you begin

- You must have cluster administrator privileges to change encryption settings.
- Ensure that the cluster is in a healthy state before changing encryption settings.

Tip: Configure NTP on the cluster to point to a local NTP server. You should use the IP address and not the DNS host name. The default NTP server at cluster creation time is set to us.pool.ntp.org; however, a connection to this site cannot always be made depending on the physical location of the SolidFire cluster.

Steps

1. Click **Cluster > Settings**.
2. Click **Enable Encryption at Rest**.
3. Optional: To disable encryption at rest, click **Disable Encryption at Rest**.

Managing Terms of Use

You can use the Element UI to configure a banner that appears containing a message for the user.

Enabling Terms of Use

You can enable a Terms of Use banner that appears when a user logs in to the Element UI. When the user clicks on the banner, a text dialog box appears containing the message you have configured for the cluster. The banner can be dismissed at any time.

Before you begin

You must have cluster administrator privileges to enable Terms of Use functionality.

Steps

1. Click **Users > Terms of Use**.
2. In the **Terms of Use** form, enter the text to be displayed for the Terms of Use dialog box.

   Note: Do not exceed 4096 characters.
3. Click **Enable**.

Editing Terms of Use

You can edit the text that a user sees when they select the Terms of Use login banner.

Before you begin

- You must have cluster administrator privileges to configure Terms of Use.
- Ensure that the Terms of Use feature is enabled.

Steps

1. Click **Users > Terms of Use**.
2. In the **Terms of Use** dialog box, edit the text that you want to appear.

   Note: Do not exceed 4096 characters.
3. Click **Save Changes**.

Disabling Terms of Use

You can disable the Terms of Use banner. With the banner disabled, the user is no longer requested to accept the terms of use when using the Element UI.

Before you begin

- You must have cluster administrator privileges to configure Terms of Use.
- Ensure that Terms of Use is enabled.

Steps

1. Click **Users > Terms of Use**.
2. Click **Disable**.

Network time protocol

The NTP is used to synchronize clocks over a network. Connection to an internal or external NTP server should be part of the initial cluster setup

You can use the Element UI to enter up to five different NTP servers.

Note: You can use both IPv4 and IPv6 addresses.

Enabling a broadcast client

You can use the broadcast client setting to instruct each node in a cluster to listen for NTP broadcasts instead of querying an NTP server for updates.

Before you begin

- You must have cluster administrator privileges to configure this setting.
- You must configure an NTP server on your network as a broadcast server.

Steps

1. Click **Cluster > Settings**.
2. Under Network Time Protocol Settings, select **Yes** to use as a broadcast client.
3. In the **Server** field, enter the NTP server you configured in broadcast mode.
4. Click **Save Changes**.

Managing SNMP

You can use the Element UI to configure Simple Network Management Protocol (SNMP) in your cluster.

You can select which version of SNMP to use and configure traps to monitor the SolidFire cluster. You can also view and access management information base files.

Note: You can use both IPv4 and IPv6 addresses.

SNMP details

On the SNMP page of the Cluster tab, you can view the following information.

SNMP MIBs

You can see which MIB files are available for you to view or download.

General SNMP Settings

You can enable or disable SNMP. After you enable SNMP, you can choose which version to use. If using version 2, you can add requestors, and if using version 3, you can set up USM users.

SNMP Trap Settings

You can identify which traps you want to capture. You can set the host, port, and community string for each trap recipient.

Configuring an SNMP requestor

When SNMP version 2 is enabled, you can enable or disable a requestor, and configure requestors to receive authorized SNMP requests.

Steps

1. Click **Cluster** > **SNMP**.
2. Under **General SNMP Settings**, click **Yes** to enable SNMP.
3. From the **Version** list, select **Version 2**.
4. In the **Requestors** section, enter the **Community String** and **Network** information.
5. Optional: To add another requestor, follow these steps:
   a. Click **Add a Requestor**.
   b. Enter the **Community String** and **Network** information.

   Note: By default, the community string is public, and the network is localhost. You can change these default settings.
6. Click **Save Changes**.

Related tasks

Configuring SNMP traps on page 38
Viewing management information base files on page 38

Configuring an SNMP USM user

When you enable SNMP version 3, you need to configure a USM user to receive authorized SNMP requests.

Steps

1. Click **Cluster** > **SNMP**.
2. Under **General SNMP Settings**, click **Yes** to enable SNMP.
3. From the **Version** list, select **Version 3**.
4. In the **USM Users** section, enter the name, password, and passphrase.

5. Optional: To add another USM user, follow these steps:
   a. Click **Add a USM User**.
   b. Enter a name, password, and passphrase.
6. Click **Save Changes**.

Configuring SNMP traps

System administrators can use SNMP traps, also referred to as notifications, to monitor the health of the SolidFire cluster.

About this task

When SNMP traps are enabled, the SolidFire cluster generates traps associated with event log entries and system alerts. To receive SNMP notifications, you need to choose the traps that should be generated and identify the recipients of the trap information. By default, no traps are generated.

Steps

1. Click **Cluster > SNMP**.
2. Select one or more types of traps in the **SNMP Trap Settings** section that the system should generate:
   - Cluster Fault Traps
   - Cluster Resolved Fault Traps
   - Cluster Event Traps
3. In the **Trap Recipients** section, enter the host, port, and community string information for a recipient.
4. Optional: To add another trap recipient, follow these steps:
   a. Click **Add a Trap Recipient**.
   b. Enter the host, port, and community string for the recipient.
5. Click **Save Changes**.

Viewing management information base files

You can view and download the management information base (MIB) files used to define each of the managed objects. The SNMP feature supports read-only access to those objects defined in the SolidFire-StorageCluster-MIB.

About this task

The statistical data provided in the MIB shows system activity for the following:

- Cluster statistics
- Volume statistics
- Volumes by account statistics
- Node statistics
- Other data such as reports, errors, and system events

The system also supports access to the MIB file containing the upper level access points (OIDS) to SF-Series products.

Steps

1. Click **Cluster** > **SNMP**.
2. Under **SNMP MIBs**, click the MIB file you want to download.
3. In the resulting download window, open or save the MIB file.

Managing drives

Each node contains one or more physical drives that are used to store a portion of the data for the cluster. The cluster utilizes the capacity and performance of the drive after the drive has been successfully added to a cluster. You can use the Element UI to manage drives.

Related tasks

Adding drives to a cluster on page 22

Drives details

The Drives page on the Cluster tab provides a list of the active drives in the cluster. You can filter the page by selecting from the `Active`, `Available`, `Removing`, `Erasing`, and `Failed` tabs.

When you first initialize a cluster, the active drives list is empty. You can add drives that are unassigned to a cluster and listed in the `Available` tab after a new SolidFire cluster is created. The following table describes the elements shown in the list of active drives.

Drive ID
The sequential number assigned to the drive.

Node ID
The node number assigned when the node is added to the cluster.

Node Name
The name of the node that houses the drive.

Slot
The slot number where the drive is physically located.

Capacity
The size of the drive, in GB.

Serial
The serial number of the drive.

Wear Remaining
The wear level indicator.

Type
The type of drive. The type can be either block or metadata.

Wear remaining on drives

The storage system reports the approximate amount of wear available on each solid-state drive (SSD) for writing and erasing data. A drive that has consumed 5 percent of its designed write and erase

cycles reports 95 percent wear remaining. The system does not refresh drive wear information automatically; you can refresh or close and reload the page to refresh the information.

Managing nodes

You can manage SolidFire storage and Fibre Channel nodes from the Nodes page of the Cluster tab.

Related tasks

Adding a node to a cluster on page 40

Related references

Node states on page 41

Adding a node to a cluster

You can add nodes to a cluster when more storage is needed or during cluster creation. Nodes require initial configuration when they are first powered on. After the node is configured, it appears in the list of pending nodes and you can add it to a cluster.

About this task

The software version on each node in a cluster must be compatible. When you add a node to a cluster, the cluster installs the cluster version of Element software on the new node as needed.

You can add nodes of smaller or larger capacities to an existing cluster. You can add larger node capacities to a cluster to allow for capacity growth. Larger nodes added to a cluster with smaller nodes must be added in pairs. This allows for sufficient space for Double Helix to move the data should one of the larger nodes fail. You can add smaller node capacities to a larger node cluster to improve performance.

Steps

1. Select **Cluster** > **Nodes**.
2. Click **Pending** to view the list of pending nodes.
3. Do one of the following:
   - To add individual nodes, click the **Actions** icon for the node you want to add.
   - To add multiple nodes, select the check box of the nodes to add, and then **Bulk Actions**.

     Note:

     If the node you are adding has a different version of Element software than the version running on the cluster, the cluster asynchronously updates the node to the version of Element software running on the cluster master. After the node is updated, it automatically adds itself to the cluster. During this asynchronous process, the node will be in a pendingActive state.

4. Click **Add**.

   The node appears in the list of active nodes.

Related concepts

Node versioning and compatibility on page 41
Configuring a Fibre Channel node on page 20

Node versioning and compatibility

Node compatibility is based on the Element software version installed on a node. Element software-based storage clusters automatically image a node to the Element software version on the cluster if the node and cluster are not at compatible versions.

The following list describes the software release significance levels that make up the Element software version number:

Major

The first number designates a software release. A node with one major component number cannot be added to a cluster containing nodes of a different major-patch number, nor can a cluster be created with nodes of mixed major versions.

Minor

The second number designates smaller software features or enhancements to existing software features that have been added to a major release. This component is incremented within a major version component to indicate that this incremental release is not compatible with any other Element software incremental releases with a different minor component. For example, 10.0 is not compatible with 10.1, and 10.1 is not compatible with 10.2.

Micro

The third number designates a compatible patch (incremental release) to the Element software version represented by the major.minor components. For example, 10.0.1 is compatible with 10.0.2, and 10.0.2 is compatible with 10.0.3.

Major and minor version numbers must match for compatibility. Micro numbers do not have to match for compatibility.

Cluster capacity in a mixed node environment

You can mix different types of nodes in a cluster. The SF-Series 2405, 3010, 4805, 6010, 9605, 9010, 19210, 38410 and the H610S-x family of nodes can coexist in a cluster.

The H610S-x family of nodes consists of H610S-1, H610S-2, and H610S-4 nodes. These nodes are both 10GbE and 25GbE capable.

It is best to not intermix non-encrypted and encrypted nodes. In a mixed node cluster, no node can be larger than 33 percent of the total cluster capacity. For instance, in a cluster with four SF-Series 4805 nodes, the largest node that can be added alone is an SF-Series 9605. The cluster capacity threshold is calculated based on the potential loss of the largest node in this situation.

Node states

A node can be in one of several states depending on the level of configuration.

- Available: The node has no associated cluster name and is not yet part of a cluster.
- Pending: The node is configured and can be added to a designated cluster.
  Authentication is not required to access the node.
- PendingActive: The system is in the process of installing compatible Element software on the node.
  When complete, the node will move to the Active state.
- Active: The node is participating in a cluster.
  Authentication is required to modify the node.

In each of these states, some fields are read only.

Node details

On the Nodes page of the Cluster tab, you can view information about nodes such as ID, name, configured IOPs, and role type.

Node ID

The system-generated ID for the node.

Node Name

The system-generated node name.

Available 4k IOPS

Displays the IOPS configured for the node.

Node Role

Identifies what role the node has in the cluster. This can be Cluster Master, Ensemble Node, or Fibre Channel node.

Node Type

Displays the model type of the node.

Active Drives

The number of active drives in the node.

Management IP

The management IP (MIP) address assigned to node for 1GbE or 10GbE network admin tasks.

Cluster IP

The cluster IP (CIP) address assigned to the node used for the communication between nodes in the same cluster.

Storage IP

The storage IP (SIP) address assigned to the node used for iSCSI network discovery and all data network traffic.

Management VLAN ID

The virtual ID for the management local area network.

Storage VLAN ID

The virtual ID for the storage local area network.

Version

The version of software running on each node.

Replication Port

The port used on nodes for remote replication.

Service Tag

The unique service tag number assigned to the node.

Viewing individual node details

You can view details for individual nodes such as service tags, drive details, and graphics for utilization and drive statistics. The Nodes page of the Cluster tab provides the Version column where you can view the software version of each node.

Steps

1. Click **Cluster > Nodes**.
2. Click the Actions icon for a node.

3. Click **View Details**.

Viewing Fibre Channel ports details

You can view details of Fibre Channel ports such as its status, name, and port address from the FC Ports page.

Steps

1. Click **Cluster > FC Ports**.
2. To filter information on this page, click **Filter**.

Related references

Fibre Channel ports details on page 43

Fibre Channel ports details

The FC Ports page on the Cluster tab provides information about the Fibre Channel ports that are connected to the cluster.

The following list describes information about the Fibre Channel ports that are connected to the cluster:

Node ID

The node hosting the session for the connection.

Node Name

System-generated node name.

Slot

Slot number where the Fibre Channel port is located.

HBA Port

Physical port on the Fibre Channel host bus adapter (HBA).

WWNN

The world wide node name.

WWPN

The target world wide port name.

Switch WWN

World wide name of the Fibre Channel switch.

Port State

Current state of the port.

nPort ID

The node port ID on the Fibre Channel fabric.

Speed

The negotiated Fibre Channel speed. Possible values are as follows:

- 4Gbps
- 8Gbps
- 16Gbps

Managing virtual networks

Virtual networking in SolidFire storage enables traffic between multiple clients that are on separate logical networks to be connected to one cluster. Connections to the cluster are segregated in the networking stack through the use of VLAN tagging.

Related tasks

Adding a virtual network on page 44
Enabling virtual routing and forwarding on page 45
Editing a virtual network on page 46
Editing VRF VLANs on page 46
Deleting a virtual network on page 46

Virtual networks details

On the Network page of the Cluster tab, you can view information about virtual networks, such as ID, VLAN Tag, SVIP, and Netmask.

ID

Unique ID of the VLAN network, which is assigned by the system.

Name

Unique user-assigned name for the VLAN network.

VLAN Tag

VLAN tag assigned when the virtual network was created.

SVIP

Storage virtual IP address assigned to the virtual network.

Netmask

Netmask for this virtual network.

Gateway

Unique IP address of a virtual network gateway. VRF must be enabled.

VRF Enabled

Shows if virtual routing and forwarding is enabled or not.

IPs Used

The range of virtual network IP addresses used for the virtual network.

Adding a virtual network

You can add a new virtual network to a cluster configuration to enable a multi-tenant environment connection to a cluster running Element software.

Before you begin

- Identify the block of IP addresses that will be assigned to the virtual networks on the cluster nodes.
- Identify a storage network IP (SVIP) address that will be used as an endpoint for all NetApp Element storage traffic.

  Attention: You must consider the following criteria for this configuration:

  - VLANs that are not VRF-enabled require initiators to be in the same subnet as the SVIP.

- VLANs that are VRF-enabled do not require initiators to be in the same subnet as the SVIP, and routing is supported.
- The default SVIP does not require initiators to be in the same subnet as the SVIP, and routing is supported.

About this task

When a virtual network is added, an interface for each node is created and each requires a virtual network IP address. The number of IP addresses you specify when creating a new virtual network must be equal to or greater than the number of nodes in the cluster. Virtual network addresses are bulk provisioned by and assigned to individual nodes automatically. You do not need to manually assign virtual network addresses to the nodes in the cluster.

Steps

1. Click **Cluster > Network**.
2. Click **Create VLAN**.
3. In the **Create a New VLAN** dialog box, enter values in the following fields:
   - **VLAN Name**
   - **VLAN Tag**
   - **SVIP**
   - **Netmask**
   - (Optional) **Description**
4. Enter the **Starting IP** address for the range of IP addresses in **IP Address Blocks**.
5. Enter the **Size** of the IP range as the number of IP addresses to include in the block.
6. Click **Add a Block** to add a non-continuous block of IP addresses for this VLAN.
7. Click **Create VLAN**.

Enabling virtual routing and forwarding

You can enable virtual routing and forwarding (VRF), which allows multiple instances of a routing table to exist in a router and work simultaneously. This functionality is available for storage networks only.

About this task

You can enable VRF only at the time of creating a VLAN. If you want to switch back to non-VRF, you must delete and re-create the VLAN.

Steps

1. Click **Cluster > Network**.
2. To enable VRF on a new VLAN, select **Create VLAN**.
   a. Enter relevant information for the new VRF/VLAN. See Adding a virtual network.
   b. Select the **Enable VRF** check box.
   c. Optional: Enter a gateway.

3. Click **Create VLAN**.

Related tasks

Adding a virtual network on page 44

Editing a virtual network

You can change VLAN attributes, such as VLAN name, netmask, and size of the IP address blocks. The VLAN tag and SVIP cannot be modified for a VLAN. The gateway attribute is not a valid parameter for non-VRF VLANs.

About this task

If any iSCSI, remote replication, or other network sessions exist, the modification might fail.

Steps

1. Click **Cluster > Network**.
2. Click the Actions icon for the VLAN you want to edit.
3. Click **Edit**.
4. In the **Edit VLAN** dialog box, enter the new attributes for the VLAN.
5. Click **Add a Block** to add a non-continuous block of IP addresses for the virtual network.
6. Click **Save Changes**.

Editing VRF VLANs

You can change VRF VLAN attributes, such as VLAN name, netmask, gateway, and IP address blocks.

Steps

1. Click **Cluster > Network**.
2. Click the Actions icon for the VLAN you want to edit.
3. Click **Edit**.
4. Enter the new attributes for the VRF VLAN in the **Edit VLAN** dialog box.
5. Click **Save Changes**.

Deleting a virtual network

You can remove a virtual network object. You must add the address blocks to another virtual network before you remove a virtual network.

Steps

1. Click **Cluster > Network**.
2. Click the Actions icon for the VLAN you want to delete.
3. Click **Delete**.
4. Confirm the message.

Related tasks

Editing a virtual network on page 46

Upgrading storage nodes

You must use the HealthTools suite of tools to upgrade storage node software. This suite is made available by installing the latest version of the management node. The management node contains the software needed to perform the upgrade process.

The software upgrade process includes the following tasks:

- Install the latest management node.
- Download and install the latest HealthTools.
- Download and install the latest software package.

Note: Certain operations are suppressed during upgrade such as adding and removing nodes, adding and removing drives, and commands associated with initiators, volume access groups, and virtual networks, to name a few.

Related concepts

Using HealthTools for software upgrades on page 48

Related tasks

Installing management node software on page 47
Upgrading Element software on page 52
Upgrading Element software on dark sites on page 55

Installing management node software

Before you upgrade the Element software on your cluster, you must ensure that you have the latest version of the management node software. To check the version of software running on your management node, look at the file `/solidfire/version` on your management node.

About this task

You need the management node 11.0 to upgrade software from 10.3 + through 11.x.

For upgrading from older Element software versions to 10.3 or 10.4, use Element management node 10.x (10.3 or 10.4; both are supported).

Note: The *Element Software User Guide Version 10.3* is valid for 10.3 and 10.4. See the NetApp Element product library.

Attention: If you have an existing management node that has been updated to 10.3 using `update-fdva`, it may need a patch from NetApp Support before it can be used to run HealthTools and/or upgrade the storage cluster.

Steps

1. Log in to the NetApp Support Site at *https://mysupport.netapp.com/NOW/cgi-bin/software/* to download the latest software package.
2. Follow the steps in *Installing a management node*.

Related tasks

Installing a management node on page 15

Related information

NetApp Element Product Library

Using HealthTools for software upgrades

The HealthTools suite includes the components required for the software upgrade process: sfupdate-healthtools, sfupgradecheck, and sfinstall.

Note: The commands noted here require escalated privileges to run. Either preface commands with `sudo` or escalate your user to root privileges.

Related tasks

Checking the installed version of HealthTools on page 48
Checking the installed version of HealthTools on dark sites on page 48
Updating HealthTools on page 49

Checking the installed version of HealthTools

You can run the `sfupdate-healthtools` command to check the version of HealthTools installed on the management node. This will compare the currently installed version with the newest available version.

Before you begin

You are using the latest management node.

Steps

1. To view the installed version, in the command line enter the following command:

   `sfupdate-healthtools -v`

   A sample of the output is as follows:

   ```
   Currently installed version of HealthTools: 2018.09.01.130
   ```

2. To view the latest available version, in the command line enter the following command:

   `sfupdate-healthtools -l`

   A sample of the output is as follows:

   ```
   Latest available version of HealthTools: 2018.09.01.130
   The latest version of HealthTools can be downloaded from:
   https://mysupport.netapp.com/NOW/cgi-bin/software/
   ```

Checking the installed version of HealthTools on dark sites

For management nodes isolated from external Internet access, the verification check for the latest version of the HealthTools always fails. You must manually verify if the latest version available is the same as the installed version.

Before you begin

- You have a management node on a dark site.

- When you run `sfupdate-healthtools -l`, you are unable to verify the latest available version of HealthTools.

Steps

1. Run the following command to check which version of HealthTools is installed on the management node:

   ```
   sfupdate-healthtools -v
   ```

2. Go to *https://library.netapp.com/ecm/ecm_get_file/ECMLP2840740* and check the latest_version field.

   If your installed version of HealthTools is not the same as what is in the latest_version field, you must manually copy the newest HealthTools software to the management node using USB.

3. Log in to the NetApp Support Site at *https://mysupport.netapp.com/NOW/cgi-bin/software/* to download the latest HealthTools software.

Related tasks

Updating HealthTools on page 49

Updating HealthTools

You can use the `sfupdate-healthtools` command to update the version of HealthTools that is installed on the management node.

Steps

1. Log in to the NetApp Support Site at *https://mysupport.netapp.com/NOW/cgi-bin/software/*.
2. Download the latest version of HealthTools to a computer that is not the management node.
3. Copy the installation file to the management node.

   You can do this using, for example, SCP.

4. Run the `sfupdate-healthtools <path to install file>` command to install the new software.

   #### Example

   See the following sample input command:

   ```
   sfupdate-healthtools /tmp/solidfire-healthtools-2018.09.01.130.tgz
   ```

   A sample of the output is as follows:

   ```
   Checking key signature for file /tmp/solidfire-
   healthtools-2018.09.01.130/components.tgz
   installing command sfupdate-healthtools
   Restarting on version 2018.09.01.130
   sfupdate-healthtools /sf/bin/sfupdate-healthtools -r 2018.09.01.130
   installing command sfupgradecheck
   installing command sfinstall
   installing command sfresetupgrade
   ```

5. Run the `sfupdate-healthtools -v` command to check the installed version.

Example

A sample of the output is as follows:

```
Currently installed version of HealthTools:
2018.09.01.130
```

Upgrade readiness checks

You can use the `sfupgradecheck` command to verify that the cluster is ready to be upgraded. This command verifies information such as pending nodes, disk space, and cluster faults.

Scenarios

- If your cluster is upgrade ready, running the `sfupgradecheck -u <cluster-user-name> -p <cluster-password> MVIP` command does not give an error.
  See the following sample input command:

  ```
  sfupgradecheck -u admin -p admin 10.117.78.244
  ```

  A sample output is as follows:

  ```
  check_pending_nodes:
  Test Description:     Verify no pending nodes in cluster
  More information:     https://kb.netapp.com/support/s/article/
  ka11A0000008ltOQAQ/pending-nodes
  check_cluster_faults:
  Test Description:     Report any cluster faults
  check_root_disk_space:
  Test Description:     Verify node root directory has at least 12 GBs
  of available disk space
  Passed node IDs:      1, 2, 3
  More information:     https://kb.netapp.com/support/s/article/
  ka11A0000008ltTQAQ/SolidFire-Disk-space-error
  check_mnode_connectivity:
  Test Description:     Verify storage nodes can communicate with
  management node
  Passed node IDs:      1, 2, 3
  More information:     https://kb.netapp.com/support/s/article/
  ka11A0000008ltYQAQ/mNode-connectivity
  check_files:
  Test Description:     Verify options file exists
  Passed node IDs:      1, 2, 3
  check_cores:
  Test Description:     Verify no core or dump files exists
  Passed node IDs:      1, 2, 3
  check_upload_speed:
  Test Description:     Measure the upload speed between the storage
  node and the management node
  Node ID: 1 Upload speed: 90063.90 KBs/sec
  Node ID: 3 Upload speed: 106511.44 KBs/sec
  Node ID: 2 Upload speed: 85038.75 KBs/sec
  ```

- If your cluster is not upgrade ready, checks within the sfupgradecheck tool will fail with error message details about the issue.
  A sample output is as follows:

  ```
  The following tests failed:
  check_root_disk_space:
  Test Description: Verify node root directory has at least 12 GBs of
  available disk space
  Severity: ERROR
  Failed node IDs: 2
  Remedy: Remove unneeded files from root drive
  ```

```
More information: https://kb.netapp.com/support/s/article/
ka11A0000008ltTQAQ/SolidFire-Disk-space-error
check_pending_nodes:
Test Description: Verify no pending nodes in cluster
More information: https://kb.netapp.com/support/s/article/
ka11A0000008ltOQAQ/pending-nodes
check_cluster_faults:
Test Description: Report any cluster faults
check_root_disk_space:
Test Description: Verify node root directory has at least 12 GBs of
available disk space
Passed node IDs: 1, 3
More information: https://kb.netapp.com/support/s/article/
ka11A0000008ltTQAQ/SolidFire-Disk-space-error
check_mnode_connectivity:
Test Description: Verify storage nodes can communicate with
management node
Passed node IDs: 1, 2, 3
More information: https://kb.netapp.com/support/s/article/
ka11A0000008ltYQAQ/mNode-connectivity
check_files:
Test Description: Verify options file exists
Passed node IDs: 1, 2, 3
check_cores:
Test Description: Verify no core or dump files exists
Passed node IDs: 1, 2, 3
check_upload_speed:
Test Description: Measure the upload speed between the storage node
and the management node
Node ID: 1 Upload speed: 86518.82 KBs/sec
Node ID: 3 Upload speed: 84112.79 KBs/sec
Node ID: 2 Upload speed: 93498.94 KBs/sec
```

In this example, node 1 is low on disk space. You can find more information in the knowledge base article listed in the error message.

