Technical Report

Visualizing NetApp HCI Performance

Using Grafana, Docker, Trident, and Graphite

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Enabled by

Grafana graphite

Abstract

Grafana is a powerful tool to visualize time-series performance data. This technical report describes how to build a fully customizable Grafana instance to visualize performance statistics for NetApp® SolidFire®, VMware, and NetApp HCI systems.

This solution is completely open source. IT uses Grafana for graphing performance data, Docker for containerizing the applications, Trident for Docker plugin for persistent storage of metrics and container state, and Graphite for storing the time-series data.

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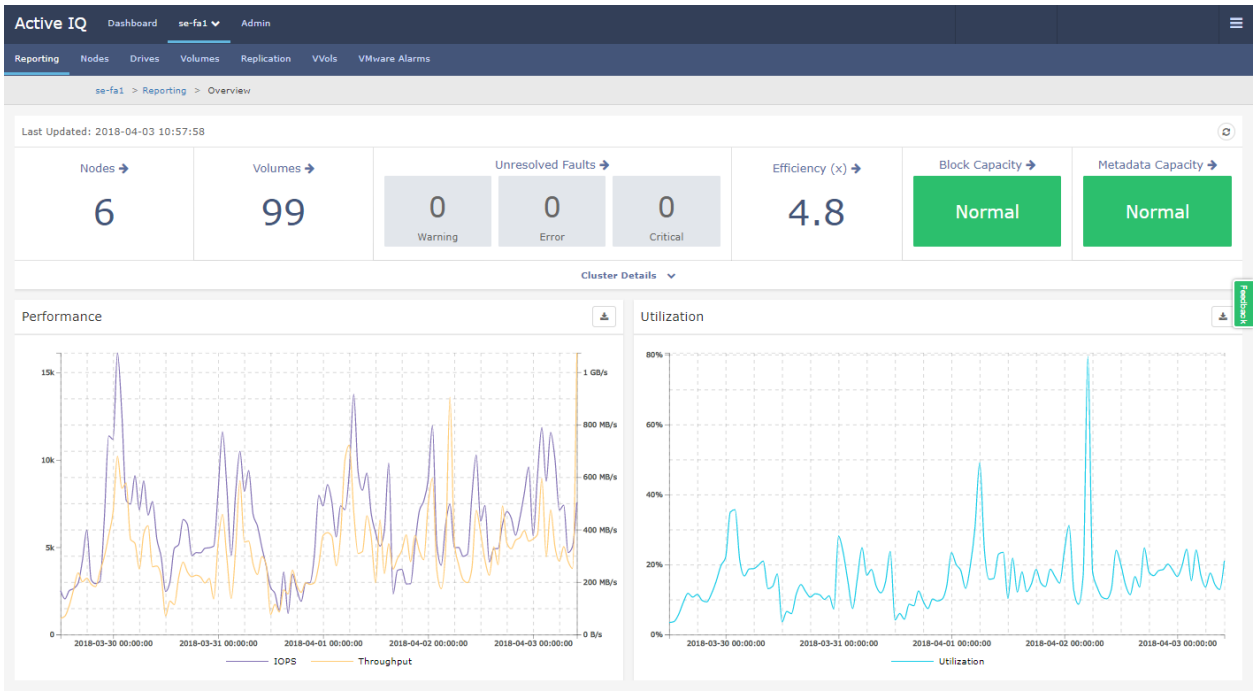
1 Overview

Effective monitoring of critical infrastructure is the keystone in maintaining operational readiness and is a key enabler of risk mitigation. Monitoring critical infrastructure for atypical workloads and events can help prevent small issues from becoming outages.

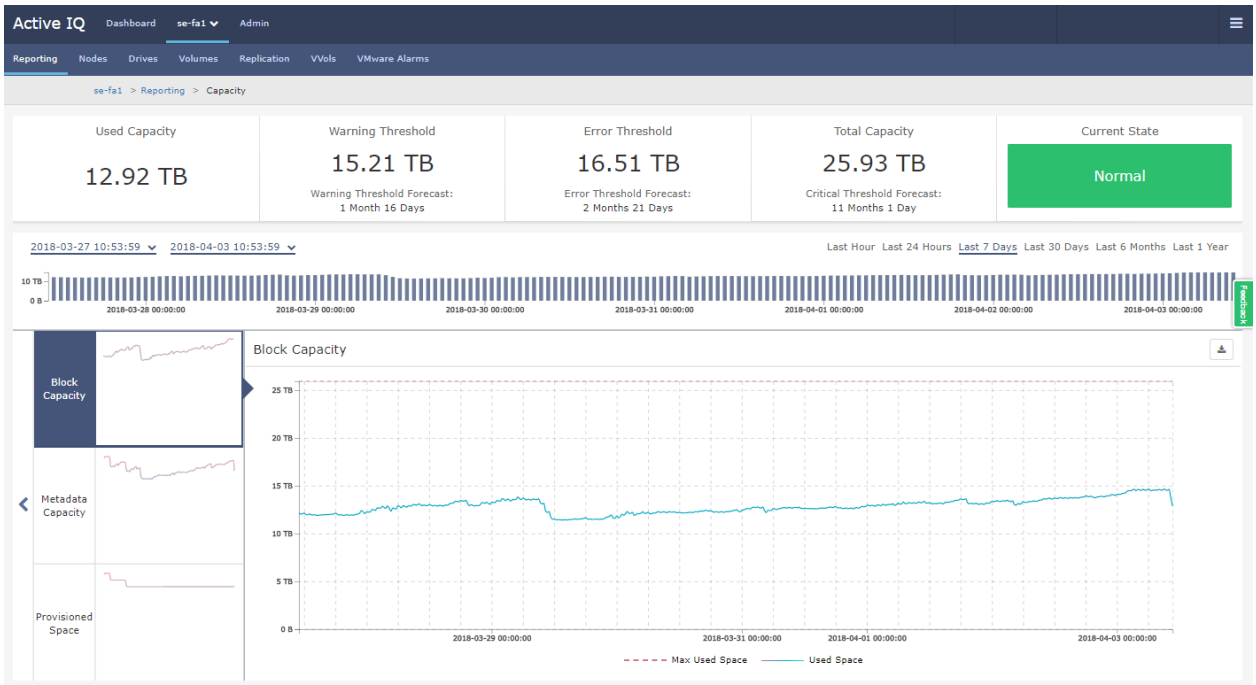
NetApp® HCI includes access to the NetApp Active IQ® platform, which is a cloud-based performance monitoring and alerting platform. Active IQ provides a rich set of preconfigured dashboards that displays real-time cluster performance and alerts and that presents a view of historical data (Figure 1).