- If HealthTools is out-of-date, the upgrade check fails with an error message.
  Sample output is as follows:

  ```
  sfupgradecheck failed: HealthTools is out of date: installed version:
  2018.02.01.200 latest version: 2018.03.05.901.
  The latest version of the HealthTools can be downloaded from: https://
  mysupport.netapp.com/NOW/cgi-bin/software/
  Or rerun with the -n option
  ```

  When this happens, you must either follow the steps described in this procedure or rerun `sfupgradecheck -n -u <cluster-user-name> -p <cluster-password> MVIP` to skip the version checking.

- If your management node is on a dark site, the upgrade check fails.
  A sample output is as follows:

  ```
  sfupgradecheck failed: Unable to verify latest available version of
  healthtools.
  Manually verify latest version by checking 'latest_version' field in
  https://library.netapp.com/ecm/ecm_get_file/ECMLP2840740 (this
  version: 2018.02.01.200)
  Re-run the command with '-n, --skip-version-check' parameter. Please
  run 'sfupgradecheck --help' for full list of parameters.
  ```

  When this happens, you must verify that the HealthTools are up-to-date and then run the following command:

  `sfupgradecheck -n -u <cluster-user-name> -p <cluster-password> MVIP`
  or

```
sfupgradecheck --skip-version-check -u <cluster-user-name> -p <cluster-
password> MVIP
```

Upgrading Element software

You must use the sfinstall file included in the HealthTools suite of tools to update the Element software.

Before you begin

Attention: Before you upgrade Element software, see the *NetApp Element Software Release Notes* for the Element version you are upgrading to and verify that the upgrade path is valid.

- You have the latest version of the management node software.
- You have the latest version of HealthTools.
- You verified that the cluster is ready to be upgraded with the command `sfupgradecheck`.

Note: For upgrades from older Element software versions to 10.3 or 10.4, use Element management node 10.x (10.3 or 10.4; both are supported).

Steps

1. Go to the *NetApp Support Site*.
2. Download the newest NetApp Element software package to a computer that is not the management node.
3. Copy the ISO file to the management node in an accessible location like `/tmp`.

   You can do this using, for example, SCP.

   Note: When you upload the ISO file, make sure that the name of the file does not change, otherwise later steps will fail.

4. Run the `sfinstall` command with the following parameters to give the path to the ISO file:

   ```
   sfinstall -u <cluster_username> -p <cluster_password> <MVIP> <path-to-
   install-file-ISO>
   ```

   #### Example

   See the following sample input command:

   ```
   sfinstall 10.117.78.244 -u admin -p admin /tmp/solidfire-rtfi-
   sodium-11.0.0.345.iso
   ```

   The output for the sample shows that `sfinstall` attempts to verify if a newer version of `sfinstall` is available:

   ```
   sfinstall 10.117.78.244 -u admin -p admin /tmp/solidfire-rtfi-
   sodium-11.0.0.345.iso
   2018-10-01 16:52:15: Newer version of sfinstall available.  This
   version: 2018.09.01.130, latest version: 2018.06.05.901. The latest
   version of the HealthTools can be downloaded from: https://
   mysupport.netapp.com/NOW/cgi-bin/software/ or rerun with --skip-
   version-check
   ```

See the following sample excerpt from a successful upgrade:

```
# sfinstall 10.117.114.161 -u admin -p admin solidfire-rtfi-
sodium-11.0.0.761.iso
2018-10-11 18:28
Checking connectivity to MVIP 10.117.114.161
Checking connectivity to node 10.117.114.23
Checking connectivity to node 10.117.114.24
Checking connectivity to node 10.117.114.26
Checking connectivity to node 10.117.114.28
Successfully connected to cluster and all nodes

################################################################################
############
 You are about to start a new upgrade
10.117.114.161
10.3.0.161
solidfire-rtfi-sodium-11.0.0.761.iso
 Nodes:
  10.117.114.23    nlabp1023         SF3010    10.3.0.161
  10.117.114.24    nlabp1025         SF3010    10.3.0.161
  10.117.114.26    nlabp1027         SF3010    10.3.0.161
  10.117.114.28    nlabp1028         SF3010    10.3.0.161
################################################################################
############

Do you want to continue?
['Yes', 'No']: yes
Automatically detected mNode MIP=10.117.64.210 [use --ip=IPAddress
to override]
validUpgradePathDataUrl=https://library.netapp.com/ecm/ecm_get_file/
ECMLP2840740
Using existing file /var/www/rtfi/solidfire-rtfi-sodium-11.0.0.761/
filesystem.squashfs.meta
Found /var/www/rtfi/solidfire-rtfi-sodium-11.0.0.761/
filesystem.squashfs checking signature
Signature is good. Using existing file /var/www/rtfi/solidfire-rtfi-
sodium-11.0.0.761/filesystem.squashfs
Watching for new network faults.  Existing fault IDs are set([]).
Checking for legacy network interface names that need renaming
Upgrading from 10.3.0.161 to 11.0.0.761 upgrade method=rtfi
Waiting 300 seconds for cluster faults to clear
Waiting for caches to fall below threshold
Cache Size Current: 0 Target: 5000000000
Caches cleared in 0.31 seconds
Checking health of volumes
Checking for negative volume stats
Installing mip=[10.117.114.23] nodeID=[1] (1 of 4 nodes)
Starting to move primaries.
Loading volume list
Moving primary slice=[7] away from mip[10.117.114.23] nodeID[1]
ssid[11] to new ssid[15]
Moving primary slice=[12] away from mip[10.117.114.23] nodeID[1]
ssid[11] to new ssid[15]
Moving primary slice=[13] away from mip[10.117.114.23] nodeID[1]
ssid[11] to new ssid[7]
Moving primary slice=[15] away from mip[10.117.114.23] nodeID[1]
ssid[11] to new ssid[15]
Waiting [10] seconds for [4] primary slices to finish moving mip
[10.117.114.23] node [1]
...
Skipping a bunch of output
...
Waiting for primaries to move away from mip=[10.117.114.23]
nodeID=[1]
RTFI Upgrade serving image at http://10.117.64.210/rtfi/solidfire-
rtfi-sodium-11.0.0.761/filesystem.squashfs
Initiating RTFI of nodeID=1 with URL=http://10.117.64.210/rtfi/
solidfire-rtfi-sodium-11.0.0.761/filesystem.squashfs
```

```
Waiting 300 seconds for cluster faults to clear
Waiting for caches to fall below threshold
Cache Size Current: 0 Target: 5000000000
Caches cleared in 0.31 seconds
Checking health of volumes
Checking for negative volume stats
Installing mip=[10.117.114.24] nodeID=[2] (2 of 4 nodes)
Starting to move primaries.
Loading volume list
Moving primary slice=[5] away from mip[10.117.114.24] nodeID[2]
ssid[7] to new ssid[11]
Moving primary slice=[8] away from mip[10.117.114.24] nodeID[2]
ssid[7] to new ssid[11]
...
Skipping a bunch of output
...
Waiting 300 seconds for cluster faults to clear
Waiting for caches to fall below threshold
Cache Size Current: 0 Target: 5000000000
Caches cleared in 0.35 seconds
Checking health of volumes
Checking for negative volume stats
Install of solidfire-rtfi-sodium-11.0.0.761 complete.
Removing old software
No staged builds present on nodeID=[1]
No staged builds present on nodeID=[2]
No staged builds present on nodeID=[3]
No staged builds present on nodeID=[4]
Starting light cluster block service check
```

Related tasks

Installing management node software on page 47

Related references

What happens when an upgrade fails on page 54

Related information

NetApp Support Site Software Download page
NetApp Element Product Library

What happens when an upgrade fails

In the case of a software upgrade failure, you can pause the upgrade.

Attention: You should only pause an upgrade with Ctrl-C. This allows the system to clean itself up.

When sfinstall waits for cluster faults to clear and if any failure causes the faults to remain, sfinstall will not proceed to the next node.

- You should stop sfinstall with Ctrl+C.
- Contact NetApp Support to assist with the failure investigation.
- Resume the upgrade with the same sfinstall command.

When an upgrade is paused using Ctrl+C, if the upgrade is currently upgrading a node, you will see a list of options:

Wait

Allow the currently upgrading node to finish before resetting the cluster constants.

Continue

Continue the upgrade, which cancels the pause.

Abort

Reset the cluster constants and abort the upgrade immediately.

Note: Aborting the cluster upgrade while a node is being updated might result in the drives being ungracefully removed from the node. If the drives are ungracefully removed, adding the drives back during an upgrade will require manual intervention by NetApp Support. The node might be taking longer to do firmware updates or post-update syncing activities. If the upgrade progress seems stalled, please contact NetApp Support for assistance.

Related tasks

Upgrading Element software on page 52

Upgrading Element software on dark sites

You must use the sfinstall file included in the HealthTools suite of tools to update NetApp Element software.

Before you begin

Attention: Before you upgrade Element software, see the *NetApp Element Software Release Notes* for the Element version you are upgrading to and verify that the upgrade path is valid.

- You have the latest version of the management node software.
- Your management node is not connected to the Internet.

Steps

1. Go to the *NetApp Support Site*.
2. Download the newest NetApp Element software package to a computer that is not the management node.
3. Copy the ISO file to the management node in an accessible location like `/tmp`.

   You can do this using, for example, SCP.

   Note: When you upload the ISO file, make sure that the name of the file does not change, otherwise later steps will fail.

4. Run the `sfinstall` command with the following parameters to give the path to the ISO file:

   ```
   sfinstall -u <cluster_username> --skip-version-check -p
   <cluster_password> <MVIP> <path-to-install-file-ISO>
   ```

   When this is run on a dark site, there is no access to the NetApp Support Site, therefore it cannot validate the latest version. The command fails unless you run the command with the `--skip-version-check` option:

   See the following sample input command:

   ```
   sfinstall 10.117.78.244 -u admin -p admin /tmp/solidfire-rtfi-
   sodium-11.0.0.345.iso.
   ```

The output for the sample is as follows:

```
sfinstall failed: Unable to verify latest available version of
healthtools.
Manually verify latest version by checking 'latest_version' field in
https://library.netapp.com/ecm/ecm_get_file/ECMLP2840740 (this
version: 2018.09.01.130)
Re-run the command with '-n, --skip-version-check' parameter.
```

Related tasks

Checking the installed version of HealthTools on dark sites on page 48
Installing management node software on page 47

Data management

You can manage the data in a cluster running Element software from the Management tab in the Element UI. Available cluster management functions include creating and managing data volumes, user accounts, volume access groups, initiators, and Quality of Service (QoS) policies.

Related concepts

Working with accounts on page 57
Working with volumes on page 59
Working with virtual volumes on page 71
Working with access groups and initiators on page 80

Working with accounts

In SolidFire storage systems, accounts enable clients to connect to volumes on a node. When you create a volume, it is assigned to a specific user account.

An account contains the CHAP authentication required to access the volumes assigned to it. An account can have up to two-thousand volumes assigned to it, but a volume can belong to only one account.

Related tasks

Creating an account on page 57
Viewing individual account details on page 58
Editing an account on page 58
Deleting an account on page 59

Creating an account

You can create an account to allow access to volumes.

About this task

Each account name in the system must be unique.

Steps

1. Select **Management > Accounts**.
2. Click **Create Account**.
3. Enter a **Username**.
4. In the **CHAP Settings** section, enter the following information:
   - **Initiator Secret** for CHAP node session authentication.
   - **Target Secret** for CHAP node session authentication.

   Note: Leave the credential fields blank to auto-generate either password.
5. Click **Create Account**.

Account details

The Accounts page on the Management tab provides information about each account in the system, such as ID, user name, and efficiency details for the volumes assigned to each account.

ID

The system-generated ID for the account.

Username

The name given to the account when it was created.

Status

The status of the account. Possible values:

- `active`: An active account.
- `locked`: A locked account.
- `removed`: An account that has been deleted and purged.

Active Volumes

The number of active volumes assigned to the account.

Compression

The compression efficiency score for the volumes assigned to the account.

Deduplication

The deduplication efficiency score for the volumes assigned to the account.

Thin Provisioning

The thin provisioning efficiency score for the volumes assigned to the account.

Overall Efficiency

The overall efficiency score for the volumes assigned to the account.

Viewing individual account details

You can view performance activity for individual accounts in a graphical format.

About this task

The graph information provides I/O and throughput information for the account. The Average and Peak activity levels are shown in increments of 10-second reporting periods. These statistics include activity for all volumes assigned to the account.

Steps

1. Select **Management > Accounts**.
2. Click the Actions icon for an account.
3. Click **View Details**.

Editing an account

You can edit an account to change the status, change the CHAP secrets, or modify the account name.

About this task

Modifying CHAP settings in an account or removing initiators or volumes from an access group can cause initiators to lose access to volumes unexpectedly. To verify that volume access will not be lost

unexpectedly, always log out iSCSI sessions that will be affected by an account or access group change, and verify that initiators can reconnect to volumes after any changes to initiator settings and cluster settings have been completed.

Steps

1. Select **Management** > **Accounts**.
2. Click the Actions icon for an account.
3. In the resulting menu, select **Edit**.
4. Optional: Edit the **Username**.
5. Optional: Click the **Status** drop-down list and select a different status.

   Attention: Changing the status to **locked** terminates all iSCSI connections to the account, and the account is no longer accessible. Volumes associated with the account are maintained; however, the volumes are not iSCSI discoverable.

6. Optional: Under **CHAP Settings**, edit the **Initiator Secret** and **Target Secret** credentials used for node session authentication.

   Note: If you do not change the **CHAP Settings** credentials, they remain the same. If you make the credentials fields blank, the system generates new passwords.

7. Click **Save Changes**.

Deleting an account

You can delete an account when it is no longer needed.

Before you begin

Delete and purge any volumes associated with the account before you delete the account.

Steps

1. Select **Management** > **Accounts**.
2. Click the Actions icon for the account you want to delete.
3. In the resulting menu, select **Delete**.
4. Confirm the action.

Working with volumes

The SolidFire system provisions storage using volumes. Volumes are block devices accessed over the network by iSCSI or Fibre Channel clients. From the Volumes page on the Management tab, you can create, modify, clone, and delete volumes on a node. You can also view statistics about volume bandwidth and I/O usage.

Related concepts

Quality of Service on page 60

Related tasks

Creating a QoS policy on page 62

Editing a QoS policy on page 63
Deleting a QoS policy on page 63
Creating a volume on page 64
Viewing individual volume performance details on page 65
Editing active volumes on page 66
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Restoring a deleted volume on page 68
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Cloning a volume on page 68
Assigning LUNs to Fibre Channel volumes on page 70
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Quality of Service

A SolidFire storage cluster has the ability to provide Quality of Service (QoS) parameters on a per-volume basis. You can guarantee cluster performance measured in inputs and outputs per second (IOPS) using three configurable parameters that define QoS: Min IOPS, Max IOPS, and Burst IOPS.

IOPS parameters are defined in the following ways:

Minimum IOPS

The minimum number of sustained inputs and outputs per second (IOPS) that the storage cluster provides to a volume. The Min IOPS configured for a volume is the guaranteed level of performance for a volume. Performance does not drop below this level.

Maximum IOPS

The maximum number of sustained IOPS that the storage cluster provides to a volume. When cluster IOPS levels are critically high, this level of IOPS performance is not exceeded.

Burst IOPS

The maximum number of IOPS allowed in a short burst scenario. If a volume has been running below the Max IOPS, burst credits are accumulated. When performance levels become very high and are pushed to maximum levels, short bursts of IOPS are allowed on the volume.

Element software uses Burst IOPS when a cluster is running in a state of low cluster IOPS utilization.

A single volume can accrue Burst IOPS and use the credits to burst above their Max IOPS up to their Burst IOPS level for a set "burst period". A volume can burst for up to 60 seconds if the cluster has the capacity to accommodate the burst.

A volume accrues one second of burst credit (up to a maximum of 60 seconds) for every second that the volume runs below its Max IOPS limit.

Burst IOPS are limited in two ways:

- A volume can burst above its Max IOPS for a number of seconds equal to the number of burst credits that the volume has accrued.
- When a volume bursts above its Max IOPS setting, it is limited by its Burst IOPS setting. Therefore, the burst IOPS never exceeds the burst IOPS setting for the volume.

Effective Max Bandwidth

The maximum bandwidth is calculated by multiplying the number of IOPS (based on the QoS curve) by the IO size.

Example:

QoS parameter settings of 100 Min IOPS, 1000 Max IOPS, and 1500 Burst IOPs have the following effects on quality of performance:

- Workloads are able to reach and sustain a maximum of 1000 IOPS until the condition of workload contention for IOPS becomes apparent on the cluster. IOPS are then reduced incrementally until IOPS on all volumes are within the designated QoS ranges and contention for performance is relieved.
- Performance on all volumes is pushed toward the Min IOPS of 100. Levels do not drop below the Min IOPS setting but could remain higher than 100 IOPS when workload contention is relieved.
- Performance is never greater than 1000 IOPS, or less than 100 IOPS for a sustained period. Performance of 1500 IOPS (Burst IOPS) is allowed, but only for those volumes that have accrued burst credits by running below Max IOPS and only allowed for a short periods of time. Burst levels are never sustained.

QoS value limits

You can find information about the possible minimum and maximum values for Quality of Service (QoS).

			I/O size maximum value			
Parameters	**Minimum value**	**Default**	**4KB**	**8KB**	**16KB**	**262KB**
Min IOPS	50	50	15,000	9,375*	5556*	385*
Max IOPS	100	15,000	200,000**	125,000	74,074	5128
Burst IOPS	100	15,000	200,000**	125,000	74,074	5128

*These estimations are approximate.

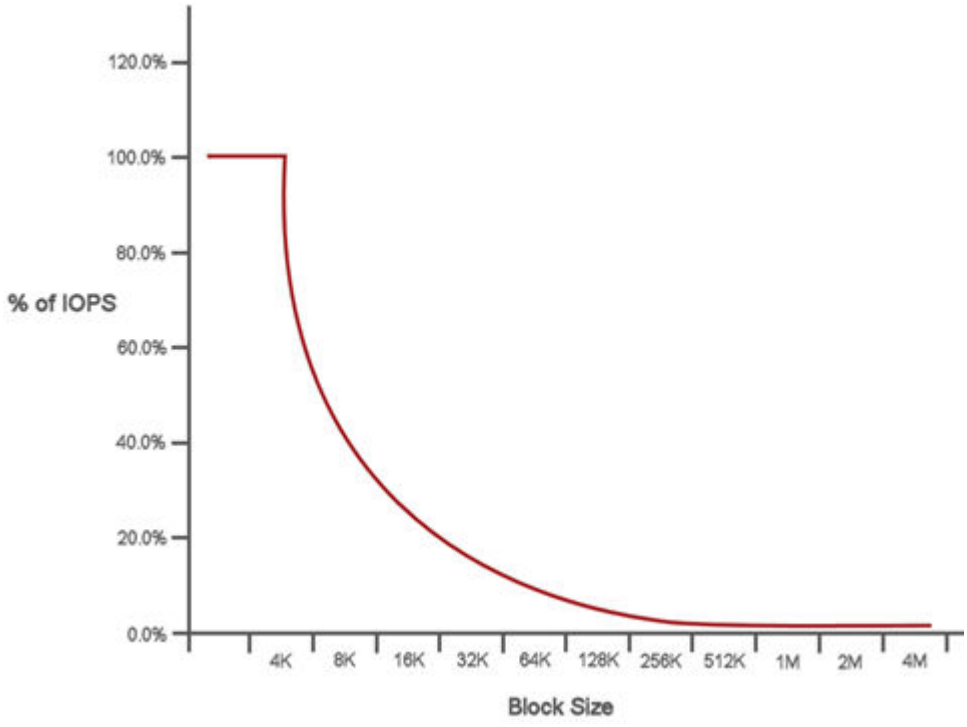
**Max IOPS and Burst IOPS can be set as high as 200,000; however, this setting is allowed only to effectively uncap the performance of a volume. Real-world maximum performance of a volume is limited by cluster usage and per-node performance.

QoS performance curve

The Quality of Service (QoS) performance curve shows the relationship between block size and the percentage of IOPS.

Block size and bandwidth have a direct impact on the number of IOPS that an application can obtain. Element software takes into account the block sizes it receives by normalizing block sizes to 4k. Based on workload, the system might increase block sizes. As block sizes increase, the system increases bandwidth to a level necessary to process the larger block sizes. As bandwidth increases the number of IOPS the system is able to attain decreases.

The QoS performance curve shows the relationship between increasing block sizes and the decreasing percentage of IOPS:



As an example, if block sizes are 4k, and bandwidth is 4000 KBps, the IOPS are 1000. If block sizes increase to 8k, bandwidth increases to 5000 KBps, and IOPS decrease to 625. By taking block size into account, the system ensures that lower priority workloads that use higher block sizes, such as backups and hypervisor activities, do not take too much of the performance needed by higher priority traffic using smaller block sizes.

QoS policies

A Quality of Service (QoS) policy enables you to create and save a standardized quality of service setting that can be applied to many volumes. You can create, edit, and delete QoS policies from the QoS Policies page on the Management tab.

Related tasks

Creating a QoS policy on page 62
Editing a QoS policy on page 63
Deleting a QoS policy on page 63

Creating a QoS policy

You can create QoS policies and apply them when creating volumes.

Steps

1. Select **Management > QoS Policies**.
2. Click **Create QoS Policy**.
3. Enter the **Policy Name**.
4. Enter the **Min IOPS**, **Max IOPS**, and **Burst IOPS** values.
5. Click **Create QoS Policy**.

QoS policies details

You can view details of QoS policies from the Management tab.

ID

The system-generated ID for the QoS policy.

Name

The user-defined name for the QoS policy.

Min IOPS

The minimum number of IOPS guaranteed for the volume.

Max IOPS

The maximum number of IOPS allowed for the volume.

Burst IOPS

The maximum number of IOPS allowed over a short period of time for the volume. Default = 15,000.

Volumes

Shows the number of volumes using the policy. This number links to a table of volumes that have the policy applied.

Editing a QoS policy

You can change the name of an existing QoS policy or edit the values associated with the policy. Changing a QoS policy affects all volumes associated with the policy.

Steps

1. Select **Management > QoS Policies**.
2. Click the Actions icon for the QoS policy you want to edit.
3. In the resulting menu, select **Edit**.
4. In the **Edit QoS Policy** dialog box, modify the following properties as required:
   - Policy Name
   - Min IOPS
   - Max IOPS
   - Burst IOPS
5. Click **Save Changes**.

Deleting a QoS policy

You can delete a QoS policy if it is no longer needed. When you delete a QoS policy, all volumes associated with the policy maintain the QoS settings but become unassociated with a policy.

Steps

1. Select **Management > QoS Policies**.
2. Click the Actions icon for the QoS policy you want to delete.
3. In the resulting menu, select **Delete**.
4. Confirm the action.

Creating a volume

You can create a volume and associate the volume with a given account. Every volume must be associated with an account. This association gives the account access to the volume through the iSCSI initiators using the CHAP credentials.

About this task

You can specify QoS settings for a volume during creation.

Steps

1. Select **Management > Volumes**.
2. Click **Create Volume**.
3. In the **Create a New Volume** dialog box, enter the **Volume Name**.
4. Enter the total size of the volume.

   Note: The default volume size selection is in GB. You can create volumes using sizes measured in GB or GiB:

   - 1GB = 1 000 000 000 bytes
   - 1GiB = 1 073 741 824 bytes

5. Select a **Block Size** for the volume.
6. Click the **Account** drop-down list and select the account that should have access to the volume.

   If an account does not exist, click the **Create Account** link, enter a new account name, and click **Create**. The account is created and associated with the new volume.

   Note: If there are more than 50 accounts, the list does not appear. Begin typing and the auto-complete function displays possible values for you to choose.

7. To set the **Quality of Service**, do one of the following:

   a. Under **Policy**, you can select an existing QoS policy, if available.

   b. Under **Custom Settings**, set customized minimum, maximum, and burst values for IOPS or use the default QoS values.

      Volumes that have a Max or Burst IOPS value greater than 20,000 IOPS might require high queue depth or multiple sessions to achieve this level of IOPS on a single volume.

8. Click **Create Volume**.

Volume details

The Volumes page on the Management tab provides information about the active volumes such as name, account, access groups associated with the volume, and size of the volume.

ID

The system-generated ID for the volume.

Name

The name given to the volume when it was created. Names can be up to 223 characters in length and contain a-z, 0-9, and dash (-) characters.

Account

The name of the account assigned to the volume.

Access Groups

The name of the volume access group or groups to which the volume belongs.

Access

The type of access assigned to the volume when it was created. Possible values:

- Read / Write: All reads and writes are accepted.
- Read Only: All read activity allowed; no writes allowed.
- Locked: Only Administrator access allowed.
- ReplicationTarget: Designated as a target volume in a replicated volume pair.

Used

The percentage of used space in the volume.

Size

The total size (in GB) of the volume.

Snapshots

The number of snapshots created for the volume.

QoS Policy

The name and link to the user-defined QoS policy.

Min IOPS

The minimum number of IOPS guaranteed for the volume.

Max IOPS

The maximum number of IOPS allowed for the volume.

Burst IOPS

The maximum number of IOPS allowed over a short period of time for the volume. Default = 15,000.

Attributes

Attributes that have been assigned to the volume as a key/value pair through an API method.

512e

Identifies if 512e is enabled on a volume. Possible values:

- Yes
- No

Created On

The date and time that the volume was created.

Viewing individual volume performance details

You can view performance statistics for individual volumes.

Steps

1. Select **Reporting** > **Volume Performance**.
2. In the volume list, click the Actions icon for a volume.

3. Click **View Details**.

   A tray appears at the bottom of the page containing general information about the volume.

4. To see more detailed information about the volume, click **See More Details**.

   The system displays detailed information as well as performance graphs for the volume.

Editing active volumes

You can modify volume attributes such as QoS values, volume size, and the unit of measurement in which byte values are calculated. You can also modify account access for replication usage or to restrict access to the volume.

About this task

You can resize a volume when there is sufficient space on the cluster under the following conditions:

- Normal operating conditions.
- Volume errors or failures are being reported.
- The volume is being cloned.
- The volume is being resynced.

Steps

1. Select **Management > Volumes**.
2. In the **Active** window, click the Actions icon for the volume you want to edit.
3. Click **Edit**.
4. Optional: Change the total size of the volume.

   Note:

   - You can increase, but not decrease, the size of the volume. You can only resize one volume in a single resizing operation. Garbage collection operations and software upgrades do not interrupt the resizing operation.
   - If you are adjusting volume size for replication, you should first increase the size of the volume assigned as the replication target. Then you can resize the source volume. The target volume can be greater or equal in size to the source volume, but it cannot be smaller.

   Note: The default volume size selection is in GB. You can create volumes using sizes measured in GB or GiB:

   - 1GB = 1 000 000 000 bytes
   - 1GiB = 1 073 741 824 bytes

5. Optional: Select a different account access level of one of the following:
   - Read Only
   - Read/Write
   - Locked
   - Replication Target

6. Optional: Select the account that should have access to the volume.

   If the account does not exist, click the **Create Account** link, enter a new account name, and click **Create**. The account is created and associated with the volume.

   Note: If there are more than 50 accounts, the list does not appear. Begin typing and the auto-complete function displays possible values for you to choose.

7. Optional: To change the selection in **Quality of Service**, do one of the following:

   a. Under **Policy**, you can select an existing QoS policy, if available.

   b. Under **Custom Settings**, set customized minimum, maximum, and burst values for IOPS or use the default QoS values.

      Note: When you change IOPS values, you should increment in tens or hundreds. Input values require valid whole numbers.

      Tip: Configure volumes with an extremely high burst value. This allows the system to process occasional large block sequential workloads more quickly, while still constraining the sustained IOPS for a volume.

8. Click **Save Changes**.

Deleting a volume

You can delete one or more volumes from a SolidFire cluster.

About this task

The system does not immediately purge a deleted volume; the volume remains available for approximately eight hours. If you restore a volume before the system purges it, the volume comes back online and iSCSI connections are restored.

If a volume used to create a snapshot is deleted, its associated snapshots become inactive. When the deleted source volumes are purged, the associated inactive snapshots are also removed from the system.

Steps

1. Select **Management > Volumes**.
2. To delete a single volume, perform the following steps:

   a. Click the Actions icon for the volume you want to delete.

   b. In the resulting menu, click **Delete**.

   c. Confirm the action.

   The system moves the volume to the **Deleted** area on the **Volumes** page.

3. To delete multiple volumes, perform the following steps:

   a. In the list of volumes, check the box next to any volumes you want to delete.

   b. Click **Bulk Actions**.

   c. In the resulting menu, click **Delete**.

   d. Confirm the action.

      The system moves the volumes to the **Deleted** area on the **Volumes** page.

Restoring a deleted volume

You can restore a volume in the system if it has been deleted but not yet purged. The system automatically purges a volume approximately eight hours after it has been deleted. If the system has purged the volume, you cannot restore it.

Steps

1. Select **Management > Volumes**.
2. Click the **Deleted** tab to view the list of deleted volumes.
3. Click the Actions icon for the volume you want to restore.
4. In the resulting menu, click **Restore**.
5. Confirm the action.

   The volume is placed in the **Active** volumes list and iSCSI connections to the volume are restored.

Purging a volume

When a volume is purged, it is permanently removed from the system. All data in the volume is lost.

About this task

The system automatically purges deleted volumes eight hours after deletion. However, if you want to purge a volume before the scheduled time, you can do so.

Steps

1. Select **Management > Volumes**.
2. Click the **Deleted** button.
3. Perform the steps to purge a single volume or multiple volumes.

Option	Steps
Purge a single volume	**a.** Click the Actions icon for the volume you want to purge. **b.** Click **Purge**. **c.** Confirm the action.
Purge multiple volumes	**a.** Select the volumes you want to purge. **b.** Click **Bulk Actions**. **c.** In the resulting menu, select **Purge**. **d.** Confirm the action.

Cloning a volume

You can create a clone of a single volume or multiple volumes to make a point-in-time copy of the data. When you clone a volume, the system creates a snapshot of the volume and then creates a copy

of the data referenced by the snapshot. This is an asynchronous process, and the amount of time the process requires depends on the size of the volume you are cloning and the current cluster load.

About this task

The cluster supports up to two running clone requests per volume at a time and up to eight active volume clone operations at a time. Requests beyond these limits are queued for later processing.

Attention: Before you truncate a cloned volume by cloning to a smaller size, ensure that you prepare the partitions so that they fit into the smaller volume.

Steps

1. Select **Management** > **Volumes**.
2. To clone a single volume, perform the following steps:
   a. In the list of volumes on the **Active** page, click the Actions icon for the volume you want to clone.
   b. In the resulting menu, click **Clone**.
   c. In the **Clone Volume** window, enter a volume name for the newly cloned volume.
   d. Select a size and measurement for the volume using the **Volume Size** spin box and list.

      Note: The default volume size selection is in GB. You can create volumes using sizes measured in GB or GiB:

      - 1GB = 1 000 000 000 bytes
      - 1GiB = 1 073 741 824 bytes

   e. Select the type of access for the newly cloned volume.
   f. Select an account to associate with the newly cloned volume from the **Account** list.

      Note: You can create an account during this step if you click the **Create Account** link, enter an account name, and click **Create**. The system automatically adds the account to the **Account** list after you create it.
3. To clone multiple volumes, perform the following steps:
   a. In the list of volumes on the **Active** page, check the box next to any volumes you want to clone.
   b. Click **Bulk Actions**.
   c. In the resulting menu, select **Clone**.
   d. In the **Clone Multiple Volumes** dialog box, enter a prefix for the cloned volumes in the **New Volume Name Prefix** field.
   e. Select an account to associate with the cloned volumes from the **Account** list.
   f. Select the type of access for the cloned volumes.
4. Click **Start Cloning**.

   Note: Increasing the volume size of a clone results in a new volume with additional free space at the end of the volume. Depending on how you use the volume, you might need to extend partitions or create new partitions in the free space to make use of it.

Assigning LUNs to Fibre Channel volumes

You can change the LUN assignment for a Fibre Channel volume in a volume access group. You can also make Fibre Channel volume LUN assignments when you create a volume access group.

About this task

Assigning new Fibre Channel LUNs is an advanced function and could have unknown consequences on the connecting host. For example, the new LUN ID might not be automatically discovered on the host, and the host might require a rescan to discover the new LUN ID.

Steps

1. Select **Management > Access Groups**.
2. Click the Actions icon for the access group you want to edit.
3. In the resulting menu, select **Edit**.
4. Under **Assign LUN IDs** in the **Edit Volume Access Group** dialog box, click the arrow on the **LUN Assignments** list.
5. For each volume in the list that you want to assign a LUN to, enter a new value in the corresponding **LUN** field.
6. Click **Save Changes**.

Applying a QoS policy to volumes

You can bulk apply an existing QoS policy to one or more volumes.

Before you begin

The QoS policy you want to bulk apply exists.

Steps

1. Select **Management > Volumes**.
2. In the list of volumes, check the box next to any volumes you want to apply the QoS policy to.
3. Click **Bulk Actions**.
4. In the resulting menu, click **Apply QoS Policy**.
5. Select the QoS policy from the drop-down list.
6. Click **Apply**.

Related concepts

QoS policies on page 62

Removing the QoS policy association of a volume

You can remove a QoS policy association from a volume by selecting custom QoS settings.

Before you begin

The volume you want to modify is associated with a QoS policy.

Steps

1. Select **Management > Volumes**.
2. Click the Actions icon for a volume that contains a QoS policy you want to modify.
3. Click **Edit**.
4. In the resulting menu under **Quality of Service**, click **Custom Settings**.
5. Modify **Min IOPS**, **Max IOPS**, and **Burst IOPS**, or keep the default settings.
6. Click **Save Changes**.

Working with virtual volumes

You can view information and perform tasks for virtual volumes and their associated storage containers, protocol endpoints, bindings, and hosts using the Element UI.

The NetApp Element software storage system ships with the Virtual Volumes (VVols) feature disabled. You must perform a one-time task of manually enabling vSphere VVol functionality through the Element UI.

After you enable the VVol functionality, a VVols tab appears in the user interface that offers VVols-related monitoring and limited management options. Additionally, a storage-side software component known as the VASA Provider acts as a storage awareness service for vSphere. Most VVols commands, such as VVol creation, cloning, and editing, are initiated by a vCenter Server or ESXi host and translated by the VASA Provider to Element APIs for the Element software storage system. Commands to create, delete, and manage storage containers and delete virtual volumes can be initiated using the Element UI.

The majority of configurations necessary for using Virtual Volumes functionality with Element software storage systems are made in vSphere. See the *VMware vSphere Virtual Volumes for SolidFire Storage Configuration Guide* to register the VASA Provider in vCenter, create and manage VVol datastores, and manage storage based on policies.

Note: The VVol functionality has a cluster limit of 8000 virtual volumes.

Related concepts

Protocol endpoints on page 78
Bindings on page 79

Related tasks

Enabling virtual volumes on page 71
Deleting a virtual volume on page 75
Creating a storage container on page 76
Editing a storage container on page 77
Deleting a storage container on page 78

Related references

Host details on page 79

Enabling virtual volumes

You must manually enable vSphere Virtual Volumes (VVols) functionality through the Element UI. The Element software system comes with VVols functionality disabled by default, and it is not

automatically enabled as part of a new installation or upgrade. Enabling the VVols feature is a one-time configuration task.

Before you begin

- The cluster must be running Element 9.0 or later.
- The cluster must be connected to an ESXi 6.0 and later environment that is compatible with VVols.
- For systems running Element software 11.x, enabling virtual volumes before or after setting protection domain monitoring causes the cluster protection domains feature to function only at node level.

About this task

Attention: Enabling vSphere Virtual Volumes functionality permanently changes the Element software configuration. You should only enable VVols functionality if your cluster is connected to a VMware ESXi VVols-compatible environment. You can disable the VVols feature and restore the default settings only by returning the cluster to the factory image.

Steps

1. Select **Clusters > Settings**.
2. Find the cluster-specific settings for Virtual Volumes.
3. Click **Enable Virtual Volumes**.
4. Click **Yes** to confirm the Virtual Volumes configuration change.

   The **VVols** tab appears in the Element UI.

   Note: When VVols functionality is enabled, the SolidFire cluster starts the VASA Provider, opens port 8444 for VASA traffic, and creates protocol endpoints that can be discovered by vCenter and all ESXi hosts.

5. Copy the VASA Provider URL from the Virtual Volumes (VVols) settings in **Clusters > Settings**. You will use this URL to register the VASA Provider in vCenter.
6. Create a storage container in **VVols > Storage Containers**.

   Note: You must create at least one storage container so that VMs can be provisioned to a VVol datastore.

7. Select **VVols > Protocol Endpoints**.
8. Verify that a protocol endpoint has been created for each node in the cluster.

   Note: Additional configuration tasks are required in vSphere. See the *VMware vSphere Virtual Volumes for SolidFire Storage Configuration Guide* to register the VASA Provider in vCenter, create and manage VVol datastores, and manage storage based on policies.

Related information

VMware vSphere Virtual Volumes for SolidFire Storage Configuration Guide

Viewing virtual volume details

You can review virtual volume information for all active virtual volumes on the cluster in the Element UI. You can also view performance activity for each virtual volume, including input, output, throughput, latency, queue depth, and volume information.

Before you begin

- You have enabled VVols functionality in the Element UI for the cluster.
- You have created an associated storage container.
- You have configured your vSphere cluster to use Element software VVols functionality.
- You have created at least one VM in vSphere.

Steps

1. Click **VVols > Virtual Volumes**.

   The information for all active virtual volumes is displayed.

2. Click the Actions icon for the virtual volume you want to review.
3. In the resulting menu, select **View Details**.

Virtual volume details

The Virtual Volumes page of the VVols tab provides information about each active virtual volume on the cluster, such as volume ID, snapshot ID, parent virtual volume ID, and virtual volume ID.

Volume ID

The ID of the underlying volume.

Snapshot ID

The ID of the underlying volume snapshot. The value is 0 if the virtual volume does not represent a SolidFire snapshot.

Parent Virtual Volume ID

The virtual volume ID of the parent virtual volume. If the ID is all zeros, the virtual volume is independent with no link to a parent.

Virtual Volume ID

The UUID of the virtual volume.

Name

The name assigned to the virtual volume.

Storage Container

The storage container that owns the virtual volume.

Guest OS Type

Operating system associated with the virtual volume.

Virtual Volume Type

The virtual volume type: Config, Data, Memory, Swap, or Other.

Access

The read-write permissions assigned to the virtual volume.

Size

The size of the virtual volume in GB or GiB.

Snapshots

The number of associated snapshots. Click the number to link to snapshot details.

Min IOPS

The minimum IOPS QoS setting of the virtual volume.

Max IOPS

The maximum IOPS QoS setting of the virtual volume.

Burst IOPS

The maximum burst QoS setting of the virtual volume.

VMW_VmID

Information in fields prefaced with "VMW_" are defined by VMware.

Create Time

The time the virtual volume creation task was completed.

Individual virtual volume details

The Virtual Volumes page on the VVols tab provides the following virtual volume information when you select an individual virtual volume and view its details.

VMW_XXX

Information in fields prefaced with "VMW_" are defined by VMware.

Parent Virtual Volume ID

The virtual volume ID of the parent virtual volume. If the ID is all zeros, the virtual volume is independent with no link to a parent.

Virtual Volume ID

The UUID of the virtual volume.

Virtual Volume Type

The virtual volume type: Config, Data, Memory, Swap, or Other.

Volume ID

The ID of the underlying volume.

Access

The read-write permissions assigned to the virtual volume.

Account Name

Name of the account containing the volume.

Access Groups

Associated volume access groups.

Total Volume Size

Total provisioned capacity in bytes.

Non-Zero Blocks

Total number of 4KiB blocks with data after the last garbage collection operation has completed.

Zero Blocks

Total number of 4KiB blocks without data after the last round of garbage collection operation has completed.

Snapshots

The number of associated snapshots. Click the number to link to snapshot details.

Min IOPS

The minimum IOPS QoS setting of the virtual volume.

Max IOPS

The maximum IOPS QoS setting of the virtual volume.

Burst IOPS

The maximum burst QoS setting of the virtual volume.

Enable 512

Because virtual volumes always use 512-byte block size emulation, the value is always `yes`.

Volumes Paired

Indicates if a volume is paired.

Create Time

The time the virtual volume creation task was completed.

Blocks Size

Size of the blocks on the volume.

Unaligned Writes

For 512e volumes, the number of write operations that were not on a 4k sector boundary. High numbers of unaligned writes might indicate improper partition alignment.

Unaligned Reads

For 512e volumes, the number of read operations that were not on a 4k sector boundary. High numbers of unaligned reads might indicate improper partition alignment.

scsiEUIDeviceID

Globally unique SCSI device identifier for the volume in EUI-64 based 16-byte format.

scsiNAADeviceID

Globally unique SCSI device identifier for the volume in NAA IEEE Registered Extended format.

Attributes

List of name-value pairs in JSON object format.

Deleting a virtual volume

Although virtual volumes should always be deleted from the VMware Management Layer, the functionality for you to delete virtual volumes is enabled from the Element UI. You should only delete a virtual volume from the Element UI when absolutely necessary, such as when vSphere fails to clean up virtual volumes on SolidFire storage.

Steps

1. Select **VVols > Virtual Volumes**.
2. Click the Actions icon for the virtual volume you want to delete.
3. In the resulting menu, select **Delete**.

   Attention: You should delete a virtual volume from the VMware Management Layer to ensure that the virtual volume is properly unbound before deletion. You should only delete a virtual volume from the Element UI when absolutely necessary, such as when vSphere fails to clean up virtual volumes on SolidFire storage. If you delete a virtual volume from the Element UI, the volume will be purged immediately.

4. Confirm the action.

5. Refresh the list of virtual volumes to confirm that the virtual volume has been removed.
6. Optional: Select **Reporting > Event Log** to confirm that the purge has been successful.

Storage containers

A storage container is a vSphere datastore representation created on a cluster running Element software.

Storage containers are created and tied to NetApp Element accounts. A storage container created on Element storage appears as a vSphere datastore in vCenter and ESXi. Storage containers do not allocate any space on Element storage. They are simply used to logically associate virtual volumes.

A maximum of four storage containers per cluster is supported. A minimum of one storage container is required to enable VVols functionality.

Creating a storage container

You can create storage containers in the Element UI and discover them in vCenter. You must create at least one storage container to begin provisioning VVol-backed virtual machines.

Before you begin

You have enabled VVols functionality in the Element UI for the cluster.

Steps

1. Select **VVols > Storage Containers**.
2. Click the **Create Storage Containers** button.
3. Enter storage container information in the **Create a New Storage Container** dialog box:
   a. Enter a name for the storage container.
   b. Configure initiator and target secrets for CHAP.

      Tip: Leave the CHAP Settings fields blank to automatically generate secrets.

   c. Click the **Create Storage Container** button.
4. Verify that the new storage container appears in the list in the **Storage Containers** sub-tab.

   Note: Because a NetApp Element account ID is created automatically and assigned to the storage container, it is not necessary to manually create an account.

Storage container details

On the Storage Containers page of the VVols tab, you can view information for all active storage containers on the cluster.

Account ID

The ID of the NetApp Element account associated with the storage container.

Name

The name of the storage container.

Status

The status of the storage container. Possible values:

- `Active`: The storage container is in use.
- `Locked`: The storage container is locked.

PE Type

Indicates the protocol endpoint type (SCSI is the only available protocol for Element software).

Storage Container ID

The UUID of the virtual volume storage container.

Active Virtual Volumes

The number of active virtual volumes associated with the storage container.

Individual storage container details

You can view the storage container information for an individual storage container by selecting it from the Storage Containers page on the VVols tab.

Account ID

The ID of the NetApp Element account associated with the storage container.

Name

The name of the storage container.

Status

The status of the storage container. Possible values:

- `Active`: The storage container is in use.
- `Locked`: The storage container is locked.

Chap Initiator Secret

The unique CHAP secret for the initiator.

Chap Target Secret

The unique CHAP secret for the target.

Storage Container ID

The UUID of the virtual volume storage container.

Protocol Endpoint Type

Indicates the protocol endpoint type (SCSI is the only available protocol).

Editing a storage container

You can modify storage container CHAP authentication in the Element UI.

Steps

1. Select **VVols > Storage Containers**.
2. Click the Actions icon for the storage container you want to edit.
3. In the resulting menu, select **Edit**.
4. Under CHAP Settings, edit the Initiator Secret and Target Secret credentials used for authentication.

   Tip: If you do not change the CHAP Settings credentials, they remain the same. If you make the credentials fields blank, the system automatically generates new secrets.

5. Click **Save Changes**.

Deleting a storage container

You can delete storage containers from the Element UI.

Before you begin

All virtual machines have been removed from the VVol datastore.

Steps

1. Select **VVols > Storage Containers**.
2. Click the Actions icon for the storage container you want to delete.
3. In the resulting menu, select **Delete**.
4. Confirm the action.
5. Refresh the list of storage containers in the **Storage Containers** sub-tab to confirm that the storage container has been removed.

Protocol endpoints

Protocol endpoints are access points used by a host to address storage on a cluster running NetApp Element software. Protocol endpoints cannot be deleted or modified by a user, are not associated with an account, and cannot be added to a volume access group.

A cluster running Element software automatically creates one protocol endpoint per storage node in the cluster. For example, a six-node storage cluster has six protocol endpoints that are mapped to each ESXi host. Protocol endpoints are dynamically managed by Element software and are created, moved, or removed as needed without any intervention. Protocol endpoints are the target for multi-pathing and act as an I/O proxy for subsidiary LUNs. Each protocol endpoint consumes an available SCSI address, just like a standard iSCSI target. Protocol endpoints appear as a single-block (512-byte) storage device in the vSphere client, but this storage device is not available to be formatted or used as storage.

iSCSI is the only supported protocol. Fibre C

hannel protocol is not supported.

Protocol endpoints details

The Protocol Endpoints page on the VVols tab provides protocol endpoint information.

Primary Provider ID

The ID of the primary protocol endpoint provider.

Secondary Provider ID

The ID of the secondary protocol endpoint provider.

Protocol Endpoint ID

The UUID of the protocol endpoint.

Protocol Endpoint State

The status of the protocol endpoint. Possible values are as follows:

- `Active`: The protocol endpoint is in use.
- `Start`: The protocol endpoint is starting.
- `Failover`: The protocol endpoint has failed over.
- `Reserved`: The protocol endpoint is reserved.

Provider Type

The type of the protocol endpoint's provider. Possible values are as follows:

- `Primary`
- `Secondary`

SCSI NAA Device ID

The globally unique SCSI device identifier for the protocol endpoint in NAA IEEE Registered Extended Format.

Bindings

To perform I/O operations with a virtual volume, an ESXi host must first bind the virtual volume.

The SolidFire cluster chooses an optimal protocol endpoint, creates a binding that associates the ESXi host and virtual volume with the protocol endpoint, and returns the binding to the ESXi host. After it is bound, the ESXi host can perform I/O operations with the bound virtual volume.

Bindings details

The Bindings page on the VVols tab provides binding information about each virtual volume.

The following information displayed:

Host ID

The UUID for the ESXi host that hosts virtual volumes and is known to the cluster.

Protocol Endpoint ID

Protocol endpoint IDs that correspond to each node in the SolidFire cluster.

Protocol Endpoint in Band ID

The SCSI NAA device ID of the protocol endpoint.

Protocol Endpoint Type

Indicates the protocol endpoint type.

VVol Binding ID

The binding UUID of the virtual volume.

VVol ID

The universally unique identifier (UUID) of the virtual volume.

VVol Secondary ID

The secondary ID of the virtual volume that is a SCSI second level LUN ID.

Host details

The Hosts page on the VVols tab provides information about VMware ESXi hosts that host virtual volumes.

The following information is displayed:

Host ID

The UUID for the ESXi host that hosts virtual volumes and is known to the cluster.

Host Address

The IP address or DNS name for the ESXi host.

Bindings

Binding IDs for all virtual volumes bound by the ESXi host.

ESX Cluster ID

The vSphere host cluster ID or vCenter GUID.

Initiator IQNs

Initiator IQNs for the virtual volume host.

SolidFire Protocol Endpoint IDs

The protocol endpoints that are currently visible to the ESXi host.

Working with access groups and initiators

You can use iSCSI initiators or Fibre Channel initiators to access volume access groups.

You can create access groups by mapping iSCSI initiator IQNs or Fibre Channel WWPNs in a collection of volumes. Each IQN that you add to an access group can access each volume in the group without requiring CHAP authentication. Each WWPN that you add to an access group enables Fibre Channel network access to the volumes in the access group.

Note: Volume access groups have the following limits:

- A maximum of 64 IQNs or WWPNs are allowed in an access group.
- An access group can be made up of a maximum of 2000 volumes.
- An IQN or WWPN can belong to only one access group.
- A single volume can belong to a maximum of four access groups.

Related tasks

Creating an access group on page 80
Adding volumes to an access group on page 82
Removing volumes from an access group on page 82
Creating an initiator on page 83
Editing an initiator on page 84
Adding a single initiator to an access group on page 84
Adding multiple initiators to an access group on page 85
Removing initiators from an access group on page 85
Deleting an access group on page 86
Deleting an initiator on page 86

Creating an access group

You can create volume access groups by mapping initiators to a collection of volumes for secured access. You can then grant access to the volumes in the group with an account CHAP initiator secret and target secret.