Figure 1) Active IQ dashboard.



To aid with future planning and budgeting, Active IQ also enables capacity modeling and forecasts as to when additional capacity should be added to the cluster (Figure 2).

Figure 2) Active IQ capacity forecast.



Active IQ is the preferred method for monitoring and alerting for NetApp HCI and SolidFire® systems. However, for Active IQ to function, it requires outbound connectivity from your site to the cloud. Active IQ is not an available option for sites that do not allow outbound connections (*dark sites*).

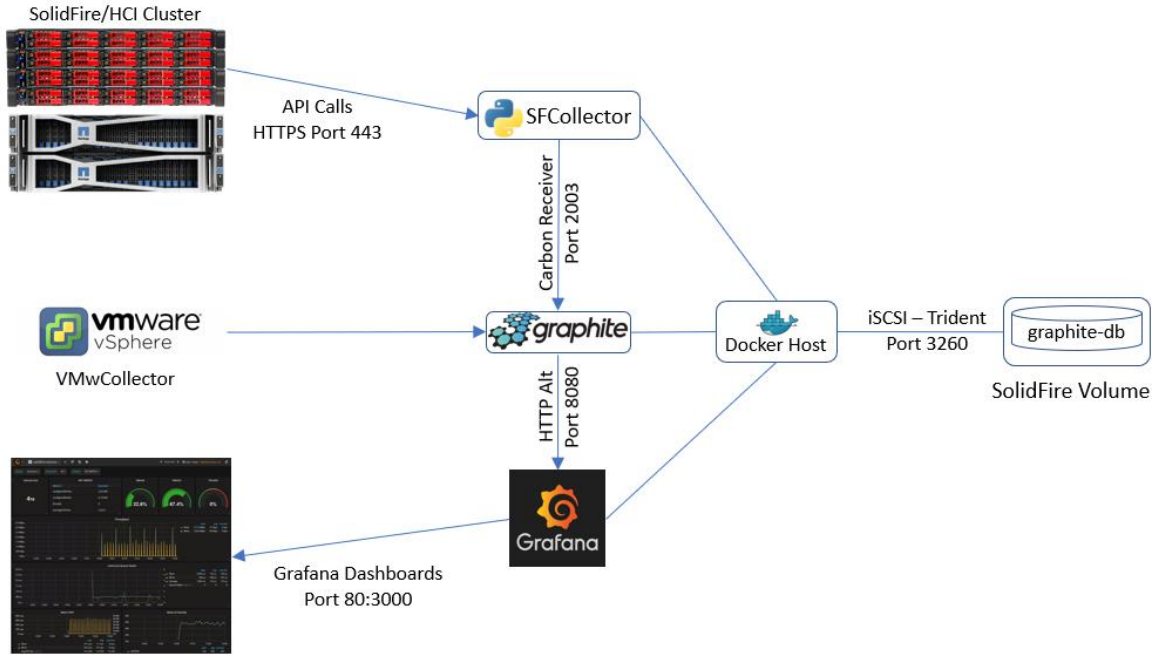
The HCICollector is a community open-source project that replicates a subset of the Active IQ functionality in a collection of Docker containers. This functionality can be run on local infrastructure, removing the need for external internet connectivity once configured. The HCI Collector assembles time-series data from both SolidFire and NetApp HCI components, including VMware vSphere, and it presents those metrics through a collection of preconfigured Grafana dashboards.

1.1 HCICollector Components

The HCICollector is composed of several individual components. Figure 3 shows how the following components work together:

- **SFCollector.** A Docker container that hosts a Python script that collects performance data from SolidFire systems or NetApp HCI storage nodes and sends the data to a Graphite time-series database.
- **Graphite.** A Docker container that hosts the time-series database for holding performance data that is collected from storage and compute hosts.
- **VMwCollector.** A Docker container that hosts a statistics collector for VMware components, written in Golang.
- **Grafana.** A Docker container that hosts the front end that is used to graphically visualize the time-series data in the Graphite database.
- **Docker host.** An Ubuntu 16.04 LTS virtual machine (VM) that hosts the HCICollector containers. It is assumed the Docker host exists in the environment.
- **Trident.** An (optional) NetApp Docker Volume Plugin that runs in the Docker host that automates the creation and presentation of persistent storage volumes for the containers that constitute the HCICollector. You can use local host volumes as well, but their configuration is not covered in this guide.

Figure 3) HCICollector components.



1.2 How It All Works Together

As implemented in this guide, the HCICollector functions as follows:

- Some initial setup is required to provide IP addresses and credentials to the components of the collector. This process is partially automated by the included `install_hcicollector.sh` shell script. Note that this configuration expects and requires DNS resolution of VMware vCenter and ESXi hosts.
- The Trident for Docker plugin creates an iSCSI volume on a SolidFire system for storing the Whisper database files for Graphite. The use of an external data source allows portability of the collected data. It also enables protection of the collected data through snapshots, clones, or replication to another SolidFire or NetApp FAS system.
- The Docker host mounts the volume that Trident provides and passes this volume through to the Graphite container for persistent storage of collected metrics. Container management is handled by Docker Compose. Docker Compose handles container configuration and provisions the networks and external volumes that the containers use.
- The SFCollector connects to one or more SolidFire storage back ends and collects statistics every 60 seconds and sends them to Graphite under the `netapp.solidfire` namespace. A list of statistics that are collected is available in Appendix B.
- The VMwCollector connects to one or more vCenter instances and collects statistics every 60 seconds and sends them to Graphite under the `vsphere` namespace. A list of statistics that are collected is available in the `./vmwcollector/vsphere-graphite.json` file in the “Metrics” section.
- Grafana accesses data from the Graphite database and uses it to draw a set of preconfigured dashboards. To aid in setup, the dashboards and data source are automatically configured and populated by using the provisioning functionality that was introduced in Grafana 5.

1.3 Primary Use Cases

The HCICollector can be used in isolation, but the primary use case is to augment the data that Active IQ provides. You can leverage the HCICollector in the following ways:

- Create custom dashboards for visualizing data that is not present in Active IQ.
- Create multisystem reporting dashboards. Currently, Active IQ reporting is performed per system.
- Visualize more complete VMware statistics.
- Extend the collectors to capture additional data from switches or from other infrastructure that is of interest.

2 Installation

This section describes the steps to deploy the HCICollector. It is assumed that a Docker host is available. These instructions use an Ubuntu 16.04 LTS VM as an example. It is also assumed that Docker CE 17.03+ and Docker Compose are installed.

The instructions for installing Docker components are available on https://docs.docker.com.

Note: Docker version 18.03.0 breaks plugins. This problem has been resolved in version 18.03.1. The earlier versions are unaffected. Docker 17.12.1 is used in this guide.