Steps

1. Click **Management** > **Access Groups**.
2. Click **Create Access Group**.
3. Enter a name for the volume access group in the **Name** field.
4. Add an initiator to the volume access group in one of the following ways:

Option	Description
Adding a Fibre Channel initiator	**a.** Under Add Initiators, select an existing Fibre Channel initiator from the Unbound Fibre Channel Initiators list. **b.** Click **Add FC Initiator**. **Note:** You can create an initiator during this step if you click the **Create Initiator** link, enter an initiator name, and click **Create**. The system automatically adds the initiator to the Initiators list after you create it. A sample of the format is as follows: `5f:47:ac:c0:5c:74:d4:02`

Adding an iSCSI initiator	Under Add Initiators, select an existing initiator from the Initiators list.
	Note:
	You can create an initiator during this step if you click the **Create Initiator** link, enter an initiator name, and click **Create**. The system automatically adds the initiator to the Initiators list after you create it.
	A sample of the format is as follows:
	`iqn.`
	`2010-01.com.solidfire:c2r9.fc0.2100000e1e09bb8b`
	Tip: You can find the initiator IQN for each volume by selecting **View Details** in the Actions menu for the volume on the **Management** > **Volumes** > **Active** list.

5. Optional: Add more initiators as needed.
6. Under Add Volumes, select a volume from the **Volumes** list.

   The volume appears in the **Attached Volumes** list.
7. Optional: Add more volumes as needed.
8. Click **Create Access Group**.

Related tasks

Adding volumes to an access group on page 82

Volume access group details

The Access Groups page on the Management tab provides information about volume access groups.

The following information is displayed:

ID

The system-generated ID for the access group.

Name

The name given to the access group when it was created.

Active Volumes

The number of active volumes in the access group.

Compression

The compression efficiency score for the access group.

Deduplication

The deduplication efficiency score for the access group.

Thin Provisioning

The thin provisioning efficiency score for the access group.

Overall Efficiency

The overall efficiency score for the access group.

Initiators

The number of initiators connected to the access group.

Viewing individual access group details

You can view details for an individual access group, such as attached volumes and initiators, in a graphical format.

Steps

1. Click **Management > Access Groups**.
2. Click the Actions icon for an access group.
3. Click **View Details**.

Adding volumes to an access group

You can add volumes to a volume access group. Each volume can belong to more than one volume access group; you can see the groups that each volume belongs to on the **Active** volumes page.

About this task

You can also use this procedure to add volumes to a Fibre Channel volume access group.

Steps

1. Click **Management > Access Groups**.
2. Click the Actions icon for the access group you want to add volumes to.
3. Click the **Edit** button.
4. Under Add Volumes, select a volume from the **Volumes** list.

   You can add more volumes by repeating this step.
5. Click **Save Changes**.

Removing volumes from an access group

When you remove a volume from an access group, the group no longer has access to that volume.

About this task

Modifying CHAP settings in an account or removing initiators or volumes from an access group can cause initiators to lose access to volumes unexpectedly. To verify that volume access will not be lost

unexpectedly, always logout iSCSI sessions that will be affected by an account or access group change, and verify that initiators can reconnect to volumes after any changes to initiator settings and cluster settings have been completed.

Steps

1. Click **Management > Access Groups**.
2. Click the Actions icon for the access group you want to remove volumes from.
3. Click **Edit**.
4. Under Add Volumes in the **Edit Volume Access Group** dialog box, click the arrow on the **Attached Volumes** list.
5. Select the volume you want to remove from the list and click the **x** icon to remove the volume from the list.

   You can remove more volumes by repeating this step.
6. Click **Save Changes**.

Creating an initiator

You can create iSCSI or Fibre Channel initiators and optionally assign them aliases.

Steps

1. Click **Management > Initiators**.
2. Click **Create Initiator**.
3. Perform the steps to create a single initiator or multiple initiators:

Option	Steps
Create a single initiator	**a.** Click **Create a Single Initiator**. **b.** Enter the IQN or WWPN for the initiator in the **IQN/WWPN** field. **c.** Enter a friendly name for the initiator in the **Alias** field. **d.** Click **Create Initiator**.
Create multiple initiators	**a.** Click **Bulk Create Initiators**. **b.** Enter a list of IQNs or WWPNs in the text box. **c.** Click **Add Initiators**. **d.** Choose an initiator from the resulting list and click the corresponding Add icon in the **Alias** column to add an alias for the initiator. **e.** Click the check mark to confirm the new alias. **f.** Click **Create Initiators**.

Editing an initiator

You can change the alias of an existing initiator or add an alias if one does not already exist.

Steps

1. Click **Management > Initiators**.
2. Click the Actions icon for the initiator you want to edit.
3. Click **Edit**.
4. Enter a new alias for the initiator in the **Alias** field.
5. Click **Save Changes**.

Adding a single initiator to an access group

You can add an initiator to an existing access group.

About this task

When you add an initiator to a volume access group, the initiator has access to all volumes in that volume access group.

Tip: You can find the initiator for each volume by clicking the Actions icon and then selecting **View Details** for the volume in the active volumes list.

Steps

1. Click **Management > Access Groups**.
2. Click the Actions icon for the access group you want to edit.
3. Click the **Edit** button.
4. To add a Fibre Channel initiator to the volume access group, perform the following steps:
   a. Under Add Initiators, select an existing Fibre Channel initiator from the **Unbound Fibre Channel Initiators** list.
   b. Click **Add FC Initiator**.

   Note: You can create an initiator during this step if you click the **Create Initiator** link, enter an initiator name, and click **Create**. The system automatically adds the initiator to the **Initiators** list after you create it.

   A sample of the format is as follows:

   ```
   5f:47:ac:c0:5c:74:d4:02
   ```

5. To add an iSCSI initiator to the volume access group, under Add Initiators, select an existing initiator from the **Initiators** list.

   Note: You can create an initiator during this step if you click the **Create Initiator** link, enter an initiator name, and click **Create**. The system automatically adds the initiator to the **Initiators** list after you create it.

   The accepted format of an initiator IQN is as follows: iqn.yyyy-mm, in which y and m are digits, followed by text which must only contain digits, lower-case alphabetic characters, a period (.), colon (:) or dash (-).

A sample of the format is as follows:

```
iqn.2010-01.com.solidfire:c2r9.fc0.2100000e1e09bb8b
```

Tip: You can find the initiator IQN for each volume from the **Management > Volumes** Active Volumes page by clicking the Actions icon and then selecting **View Details** for the volume.

6. Click **Save Changes**.

Adding multiple initiators to an access group

You can add multiple initiators to an existing volume access group to allow access to volumes in the volume access group without requiring CHAP authentication..

About this task

When you add initiators to a volume access group, the initiators have access to all volumes in that volume access group.

Tip: You can find the initiator for each volume by clicking the Actions icon and then **View Details** for the volume in the active volumes list.

Steps

1. Click **Management > Initiators**.
2. Select the initiators you want to add to an access group.
3. Click the **Bulk Actions** button.
4. Click **Add to Volume Access Group**.
5. In the Add to Volume Access Group dialog box, select an access group from the **Volume Access Group** list.
6. Click **Add**.

Removing initiators from an access group

When you remove an initiator from an access group, it can no longer access the volumes in that volume access group. Normal account access to the volume is not disrupted.

About this task

Modifying CHAP settings in an account or removing initiators or volumes from an access group can cause initiators to lose access to volumes unexpectedly. To verify that volume access will not be lost unexpectedly, always logout iSCSI sessions that will be affected by an account or access group change, and verify that initiators can reconnect to volumes after any changes to initiator settings and cluster settings have been completed.

Steps

1. Click **Management > Access Groups**.
2. Click the Actions icon for the access group you want to remove.
3. In the resulting menu, select **Edit**.
4. Under Add Initiators in the **Edit Volume Access Group** dialog box, click the arrow on the **Initiators** list.

5. Select the x icon for each initiator you want to remove from the access group.
6. Click **Save Changes**.

Deleting an access group

You can delete an access group when it is no longer needed. You do not need to delete Initiator IDs and Volume IDs from the volume access group before deleting the group. After you delete the access group, group access to the volumes is discontinued.

Steps

1. Click **Management > Access Groups**.
2. Click the Actions icon for the access group you want to delete.
3. In the resulting menu, click **Delete**.
4. To also delete the initiators associated with this access group, select the **Delete initiators in this access group** check box.
5. Confirm the action.

Deleting an initiator

You can delete an initiator after it is no longer needed. When you delete an initiator, the system removes it from any associated volume access group. Any connections using the initiator remain valid until the connection is reset.

Steps

1. Click **Management > Initiators**.
2. Perform the steps to delete a single initiator or multiple initiators:

Option	Steps
Delete single initiator	**a.** Click the Actions icon for the initiator you want to delete. **b.** Click **Delete**. **c.** Confirm the action.
Delete multiple initiators	**a.** Select the check boxes next to the initiators you want to delete. **b.** Click the **Bulk Actions** button. **c.** In the resulting menu, select **Delete**. **d.** Confirm the action.

Data protection

Element software enables you to protect your data in a variety of ways with capabilities such as snapshots for individual volumes or groups of volumes, snapshot scheduling capability, replication between clusters and volumes, and replication to ONTAP systems.

Related concepts

Using individual volume snapshots on page 87
Using group snapshots on page 92
Using snapshot schedules on page 97
Using replication between clusters running Element software on page 100
Using SnapMirror replication between Element and ONTAP clusters on page 111
Backing up and restoring volumes on page 124

Using individual volume snapshots

A volume snapshot is a point-in-time copy of a volume. You can take a snapshot of a volume and use the snapshot later if you need to roll a volume back to the state it was in at the time the snapshot was created.

Snapshots are similar to volume clones. However, snapshots are simply replicas of volume metadata, so you cannot mount or write to them. Creating a volume snapshot also takes only a small amount of system resources and space, which makes snapshot creation faster than cloning.

You can replicate snapshots to a remote cluster and use them as a backup copy of the volume. This enables you to roll back a volume to a specific point in time by using the replicated snapshot; you can also create a clone of a volume from a replicated snapshot.

Related tasks

Creating a volume snapshot on page 87
Editing snapshot retention on page 88
Deleting a snapshot on page 89
Cloning a volume from a snapshot on page 89
Rolling back a volume to a snapshot on page 90
Backing up a volume snapshot to an Amazon S3 object store on page 90
Backing up a volume snapshot to an OpenStack Swift object store on page 91
Backing up a volume snapshot to a SolidFire cluster on page 91

Creating a volume snapshot

You can create a snapshot of an active volume to preserve the volume image at any point in time. You can create up to 32 snapshots for a single volume.

Steps

1. Click **Management** > **Volumes**.
2. Click the Actions icon for the volume you want to use for the snapshot.
3. In the resulting menu, select **Snapshot**.
4. In the **Create Snapshot of Volume** dialog box, enter the new snapshot name.

5. Optional: Select the **Include Snapshot in Replication When Paired** check box to ensure that the snapshot is captured in replication when the parent volume is paired.
6. To set the retention for the snapshot, select from one of the following options:
   - Click **Keep Forever** to retain the snapshot on the system indefinitely.
   - Click **Set Retention Period** and use the date spin boxes to choose a length of time for the system to retain the snapshot.
7. To take a single, immediate snapshot, perform the following steps:
   a. Click **Take Snapshot Now**.
   b. Click **Create Snapshot**.
8. To schedule the snapshot to run at a future time, perform the following steps:
   a. Click **Create Snapshot Schedule**.
   b. Enter a **New Schedule Name**.
   c. Choose a **Schedule Type** from the list.
   d. Optional: Select the **Recurring Schedule** check box to repeat the scheduled snapshot periodically.
   e. Click **Create Schedule**.

Related concepts

Using snapshot schedules on page 97

Editing snapshot retention

You can change the retention period for a snapshot to control when or if the system deletes snapshots. The retention period you specify begins when you enter the new interval. When you set a retention period, you can select a period that begins at the current time (retention is not calculated from the snapshot creation time). You can specify intervals in minutes, hours, and days.

Steps

1. Click **Data Protection** > **Snapshots**.
2. Click the Actions icon for the snapshot you want to edit.
3. In the resulting menu, click **Edit**.
4. Optional: Select the **Include Snapshot in Replication When Paired** check box to ensure that the snapshot is captured in replication when the parent volume is paired.
5. Optional: Select a retention option for the snapshot:
   - Click **Keep Forever** to retain the snapshot on the system indefinitely.
   - Click **Set Retention Period** and use the date spin boxes to select a length of time for the system to retain the snapshot.
6. Click **Save Changes**.

Deleting a snapshot

You can delete a volume snapshot from a storage cluster running Element software. When you delete a snapshot, the system immediately removes it.

About this task

You can delete snapshots that are being replicated from the source cluster. If a snapshot is syncing to the target cluster when you delete it, the sync replication completes and the snapshot is deleted from the source cluster. The snapshot is not deleted from the target cluster.

You can also delete snapshots that have been replicated to the target from the target cluster. The deleted snapshot is kept in a list of deleted snapshots on the target until the system detects that you have deleted the snapshot on the source cluster. When the target detects that you have deleted the source snapshot, the target stops replication of the snapshot.

When you delete a snapshot from the source cluster, the target cluster snapshot is not affected (the reverse is also true).

Steps

1. Click **Data Protection** > **Snapshots**.
2. Click the Actions icon for the snapshot you want to delete.
3. In the resulting menu, select **Delete**.
4. Confirm the action.

Cloning a volume from a snapshot

You can create a new volume from a snapshot of a volume. When you do this, the system uses the snapshot information to clone a new volume using the data contained on the volume at the time the snapshot was created. This process stores information about other snapshots of the volume in the newly created volume.

Steps

1. Click **Data Protection** > **Snapshots**.
2. Click the Actions icon for the snapshot you want to use for the volume clone.
3. In the resulting menu, click **Clone Volume From Snapshot**.
4. Enter a **Volume Name** in the **Clone Volume From Snapshot** dialog box.
5. Select a **Total Size** and size units for the new volume.
6. Select an **Access** type for the volume.
7. Select an **Account** from the list to associate with the new volume.
8. Click **Start Cloning**.

Rolling back a volume to a snapshot

You can roll back a volume to a previous snapshot at any time. This reverts any changes made to the volume since the snapshot was created.

Steps

1. Click **Data Protection** > **Snapshots**.
2. Click the Actions icon for the snapshot you want to use for the volume rollback.
3. In the resulting menu, select **Rollback Volume To Snapshot**.
4. Optional: To save the current state of the volume before rolling back to the snapshot:
   a. In the **Rollback To Snapshot** dialog box, select **Save volume's current state as a snapshot**.
   b. Enter a name for the new snapshot.
5. Click **Rollback Snapshot**.

Volume snapshot backup operations

You can use the integrated backup feature to back up a volume snapshot. You can back up snapshots from a SolidFire cluster to an external object store, or to another SolidFire cluster. When you back up a snapshot to an external object store, you must have a connection to the object store that allows read/write operations.

Backing up a volume snapshot to an Amazon S3 object store

You can back up SolidFire snapshots to external object stores that are compatible with Amazon S3.

Steps

1. Click **Data Protection** > **Snapshots**.
2. Click the Actions icon for the snapshot you want to back up.
3. In the resulting menu, click **Backup to**.
4. In the **Integrated Backup** dialog box under **Backup to**, select **S3**.
5. Select an option under **Data Format**:
   - **Native**: A compressed format readable only by SolidFire storage systems.
   - **Uncompressed**: An uncompressed format compatible with other systems.
6. Enter a hostname to use to access the object store in the **Hostname** field.
7. Enter an access key ID for the account in the **Access Key ID** field.
8. Enter the secret access key for the account in the **Secret Access Key** field.
9. Enter the S3 bucket in which to store the backup in the **S3 Bucket** field.
10. Optional: Enter a nametag to append to the prefix in the **Nametag** field.
11. Click **Start Read**.

Backing up a volume snapshot to an OpenStack Swift object store

You can back up SolidFire snapshots to secondary object stores that are compatible with OpenStack Swift.

Steps

1. Click **Data Protection** > **Snapshots**.
2. Click the Actions icon for the snapshot you want to back up.
3. In the resulting menu, click **Backup to**.
4. In the **Integrated Backup** dialog box, under **Backup to**, select **Swift**.
5. Select an option under **Data Format**:
   - **Native**: A compressed format readable only by SolidFire storage systems.
   - **Uncompressed**: An uncompressed format compatible with other systems.
6. Enter a **URL** to use to access the object store.
7. Enter a **Username** for the account.
8. Enter the **Authentication Key** for the account.
9. Enter the **Container** in which to store the backup.
10. Optional: Enter a **Nametag**.
11. Click **Start Read**.

Backing up a volume snapshot to a SolidFire cluster

You can back up volume snapshots residing on a SolidFire cluster to a remote SolidFire cluster.

Before you begin

Ensure that the source and target clusters are paired.

About this task

When backing up or restoring from one cluster to another, the system generates a key to be used as authentication between the clusters. This bulk volume write key allows the source cluster to authenticate with the destination cluster, providing a level of security when writing to the destination volume. As part of the backup or restore process, you need to generate a bulk volume write key from the destination volume before starting the operation.

Steps

1. On the destination cluster, click **Management** > **Volumes**.
2. Click the Actions icon for the destination volume.
3. In the resulting menu, click **Restore from**.
4. In the **Integrated Restore** dialog box under **Restore from**, select **SolidFire**.
5. Select a data format under **Data Format**:
   - **Native**: A compressed format readable only by SolidFire storage systems.

- **Uncompressed**: An uncompressed format compatible with other systems.

6. Click **Generate Key**.
7. Copy the key from the **Bulk Volume Write Key** box to your clipboard.
8. On the source cluster, click **Data Protection** > **Snapshots**.
9. Click the Actions icon for the snapshot you want to use for the backup.
10. In the resulting menu, click **Backup to**.
11. In the **Integrated Backup** dialog box under **Backup to**, select **SolidFire**.
12. Select the same data format you selected earlier in the **Data Format** field.
13. Enter the management virtual IP address of the destination volume's cluster in the **Remote Cluster MVIP** field.
14. Enter the remote cluster user name in the **Remote Cluster Username** field.
15. Enter the remote cluster password in the **Remote Cluster Password** field.
16. In the **Bulk Volume Write Key** field, paste the key you generated on the destination cluster earlier.
17. Click **Start Read**.

Using group snapshots

You can create a group snapshot of a related set of volumes to preserve a point-in-time copy of the metadata for each volume. You can use the group snapshot in the future as a backup or rollback to restore the state of the group of volumes to a certain state.

Related tasks

Creating a group snapshot on page 93
Editing group snapshots on page 94
Editing members of group snapshot on page 95
Deleting a group snapshot on page 94
Rolling back volumes to a group snapshot on page 95
Cloning multiple volumes on page 96
Cloning multiple volumes from a group snapshot on page 96

Group snapshot details

The Group Snapshots page on the Data Protection tab provides information about the group snapshots.

ID

The system-generated ID for the group snapshot.

UUID

The unique ID of the group snapshot.

Name

User-defined name for the group snapshot.

Create Time

The time at which the group snapshot was created.

Status

The current status of the snapshot. Possible values:

- `Preparing`: The snapshot is being prepared for use and is not yet writable.
- `Done`: This snapshot has finished preparation and is now usable.
- `Active`: The snapshot is the active branch.

 # Volumes

The number of volumes in the group.

Retain Until

The day and time the snapshot will be deleted.

Remote Replication

Identifies whether or not the snapshot is enabled for replication to a remote SolidFire cluster. Possible values:

- `Enabled`: The snapshot is enabled for remote replication.
- `Disabled`: The snapshot is not enabled for remote replication.

Creating a group snapshot

You can create a snapshot of a group of volumes, and you can also create a group snapshot schedule to automate group snapshots. A single group snapshot can consistently snapshot up to 32 volumes at one time.

Steps

1. Click **Management** > **Volumes**.
2. Use the check boxes to select multiple volumes for a group of volumes.
3. Click **Bulk Actions**.
4. Click **Group Snapshot**.
5. Enter a new group snapshot name in the Create Group Snapshot of Volumes dialog box.
6. Optional: Select the **Include Each Group Snapshot Member in Replication When Paired** check box to ensure that each snapshot is captured in replication when the parent volume is paired.
7. Select a retention option for the group snapshot:
   - Click **Keep Forever** to retain the snapshot on the system indefinitely.
   - Click **Set Retention Period** and use the date spin boxes to choose a length of time for the system to retain the snapshot.
8. To take a single, immediate snapshot, perform the following steps:
   a. Click **Take Group Snapshot Now**.
   b. Click **Create Group Snapshot**.
9. To schedule the snapshot to run at a future time, perform the following steps:
   a. Click **Create Group Snapshot Schedule**.
   b. Enter a **New Schedule Name**.

c. Select a **Schedule Type** from the list.

d. Optional: Select the **Recurring Schedule** check box to repeat the scheduled snapshot periodically.

e. Click **Create Schedule**.

Editing group snapshots

You can edit the replication and retention settings for existing group snapshots.

Steps

1. Click **Data Protection** > **Group Snapshots**.
2. Click the Actions icon for the group snapshot you want to edit.
3. In the resulting menu, select **Edit**.
4. Optional: To change the replication setting for the group snapshot:
   a. Click **Edit** next to **Current Replication**.
   b. Select the **Include Each Group Snapshot Member in Replication When Paired** check box to ensure that each snapshot is captured in replication when the parent volume is paired.
5. Optional: To change the retention setting for the group snapshot, select from the following options:
   a. Click **Edit** next to **Current Retention**.
   b. Select a retention option for the group snapshot:
      - Click **Keep Forever** to retain the snapshot on the system indefinitely.
      - Click **Set Retention Period** and use the date spin boxes to choose a length of time for the system to retain the snapshot.
6. Click **Save Changes**.

Deleting a group snapshot

You can delete a group snapshot from the system. When you delete the group snapshot, you can choose whether all snapshots associated with the group are deleted or retained as individual snapshots.

About this task

If you delete a volume or snapshot that is a member of a group snapshot, you can no longer roll back to the group snapshot. However, you can roll back each volume individually.

Steps

1. Click **Data Protection** > **Group Snapshots**.
2. Click the Actions icon for the snapshot you want to delete.
3. In the resulting menu, click **Delete**.
4. Select from one of the following options in the confirmation dialog box:
   - Click **Delete group snapshot AND all group snapshot members** to delete the group snapshot and all member snapshots.

- Click **Retain group snapshot members as individual snapshots** to delete the group snapshot but keep all member snapshots.

5. Confirm the action.

Rolling back volumes to a group snapshot

You can roll back a group of volumes at any time to a group snapshot.

About this task

When you roll back a group of volumes, all volumes in the group are restored to the state they were in at the time the group snapshot was created. Rolling back also restores volume sizes to the size recorded in the original snapshot. If the system has purged a volume, all snapshots of that volume were also deleted at the time of the purge; the system does not restore any deleted volume snapshots.

Steps

1. Click **Data Protection** > **Group Snapshots**.
2. Click the Actions icon for the group snapshot you want to use for the volume rollback.
3. In the resulting menu, select **Rollback Volumes To Group Snapshot**.
4. Optional: To save the current state of the volumes before rolling back to the snapshot:
   a. In the **Rollback To Snapshot** dialog box, select **Save volumes' current state as a group snapshot**.
   b. Enter a name for the new snapshot.
5. Click **Rollback Group Snapshot**.

Editing members of group snapshot

You can edit the retention settings for members of an existing group snapshot.

Steps

1. Click **Data Protection** > **Snapshots**.
2. Click the **Members** tab.
3. Click the Actions icon for the group snapshot member you want to edit.
4. In the resulting menu, select **Edit**.
5. To change the replication setting for the snapshot, select from the following options:
   - Click **Keep Forever** to retain the snapshot on the system indefinitely.
   - Click **Set Retention Period** and use the date spin boxes to choose a length of time for the system to retain the snapshot.
6. Click **Save Changes**.

Cloning multiple volumes

You can create multiple volume clones in a single operation to create a point-in-time copy of the data on a group of volumes.

About this task

When you clone a volume, the system creates a snapshot of the volume and then creates a new volume from the data in the snapshot. You can mount and write to the new volume clone. Cloning multiple volumes is an asynchronous process and takes a variable amount of time depending on the size and number of the volumes being cloned.

Volume size and current cluster load affect the time needed to complete a cloning operation.

Steps

1. Click **Management > Volumes**.
2. Click the **Active** tab.
3. Use the check boxes to select multiple volumes, creating a group of volumes.
4. Click **Bulk Actions**.
5. Click **Clone** in the resulting menu.
6. Enter a **New Volume Name Prefix** in the **Clone Multiple Volumes** dialog box.

   The prefix is applied to all volumes in the group.
7. Optional: Select a different account to which the clone will belong.

   If you do not select an account, the system assigns the new volumes to the current volume account.
8. Optional: Select a different access method for the volumes in the clone.

   If you do not select an access method, the system uses the current volume access.
9. Click **Start Cloning**.

Cloning multiple volumes from a group snapshot

You can clone a group of volumes from a point-in-time group snapshot. This operation requires that a group snapshot of the volumes already exist, because the group snapshot is used as the basis to create the volumes. After you create the volumes, you can use them like any other volume in the system.

About this task

Volume size and current cluster load affect the time needed to complete a cloning operation.

Steps

1. Click **Data Protection > Group Snapshots**.
2. Click the Actions icon for the group snapshot you want to use for the volume clones.
3. In the resulting menu, select **Clone Volumes From Group Snapshot**.
4. Enter a **New Volume Name Prefix** in the **Clone Volumes From Group Snapshot** dialog box.

   The prefix is applied to all volumes created from the group snapshot.

5. Optional: Select a different account to which the clone will belong.

   If you do not select an account, the system assigns the new volumes to the current volume account.

6. Optional: Select a different access method for the volumes in the clone.

   If you do not select an access method, the system uses the current volume access.

7. Click **Start Cloning**.

Using snapshot schedules

You can protect data on a volume or a group of volumes by scheduling volume snapshots to occur at specified intervals. You can schedule either single volume snapshots or group snapshots to run automatically.

When you configure a snapshot schedule, you can choose from time intervals based on days of the week or days of the month. You can also specify the days, hours, and minutes before the next snapshot occurs. You can store the resulting snapshots on a remote storage system if the volume is being replicated.

Related tasks

Creating a snapshot schedule on page 98
Editing a snapshot schedule on page 98
Deleting a snapshot schedule on page 99
Copying a snapshot schedule on page 99

Snapshot schedule details

On the Data Protection > Schedules page, you can view the following information in the list of snapshot schedules.

ID

The system-generated ID for the snapshot.

Type

Indicates the type of schedule. Snapshot is currently the only type supported.

Name

The name given to the schedule when it was created. Snapshot schedule names can be up to 223 characters in length and contain a-z, 0-9, and dash (-) characters.

Frequency

The frequency at which the schedule is run. The frequency can be set in hours and minutes, weeks, or months.

Recurring

The frequency at which the schedule is run. The frequency can be set in hours and minutes, weeks, or months.

Manually Paused

Identifies whether or not the schedule has been manually paused.

Volume IDs

Displays the ID of the volume the schedule will use when the schedule is run.

Last Run

Displays the last time the schedule was run.

Last Run Status

Displays the outcome of the last schedule execution. Possible values:

- `Success`
- `Failure`

Creating a snapshot schedule

You can schedule a snapshot of a volume or volumes to automatically occur at specified intervals.

About this task

When you configure a snapshot schedule, you can choose from time intervals based on days of the week or days of the month. You can also create a recurring schedule and specify the days, hours, and minutes before the next snapshot occurs.

If you schedule a snapshot to run at a time period that is not divisible by 5 minutes, the snapshot will run at the next time period that is divisible by 5 minutes. For example, if you schedule a snapshot to run at 12:42:00 UTC, it will run at 12:45:00 UTC. You cannot schedule a snapshot to run at intervals of less than 5 minutes.

Steps

1. Click **Data Protection > Schedules**.
2. Click **Create Schedule**.
3. In the **Volume IDs CSV** field, enter a single volume ID or a comma-separated list of volume IDs to include in the snapshot operation.
4. Enter a new schedule name.
5. Select a schedule type and set the schedule from the options provided.
6. Optional: Select **Recurring Schedule** to repeat the snapshot schedule indefinitely.
7. Optional: Enter a name for the new snapshot in the **New Snapshot Name** field.

   If you leave the field blank, the system uses the time and date of the snapshot's creation as the name.
8. Optional: Select the **Include Snapshots in Replication When Paired** check box to ensure that the snapshots are captured in replication when the parent volume is paired.
9. To set the retention for the snapshot, select from the following options:
   - Click **Keep Forever** to retain the snapshot on the system indefinitely.
   - Click **Set Retention Period** and use the date spin boxes to choose a length of time for the system to retain the snapshot.
10. Click **Create Schedule**.

Editing a snapshot schedule

You can modify existing snapshot schedules. After modification, the next time the schedule runs it uses the updated attributes. Any snapshots created by the original schedule remain on the storage system.

Steps

1. Click **Data Protection > Schedules**.

2. Click the Actions icon for the schedule you want to change.
3. In the resulting menu, click **Edit**.
4. In the **Volume IDs CSV** field, modify the single volume ID or comma-separated list of volume IDs currently included in the snapshot operation.
5. To pause or resume the schedule, select from the following options:
   - To pause an active schedule, select **Yes** from the **Manually Pause Schedule** list.
   - To resume a paused schedule, select **No** from the **Manually Pause Schedule** list.
6. Enter a different name for the schedule in the **New Schedule Name** field if desired.
7. To change the schedule to run on different days of the week or month, select **Schedule Type** and change the schedule from the options provided.
8. Optional: Select **Recurring Schedule** to repeat the snapshot schedule indefinitely.
9. Optional: Enter or modify the name for the new snapshot in the **New Snapshot Name** field.

   If you leave the field blank, the system uses the time and date of the snapshot's creation as the name.
10. Optional: Select the **Include Snapshots in Replication When Paired** check box to ensure that the snapshots are captured in replication when the parent volume is paired.
11. To change the retention setting, select from the following options:
    - Click **Keep Forever** to retain the snapshot on the system indefinitely.
    - Click **Set Retention Period** and use the date spin boxes to select a length of time for the system to retain the snapshot.
12. Click **Save Changes**.

Copying a snapshot schedule

You can copy a schedule and maintain its current attributes.

Steps

1. Click **Data Protection > Schedules**.
2. Click the Actions icon for the schedule you want to copy.
3. In the resulting menu, click **Make a Copy**.

   The **Create Schedule** dialog box appears, populated with the current attributes of the schedule.
4. Optional: Enter a name and updated attributes for the new schedule.
5. Click **Create Schedule**.

Deleting a snapshot schedule

You can delete a snapshot schedule. After you delete the schedule, it does not run any future scheduled snapshots. Any snapshots that were created by the schedule remain on the storage system.

Steps

1. Click **Data Protection > Schedules**.

2. Click the Actions icon for the schedule you want to delete.
3. In the resulting menu, click **Delete**.
4. Confirm the action.

Using replication between clusters running Element software

For clusters running Element software, real-time replication enables the quick creation of remote copies of volume data. You can pair a storage cluster with up to four other storage clusters. You can replicate volume data synchronously or asynchronously from either cluster in a cluster pair for failover and failback scenarios.

Related tasks

Pairing clusters on page 101
Pairing volumes on page 104

Configuring cluster and volume pairing for real-time replication

You must first pair two storage clusters running Element software and then pair volumes on each cluster to take advantage of real-time remote replication.

Before you begin

- You must have cluster administrator privileges to one or both clusters being paired.
- All node IP addresses on both management and storage networks for paired clusters are routed to each other.
- MTU of all paired nodes must be the same and be supported end-to-end between clusters.
- The difference between Element software versions on the clusters is no greater than one major version. If the difference is greater, one of the clusters must be upgraded to perform data replication.

Note: WAN Accelerator appliances have not been qualified by NetApp for use when replicating data. These appliances can interfere with compression and deduplication if deployed between two clusters that are replicating data. Be sure to fully qualify the effects of any WAN Accelerator appliance before you deploy it in a production environment.

Steps

1. Create a cluster pair.
2. Create a volume pair.
3. Assign a replication source and target to the paired volumes.

Related tasks

Pairing clusters on page 101
Pairing volumes on page 104
Assigning a replication source and target to paired volumes on page 107

Cluster pairs

You must pair two clusters as a first step to using real-tme replication functionality. After you pair and connect two clusters, you can configure active volumes on one cluster to be continuously replicated to a second cluster, providing continuous data protection (CDP).

You can pair one cluster with up to four other clusters for replicating volumes. You can also pair clusters within the cluster group with each other.

Pairing clusters

You can pair a source and target cluster using the MVIP of the target cluster if there is cluster administrator access to both clusters. If cluster administrator access is only available on one cluster in a cluster pair, a pairing key can be used on the target cluster to complete the cluster pairing.

Before you begin

- You must have cluster administrator privileges to one or both clusters being paired.
- All node MIPs and SIPs are routed to each other.
- Less than 2000 ms of round-trip latency between clusters.
- The difference between Element software versions on the clusters is no greater than one major version. If the difference is greater, one of the clusters must be upgraded to perform data replication.

Note: Cluster pairing requires full connectivity between nodes on the management network. Replication requires connectivity between the individual nodes on the storage cluster network.

Step

1. Select one of the following methods to pair clusters:
   - Pair clusters using MVIP: Use this method if there is cluster administrator access to both clusters. This method uses the MVIP of the remote cluster to pair two clusters.
   - Pair clusters using a pairing key: Use this method if there is cluster administrator access to only one of the clusters. This method generates a pairing key that can be used on the target cluster to complete the cluster pairing.

Related tasks

Pairing clusters using MVIP on page 101
Pairing clusters using a pairing key on page 102

Related references

Network port requirements on page 11

Pairing clusters using MVIP

You can pair two clusters for real-time replication by using the MVIP of one cluster to establish a connection with the other cluster. Cluster administrator access on both of clusters is required to use this method. The cluster administrator user name and password is used to authenticate cluster access before the clusters can be paired.

Steps

1. On the local cluster, select **Data Protection** > **Cluster Pairs**.

2. Click **Pair Cluster**.
3. Click **Start Pairing** and click **Yes** to indicate that you have access to the remote cluster.
4. Enter the remote cluster MVIP address.
5. Click **Complete pairing on remote cluster**.

   In the **Authentication Required** window, enter the cluster administrator user name and password of the remote cluster.
6. On the remote cluster, select **Data Protection > Cluster Pairs**.
7. Click **Pair Cluster**.
8. Click **Complete Pairing**.
9. Click the **Complete Pairing** button.

   In the **Cluster Pairs** window, verify that the cluster pair is connected.

   (Optional) Navigate back to the local cluster and the **Cluster Pairs** window and verify that the cluster pair is connected.

Related tasks

Pairing clusters using a pairing key on page 102

Related information

Pairing clusters using MVIP (video)

Pairing clusters using a pairing key

If you have cluster administrator access to a local cluster but not the remote cluster, you can pair the clusters using a pairing key. A pairing key is generated on a local cluster and then sent securely to a cluster administrator at a remote site to establish a connection and complete the cluster pairing for real-time replication.

Steps

1. On the local cluster, select **Data Protection > Cluster Pairs**.
2. Click **Pair Cluster**.
3. Click **Start Pairing** and click **No** to indicate that you do not have access to the remote cluster.
4. Click **Generate Key**.

   Note: This action generates a text key for pairing and creates an unconfigured cluster pair on the local cluster. If you do not complete the procedure, you will need to manually delete the cluster pair.
5. Copy the cluster pairing key to your clipboard.
6. Make the pairing key accessible to the cluster administrator at the remote cluster site.

   Note: The cluster pairing key contains a version of the MVIP, user name, password, and database information to permit volume connections for remote replication. This key should be treated in a secure manner and not stored in a way that would allow accidental or unsecured access to the user name or password.

   Attention: Do not modify any of the characters in the pairing key. The key becomes invalid if it is modified.

7. On the remote cluster, select **Data Protection** > **Cluster Pairs**.
8. Click **Pair Cluster**.
9. Click **Complete Pairing** and enter the pairing key in the **Pairing Key** field (paste is the recommended method).
10. Click **Complete Pairing**.

    In the **Cluster Pairs** window, verify that the cluster pair is connected.

    (Optional) Navigate back to the local cluster and the **Cluster Pairs** window and verify that the cluster pair is connected.

Related tasks

Pairing clusters using MVIP on page 101

Related information

Pairing clusters using a cluster pairing key (video)

Cluster pair details

The Cluster Pairs page on the Data Protection tab provides information about clusters that have been paired or are in the process of being paired. The system displays pairing and progress messages in the Status column.

ID

A system-generated ID given to each cluster pair.

Remote Cluster Name

The name of the other cluster in the pair.

Remote MVIP

The management virtual IP address of the other cluster in the pair.

Status

Replication status of the remote cluster

Replicating Volumes

The number of volumes contained by the cluster that are paired for replication.

UUID

A unique ID given to each cluster in the pair.

Deleting a cluster pair

You can delete a cluster pair from the Element UI of either of the clusters in the pair.

Steps

1. Click **Data Protection** > **Cluster Pairs**.
2. Click the Actions icon for a cluster pair.
3. In the resulting menu, click **Delete**.
4. Confirm the action.
5. Perform the steps again from the second cluster in the cluster pairing.

Volume pairs

You can pair two volumes for real-time replication that are stored on different storage clusters in a connected cluster pair. After you pair two clusters, you can configure active volumes on one cluster to be continuously replicated to a second cluster, providing continuous data protection (CDP). You can also assign either volume to be the source or target of the replication.

Volume pairings are always one-to-one. After a volume is part of a pairing with a volume on another cluster, you cannot pair it again with any other volume.

Pairing volumes

After you have established a connection between clusters in a cluster pair, you can pair a volume on one cluster with a volume on the other cluster in the pair. When a volume pairing relationship is established, you must identify which volume is the replication target.

Before you begin

- You have established a connection between clusters in a cluster pair.
- You have cluster administrator privileges to one or both clusters being paired.

Steps

1. Pair volumes by selecting one of the following methods:
   - Using a volume ID: Use this method if you have cluster administrator access to both clusters on which volumes are to be paired. This method uses the volume ID of the volume on the remote cluster to initiate a connection.
   - Using a pairing Key: Use this method if you have cluster administrator access to only the source cluster. This method generates a pairing key that can be used on the remote cluster to complete the volume pair.

     Note: The volume pairing key contains an encrypted version of the volume information and might contain sensitive information. Only share this key in a secure manner.
2. Assign a replication target and source to the paired volumes.

   Note: A replication source volume has read/write account access. A replication target volume can only be accessed by the replication source as read/write.
3. Optional: Verify that the cluster pairs have an active connection.

Related tasks

Pairing clusters using MVIP on page 101
Pairing clusters using a pairing key on page 102
Pairing volumes using a volume ID on page 105
Pairing volumes using a pairing key on page 106
Assigning a replication source and target to paired volumes on page 107

Related references

Network port requirements on page 11

Pairing volumes using a volume ID

You can pair a volume with another volume on a remote cluster if you have cluster administrator credentials for the remote cluster.

Before you begin

- Ensure that the clusters containing the volumes are paired.
- Create a new volume on the remote cluster.

  Note: You can assign a replication source and target after the pairing process. A replication source or target can be either volume in a volume pair. You should create a target volume that contains no data and has the exact characteristics of the source volume, such as size, 512e setting, and QoS configuration. If you assign an existing volume as the replication target, the data on that volume will be overwritten. The target volume can be greater or equal in size to the source volume, but it cannot be smaller.

- Know the target Volume ID.

Steps

1. Select **Management** > **Volumes**.
2. Click the Actions icon for the volume you want to pair.
3. Click **Pair**.
4. In the **Pair Volume** dialog box, select **Start Pairing**.
5. Select **I Do** to indicate that you have access to the remote cluster.
6. Select a **Replication Mode** from the list:
   - **Real-time (Asynchronous)**: Writes are acknowledged to the client after they are committed on the source cluster.
   - **Real-time (Synchronous)**: Writes are acknowledged to the client after they are committed on both the source and target clusters.
   - **Snapshots Only**: Only snapshots created on the source cluster are replicated. Active writes from the source volume are not replicated.
7. Select a remote cluster from the list.
8. Choose a remote volume ID.
9. Click **Start Pairing**.

   The system opens a web browser tab that connects to the Element UI of the remote cluster. You might be required to log on to the remote cluster with cluster administrator credentials.
10. In the Element UI of the remote cluster, select **Complete Pairing**.
11. Confirm the details in **Confirm Volume Pairing**.
12. Click **Complete Pairing**.

    After you confirm the pairing, the two clusters begin the process of connecting the volumes for pairing. During the pairing process, you can see messages in the **Volume Status** column of the **Volume Pairs** window. The volume pair displays the following message until the volume pair source and target are assigned: `PausedMisconfigured`

Related tasks

Assigning a replication source and target to paired volumes on page 107

Related references

Volume pairing messages on page 109
Volume pairing warnings on page 109

Pairing volumes using a pairing key

If you do not have cluster admin credentials for a remote cluster, you can pair a volume with another volume on a remote cluster using a pairing key.

Before you begin

- Ensure that the clusters containing the volumes are paired.
- Ensure that there is a volume on the remote cluster to use for the pairing.

  Note: You can assign a replication source and target after the pairing process. A replication source or target can be either volume in a volume pair. You should create a target volume that contains no data and has the exact characteristics of the source volume, such as size, 512e setting, and QoS configuration. If you assign an existing volume as the replication target, the data on that volume will be overwritten. The target volume can be greater or equal in size to the source volume, but it cannot be smaller.

Steps

1. Select **Management** > **Volumes**.
2. Click Actions icon for the volume you want to pair.
3. Click **Pair**.
4. In the **Pair Volume** dialog box, select **Start Pairing**.
5. Select **I Do Not** to indicate that you do not have access to the remote cluster.
6. Select a **Replication Mode** from the list:
   - **Real-time (Asynchronous)**: Writes are acknowledged to the client after they are committed on the source cluster.
   - **Real-time (Synchronous)**: Writes are acknowledged to the client after they are committed on both the source and target clusters.
   - **Snapshots Only**: Only snapshots created on the source cluster are replicated. Active writes from the source volume are not replicated.
7. Click **Generate Key**.

   Note: This action generates a text key for pairing and creates an unconfigured volume pair on the local cluster. If you do not complete the procedure, you will need to manually delete the volume pair.
8. Copy the pairing key to your computer's clipboard.
9. Make the pairing key accessible to the cluster admin at the remote cluster site.

   Note: The volume pairing key should be treated in a secure manner and not used in a way that would allow accidental or unsecured access.

Attention: Do not modify any of the characters in the pairing key. The key becomes invalid if it is modified.

10. In the remote cluster Element UI, select **Management > Volumes**.
11. Click the Actions icon for the volume you want to pair.
12. Click **Pair**.
13. In the **Pair Volume** dialog box, select **Complete Pairing**.
14. Paste the pairing key from the other cluster into the **Pairing Key** box.
15. Click **Complete Pairing**.

    After you confirm the pairing, the two clusters begin the process of connecting the volumes for pairing. During the pairing process, you can see messages in the **Volume Status** column of the **Volume Pairs** window. The volume pair displays `PausedMisconfigured` until the volume pair source and target are assigned.

Related tasks

Assigning a replication source and target to paired volumes on page 107

Related references

Volume pairing messages on page 109
Volume pairing warnings on page 109

Assigning a replication source and target to paired volumes

After volumes are paired, you must assign a source volume and its replication target volume. A replication source or target can be either volume in a volume pair. You can also use this procedure to redirect data sent to a source volume to a remote target volume should the source volume become unavailable.

Before you begin

You have access to the clusters containing the source and target volumes.

Steps

1. From the cluster that contains the volume you want to assign as source, select **Management > Volumes**.
2. Click the Actions icon for the volume you want to assign as source.
3. Click **Edit**.
4. In the **Access** drop-down list, select **Read/Write**.

   Attention: If you are reversing source and target assignment, this action will cause the volume pair to display the following message until a new replication target is assigned: `PausedMisconfigured`

   Changing access pauses volume replication and causes the transmission of data to cease. Be sure that you have coordinated these changes at both sites.

5. Click **Save Changes**.
6. From the cluster that contains the volume you want to assign as target, select **Management > Volumes**.

7. Click the Actions icon for the volume you want to assign as target.
8. Click **Edit**.
9. In the **Access** drop-down list, select **Replication Target**.

   Attention: If you assign an existing volume as the replication target, the data on that volume will be overwritten. You should use a new target volume that contains no data and has the exact characteristics of the source volume, such as size, 512e setting, and QoS configuration. The target volume can be greater or equal in size to the source volume, but it cannot be smaller.

10. Click **Save Changes**.
11. Optional: From either cluster, select **Data Protection** > **Volume Pairs**.
12. Optional: Verify that the volume status is `Active`.

Related tasks

Pairing volumes using a volume ID on page 105
Pairing volumes using a pairing key on page 106

Volume pair details

The Volume Pairs page on the Data Protection tab provides information about volumes that have been paired or are in the process of being paired. The system displays pairing and progress messages in the Volume Status column.

ID

System-generated ID for the volume.

Name

The name given to the volume when it was created. Volume names can be up to 223 characters and contain a-z, 0-9, and dash (-).

Account

Name of the account assigned to the volume.

Volume Status

Replication status of the volume

Snapshot Status

Status of the snapshot volume.

Mode

Indicates the client write replication method. Possible values are as follows:

- Async
- Snapshot-Only
- Sync

Direction

Indicates the direction of the volume data:

- Source volume icon ( ) indicates data is being written to a target outside the cluster.
- Target volume icon ( ) indicates data is being written to the local volume from an outside source.

Async Delay

Length of time since the volume was last synced with the remote cluster. If the volume is not paired, the value is null.

Remote Cluster

Name of the remote cluster on which the volume resides.

Remote Volume ID

Volume ID of the volume on the remote cluster.

Remote Volume Name

Name given to the remote volume when it was created.

Volume pairing messages

You can view volume pairing messages during the initial pairing process from the Volume Pairs page under the Data Protection tab. These messages can display on both source and target ends of the pair in the Replicating Volumes list view.

PausedDisconnected

Source replication or sync RPCs timed out. Connection to the remote cluster has been lost. Check network connections to the cluster.

ResumingConnected

The remote replication sync is now active. Beginning the sync process and waiting for data.

ResumingRRSync

A single helix copy of the volume metadata is being made to the paired cluster.

ResumingLocalSync

A double helix copy of the volume metadata is being made to the paired cluster.

ResumingDataTransfer

Data transfer has resumed.

Active

Volumes are paired and data is being sent from the source to the target volume and the data is in sync.

Idle

No replication activity is occurring.

Volume pairing warnings

The Volume Pairs page on the Data Protection tab provides these messages after you pair volumes. These messages can display on both source and target ends of the pair (unless otherwise indicated) in the Replicating Volumes list view.

PausedClusterFull

Because the target cluster is full, source replication and bulk data transfer cannot proceed. The message displays on the source end of the pair only.

PausedExceededMaxSnapshotCount

The target volume already has the maximum number of snapshots and cannot replicate additional snapshots.

PausedManual

Local volume has been manually paused. It must be unpaused before replication resumes.

PausedManualRemote

Remote volume is in manual paused mode. Manual intervention required to unpause the remote volume before replication resumes.

PausedMisconfigured

Waiting for an active source and target. Manual intervention required to resume replication.

PausedQoS

Target QoS could not sustain incoming IO. Replication auto-resumes. The message displays on the source end of the pair only.

PausedSlowLink

Slow link detected and stopped replication. Replication auto-resumes. The message displays on the source end of the pair only.

PausedVolumeSizeMismatch

Target volume is smaller than the source volume.

PausedXCopy

A SCSI XCOPY command is being issued to a source volume. The command must complete before replication can resume. The message displays on the source end of the pair only.

StoppedMisconfigured

A permanent configuration error has been detected. The remote volume has been purged or unpaired. No corrective action is possible; a new pairing must be established.

Editing volume pairs

You can edit volume pair properties to make changes to the replication mode of the volume pair relationship or manually pause replication.

Steps

1. Select **Data Protection > Volume Pairs**.
2. Click the Actions icon that corresponds to the volume pair you want to edit.
3. Click **Edit**.
4. In the **Edit Volume Pair** pane, do any of the following:

   Attention: Pausing or resuming volume replication manually will cause the transmission of data to cease or resume. Changing the mode of replication will cause the mode to change immediately. Be sure that you have coordinated these changes at both sites.

   - Manually pause or start the replication process.
   - Select a new replication mode:
     - **Real-time (Asynchronous)**: Writes are acknowledged to the client after they are committed on the source cluster.
     - **Real-time (Synchronous)**: Writes are acknowledged to the client after they are committed on both the source and target clusters.
     - **Snapshots Only**: Only snapshots created on the source cluster are replicated. Active writes from the source volume are not replicated.
5. Click **Save Changes**.

Deleting volume pairs

You can delete a volume pair if want to remove a pair association between two volumes.

Steps

1. Select **Data Protection** > **Volume Pairs**.
2. Click the Actions icon that corresponds to the volume pair you want to delete.
3. Click **Delete**.
4. Confirm the message.

Using SnapMirror replication between Element and ONTAP clusters

You can create SnapMirror relationships from the Data Protection tab in the NetApp Element UI. SnapMirror functionality must be enabled to see this in the user interface.

Note: IPv6 is not supported for SnapMirror replication between NetApp Element software and ONTAP clusters.

Related concepts

SnapMirror endpoints on page 113
SnapMirror labels on page 115
SnapMirror relationships on page 116
Disaster recovery using SnapMirror on page 119

Related tasks

Enabling SnapMirror on the cluster on page 111
Enabling SnapMirror on the volume on page 112

SnapMirror overview

NetApp Element 10.1 and above supports SnapMirror functionality to copy and restore snapshots with NetApp ONTAP systems.

Systems running Element 10.1 and above include code that can communicate directly with SnapMirror on ONTAP systems running 9.3 or higher. The NetApp Element API provides methods to enable SnapMirror functionality on clusters, volumes, and snapshots. Additionally, the Element UI includes all necessary functionality to manage SnapMirror relationships between Element software and ONTAP based systems.

Starting with Element 10.3 and ONTAP 9.4 systems, you can replicate ONTAP originated volumes to Element volumes in specific use cases with limited functionality. For more information, see ONTAP documentation.

Related information

Replication between Element software and ONTAP

Enabling SnapMirror on the cluster

You must manually enable SnapMirror functionality at the cluster level through the NetApp Element UI. The system comes with SnapMirror functionality disabled by default, and it is not automatically

enabled as part of a new installation or upgrade. Enabling the SnapMirror feature is a one-time configuration task.

Before you begin

The storage cluster must be running NetApp Element software version 10.1 or later.