2.1 Preparation

Before you continue, be sure to carry out the following preparation:

- Verify that you have a suitable Docker host machine available and that the machine has a supported version of Docker installed, as well as any support tools that you might require.
- Confirm that DNS records exist for the equipment that you will be monitoring.
- Confirm that you have the following environment information:
  - vCenter host name, fully qualified domain name (FQDN), user name, and password
  - SolidFire management virtual IP address (MVIP address), storage virtual IP address (SVIP address), user name, and password
  - Docker host IP and login information
- Verify that the https://github.com/jedimt/hcicollector repository has been cloned into `/opt/github/hcicollector` on the Docker host.
- If you use Trident, confirm that the Docker host can connect to the SolidFire SVIP address.

After the repository has been cloned, the following high-level directory structure should be in place:

```
root@sfps-grafana-dev:/opt/github/hcicollector# tree -d -L 3
├── sfcollector             #Container configuration for the SFCollector components
├── grafana                 #Container configuration for the Grafana components
│   ├── dashboards          #Contains all the preconfigured dashboards
│   └── provisioning        #Configuration files for Grafana automated provisioning
│       ├── dashboards      #Dashboard provisioning configuration
│       └── datasources     #Datasource provisioning configuration
├── graphite                #Container configuration for Graphite database
└── vmwcollector            #Contain configuration for the vSphere-Graphite collector
```

Note: This tree view is abbreviated to show the directories of interest.

2.2 HCICollector Installation: Scripted

The HCICollector includes a rudimentary bash install script (`install_hcicollector.sh`) that performs the following tasks:

1. Prompts the user for required information.
2. Writes the Trident configuration file to `/etc/netappdvp/config.json` and installs Trident 18.04.
3. Creates the Docker volume for the Graphite database to mount.
4. Writes out the following configuration files:
   - `./docker-compose.yml`
   - `./sfcollector/wrapper.sh` file for the SolidFire collector
   - `./vmwcollector/vsphere-graphite.json`
5. Sets the correct data source for the included dashboards in the `./grafana/dashboards` directory.

When you use the script to drive the installation, the workflow is as follows:

1. Create the directory to house the GitHub repository, for example `/opt/github/hcicollector`.
2. Clone the https://github.com/jedimt/hcicollector GitHub repository into the desired directory.
3. Execute the `install_hcicollector.sh` script and provide the requested inputs.
4. Start the collector by running `docker-compose up -d` from the `/opt/github/hcicollector` directory. Starting the containers for the first time requires about 10 minutes on most systems.

Figure 4) Scripted installation with the `install_hcicollector.sh` script.

```
root@sfps-grafana-devtemp:/opt/github/hcicollector# ./install_hcicollector.sh
 #########  #########  #########
 Enter the SolidFire management virtual IP (MVIP):
10.193.136.240
 Enter the SolidFire storage virtual IP (SVIP):
10.193.139.44
 Enter the SolidFire username (case sensitive):
netapp
 Enter the Solidfire password:
 Enter the tenant account to use for Trident:
docker-dev
 Enter the volume name to create for Graphite
graphite-db-dev
 Enter the password to use for the Grafana admin account:
 Enter the vCenter username:
administrator@vsphere.local
 Enter the vCenter password:
 Enter the vCenter hostname. Ex. vcsa:
sfps-prototype-vcsa
 Enter the vCenter domain. Ex. rtp.openenglab.netapp.com:
rtp.openenglab.netapp.com
 Enter the IP address of this Docker host:
10.193.136.230
 Beginning Install
Installing Trident and creating the  volume
18.01: Pulling from netapp/trident-plugin
88c0023f068a: Download complete
Digest: sha256:306c6dcb4c6e822f2db85c7ed2f73bb5254e4cdb4f14fa36e629451f70a35055
Status: Downloaded newer image for netapp/trident-plugin:18.01
Installed plugin netapp/trident-plugin:18.01
graphite-db-dev
Creating the docker-compose.yml file
Creating the SolidFire collector wrapper.sh script
 Marking wrapper.sh as executable
Creating the storage-schemas.conf file
Creating the vsphere-graphite.json file
Modifying the default 'datasource' values in the pre-packeged dashboards
```

If you plan to customize the collector, you can modify the `install_hciscollector.sh` script. Alternatively, the manual setup instructions are also covered in section 2, HCICollector Installation: Manual.

2.3 HCICollector Installation: Manual

This section describes the manual installation of the collector on a Docker host.

If you plan to use multipathing, follow the steps that are outlined at https://netapp-trident.readthedocs.io/en/stable-v18.04/docker/install/host_config.html#host-configuration.

Trident Installation and Configuration

To install and configure Trident, complete the following steps:

1. Clone the GitHub repository to `/opt/github`.

```
mkdir -p /opt/github
git clone https://github.com/jedimt/hcicollector /opt/github/hcicollector
```

2. Create a location to store the Trident for Docker plugin configuration files.

```
sudo mkdir -p /etc/netappdvp
```

3. Create the configuration file for SolidFire.

```
cat << EOF > /etc/netappdvp/config.json
{
    "version": 1,
    "storageDriverName": "solidfire-san",
    "Endpoint": "https://admin:solidfire@10.193.136.240/json-rpc/9.0",
    "SVIP": "10.193.137.240:3260",
    "TenantName": "docker",
    "InitiatorIFace": "default",
    "Types": [
        {
            "Type": "docker-default",
            "Qos": {
                "minIOPS": 1000,
                "maxIOPS": 2000,
                "burstIOPS": 4000
            }
        },
        {
            "Type": "docker-app",
            "Qos": {
                "minIOPS": 4000,
                "maxIOPS": 6000,
                "burstIOPS": 8000
            }
        },
        {
            "Type": "docker-db",
            "Qos": {
                "minIOPS": 6000,
                "maxIOPS": 8000,
                "burstIOPS": 10000
            }
        }
    ]
}
EOF
```

4. Install the Trident plugin.

```
docker plugin install --grant-all-permissions --alias netapp netapp/trident-plugin:18.04
config=config.json
```

5. Verify that the plugin is installed and is enabled.

```
docker plugin list
ID                  NAME                DESCRIPTION                               ENABLED
047ac2d0663f        netapp:latest       Trident - NetApp Docker Volume Plugin   true
```

6. Create Docker volumes to be used for Graphite persistent storage.

```
# Create Graphite docker volume
docker volume create -d netapp --name graphite-db -o type=docker-db -o size=100G

#show volume
docker volume list --filter 'driver=netapp:latest'
DRIVER              VOLUME NAME
netapp:latest       graphite-db
```

Docker Container Setup and Configuration

To install and configure the Docker containers, complete the following steps.