About this task

SnapMirror can only be enabled for clusters running Element software used in conjunction with volumes on a NetApp ONTAP system. You should enable SnapMirror functionality only if your cluster is connected for use with NetApp ONTAP volumes.

Steps

1. Click **Clusters > Settings**.
2. Find the cluster-specific settings for SnapMirror.
3. Click **Enable SnapMirror**.

   Note: Enabling SnapMirror functionality permanently changes the Element software configuration. You can disable the SnapMirror feature and restore the default settings only by returning the cluster to the factory image.

4. Click **Yes** to confirm the SnapMirror configuration change.

Enabling SnapMirror on the volume

You must enable SnapMirror on the volume in the Element UI. This allows replication of data to specified ONTAP volumes. This is permission from the administrator of the cluster running NetApp Element software for SnapMirror to control a volume.

Before you begin

- You have enabled SnapMirror in the Element UI for the cluster.
- A SnapMirror endpoint is available.
- The volume must be 512e block size.
- The volume is not participating in remote replication.
- The volume access type is not Replication Target.

Note: You can also set this property when creating or cloning a volume.

Steps

1. Click **Management > Volumes**.
2. Click the Actions icon for the volume you want to enable SnapMirror for.
3. In the resulting menu, select **Edit**.
4. In the **Edit Volume** dialog box, select the check box **Enable SnapMirror**.
5. Click **Save Changes**.

SnapMirror endpoints

A SnapMirror endpoint is an ONTAP cluster that serves as a replication target for a cluster running NetApp Element software. You must create a SnapMirror endpoint before you can create a SnapMirror relationship.

You can create and manage up to four SnapMirror endpoints on a storage cluster running Element software.

Note: If an existing endpoint was originally created using the API and credentials were not saved, you can see the endpoint in the Element UI and verify its existence, but it cannot be managed using the Element UI. This endpoint can then only be managed using the Element API. For information about the API methods, see the *NetApp Element Software API Reference Guide* in the Element product library.

Related information

NetApp Element Product Library

Creating an endpoint

You must create a SnapMirror endpoint in the NetApp Element UI before you can create a relationship.

Before you begin

- You have enabled SnapMirror in the Element UI for the storage cluster.
- You know the ONTAP credentials for the endpoint.

Steps

1. Click **Data Protection > SnapMirror Endpoints**.
2. Click **Create Endpoint**.
3. In the **Create a New Endpoint** dialog box, enter the cluster management IP address of the ONTAP system.
4. Enter the ONTAP administrator credentials associated with the endpoint.
5. Click **Create Endpoint**.

SnapMirror endpoint details

The SnapMirror Endpoints page on the Data Protection tab provides information about all SnapMirror endpoints on the cluster such as ID, cluster name, and cluster management IP.

ID

The ID of the endpoint.

Cluster Name

Name of the destination cluster.

Cluster Management IP

IP address of the destination cluster.

LIFs

This lists the ONTAP intercluster logical interfaces used to communicate with Element.

Relationships

Number of relationships associated with this endpoint.

Status

Current status of the SnapMirror endpoint. Possible values are as follows:

- connected
- disconnected
- unmanaged

Editing an endpoint

You must modify a SnapMirror endpoint in the NetApp Element UI.

Before you begin

- You have enabled SnapMirror in the Element UI for the cluster.
- An existing SnapMirror endpoint is available to modify.

Steps

1. Click **Data Protection** > **SnapMirror Endpoints**.
2. Click the Actions icon for the endpoint you want to edit.
3. In the resulting menu, select **Edit**.
4. Under **Cluster Management IP**, edit the IP address as needed.
5. Under **ONTAP Credentials**, edit the user name or password, if necessary.
6. Click **Save Changes**.

Deleting an endpoint

You must delete a SnapMirror endpoint from the NetApp Element UI.

Before you begin

- You have enabled SnapMirror in the Element UI for the cluster.
- An existing SnapMirror endpoint is available to delete.

Steps

1. Click **Data Protection** > **SnapMirror Endpoints**.
2. Click the Actions icon for the endpoint you want to delete.
3. In the resulting menu, select **Delete**.
4. Confirm the action.
5. Refresh the list of SnapMirror endpoints to confirm that the endpoint has been removed.

SnapMirror labels

A SnapMirror label serves as a marker for transferring a specified snapshot according to the retention rules of the relationship.

Applying a label to a snapshot marks it as a target for SnapMirror replication. The role of the relationship is to enforce the rules upon data transfer by selecting the matching labeled snapshot, copying it to the destination volume, and ensuring the correct number of copies are kept. It refers to the policy to determine the keep count and the retention period. The policy can have any number of rules and each rule has a unique label. This label serves as the link between the snapshot and the retention rule.

It is the SnapMirror label that indicates which rule is applied for the selected snapshot, group snapshot, or schedule.

Adding SnapMirror labels to snapshots

SnapMirror labels specify the snapshot retention policy on the SnapMirror endpoint. You can add labels to snapshots and group snapshots.

Before you begin

- SnapMirror is enabled on the cluster.
- The label you want to add already exists in ONTAP.

About this task

You can view available labels from an existing SnapMirror relationship dialog box or the NetApp OnCommand System Manager.

Attention: When adding a label to a group snapshot, any existing labels to individual snapshots are overwritten.

Steps

1. Click **Data Protection** > **Snapshots** or **Group Snapshots** page.
2. Click the Actions icon for the snapshot or group snapshot you want to add a SnapMirror label to.
3. In the **Edit Snapshot** dialog box, enter text in the **SnapMirror Label** field. The label must match a rule label in the policy applied to the SnapMirror relationship.
4. Click **Save Changes**.

Adding SnapMirror labels to snapshot schedules

You can add SnapMirror labels to snapshot schedules to ensure that a SnapMirror policy is applied. You can view available labels from an existing SnapMirror relationship dialog box or the NetApp OnCommand System Manager.

Before you begin

- SnapMirror is enabled at the cluster level.
- The label you want to add already exists in ONTAP.

Steps

1. Click **Data Protection** > **Schedules**.

2. Add a SnapMirror label to a schedule in one of the following ways:

Option	Steps
Creating a new schedule	**a.** Select **Create Schedule**. **b.** Enter all other relevant details. **c.** Select **Create Schedule**.
Modifying existing schedule	**a.** Click the Actions icon for the schedule you want to add a label to and select **Edit**. **b.** In the resulting dialog box, enter text in the **SnapMirror Label** field. **c.** Select **Save Changes**.

Related tasks

Creating a snapshot schedule on page 98

SnapMirror relationships

A SnapMirror relationship is the relationship between a source volume and a destination volume. Data is replicated to the destination volume by using NetApp snapshot copies. You can edit and delete SnapMirror relationships using the NetApp Element UI.

Creating a SnapMirror relationship

You must create a SnapMirror relationship in the NetApp Element UI.

Before you begin

SnapMirror is enabled on the volume.

Note: When a volume is not yet enabled for SnapMirror and you select to create a relationship from the Element UI, SnapMirror is automatically enabled on that volume.

Steps

1. Click **Management > Volumes**.
2. Click the Actions icon for the volume that is to be a part of the relationship.
3. Click **Create a SnapMirror Relationship**.
4. In the **Create a SnapMirror Relationship** dialog box, select an endpoint from the **Endpoint** list.
5. Select if the relationship will be created using a new ONTAP volume or an existing ONTAP volume.
6. To create a new ONTAP volume in the Element UI, click **Create new volume**.
   a. Select the **Storage Virtual Machine** for this relationship.
   b. Select the **Aggregate** from the drop-down list.
   c. In the **Volume Name Suffix** field, enter a suffix.

      Note: The system detects the source volume name and copies it to the **Volume Name** field. The suffix you enter appends the name.

   d. Click **Create Destination Volume**.

7. To use an existing ONTAP volume, click **Use existing volume**.
   a. Select the **Storage Virtual Machine** for this relationship.
   b. Select the volume that is the destination for this new relationship.
8. In the **Relationship Details** section, select a policy. If the selected policy has keep rules, the Rules table displays the rules and associated labels.
9. Optional: Select a schedule.

   This determines how often the relationship creates copies.
10. Optional: In the **Limit Bandwidth to** field, enter the maximum amount of bandwidth that can be consumed by data transfers associated with this relationship.
11. To not initialize at this time, ensure that the **Initialize** check box is not selected.

    Note: Initialization can be time-consuming. You might want to run this during off-peak hours. Initialization performs a baseline transfer; it makes a snapshot copy of the source volume, then transfers that copy and all the data blocks it references to the destination volume. You can initialize manually or use a schedule to start the initialization process (and subsequent updates) according to the schedule.
12. Click **Create Relationship**.
13. Click **Data Protection > SnapMirror Relationships** to view this new SnapMirror relationship.

SnapMirror relationship details

The SnapMirror Relationships page on the Data Protection tab provides information about all SnapMirror relationships on the cluster such as endpoint ID, name of destination cluster, and name of destination volume.

Endpoint ID

The ID of the endpoint.

Source Cluster

Name of the source cluster.

Source Volume

Name of the source volume.

Destination Cluster

Name of the destination ONTAP cluster.

Destination Volume

Name of the destination ONTAP volume.

State

Current relationship state of the destination volume. Possible values are as follows:

- uninitialized: The destination volume has not been initialized.
- snapmirrored: The destination volume has been initialized and is ready to receive SnapMirror updates.
- broken-off: The destination volume is read/write and snapshots are present.

Status

Current status of the relationship. Possible values are idle, transferring, checking, quiescing, quiesced, queued, preparing, finalizing, aborting, and breaking.

Lag Time

The amount of time in seconds that the destination system lags behind the source system. The lag time must be no more than the transfer schedule interval.

Bandwidth Limit

The maximum amount of bandwidth that can be consumed by data transfers associated with this relationship.

Last Transferred

Timestamp of the last transferred snapshot. Click for further information.

Policy Name

The name of the ONTAP SnapMirror policy for the relationship.

Policy Type

Type of ONTAP SnapMirror policy selected for the relationship. Possible values are as follows:

- async_mirror
- mirror_vault

Schedule Name

Name of the pre-existing schedule on the ONTAP system selected for this relationship.

Editing a SnapMirror relationship

You must edit a SnapMirror relationship in the NetApp Element UI.

Before you begin

- SnapMirror is enabled on the volume.
- An existing SnapMirror relationship is available to modify.

Steps

1. Click **Data Protection** > **SnapMirror Relationships**.
2. Click the Actions icon for the relationship that is to be edited.
3. Click **Edit**.
4. In the **Edit SnapMirror Relationship** dialog box, you can change the policy, schedule, or bandwidth limit settings.
5. Click **Save Changes**.

Deleting a SnapMirror relationship

You can delete a SnapMirror relationship from the NetApp Element UI.

Before you begin

- You have enabled SnapMirror in the Element UI for the cluster.
- An existing SnapMirror relationship is available to delete.

Steps

1. Click **Data Protection** > **SnapMirror Relationships**.

2. Click the Actions icon for the relationship you want to delete.
3. In the resulting menu, select **Delete**.
4. Confirm the action.
5. Refresh the list of SnapMirror relationships to confirm that the relationship has been removed.

SnapMirror relationship actions

You can configure a relationship from the SnapMirror Relationships page of the Data Protection tab. The options from the Actions icon are described here.

Edit

Edits the policy used or schedule for the relationship.

Delete

Deletes the SnapMirror relationship. This function does not delete the destination volume.

Initialize

Performs the first initial baseline transfer of data to establish a new relationship.

Update

Performs an on-demand update of the relationship, replicating any new data and Snapshot copies included since the last update to the destination.

Quiesce

Prevents any further updates for a relationship.

Resume

Resumes a relationship that is quiesced.

Break

Makes the destination volume read-write and stops all current and future transfers. Determine that clients are not using the original source volume, because the reverse resync operation makes the original source volume read-only.

Resync

Reestablishes a broken relationship in the same direction before the break occurred.

Reverse Resync

Automates the necessary steps to create and initialize a new relationship in the opposite direction. This can be done only if the existing relationship is in a broken state. This operation will not delete the current relationship. The original source volume reverts to the most recent common Snapshot copy and resynchronizes with the destination. Any changes that are made to the original source volume since the last successful SnapMirror update are lost. Any changes that were made to, or new data written into the current destination volume is sent back to the original source volume.

Abort

Cancels a current transfer in progress. If a SnapMirror update is issued for an aborted relationship, the relationship continues with the last transfer from the last restart checkpoint that was created before the abort occurred.

Disaster recovery using SnapMirror

In the event of a problem with a volume or cluster running NetApp Element software, use the SnapMirror functionality to break the relationship and failover to the destination volume.

Note: If the original cluster has completely failed or is non-existent, contact NetApp Support for further assistance.

Performing a failover

You can perform a failover from the Element cluster to make the destination volume read/write and accessible to hosts on the destination side.

Before you begin

- A SnapMirror relationship exists and has at least one valid snapshot on the destination volume.
- You have a need to failover to the destination volume due to unplanned outage or planned event at the primary site.

About this task

Use the NetApp Element UI to perform the failover. If the Element UI is not available, you can also use OnCommand System Manager or ONTAP CLI to issue the break relationship command.

Steps

1. In the Element UI, click **Data Protection > SnapMirror Relationships**.
2. Find the relationship with the source volume that you want to failover.
3. Click the Actions icon of this relationship.
4. Click **Break**.
5. Confirm the action.

   The volume on the destination cluster now has read-write access and can be mounted to the application hosts to resume production workloads. All SnapMirror replication is halted as a result of this action. The relationship shows a state of broken-off.

SnapMirror failback to Element

When the issue on the primary side has been mitigated, you must resynchronize the original source volume and fail back. The steps you perform vary depending on whether the original source volume still exists or whether you need to failback to a newly created volume.

Related concepts

SnapMirror failback scenarios on page 122

Related tasks

Performing a failback when source volume still exists on page 120
Performing a failback when source volume no longer exists on page 121

Performing a failback when source volume still exists

You can resynchronize the original source volume and fail back using the NetApp Element UI. This procedure applies to scenarios where the original source volume still exists.

Steps

1. In the Element UI, find the relationship that you broke to perform the failover.
2. Click the Actions icon and click **Reverse Resync**.
3. Confirm the action.

Note: The Reverse Resync operation creates a new relationship in which the roles of the original source and destination volumes are reversed (this results in two relationships as the original relationship persists). Any new data from the original destination volume is transferred to the original source volume as part of the reverse resync operation. You can continue to access and write data to the active volume on the destination side, but you will need to disconnect all hosts to the source volume and perform a SnapMirror update before redirecting back to the original primary.

4. Click the Actions icon of the inverse relationship that you just created and click **Update**.

   Now that you have completed the reverse resync and ensured that there are no active sessions connected to the volume on the destination side and that the latest data is on the original primary volume, you can perform the following steps to complete the failback and reactivate the original primary volume:

5. Click the Actions icon of the inverse relationship and click **Break**.
6. Click the Actions icon of the original relationship and click **Resync**.

   Note: The original primary volume can now be mounted to resume production workloads on the original primary volume. The original SnapMirror replication resumes based on the policy and schedule configured for the relationship.

7. After you confirm that the original relationship status is “snapmirrored”, click the Actions icon of the inverse relationship and click **Delete**.

Related concepts

SnapMirror failback scenarios on page 122

Performing a failback when source volume no longer exists

You can resynchronize the original source volume and fail back using the NetApp Element UI. This section applies to scenarios in which the original source volume has been lost but the original cluster is still intact. For instructions about how to restore to a new cluster, see the documentation on the NetApp Support Site.

Before you begin

- You have a broken-off replication relationship between Element and ONTAP volumes.
- The Element volume is irretrievably lost.
- The original volume name shows as NOT FOUND.

Steps

1. In the Element UI, find the relationship that you broke to perform the failover.

   Best Practices: Make note of the SnapMirror policy and schedule details of the original broken-off relationship. This information will be required when recreating the relationship.

2. Click the Actions icon and click **Reverse Resync**.
3. Confirm the action.

   Note: The Reverse Resync operation creates a new relationship in which the roles of the original source volume and the destination volume are reversed (this results in two relationships as the original relationship persists). Because the original volume no longer exists, the system creates a new Element volume with the same volume name and volume size as the original source volume. The new volume is assigned a default QoS policy called sm-recovery and is associated with a default account called sm-recovery. You will want to

manually edit the account and QoS policy for all volumes that are created by SnapMirror to replace the original source volumes that were destroyed.

Data from the latest snapshot is transferred to the new volume as part of the reverse resync operation. You can continue to access and write data to the active volume on the destination side, but you will need to disconnect all hosts to the active volume and perform a SnapMirror update before reinstating the original primary relationship in a later step. After you complete the reverse resync and ensure that there are no active sessions connected to the volume on the destination side and that the latest data is on the original primary volume, continue with the following steps to complete the failback and reactivate the original primary volume:

4. Click the Actions icon of the inverse relationship that was created during the Reverse Resync operation and click **Break**.
5. Click the Actions icon of the original relationship, in which the source volume does not exist, and click **Delete**.
6. Click the Actions icon of the inverse relationship, which you broke in step 4, and click **Reverse Resync**.
7. This reverses the source and destination and results in a relationship with the same volume source and volume destination as the original relationship.
8. Click the Actions icon and **Edit** to update this relationship with the original QoS policy and schedule settings you took note of.
9. Now it is safe to delete the inverse relationship that you reverse resynced in step 6.

Related concepts

SnapMirror failback scenarios on page 122

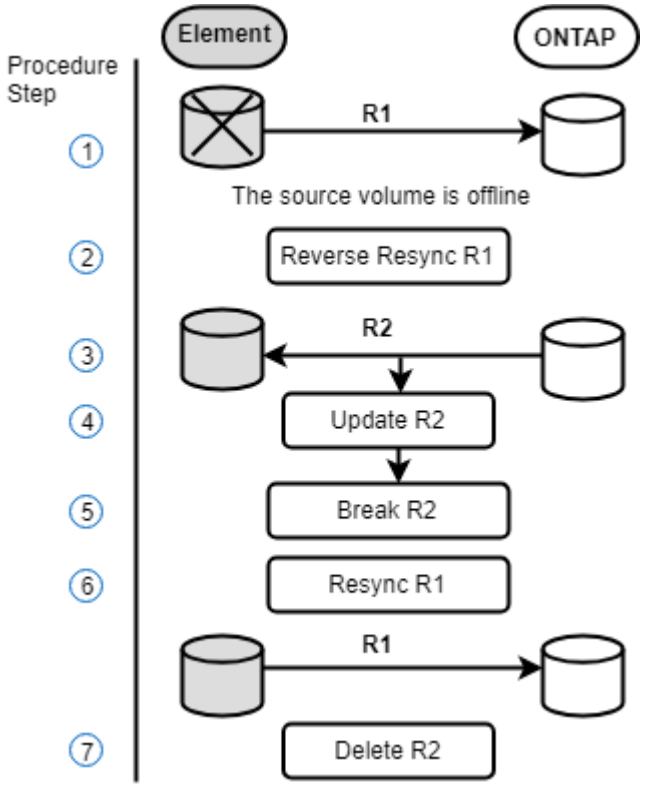
SnapMirror failback scenarios

The SnapMirror disaster recovery functionality is illustrated in two failback scenarios. These assume the original relationship has been failed over (broken).

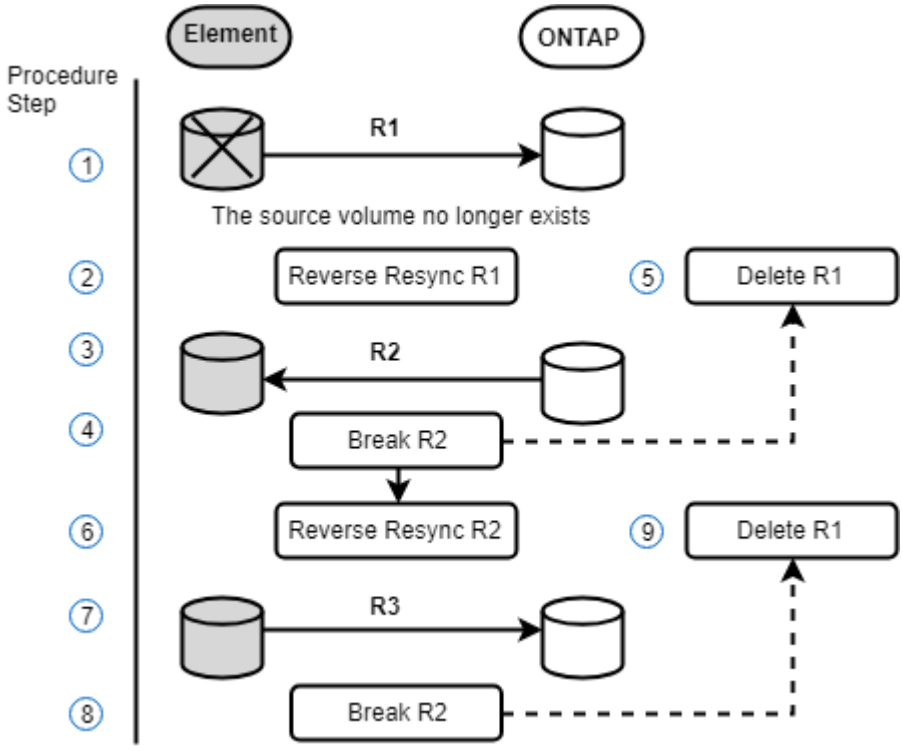
The steps from the corresponding procedures are added for reference.

Note: In the examples here, R1 = the original relationship in which the cluster running NetApp Element software is the original source volume (Element) and ONTAP is the original destination volume (ONTAP). R2 and R3 represent the inverse relationships created through the reverse resync operation.

The following image shows the failback scenario when the source volume still exists:



The following image shows the failback scenario when the source volume no longer exists:



Related tasks

Performing a failback when source volume still exists on page 120
Performing a failback when source volume no longer exists on page 121

Backing up and restoring volumes

You can back up and restore volumes to other SolidFire storage, as well as secondary object stores that are compatible with Amazon S3 or OpenStack Swift.

When you restore volumes from OpenStack Swift or Amazon S3, you need manifest information from the original backup process. If you are restoring a volume that was backed up on a SolidFire storage system, no manifest information is required.

Related tasks

Backing up a volume to an Amazon S3 object store on page 124
Backing up a volume to an OpenStack Swift object store on page 124
Backing up a volume to a SolidFire storage cluster on page 125
Restoring a volume from backup on an Amazon S3 object store on page 126
Restoring a volume from backup on an OpenStack Swift object store on page 127
Restoring a volume from backup on a SolidFire storage cluster on page 127

Backing up a volume to an Amazon S3 object store

You can back up volumes to external object stores that are compatible with Amazon S3.

Steps

1. Click **Management** > **Volumes**.
2. Click the Actions icon for the volume you want to back up.
3. In the resulting menu, click **Backup to**.
4. In the **Integrated Backup** dialog box under **Backup to**, select **S3**.
5. Select an option under **Data Format**:
   - **Native**: A compressed format readable only by SolidFire storage systems.
   - **Uncompressed**: An uncompressed format compatible with other systems.
6. Enter a hostname to use to access the object store in the **Hostname** field.
7. Enter an access key ID for the account in the **Access Key ID** field.
8. Enter the secret access key for the account in the **Secret Access Key** field.
9. Enter the S3 bucket in which to store the backup in the **S3 Bucket** field.
10. Optional: Enter a nametag to append to the prefix in the **Nametag** field.
11. Click **Start Read**.

Backing up a volume to an OpenStack Swift object store

You can back up volumes to external object stores that are compatible with OpenStack Swift.

Steps

1. Click **Management** > **Volumes**.
2. Click the Actions icon for the volume to back up.

3. In the resulting menu, click **Backup to**.
4. In the **Integrated Backup** dialog box under **Backup to**, select **Swift**.
5. Select a data format under **Data Format**:
   - **Native**: A compressed format readable only by SolidFire storage systems.
   - **Uncompressed**: An uncompressed format compatible with other systems.
6. Enter a URL to use to access the object store in the **URL** field.
7. Enter a user name for the account in the **Username** field.
8. Enter the authentication key for the account in the **Authentication Key** field.
9. Enter the container in which to store the backup in the **Container** field.
10. Optional: Enter a name tag to append to the prefix in the **Nametag** field.
11. Click **Start Read**.

Backing up a volume to a SolidFire storage cluster

You can back up volumes residing on a cluster to a remote cluster for storage clusters running Element software.

Before you begin

Ensure that the source and target clusters are paired. See Cluster Pairing for more information.

About this task

When backing up or restoring from one cluster to another, the system generates a key to be used as authentication between the clusters. This bulk volume write key allows the source cluster to authenticate with the destination cluster, providing a level of security when writing to the destination volume. As part of the backup or restore process, you need to generate a bulk volume write key from the destination volume before starting the operation.

Steps

1. On the destination cluster, **Management > Volumes**.
2. Click the Actions icon for the destination volume.
3. In the resulting menu, click **Restore from**.
4. In the **Integrated Restore** dialog box, under **Restore from**, select **SolidFire**.
5. Select an option under **Data Format**:
   - **Native**: A compressed format readable only by SolidFire storage systems.
   - **Uncompressed**: An uncompressed format compatible with other systems.
6. Click **Generate Key**.
7. Copy the key from the **Bulk Volume Write Key** box to your clipboard.
8. On the source cluster, go to **Management > Volumes**.
9. Click the Actions icon for the volume to back up.
10. In the resulting menu, click **Backup to**.

11. In the **Integrated Backup** dialog box under **Backup to**, select **SolidFire**.
12. Select the same option you selected earlier in the **Data Format** field.
13. Enter the management virtual IP address of the destination volume's cluster in the **Remote Cluster MVIP** field.
14. Enter the remote cluster user name in the **Remote Cluster Username** field.
15. Enter the remote cluster password in the **Remote Cluster Password** field.
16. In the **Bulk Volume Write Key** field, paste the key you generated on the destination cluster earlier.
17. Click **Start Read**.

Related concepts

Cluster pairs on page 101

Restoring a volume from backup on an Amazon S3 object store

You can restore a volume from a backup on an Amazon S3 object store.

Steps

1. Click **Reporting** > **Event Log**.
2. Locate the backup event that created the backup you need to restore.
3. In the **Details** column for the event, click **Show Details**.
4. Copy the manifest information to your clipboard.
5. Click **Management** > **Volumes**.
6. Click the Actions icon for the volume you want to restore.
7. In the resulting menu, click **Restore from**.
8. In the **Integrated Restore** dialog box under **Restore from**, select **S3**.
9. Select the option that matches the backup under **Data Format**:
   - **Native**: A compressed format readable only by SolidFire storage systems.
   - **Uncompressed**: An uncompressed format compatible with other systems.
10. Enter a hostname to use to access the object store in the **Hostname** field.
11. Enter an access key ID for the account in the **Access Key ID** field.
12. Enter the secret access key for the account in the **Secret Access Key** field.
13. Enter the S3 bucket in which to store the backup in the **S3 Bucket** field.
14. Paste the manifest information into the **Manifest** field.
15. Click **Start Write**.

Restoring a volume from backup on an OpenStack Swift object store

You can restore a volume from a backup on an OpenStack Swift object store.

Steps

1. Click **Reporting** > **Event Log**.
2. Locate the backup event that created the backup you need to restore.
3. In the **Details** column for the event, click **Show Details**.
4. Copy the manifest information to your clipboard.
5. Click **Management** > **Volumes**.
6. Click the Actions icon for the volume you want to restore.
7. In the resulting menu, click **Restore from**.
8. In the **Integrated Restore** dialog box under **Restore from**, select **Swift**.
9. Select the option that matches the backup under **Data Format**:
   - **Native**: A compressed format readable only by SolidFire storage systems.
   - **Uncompressed**: An uncompressed format compatible with other systems.
10. Enter a URL to use to access the object store in the **URL** field.
11. Enter a user name for the account in the **Username** field.
12. Enter the authentication key for the account in the **Authentication Key** field.
13. Enter the name of the container in which the backup is stored in the **Container** field.
14. Paste the manifest information into the **Manifest** field.
15. Click **Start Write**.

Restoring a volume from backup on a SolidFire storage cluster

You can restore a volume from a backup on a SolidFire storage cluster.

About this task

When backing up or restoring from one cluster to another, the system generates a key to be used as authentication between the clusters. This bulk volume write key allows the source cluster to authenticate with the destination cluster, providing a level of security when writing to the destination volume. As part of the backup or restore process, you need to generate a bulk volume write key from the destination volume before starting the operation.

Steps

1. On the destination cluster, click **Management** > **Volumes**.
2. Click the Actions icon for the volume you want to restore.
3. In the resulting menu, click **Restore from**.
4. In the **Integrated Restore** dialog box, under **Restore from**, select **SolidFire**.
5. Select the option that matches the backup under **Data Format**:

- **Native**: A compressed format readable only by SolidFire storage systems.
- **Uncompressed**: An uncompressed format compatible with other systems.

6. Click **Generate Key**.
7. Copy the **Bulk Volume Write Key** information to the clipboard.
8. On the source cluster, click **Management > Volumes**.
9. Click the Actions icon for the volume you want to use for the restore.
10. In the resulting menu, click **Backup to**.
11. In the **Integrated Backup** dialog box, select **SolidFire** under **Backup to**.
12. Select the option that matches the backup under **Data Format**.
13. Enter the management virtual IP address of the destination volume's cluster in the **Remote Cluster MVIP** field.
14. Enter the remote cluster user name in the **Remote Cluster Username** field.
15. Enter the remote cluster password in the **Remote Cluster Password** field.
16. Paste the key from your clipboard into the **Bulk Volume Write Key** field.
17. Click **Start Read**.

System monitoring and troubleshooting

You must monitor the system for diagnostic purposes and to get information about performance trends and statuses of various system operations. You might need to replace nodes or SSDs for maintenance purposes.

Related concepts

Troubleshooting drives on page 142
Troubleshooting nodes on page 145
Working with per-node utilities on page 146
Working with the management node on page 149
Understanding cluster fullness levels on page 154

Related tasks

Viewing information about system events on page 129
Viewing system alerts on page 132
Viewing node performance activity on page 138
Viewing volume performance on page 139
Viewing iSCSI sessions on page 140
Viewing Fibre Channel sessions on page 141
Enabling FIPS 140-2 on your cluster on page 155

Related references

Viewing status of running tasks on page 132

Viewing information about system events

You can view information about various events detected in the system. The system refreshes the event messages every 30 seconds. The event log displays key events for the cluster.

Step

1. In the Element UI, select **Reporting > Event Log**.

   For every event, you see the following information:

Item	Description
ID	Unique ID associated with each event.
Event Type	The type of event being logged, for example, API events or clone events.
Message	Message associated with the event.
Details	Information that helps identify why the event occurred.
Service ID	The service that reported the event (if applicable).
Node	The node that reported the event (if applicable).

Item	Description
Drive ID	The drive that reported the event (if applicable).
Event Time	The time the event occurred.

Related references

Event types on page 130

Related information

Product Documentation Library

Event types

The system reports multiple types of events; each event is an operation that the system has completed. Events can be routine, normal events or events that require administrator attention. The Event Types column on the Event Log page indicates in which part of the system the event occurred.

Note: The system does not log read-only API commands in the event log.

The following list describes the types of events that appear in the event log:

apiEvent

Events initiated by a user through an API or web UI that modify settings.

binAssignmentsEvent

Events related to the assignment of data bins. Bins are essentially containers that hold data and are mapped across the cluster.

binSyncEvent

System events related to a reassignment of data among block services.

bsCheckEvent

System events related to block service checks.

bsKillEvent

System events related to block service terminations.

bulkOpEvent

Events related to operations performed on an entire volume, such as a backup, restore, snapshot, or clone.

cloneEvent

Events related to volume cloning.

clusterMasterEvent

Events appearing upon cluster initialization or upon configuration changes to the cluster, such as adding or removing nodes.

dataEvent

Events related to reading and writing data.

dbEvent

Events related to the global database maintained by ensemble nodes in the cluster.

driveEvent

Events related to drive operations.

encryptionAtRestEvent

Events related to the process of encryption on a cluster.

ensembleEvent

Events related to increasing or decreasing the number of nodes in an ensemble.

fibreChannelEvent

Events related to the configuration of and connections to the nodes.

gcEvent

Events related to processes run every 60 minutes to reclaim storage on block drives. This process is also known as garbage collection.

ieEvent

Internal system error.

installEvent

Automatic software installation events. Software is being automatically installed on a pending node.

iSCSIEvent

Events related to iSCSI issues in the system.

limitEvent

Events related to the number of volumes or virtual volumes in an account or in the cluster nearing the maximum allowed.

networkEvent

Events related to the status of virtual networking.

platformHardwareEvent

Events related to issues detected on hardware devices.

remoteClusterEvent

Events related to remote cluster pairing.

schedulerEvent

Events related to scheduled snapshots.

serviceEvent

Events related to system service status.

sliceEvent

Events related to the Slice Server, such as removing a metadata drive or volume.

snmpTrapEvent

Events related to SNMP traps.

statEvent

Events related to system statistics.

tsEvent

Events related to the system transport service.

unexpectedException

Events related to unexpected system exceptions.

vasaProviderEvent

Events related to a VASA (vSphere APIs for Storage Awareness) Provider.

Viewing status of running tasks

You can view the progress and completion status of running tasks in the web UI that are being reported by the `ListSyncJobs` and `ListBulkVolumeJobs` API methods. You can access the Running Tasks page from the Reporting tab of the Element UI.

If there are a large number of tasks, the system might queue them and run them in batches. The Running Tasks page displays the services currently being synchronized. When a task is complete, it is replaced by the next queued synchronizing task. Synchronizing tasks might continue to appear on the Running Tasks page until there are no more tasks to complete.

Note: You can see replication synchronizations data for volumes undergoing replication on the Running Tasks page of the cluster containing the target volume.

Viewing system alerts

You can view alerts for information about cluster faults or errors in the system. Alerts can be information, warnings, or errors and are a good indicator of how well the cluster is running. Most errors resolve themselves automatically.

About this task

You can use the `ListClusterFaults` API method to automate alert monitoring. This enables you to be notified about all alerts that occur.

Steps

1. In the Element UI, select **Reporting > Alerts**.

   The system refreshes the alerts on the page every 30 seconds.

   For every event, you see the following information:

Item	Description
ID	Unique ID associated with a cluster alert.
Severity	The degree of importance of the alert. Possible values: • warning: A minor issue that might soon require attention. System upgrades are still allowed. • error: A failure that might cause performance degradation or loss of high availability (HA). Errors generally should not affect service otherwise. • critical: A serious failure that affects service. The system is unable to serve API or client I/O requests. Operating in this state could lead to potential loss of data. • bestPractice: A recommended system configuration best practice is not being used.
Type	The component that the fault affects. Can be node, drive, cluster, service, or volume.
Node	Node ID for the node that this fault refers to. Included for node and drive faults, otherwise set to - (dash).

Item	Description
Drive ID	Drive ID for the drive that this fault refers to. Included for drive faults, otherwise set to - (dash).
Error Code	A descriptive code that indicates what caused the fault.
Details	A description of the fault with additional details.
Date	The date and time the fault was logged.

2. Click **Show Details** for an individual alert to view information about the alert.
3. To view the details of all alerts on the page, click the Details column.

   After the system resolves an alert, all information about the alert including the date it was resolved is moved to the Resolved area.

Related references

Cluster fault codes on page 133

Related information

https://mysupport.netapp.com/documentation/productlibrary/index.html?productID=62480

Cluster fault codes

The system reports an error or a state that might be of interest by generating a fault code, which is listed on the Alerts page. These codes help you determine what component of the system experienced the alert and why the alert was generated.

The following list outlines the different types of codes:

availableVirtualNetworkIPAddressesLow

The number of virtual network addresses in the block of IP addresses is low. To resolve this fault, add more IP addresses to the block of virtual network addresses.

blockClusterFull

There is not enough free block storage space to support a single node loss. To resolve this fault, add another storage node to the storage cluster.

blockServiceTooFull

A block service is using too much space. To resolve this fault, add more provisioned capacity.

blockServiceUnhealthy

A block service has been detected as unhealthy. The system is automatically moving affected data to other healthy drives.

clusterCannotSync

There is an out-of-space condition and data on the offline block storage drives cannot be synced to drives that are still active. To resolved this fault, add more storage.

clusterFull

There is no more free storage space in the storage cluster. To resolve this fault, add more storage.

clusterIOPSAreOverProvisioned

Cluster IOPS are over provisioned. The sum of all minimum QoS IOPS is greater than the expected IOPS of the cluster. Minimum QoS cannot be maintained for all volumes simultaneously.

disconnectedClusterPair

A cluster pair is disconnected or configured incorrectly.

disconnectedRemoteNode

A remote node is either disconnected or configured incorrectly.

disconnectedSnapMirrorEndpoint

A remote SnapMirror endpoint is disconnected or configured incorrectly.

driveAvailable

One or more drives are available in the cluster. In general, all clusters should have all drives added and none in the available state. If this fault appears unexpectedly, contact NetApp Support. To resolve this fault, add any available drives to the storage cluster.

driveFailed

One or more drives have failed. Contact NetApp Support to have the drive replaced.

driveWearFault

A drive's remaining life has dropped below thresholds, but it is still functioning. To resolve this fault, replace the drive soon.

duplicateClusterMasterCandidates

More than one storage cluster master candidate has been detected. Contact NetApp Support for assistance.

ensembleDegraded

Network connectivity or power has been lost to one or more of the ensemble nodes. To resolve this fault, restore network connectivity or power.

exception

A fault reported that is other than a routine fault. These faults are not automatically cleared from the fault queue. Contact NetApp Support for assistance.

failedSpaceTooFull

A block service is not responding to data write requests. This causes the slice service to run out of space to store failed writes. To resolve this fault, restore block services functionality to allow writes to continue normally and failed space to be flushed from the slice service.

fanSensor

A fan sensor has failed or is missing. Contact NetApp Support for assistance.

fibreChannelAccessDegraded

A Fibre Channel node is not responding to other nodes in the storage cluster over its storage IP for a period of time. In this state, the node will then be considered unresponsive and generate a cluster fault.

fibreChannelAccessUnavailable

All Fibre Channel nodes are unresponsive. The node IDs are displayed.

fibreChannelConfig

This cluster fault indicates one of the following conditions:

- There is an unexpected Fibre Channel port on a PCI slot.
- There is an unexpected Fibre Channel HBA model.
- There is a problem with the firmware of a Fibre Channel HBA.
- A Fibre Channel port is not online.
- There is a persistent issue configuring Fibre Channel passthrough.

Contact NetApp Support for assistance.

fileSystemCapacityLow

There is insufficient space on one of the filesystems.

To resolve this fault, add more capacity to the filesystem.

fipsSelfTestFailure

The FIPS subsystem has detected a failure during the self test.

Contact NetApp Support for assistance.

hardwareConfigMismatch

This cluster fault indicates one of the following conditions:

- The configuration does not match the node definition.
- There is an incorrect drive size for this type of node.
- An unsupported drive has been detected.
- There is a drive firmware mismatch.
- The drive encryption capable state does not match the node.

Contact NetApp Support for assistance.

inconsistentBondModes

The bond modes on the VLAN device are missing. This fault will display the expected bond mode and the bond mode currently in use.

inconsistentInterfaceConfiguration

The interface configuration is inconsistent.

To resolve this fault, ensure the node interfaces in the storage cluster are consistently configured.

inconsistentMtus

This cluster fault indicates one of the following conditions:

- Bond1G mismatch: Inconsistent MTUs have been detected on Bond1G interfaces.
- Bond10G mismatch: Inconsistent MTUs have been detected on Bond10G interfaces.

This fault displays the node or nodes in question along with the associated MTU value.

inconsistentRoutingRules

The routing rules for this interface are inconsistent.

inconsistentSubnetMasks

The network mask on the VLAN device does not match the internally recorded network mask for the VLAN. This fault displays the expected network mask and the network mask currently in use.

incorrectBondPortCount

The number of bond ports is incorrect.

invalidConfiguredFibreChannelNodeCount

One of the two expected Fibre Channel node connections is degraded. This fault appears when only one Fibre Channel node is connected.

irqBalanceFailed

An exception occurred while attempting to balance interrupts.

Contact NetApp Support for assistance.

memoryUsageThreshold

Memory usage is above normal.

Contact NetApp Support for assistance.

metadataClusterFull

There is not enough free metadata space to support a single node loss.

To resolve this fault, add another storage node to the storage cluster.

mtuCheckFailure

A network device is not configured for the proper MTU size.

To resolve this fault, ensure that all network interfaces and switch ports are configured for jumbo frames (MTUs up to 9000 bytes in size).

networkConfig

This cluster fault indicates one of the following conditions:

- An expected interface is not present.
- A duplicate interface is present.
- A configured interface is down.
- A network restart is required.

Contact NetApp Support for assistance.

networkErrorsExceedThreshold

This cluster fault indicates one of the following conditions:

- The number of frame errors is above normal.
- The number of CRC errors is above normal.

To resolve this fault, replace the network cable connected to the interface reporting these errors.

Contact NetApp Support for assistance.

noAvailableVirtualNetworkIPAddresses

There are no available virtual network addresses in the block of IP addresses. No more storage nodes can be added to the cluster.

To resolve this fault, add more IP addresses to the block of virtual network addresses.

nodeOffline

Element software cannot communicate with the specified node.

notUsingLACPBondMode

LACP bonding mode is not configured.

To resolve this fault, use LACP bonding when deploying storage nodes; clients might experience performance issues if LACP is not enabled and properly configured.

ntpServerUnreachable

The storage cluster cannot communicate with the specified NTP server or servers.

To resolve this fault, check the configuration for the NTP server, network, and firewall.

ntpTimeNotInSync

The difference between storage cluster time and the specified NTP server time is too large. The storage cluster cannot correct the difference automatically. To resolve this fault, use NTP servers that are internal to your network, rather than the installation defaults. If you

are using internal NTP servers and the issue persists, contact NetApp Support for assistance.

nvramDeviceStatus

An NVRAM device has an error, is failing, or has failed.

Contact NetApp Support for assistance.

powerSupplyError

This cluster fault indicates one of the following conditions:

- A power supply is not present.
- A power supply has failed.
- A power supply input is missing or out of range.

To resolve this fault, verify that redundant power is supplied to all nodes. Contact NetApp Support for assistance.

provisionedSpaceTooFull

The overall provisioned capacity of the cluster is too full.

To resolve this fault, add more provisioned space, or delete and purge volumes.

remoteRepAsyncDelayExceeded

The configured asynchronous delay for replication has been exceeded.

remoteRepClusterFull

The volumes have paused remote replication because the target storage cluster is too full.

remoteRepSnapshotClusterFull

The volumes have paused remote replication of snapshots because the target storage cluster is too full.

To resolve this fault, free up some space on the target storage cluster.

remoteRepSnapshotsExceededLimit

The volumes have paused remote replication of snapshots because the target storage cluster volume has exceeded its snapshot limit.

scheduleActionError

One or more of the scheduled activities ran, but failed.

The fault clears if the scheduled activity runs again and succeeds, if the scheduled activity is deleted, or if the activity is paused and resumed.

sensorReadingFailed

The Baseboard Management Controller (BMC) self-test failed or a sensor could not communicate with the BMC.

Contact NetApp Support for assistance.

serviceNotRunning

A required service is not running.

Contact NetApp Support for assistance.

sliceServiceTooFull

A slice service has too little provisioned capacity assigned to it.

To resolve this fault, add more provisioned capacity.

sliceServiceUnhealthy

The system has detected that a slice service is unhealthy and is automatically decommissioning it.

sshEnabled

The SSH service is enabled on one or more nodes in the storage cluster.

To resolve this fault, disable the SSH service on the appropriate node or nodes or contact NetApp Support for assistance.

sslCertificateExpiration

The SSL certificate associated with this node has expired.

To resolve this fault, renew the SSL certificate. If needed, contact NetApp Support for assistance.

tempSensor

A temperature sensor is reporting higher than normal temperatures. This fault can be triggered in conjunction with powerSupplyError or fanSensor faults.

To resolve this fault, check for airflow obstructions near the storage cluster. If needed, contact NetApp Support for assistance.

upgrade

An upgrade has been in progress for more than 24 hours.

to resolve this fault, resume the upgrade or contact NetApp Support for assistance.

unbalancedMixedNodes

A single node accounts for more than one-third of the storage cluster's capacity.

Contact NetApp Support for assistance.

unresponsiveService

A service has become unresponsive.

Contact NetApp Support for assistance.

virtualNetworkConfig

This cluster fault indicates one of the following conditions:

- An interface is not present.
- There is an incorrect namespace on an interface.
- There is an incorrect netmask.
- There is an incorrect IP address.
- An interface is not up and running.
- There is a superfluous interface on a node.

Contact NetApp Support for assistance.

volumeDegraded

Secondary volumes have not finished replicating and synchronizing. The message is cleared when the synchronizing is complete.

volumesOffline

One or more volumes in the storage cluster are offline.

Contact NetApp Support for assistance.

Viewing node performance activity

You can view performance activity for each node in a graphical format. This information provides real-time statistics for CPU and read/write I/O operations per second (IOPS) for each drive the node.

The utilization graph is updated every five seconds, and the drive statistics graph updates every ten seconds.

Steps

1. Click **Cluster** > **Nodes**.
2. Click **Actions** for the node you want to view.
3. Click **View Details**.

   Note: You can see specific points in time on the line and bar graphs by positioning your cursor over the line or bar.

Viewing volume performance

You can view detailed performance information for all volumes in the cluster. You can sort the information by volume ID or by any of the performance columns. You can also use filter the information by certain criteria.

About this task

You can change how often the system refreshes performance information on the page by clicking the **Refresh every** list, and choosing a different value. The default refresh interval is 10 seconds if the cluster has less than 1000 volumes; otherwise, the default is 60 seconds. If you choose a value of Never, automatic page refreshing is disabled.

You can reenable automatic refreshing by clicking **Turn on auto-refresh**.

Steps

1. In the Element UI, select **Reporting** > **Volume Performance**.
2. In the volume list, click the Actions icon for a volume.
3. Click **View Details**.

   A tray is displayed at the bottom of the page containing general information about the volume.
4. To see more detailed information about the volume, click **See More Details**.

   The system displays detailed information as well as performance graphs for the volume.

Related references

Volume performance details on page 139

Volume performance details

You can view performance statistics of volumes from the Volume Performance page of the Reporting tab in the Element UI.

The following list describes the details that are available to you:

ID

The system-generated ID for the volume.

Name

The name given to the volume when it was created.

Account

The name of the account assigned to the volume.

Access Groups

The name of the volume access group or groups to which the volume belongs.

Volume Utilization

A percentage value that describes how much the client is using the volume.

Possible values:

- 0 = Client is not using the volume
- 100 = Client is using their max
- >100 = Client is using their burst

Total IOPS

The total number of IOPS (read and write) currently being executed against the volume.

Read IOPS

The total number of read IOPS currently being executed against the volume.

Write IOPS

The total number of write IOPS currently being executed against the volume.

Total Throughput

The total amount of throughput (read and write) currently being executed against the volume.

Read Throughput

The total amount of read throughput currently being executed against the volume.

Write Throughput

The total amount of write throughput currently being executed against the volume.

Total Latency

The average time, in microseconds, to complete read and write operations to a volume.

Read Latency

The average time, in microseconds, to complete read operations to the volume in the last 500 milliseconds.

Write Latency

The average time, in microseconds, to complete write operations to a volume in the last 500 milliseconds.

Queue Depth

The number of outstanding read and write operations to the volume.

Average IO Size

Average size in bytes of recent I/O to the volume in the last 500 milliseconds.

Viewing iSCSI sessions

You can view the iSCSI sessions that are connected to the cluster. You can filter the information to include only the desired sessions.

Steps

1. In the Element UI, select **Reporting > iSCSI Sessions**.
2. To see the filter criteria fields, click **Filter**.

Related references

iSCSI session details on page 141

iSCSI session details

You can view information about the iSCSI sessions that are connected to the cluster.

The following list describes the information that you can find about the iSCSI sessions:

Node

The node hosting the primary metadata partition for the volume.

Account

The name of the account that owns the volume. If value is blank, a dash (-) is displayed.

Volume

The volume name identified on the node.

Volume ID

ID of the volume associated with the Target IQN.

Initiator ID

A system-generated ID for the initiator.

Initiator Alias

An optional name for the initiator that makes finding the initiator easier when in a long list.

Initator IP

The IP address of the endpoint that initiates the session.

Initiator IQN

The IQN of the endpoint that initiates the session.

Target IP

The IP address of the node hosting the volume.

Target IQN

The IQN of the volume.

Created On

Date the session was established.

Viewing Fibre Channel sessions

You can view the Fibre Channel (FC) sessions that are connected to the cluster. You can filter information to include only those connections you want displayed in the window.

Steps

1. In the Element UI, select **Reporting > FC Sessions**.
2. To see the filter criteria fields, click **Filter**.

Related references

Fibre Channel session details on page 142

Fibre Channel session details

You can find information about the active Fibre Channel (FC) sessions that are connected to the cluster.

The following list describes the information you can find about the FC sessions connected to the cluster:

Node ID

The node hosting the session for the connection.

Node Name

System-generated node name.

Initiator ID

A system-generated ID for the initiator.

Initiator WWPN

The initiating worldwide port name.

Initiator Alias

An optional name for the initiator that makes finding the initiator easier when in a long list.

Target WWPN

The target worldwide port name.

Volume Access Group

Name of the volume access group that the session belongs to.

Volume Access Group ID

System-generated ID for the access group.

Troubleshooting drives

You can replace a failed solid-state drive (SSD) with a replacement drive. SSDs for SolidFire storage nodes are hot-swappable. If you suspect an SSD has failed, contact NetApp Support to verify the failure and walk you through the proper resolution procedure. NetApp Support also works with you to get a replacement drive according to your service-level agreement.

You should maintain on-site spares suggested by NetApp Support to allow for immediate replacement of the drive if it fails.

Note: For testing purposes, if you are simulating a drive failure by pulling a drive from a node, you must wait 30 seconds before inserting the drive back into the drive slot.

If a drive fails, Double Helix redistributes the data on the drive across the nodes remaining on the cluster. Multiple drive failures on the same node are not an issue since Element software protects against two copies of data residing on the same node. A failed drive results in the following events:

- Data is migrated off of the drive.
- Overall cluster capacity is reduced by the capacity of the drive.
- Double Helix data protection ensures that there are two valid copies of the data.