1. Install Docker Compose if it is not already installed.

```
apt install docker-compose
```

2. Create the `docker-compose.yml`, specifying the persistent data volumes to use for Graphite and for Grafana and the password to secure the Grafana web interface.

```
cat << EOF > /opt/github/hcicollector/docker-compose.yml
version: "2"
services:
  graphite:
    build: ./graphite
    container_name: graphite-v.6
    restart: always
    ports:
        - "8080:80"
        - "8125:8125/udp"
        - "8126:8126"
        - "2003:2003"
        - "2004:2004"
    volumes: #Trident or local volumes for persistent storage
        - graphite-db:/opt/graphite/storage/whisper
    networks:
        - net_hcicollector

  grafana:
    build: ./grafana
    container_name: grafana-v.6
    restart: always
    ports:
        - "80:3000"
    networks:
        - net_hcicollector
    environment:
        #Set password for Grafana web interface
        - GF_SECURITY_ADMIN_PASSWORD=<your password>
        #Optional SMTP configuration for alert queries
        #- GF_SMTP_ENABLED=true
        #- GF_SMTP_HOST=smtp.gmail.com:465
        #- GF_SMTP_USER=<email address>
        #- GF_SMTP_PASSWORD=<email password>
        #- GF_SMTP_SKIP_VERIFY=true

  sfcollector:
    build: ./sfcollector
    container_name: sfcollector-v.6
    restart: always
    networks:
        - net_hcicollector
```

```
  vmwcollector:
    build: ./vmwcollector
    container_name: vmwcollector-v.6
    restart: always
    networks:
        - net_hcicollector
    depends_on:
        - graphite

networks:
  net_hcicollector:
    driver: bridge

volumes:
  graphite-db:
    external: true
EOF
```

3. Create the `/opt/github/hcicollector/sfcollector/wrapper.sh` script with the appropriate SolidFire cluster MVIP address, user name, and password. If you changed the Graphite container name, specify the new host name by using the `-g` option.

```
cat << EOF > /opt/github/hcicollector/sfcollector/wrapper.sh
#!/usr/bin/env bash
while true
do
/usr/bin/python /solidfire_graphite_collector.py -s 10.193.136.39 -u admin -p <yourpassword> -g
graphite &
sleep 60
done
EOF
```

4. If you want to adjust the retention period for the NetApp statistics, edit the `/opt/github/hcicollector/graphite/storage-schemas.conf` file. By default, the following retention is set, which keeps 1-minute statistics for 7 days, 5-minute statistics for 28 days, and 10-minute statistics for 1 year. If you are also collecting statistics from vCenter, add the `[vsphere]` section as well. This must be done before starting the containers for the first time.

```
[netapp]
pattern = ^netapp\.*
retentions = 1m:7d,5m:28d,10m:1y

[vsphere]
pattern = ^vsphere\.*
retentions = 1m:7d,5m:28d,10m:1y
```

5. Create the `/opt/github/hcicollector/vmwcollector/vsphere-graphite.json` file and add your vCenter details.

```
cat << EOF > /opt/github/hcicollector/vmwcollector/vsphere-graphite.json
{
  "Domain": "<yourdomain>",
  "Interval": 60,
  "FlushSize": 100,
  "VCenters": [
    { "Username": "administrator@vsphere.local", "Password": "<yourpassword>", "Hostname": "sfps-
prototype-vcsa" }
  ],
  "Backend": {
    "Type": "graphite",
    "Hostname": "graphite",
    "Port": 2003
  },
  "Metrics": [
    {
      "ObjectType": [ "VirtualMachine", "HostSystem" ],
      "Definition": [
        { "Metric": "cpu.usage.average", "Instances": "" },
        { "Metric": "cpu.usage.maximum", "Instances": "" },
```

```
        { "Metric": "cpu.usagemhz.average", "Instances": "" },
        { "Metric": "cpu.usagemhz.maximum", "Instances": "" },
        { "Metric": "cpu.totalCapacity.average", "Instances": "" },
        { "Metric": "cpu.ready.summation", "Instances": "" },
        { "Metric": "mem.usage.average", "Instances": "" },
        { "Metric": "mem.usage.maximum", "Instances": "" },
        { "Metric": "mem.consumed.average", "Instances": "" },
        { "Metric": "mem.consumed.maximum", "Instances": "" },
        { "Metric": "mem.active.average", "Instances": "" },
        { "Metric": "mem.active.maximum", "Instances": "" },
        { "Metric": "mem.vmmemctl.average", "Instances": "" },
        { "Metric": "mem.vmmemctl.maximum", "Instances": "" },
        { "Metric": "disk.commandsAveraged.average", "Instances": "*" },
        { "Metric": "mem.totalCapacity.average", "Instances": "" }
      ]
    },
    {
      "ObjectType": [ "VirtualMachine" ],
      "Definition": [
        { "Metric": "virtualDisk.totalWriteLatency.average", "Instances": "*" },
        { "Metric": "virtualDisk.totalReadLatency.average", "Instances": "*" },
        { "Metric": "virtualDisk.numberReadAveraged.average", "Instances": "*" },
        { "Metric": "virtualDisk.numberWriteAveraged.average", "Instances": "*" },
        { "Metric": "cpu.ready.summation", "Instance": ""}
      ]
    },
    {
      "ObjectType": [ "HostSystem" ],
      "Definition": [
        { "Metric": "disk.maxTotalLatency.latest", "Instances": "" },
        { "Metric": "disk.numberReadAveraged.average", "Instances": "*" },
        { "Metric": "disk.numberWriteAveraged.average", "Instances": "*" },
        { "Metric": "disk.deviceLatency.average", "Instances": "*" },
        { "Metric": "disk.deviceReadLatency.average", "Instances": "*" },
        { "Metric": "disk.deviceWriteLatency.average", "Instances": "*" },
        { "Metric": "disk.kernelLatency.average", "Instances": "*" },
        { "Metric": "disk.queueLatency.average", "Instances": "*" },
        { "Metric": "datastore.datastoreIops.average", "Instances": "*" },
        { "Metric": "datastore.datastoreMaxQueueDepth.latest", "Instances": "*" },
        { "Metric": "datastore.datastoreReadBytes.latest", "Instances": "*" },
        { "Metric": "datastore.datastoreReadIops.latest", "Instances": "*" },
        { "Metric": "datastore.datastoreWriteBytes.latest", "Instances": "*" },
        { "Metric": "datastore.datastoreWriteIops.latest", "Instances": "*" },
        { "Metric": "datastore.numberReadAveraged.average", "Instances": "*" },
        { "Metric": "datastore.numberWriteAveraged.average", "Instances": "*" },
        { "Metric": "datastore.ready.average", "Instances": "*" },
        { "Metric": "datastore.totalReadLatency.average", "Instances": "*" },
        { "Metric": "datastore.totalWriteLatency.average", "Instances": "*" },
        { "Metric": "datastore.write.average", "Instances": "*" },
        { "Metric": "mem.state.latest", "Instances": "" }
      ]
    }
  ]
}
EOF
```

6. Create the `datasource.yml` file at the following location, providing the IP address for the Docker host in the `url` field:
   `/opt/github/hcicollector/grafana/provisioning/datasources/datasource.yml`.

```
apiVersion: 1
datasources:
  - name: graphite-db-dev
    type: graphite
    access: proxy
    orgId: 1
    url: http://10.193.136.222:8080
    isDefault: true
    version: 1
    editable: true
```

```
basicAuth: false
```

7. Bring up the containers by using `docker-compose`. This task takes several minutes to complete.

```
docker-compose -f /opt/github/hcicollector/docker-compose.yml up -d
```

Note: If you want to view the logs, you can bring up the containers the first time with the `-d` flag omitted.

2.4 Grafana Configuration

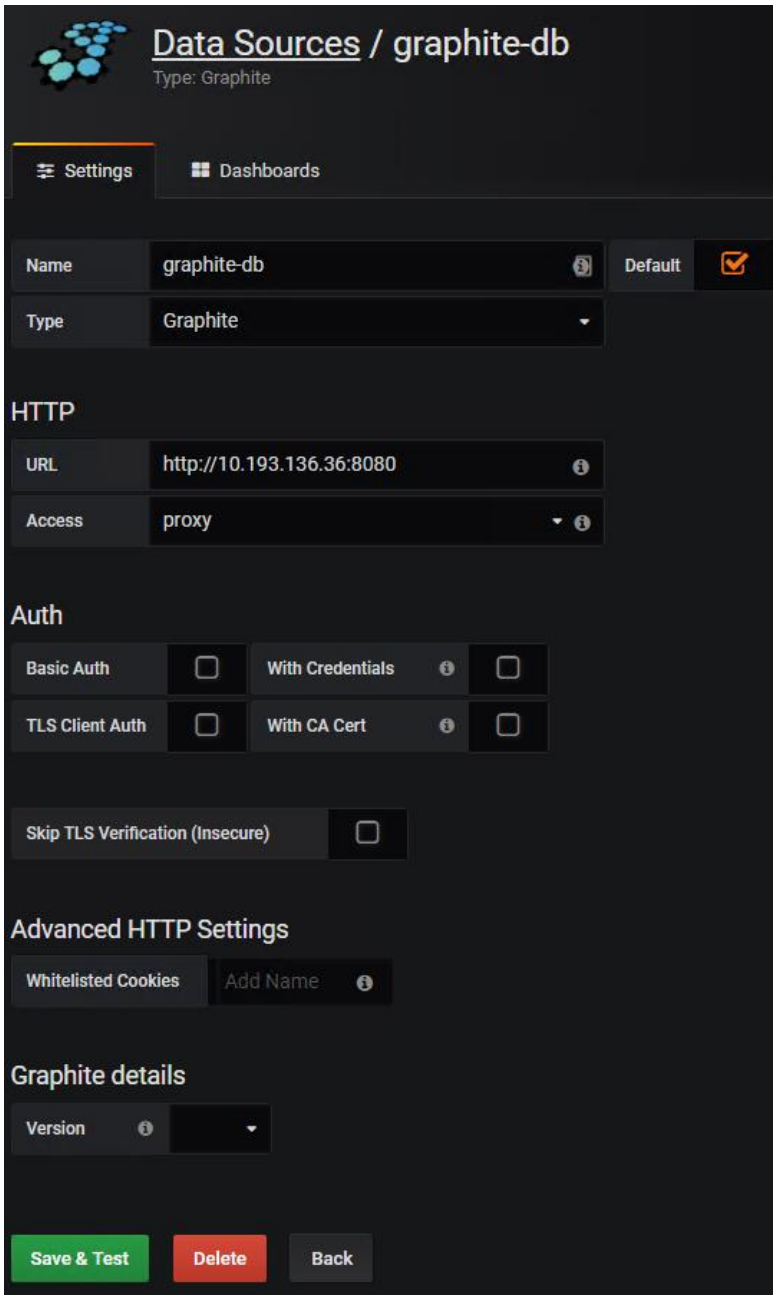
To configure Grafana, complete the following steps:

1. After the Docker Compose process completes, launch a web browser to http://<Docker VM IP Addr>. The Grafana web interface appears. Log in as an admin user and use the password that was configured in the `docker-compose.yml` file.

   Note: If you open the Grafana interface before any metrics have been collected, all dashboards might display "`N/A`" values for all counters. Wait 2 minutes and reload the dashboard, and the issue should resolve itself.

2. Verify that the Graphite data source is automatically provisioned (Figure 5).

Figure 5) Graphite data source.



3. Verify that the dashboards are automatically provisioned and functional. Figure 6 shows a list, and Figure 7 shows an example dashboard.

Figure 6) Grafana dashboards.