Attention: SolidFire storage systems do not support removal of a drive if it results in an insufficient amount of storage to migrate data.

Related concepts

Basic MDSS drive troubleshooting on page 143

Related tasks

Removing failed drives from the cluster on page 143
Removing MDSS drives on page 145

Related information

Replacing drives for SolidFire storage nodes
Replacing drives for H600S series storage nodes

Removing failed drives from the cluster

The SolidFire system puts a drive in a failed state if the drive's self-diagnostics tells the node it has failed or if communication with the drive stops for five and a half minutes or longer. The system displays a list of the failed drives. You must remove a failed drive from the failed drive list in NetApp Element software.

About this task

Drives in the **Alerts** list show as **blockServiceUnhealthy** when a node is offline. When restarting the node, if the node and its drives come back online within five and a half minutes, the drives automatically update and continue as active drives in the cluster.

Steps

1. In the Element UI, select **Cluster > Drives**.
2. Click **Failed** to view the list of failed drives.
3. Note the slot number of the failed drive.

   You need this information to locate the failed drive in the chassis.
4. Remove the failed drives using one of the following methods:

Option	Steps
To remove individual drives	**a.** Click **Actions** for the drive you want to remove. **b.** Click **Remove**.
To remove multiple drives	**a.** Select all the drives you want to remove, and click **Bulk Actions**. **b.** Click **Remove**.

Basic MDSS drive troubleshooting

You can recover metadata (or slice) drives by adding them back to the cluster in the event that one or both metadata drives fail. You can perform the recovery operation in the NetApp Element UI if the MDSS feature is already enabled on the node.

If either or both of the metadata drives in a node experiences a failure, the slice service will shut down and data from both drives will be backed up to different drives in the node.

The following scenarios outline possible failure scenarios, and provide basic recommendations to correct the issue:

System slice drive fails

- In this scenario, the slot 2 is verified and returned to an available state.
- The system slice drive must be repopulated before the slice service can be brought back online.
- You should replace the system slice drive, when the system slice drive becomes available, add the drive and the slot 2 drive at the same time.

Note: You cannot add the drive in slot 2 by itself as a metadata drive. You must add both drives back to the node at the same time.

Slot 2 fails

- In this scenario, the system slice drive is verified and returned to an available state.
- You should replace slot 2 with a spare, when slot 2 becomes available, add the system slice drive and the slot 2 drive at the same time.

System slice drive and slot 2 fails

- You should replace both system slice drive and slot 2 with a spare drive. When both drives become available, add the system slice drive and the slot 2 drive at the same time.

Order of operations

- Replace the failed hardware drive with a spare drive (replace both drives if both have failed).
- Add drives back to the cluster when they have been repopulated and are in an available state.

Verify operations

- Verify that the drives in slot 0 (or internal) and slot 2 are identified as metadata drives in the Active Drives list.
- Verify that all slice balancing has completed (there are no further moving slices messages in the event log for at least 30 minutes).

Related tasks

Adding MDSS drives on page 144

Adding MDSS drives

You can add a second metadata drive on a SolidFire node by converting the block drive in slot 2 to a slice drive. This is accomplished by enabling the multi-drive slice service (MDSS) feature. To enable this feature, you must contact NetApp Support.

About this task

Getting a slice drive into an available state might require replacing a failed drive with a new or spare drive. You must add the system slice drive at the same time you add the drive for slot 2. If you try to add the slot 2 slice drive alone or before you add the system slice drive, the system will generate an error.

Steps

1. Click **Cluster** > **Drives**.
2. Click **Available** to view the list of available drives.

3. Select the slice drives to add.
4. Click **Bulk Actions**.
5. Click **Add**.
6. Confirm from the **Active Drives** tab that the drives have been added.

Removing MDSS drives

You can remove the multi-drive slice service (MDSS) drives. This procedure applies only if the node has multiple slice drives.

About this task

Note: If the system slice drive and the slot 2 drive fail, the system will shutdown slice services and remove the drives. If there is no failure and you remove the drives, both drives must be removed at the same time.

Steps

1. Click **Cluster > Drives**.
2. From the **Available** drives tab, click the check box for the slice drives being removed.
3. Click **Bulk Actions**.
4. Click **Remove**.
5. Confirm the action.

Troubleshooting nodes

You can remove nodes from a cluster for maintenance or replacement. You should use the NetApp Element UI or API to remove nodes before taking them offline.

An overview of the procedure to remove storage nodes is as follows:

- Ensure that there is sufficient capacity in the cluster to create a copy of the data on the node.
- Remove drives from the node.
  This results in the system migrating data from the node's drives to other drives in the cluster. The time this process takes is dependent on how much data must be migrated.
- Remove the node from the cluster.

Keep the following considerations in mind before you power down or power up a node:

- Powering down nodes and clusters involves risks if not performed properly.
  Powering down a node should be done under the direction of NetApp Support.
- If a node has been down longer than 5.5 minutes under any type of shutdown condition, Double Helix data protection begins the task of writing single replicated blocks to another node to replicate the data. In this case, contact NetApp Support for help with analyzing the failed node.
- To safely reboot or power down a node, you can use the `Shutdown` API command.
- If a node is in a down, or in an off state, you must contact NetApp Support before bringing it back online.
- After a node is brought back online, you must add the drives back to the cluster, depending on how long it has been out of service.

Related information

Replacing a failed SolidFire chassis
Replacing a failed H600S series node

Powering down a cluster

You can power down an entire cluster after you have contacted NetApp Support and completed preliminary steps..

Before you begin

Prepare the cluster for shutdown by doing the following:

- Stop all I/O.
- Disconnect all iSCSI sessions.
- Shut down all the nodes at the same time.

Steps

1. Navigate to the management virtual IP (MVIP) address on the cluster to open the Element UI.
2. Note the nodes listed in the Nodes list.
3. Run the `Shutdown` API method with the `halt` option specified on each Node ID in the cluster.

Working with per-node utilities

You can use the per-node utilities for troubleshooting network problems if the standard monitoring tools in the NetApp Element UI do not give you enough information for troubleshooting. Per-node utilities provide specific information that can help you troubleshoot network problems between nodes or with the management node.

Related tasks

Accessing per-node settings on page 155
Running system tests on page 148
Running system utilities from the per-node UI on page 149

Related references

Per-node network settings details on page 146
Per-node cluster settings details on page 147

Per-node network settings details

You can change the node network settings to give the node a new set of network attributes.

The network settings for a node appear in the Network Settings window. You can see the network settings when you log in to the node. The following list describes the settings that you can modify when a node is in available, pending, and active states:

Method

The method used to configure the interface. This depends on other settings, such as the use of a static IP address, which will change the method to static. Possible methods are:

- `loopback`: Used to define the IPv4 loopback interface.

- `manual`: Used to define interfaces for which no configuration is done by default.
- `dhcp`: Might be used to obtain an IP address via Dynamic Host Configuration Protocol (DHCP).
- `static`: Used to define Ethernet interfaces with statically allocated IPv4 addresses.

IP Address

IP address for the 10G or 1G network.

Subnet Mask

Address subdivisions of the IP network.

Gateway Address

Router network address to send packets out of the local network.

MTU

Largest packet size that a network protocol can transmit. Must be greater than or equal to 1500 bytes.

DNS Servers

Network interface used for cluster communication.

Search Domains

Search for additional MAC addresses available to the system.

Bond Mode

Can be one of the following modes:

- `ActivePassive` (default)
- `ALB`
- `LACP`

Per-node cluster settings details

You can modify the cluster settings for a node. You can view the Cluster Settings tab after you log in to the node.

The following list describes the cluster settings for a node that you can modify:

Role

Role the node has in the cluster; it can be one of the following values:

- `Storage`: Storage or Fibre Channel node.
- `Management`: Node is a management node.

Hostname

Name of the node.

Cluster

Name of the cluster.

Cluster Membership

State of the node; it can be one of the following values:

- `Available`: The node has no associated cluster name and is not yet part of a cluster.
- `Pending`: The node is configured and can be added to a designated cluster. Authentication is not required to access the node.

- `PendingActive`: The system is in the process of installing compatible software on the node. When complete, the node will move to the Active state.
- `Active`: The node is participating in a cluster. Authentication is required to modify the node.

Version

Version of the Element software running on the node.

Ensemble

Node that are part of the database ensemble.

Node ID

ID assigned when a node is added to the cluster.

Cluster Interface

Network interface used for cluster communication.

Management Interface

Management network interface. This defaults to Bond1G but can also use Bond10G.

Storage Interface

Storage network interface using Bond10G.

Running system tests

You can test changes to the network settings after you commit them to the network configuration. You can run the tests to ensure that the node is stable and can be brought online without any issues.

Before you begin

You have logged in to the per-node user interface (UI).

Steps

1. Click **System Tests**.
2. Click the button to run the type of test that you want.
   - Run All Tests: Runs all test operations. This can be time consuming and should be done only at the direction of NetApp Support.
   - Test Connected Ensemble: Tests and verifies the connectivity to a database ensemble.
   - Test Connect Mvip: Pings the specified management virtual IP (MVIP) address and then executes a simple API call to the MVIP to verify connectivity.
   - Test Connect Svip: Pings the specified storage virtual IP (SVIP) address using Internet Control Message Protocol (ICMP) packets that match the Maximum Transmission Unit (MTU) size set on the network adapter. It then connects to the SVIP as an iSCSI initiator.
   - Test Hardware Config: Tests that all hardware configurations are correct, validates firmware versions are correct, and confirms all drives are installed and running properly. This is the same as factory testing. This test is resource intensive and should only be run if requested by support.
   - Test Local Connectivity: Tests the connectivity to all of the other nodes in the cluster by pinging the cluster IP (CIP) on each node. This test will only be displayed on a node if the node is part of an active cluster.
   - Test Locate Cluster: Locates the cluster on the network by its name.

- Test Network Config: Verifies that the configured network settings match the network settings being used on the system. This test is not intended to detect hardware failures when a node is actively participating in a cluster.
- Test Ping: Pings a specified list of hosts or, if none specified, dynamically builds a list of all registered nodes in the cluster and pings each for simple connectivity.
- Test Remote Connectivity: Tests the connectivity to all remotely paired clusters' nodes by pinging the cluster IP (CIP) on each node. This test will only be displayed on a node if the node is part of an active cluster.

Running system utilities from the per-node UI

You can use the per-node user interface (UI) to create or delete support bundles, reset configuration settings for drives, and restart network or cluster services.

Before you begin

You have logged in to a per-node user interface (UI).

Steps

1. Click **System Utilities**.
2. Click the button to run the type of utility that you want.
   - **Create Support Bundle**: Creates a support bundle under the node's `/tmp/bundles` directory.
   - **Delete All Support Bundles**: Deletes any current support bundles residing on the node.
   - **Reset Drives**: Initializes drives and removes all data currently residing on the drive. You can reuse the drive in an existing node or in an upgraded node.
   - **Restart Networking**: Restarts all networking services on a node.

     Attention: This operation can cause temporary loss of network connectivity.
   - **Restart Services**: Restarts Element software services on a node.

     Attention: This operation can cause temporary node service interruption. You should perform this operation only at the direction of NetApp Support.

Working with the management node

You can use the management node UI to enable remote access to your SolidFire cluster.

Related tasks

Accessing a management node on page 150
Testing the management node settings on page 152
Running system utilities from the management node on page 152
Configuring a proxy server for the management node on page 152
Enabling remote NetApp Support connections on page 153

Related references

Management node network settings on page 150

Accessing a management node

You can access network and cluster settings, and system tests and utilities in the management node user interface after you enter the management node IP and authenticate.

About this task

You need only one management node for reporting to and managing upgrades for a cluster. However, you might need to have multiple management nodes to allow multiple vCenter plug-ins to connect to a single cluster.

Steps

1. In a browser window, enter the management node IP address followed by 442:

   `https://192.168.107.112:442`

2. In the authentication dialog box, enter an admin user name and password, if required.

   After you log in, you can configure the management node and modify management node settings.

Related references

Management node network settings on page 150

NetApp HCI alert monitoring

On the Alert Monitor tab in the web UI for the management node, you can configure settings for the NetApp Monitoring Agent.

The NetApp Monitoring Agent forwards NetApp HCI storage cluster system alerts to vCenter Server, enabling you to view all alerts for NetApp HCI from the vSphere Web Client interface. You need to use the NetApp HCI API to enable system alerts.

Attention: These tools are not configured or used for storage-only clusters, such as SolidFire all-flash array. Running the tools results in the following 405 error, which is expected given the configuration: `webUIParseError : Invalid response from server. 405`

Related information

NetApp HCI doc center

Management node network settings

On the Network Settings tab of the Node UI for management node, you can modify the management node network interface fields.

Method

The method used to configure the interface. Possible methods are:

- `loopback`: Used to define the IPv4 loopback interface.
- `manual`: Used to define interfaces for which no configuration is done by default.
- `dhcp`: Might be used to obtain an IP address via DHCP.
- `static`: Used to define Ethernet interfaces with statically allocated IPv4 addresses.

Link Speed

The speed negotiated by the virtual NIC.

IPv4 Address

The IPv4 address for the eth0 network.

IPv4 Subnet Mask

Address subdivisions of the IPv4 network.

IPv4 Gateway Address

Router network address to send packets out of the local network.

IPv6 Address

The IPv6 address for the eth0 network.

IPv6 Gateway Address

Router network address to send packets out of the local network.

MTU

Largest packet size that a network protocol can transmit. Must be greater than or equal to 1500.

DNS Servers

Network interface used for cluster communication.

Search Domains

Search for additional MAC addresses available to the system.

Status

Possible values:

- `UpAndRunning`
- `Down`
- `Up`

Routes

Static routes to specific hosts or networks via the associated interface the routes are configured to use.

Management node cluster settings

On the Cluster Settings tab of the Node UI for the management node, you can modify cluster interface fields when a node is in Available, Pending, PendingActive, and Active states.

Role

Role the management node has in the cluster. Possible value: `Management`.

Hostname

Name of the management node.

Version

Element software version running on the cluster.

Default Interface

Default network interface used for management node communication with the SolidFire cluster.

Testing the management node settings

After you change settings for the management node and commit the changes, you can run tests to validate the changes you made.

Steps

1. In the management node user interface, click **System Tests**.
2. To run all test operations, click **Run All Tests**.
3. To verify that the network settings you configured match the network settings being used on the system, click **Test Network Config**.
4. To check connectivity with host, click **Test Ping**, and specify the list of hosts to ping.

   If you do not specify a host, the system pings each registered node in the cluster.

Related references

Management node network settings on page 150

Running system utilities from the management node

You can use the management node user interface (UI) to create or delete cluster support bundles, reset node configuration settings, or restart networking.

Before you begin

You are logged in to the management node using the management node admin credentials.

Steps

1. In the management node UI, click **System Utilities**.
2. Click the button to run the type of utility that you want.
   - **Create Cluster Support Bundle**: Creates the cluster support bundle to assist NetApp Support diagnostic evaluations of one or more nodes in a cluster. Click **show options** to display the fields you must fill.
   - **Delete All Support Bundles**: Deletes any current support bundles residing on the node.
   - **Reset Node**: Resets the management node to a new install image. This changes all settings to the default state, except the network configuration.
   - **Restart Networking**: Restarts all networking services on the management node.

     Attention: This operation causes temporary loss of networking connectivity.

Configuring a proxy server for the management node

If your SolidFire cluster is behind a proxy server, you must configure the proxy settings so you can reach a public network.

Steps

1. Run the `sfsetproxy` to configure proxy settings for the management node.

   The `sfsetproxy` command modifies settings for the following:

   - Reverse Secure Shell (SSH) tunnel

- apt-get and aptitude (via `/etc/profile.d/sf_proxy_settings.sh`)
- apt-mirror (via `wget`)
- collector (script)

2. To verify that the proxy settings are consistent, run `sfsetproxy` without any arguments.

   Example

   For example, run the following command:

   ```
   admin@mnode:~$ sudo sfsetproxy
   ```

   The above command gives the following output:

   ```
   Proxy host: 192.168.140.136
   Proxy port: 3128
   ```

3. To set the host and port arguments when a user name and password are not required on the proxy server, run the following command:

   `sfsetproxy [-P ssh_port]`

   Example

   ```
   sfsetproxy 192.168.140.136 3128
   ```

4. To set the host and port arguments when a user name and password are required on the proxy server, run the following command:

   `sfsetproxy [-P ssh_port] [-u username -p password]`
   `ProxyHostnameOrIPAddress ProxyPort (Initial setup of proxy)`

   Example

   ```
   sfsetproxy –u testproxy –p solidfire 192.168.140.136 3128
   ```

   Note: This command does not return output if it completes successfully. Run `./sfsetproxy` to see if the proxy has been set.

Enabling remote NetApp Support connections

If you require technical support for your SolidFire storage system, NetApp Support can connect remotely with your system. To gain remote access, NetApp Support can open a reverse Secure Shell (SSH) connection to your environment.

About this task

You can open a Transmission Control Protocol (TCP) port for SSH reverse tunnel connection with NetApp Support. This connection allows Support to log in to your management node. If your management node is behind a proxy server, the following TCP ports are required in the `sshd.config` file:

TCP port	Description	Connection direction
443	API calls/HTTPS for reverse port forwarding via open support tunnel to the web UI	Management node to SolidFire nodes

TCP port	Description	Connection direction
22	SSH login access	Management node to SolidFire nodes or from SolidFire nodes to management node

Steps

1. Log in to your management node and open a terminal session.
2. At a prompt, enter the following:

   ```
   rst –r sfsupport.solidfire.com –u element –p <port number>
   ```

   NetApp Support can provide the port number to access your management node with an SSH connection.
3. To close a remote support tunnel, enter the following:

   ```
   rst --killall
   ```

Related references

Network port requirements on page 11

Understanding cluster fullness levels

The cluster running Element software generates cluster faults to warn the storage administrator when the cluster is running out of capacity. There are three levels of cluster fullness, all of which are displayed in the NetApp Element UI: warning, error, and critical.

The system uses the BlockClusterFull error code to warn about cluster block storage fullness. You can view the cluster fullness severity levels from the Alerts tab of the Element UI.

The following list includes information about the BlockClusterFull severity levels:

Warning

This is a customer-configurable warning that appears when the cluster's block capacity is approaching the error severity level. By default, this level is set at three percent under the error level and can be tuned via the Element UI and API. You must add more capacity, or free up capacity as soon as possible.

Error

When the cluster is in this state, if a node is lost, there will not be enough capacity in the cluster to rebuild Double Helix data protection. New volume creation, clones, and snapshots are all blocked while the cluster is in this state. This is not a safe or recommended state for any cluster to be in. You must add more capacity, or free up capacity immediately.

Critical

This critical error has occurred because the cluster is 100 percent consumed. It is in a read-only state and no new iSCSI connections can be made to the cluster. When this stage is reached, you must free up or add more capacity immediately.

The system uses the MetadataClusterFull error code to warn about cluster metadata storage fullness. You can view the cluster metadata storage fullness from the Cluster Capacity section on the Overview page of the Reporting tab in the Element UI.

The following list includes information about the MetadataClusterFull severity levels:

Warning

When the cluster is in this state, if two nodes are lost, there will not be enough capacity in the cluster to rebuild Double Helix data protection.

Error

When the cluster is in this state, if a node is lost, there will not be enough capacity in the cluster to rebuild Double Helix data protection. New volume creation, clones, and snapshots are all blocked while the cluster is in this state. This is not a safe or recommended state for any cluster to be in. You must add more capacity, or free up capacity immediately.

Critical

This critical error has occurred because the cluster is 100 percent consumed. It is in a read-only state and no new iSCSI connections can be made to the cluster. When this stage is reached, you must free up or add more capacity immediately.

Accessing per-node settings

You can access network and cluster settings, and system tests and utilities in the per-node user interface after you enter the management node IP and authenticate.

About this task

If you want to modify settings of a node in an active state that is part of a cluster, you must log in as a cluster administrator user.

Note: You should configure or modify one node at a time. You must ensure that the network settings specified are having the expected effect, are stable, and are performing well before you make modifications to another node.

Step

1. Open the per-node UI by using one of the following methods:
   - Enter the management IP address followed by :442 in a browser window, and log in using an admin user name and password.
   - In the Element UI, select **Cluster > Nodes**, and click the management IP address link for the node you want to configure or modify.

   In the browser window that opens, you can edit the settings of the node.

Enabling FIPS 140-2 on your cluster

You can use the `EnableFeature` API method to enable the FIPS 140-2 operating mode for HTTPS communications.

About this task

Starting with Element 10.3, you can choose to enable Federal Information Processing Standards (FIPS) 140-2 operating mode on your cluster. Enabling this mode activates the NetApp Cryptographic Security Module (NCSM) and leverages FIPS 140-2 Level 1 certified encryption for all communication via HTTPS to the NetApp Element UI and API.

Attention: After you enable FIPS 140-2 mode, it cannot be disabled. When FIPS 140-2 mode is enabled, each node in the cluster reboots and runs through a self-test ensuring that the NCSM is correctly enabled and operating in the FIPS 140-2 certified mode. This causes an interruption to both management and storage connections on the cluster. You should plan carefully and only enable this mode if your environment needs the encryption mechanism it offers.

For more information see the *NetApp Element Software API Reference Guide* in the Element product library. If needed, contact NetApp Support for assistance.

The following is an example of the API request to enable FIPS:

```
{
  "method": "EnableFeature",
    "params": {
        "feature" : "fips"
    },
    "id": 1
}
```

After this operating mode is enabled, all HTTPS communication uses the FIPS 140-2 approved ciphers.

Related references

SSL ciphers on page 156

Related information

NetApp Element Product Library

SSL ciphers

SSL ciphers are encryption algorithms used by hosts to establish a secure communication. There are standard ciphers that Element software supports and non-standard ones when FIPS 140-2 mode is enabled.

The following lists provide the standard Secure Socket Layer (SSL) ciphers supported by Element software and the SSL ciphers supported when FIPS 140-2 mode is enabled:

FIPS 140-2 disabled

TLS_RSA_WITH_3DES_EDE_CBC_SHA (rsa 2048) - C

TLS_RSA_WITH_AES_128_CBC_SHA (rsa 2048) - A

TLS_RSA_WITH_AES_128_CBC_SHA256 (rsa 2048) - A

TLS_RSA_WITH_AES_128_GCM_SHA256 (rsa 2048) - A

TLS_RSA_WITH_AES_256_CBC_SHA (rsa 2048) - A

TLS_RSA_WITH_AES_256_CBC_SHA256 (rsa 2048) - A

TLS_RSA_WITH_AES_256_GCM_SHA384 (rsa 2048) - A

TLS_RSA_WITH_CAMELLIA_128_CBC_SHA (rsa 2048) - A

TLS_RSA_WITH_CAMELLIA_256_CBC_SHA (rsa 2048) - A

TLS_RSA_WITH_IDEA_CBC_SHA (rsa 2048) - A

TLS_RSA_WITH_RC4_128_MD5 (rsa 2048) - C

TLS_RSA_WITH_RC4_128_SHA (rsa 2048) - C

TLS_RSA_WITH_SEED_CBC_SHA (rsa 2048) - A

FIPS 140-2 enabled

TLS_DHE_RSA_WITH_AES_128_CBC_SHA256 (dh 2048) - A

TLS_DHE_RSA_WITH_AES_128_GCM_SHA256 (dh 2048) - A

TLS_DHE_RSA_WITH_AES_256_CBC_SHA256 (dh 2048) - A

TLS_DHE_RSA_WITH_AES_256_GCM_SHA384 (dh 2048) - A

TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256 (secp256r1) - A

TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256 (secp256r1) - A

TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384 (secp256r1) - A

TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384 (secp256r1) - A

TLS_RSA_WITH_3DES_EDE_CBC_SHA (rsa 2048) - C

TLS_RSA_WITH_AES_128_CBC_SHA (rsa 2048) - A

TLS_RSA_WITH_AES_128_CBC_SHA256 (rsa 2048) - A

TLS_RSA_WITH_AES_128_GCM_SHA256 (rsa 2048) - A

TLS_RSA_WITH_AES_256_CBC_SHA (rsa 2048) - A

TLS_RSA_WITH_AES_256_CBC_SHA256 (rsa 2048) - A

TLS_RSA_WITH_AES_256_GCM_SHA384 (rsa 2048) - A

Related tasks

Enabling FIPS 140-2 on your cluster on page 155

Where to find additional information

You can learn more about tasks related to the SolidFire storage system in NetApp's extensive documentation library.

How to calculate max provisioned space in a SolidFire cluster

Describes how to calculate the max provisioned space in a SolidFire storage cluster. Max provisioned space is the metadata drive capacity in a cluster.

How to calculate SolidFire system error alert percentage

Describes how to calculate the SolidFire storage cluster fullness percentage at which the system notifies you.

NetApp SolidFire Element OS Documentation Library

Includes documentation for various releases of Element software.

NetApp SolidFire Element OS Known Issues

Provides a list of known issues in the current and earlier versions of Element software.

NetApp SolidFire Element OS Resolved Issues

Provides a list of resolved issues in the current and earlier versions of Element software.

NetApp SolidFire Resources page

Provides resources about Element software, including links to video content and technical reports.

NetApp Technical Report 4677: NetApp SolidFire Element OS Remote Replication

Describes different types of remote replication supported by NetApp SolidFire storage clusters.

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