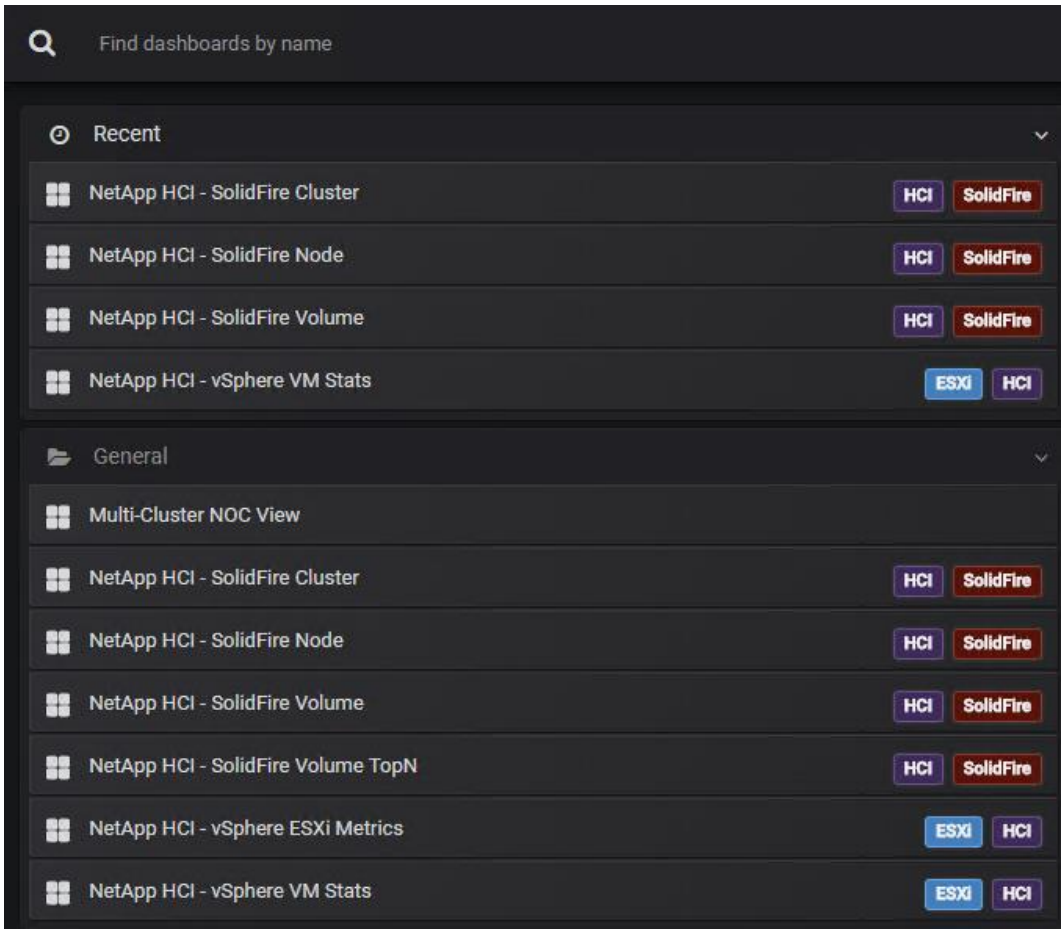
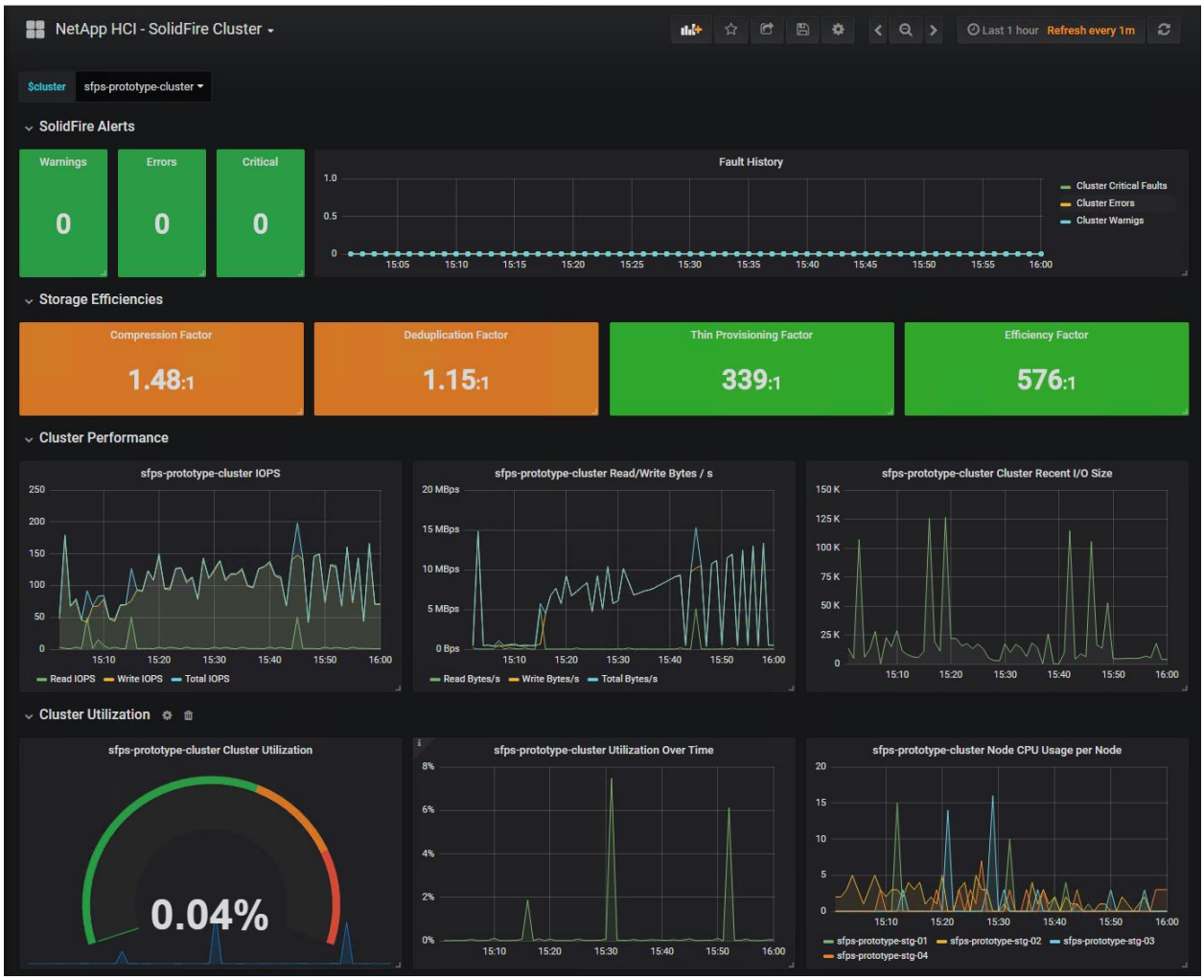


Figure 7) Sample dashboard.



2.5 Graph Conventions That Are Used

The following conventions are used in the system graphs.

- Dashboards expect the host objects (vCenter, ESXi hosts, and so on) to be pulled in by their FQDN. Because Graphite uses "`.`" to delimit metrics, pulling in an IP address breaks the dashboard templating. Alternatively, you can change the dashboard templating to account for IP addresses.
- Null values are shown as `null` for most graphs, enabling you to spot objects that fail to report statistics. Null values are augmented by `keepLastValue`.
- `keepLastValue(5)` continues the line with the last received value when gaps (`null` values) appear in your data, rather than breaking your line. If there are more than five consecutive missed reporting periods, a break shows in the graph. Removing this option shows a graph with breaks for any object that has no statistics for the reporting period (Figure 8). A value of 5 minutes was chosen because that is the break point for evicting a SolidFire node from the storage cluster (Figure 9). Note the difference in the following screenshots.

Figure 8) `keepLastValue` is not set.

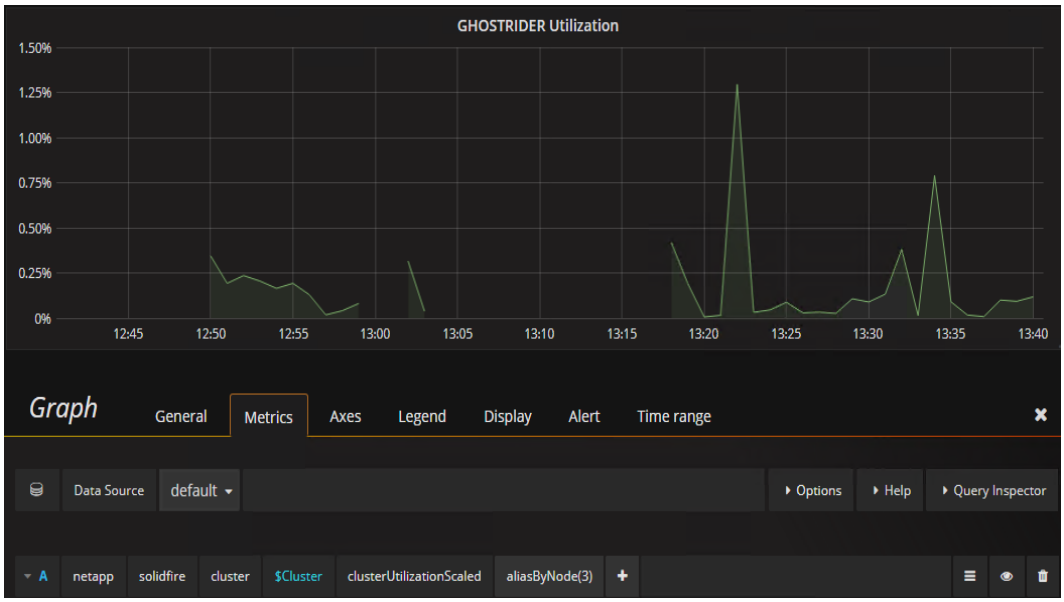
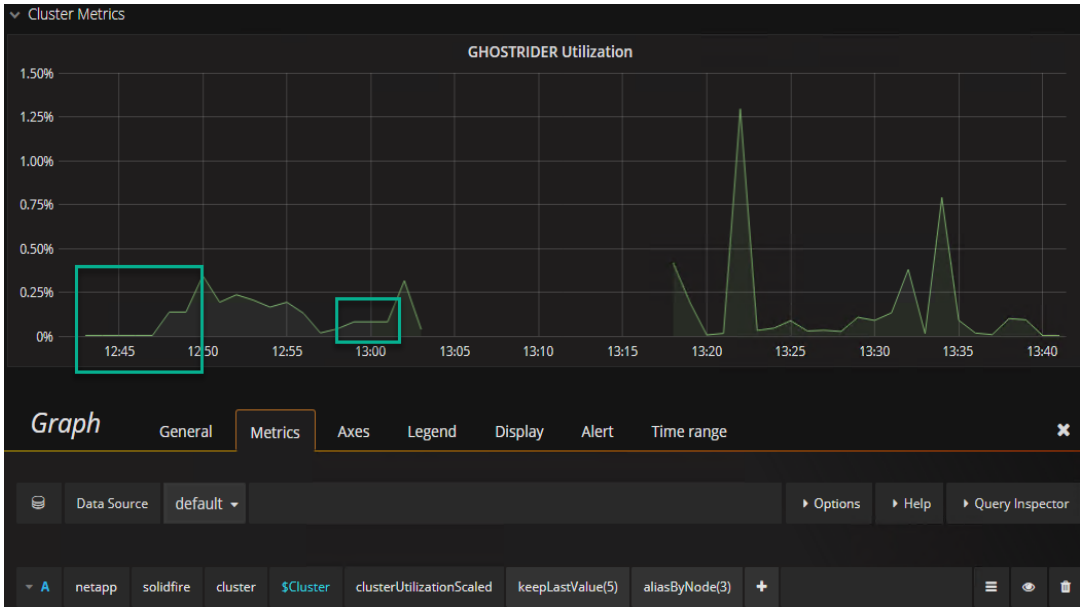


Figure 9) `keepLastValue` is set to 5.



Appendix A: Troubleshooting

This section includes some troubleshooting steps that you can use when you have issues with the configuration of the Docker Collector.

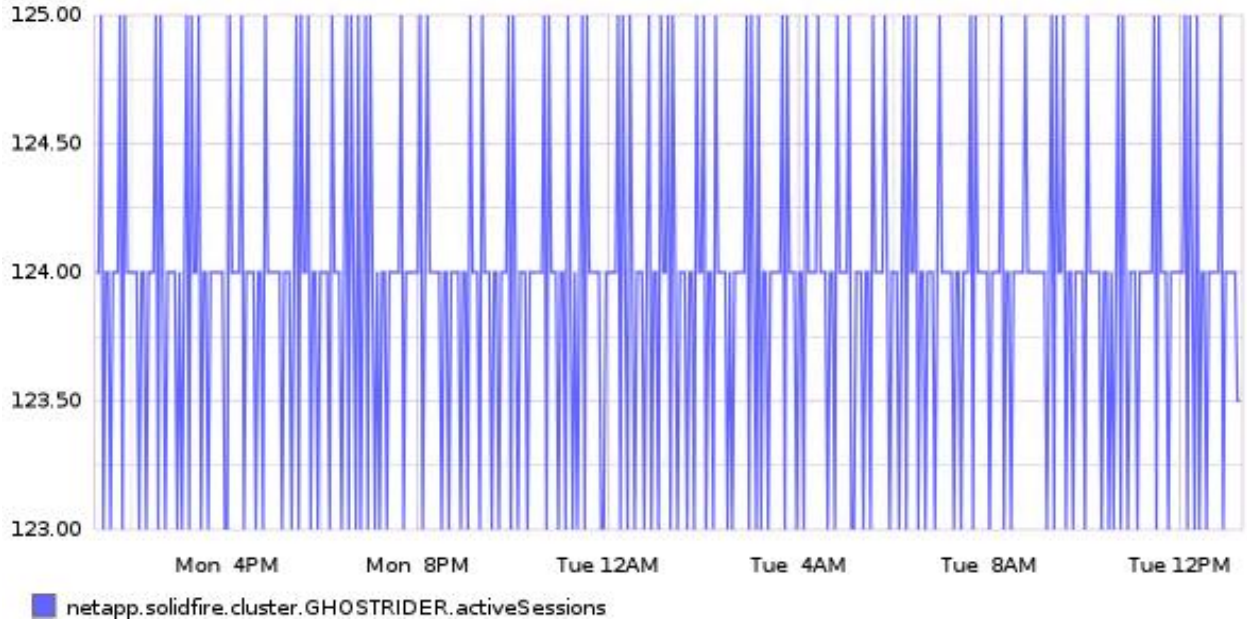
Validating Metrics in the Graphite Database

The Graphite API that was used in this project does not include the graphical front end for Graphite, so the render API for Graphite can be used to verify that metrics are being pushed into the Graphite database. The format for displaying cluster metrics is:
http://<docker VM IP>:8080/render?target=netapp.solidfire.cluster.<cluster name>.<metric>.

For example, to see the cluster `activeSessions`:

http://10.193.136.37:8080/render?target=netapp.solidfire.cluster.GHOSTRIDER.activeSessions

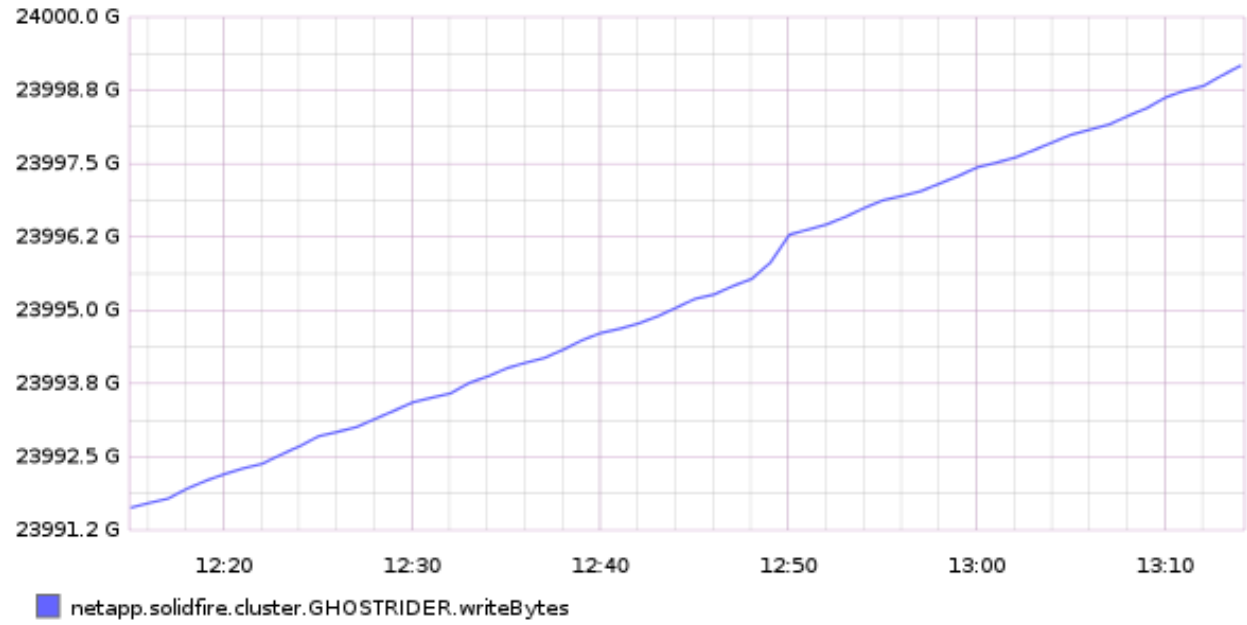
Figure 10) Using the render API for Graphite.



To display only the metrics from the past hour, add the `&from=-<time window>` argument:

http://10.193.136.37:8080/render?target=netapp.solidfire.cluster.GHOSTRIDER.writeBytes&from=-1hour

Figure 11) Viewing statistics from the past hour.



Checking Collector Logs

If you have to connect to the SFCollector to troubleshoot, you must override the `entrypoint` for the container.

```
docker run --entrypoint "/bin/bash" -it sfcollector-v.6
```

The logs for the collector are stored in the `/tmp` directory of the container.

Rebuilding a Container

If you need to change a single container in the Docker Compose setup (for instance, to change the collector wrapper script), you can make that change without taking down all the containers.

```
#List the services
root@hci-grafana01:/opt/github/hcicollector# docker-compose config --services
graphite
grafana
sfcollector
vmwcollector

#Stop the service
docker-compose stop sfcollector #this is the service name
<make changes>

#Start the service
docker-compose up -d --no-deps --build sfcollector
```

Removing Stale Metrics

If the Whisper database has stale metrics, you must remove the corresponding metric files from the Graphite container persistent storage. You can remove them either from the perspective of the container (method 1) or from the Docker host (method 2).

For example, to remove all the metrics for the `ultron` cluster from Graphite, use one of the following procedures.

Method 1: From the Container Perspective

```
#Using Trident - Deleting stale stats from the container's perspective
#Stop the sfcollector container
root@vmgrafana01-0:/opt/github/hcicollector/# docker-compose down graphite
Stopping graphite-v.6 ... done
Removing graphite-v.6 ... done

#Start the graphite container interactively with persistent storage
docker run --rm -it --entrypoint "/bin/bash" --volume graphite-db:/opt/graphite/storage/whisper
graphite-v.6

#Remove old stats for the ultron cluster
root@ed7dbf28f424:/# ls /opt/graphite/storage/whisper/netapp/solidfire/cluster/
ultron  wolverine

root@ed7dbf28f424:/# rm -rf /opt/graphite/storage/whisper/netapp/solidfire/cluster/ultron
```

Method 2: From the Docker Host Perspective

```
#Using Trident - Deleting stats from the Docker host's perspective
root@vmgrafana01-0:/opt/github/hcicollector/collector# docker-compose down graphite
Stopping graphite-v.6  ... done
Removing graphite-v.6  ... done

#Find the "Id" of the Trident plugin
root@sfps-grafana01:/opt/github/hcicollector# docker plugin list
ID                  NAME                DESCRIPTION                               ENABLED
```

```
047ac2d0663f        netapp:latest       Trident - NetApp Docker Volume Plugin   true

root@sfps-grafana01:/opt/github/hcicollector# docker plugin inspect 047ac2d0663f | grep Id
        "Id": "047ac2d0663f75405b42cb0343ab60ef92da3af8d13c9af751f0a1a1ada0bdec",

#variable for long pathname
graphitedb=/var/lib/docker/plugins/047ac2d0663f75405b42cb0343ab60ef92da3af8d13c9af751f0a1a1ada0bd
ec/rootfs/var/lib/docker-volumes/netapp/graphite-db/

#Navigate to the file system location
root@sfps-grafana01:/opt/github/hcicollector# cd $graphitedb

#Remove the old stats (old ESXi servers in ./vsphere/sfps-vcsa/hostsystem)
root@sfps-
grafana01:/var/lib/docker/plugins/047ac2d0663f75405b42cb0343ab60ef92da3af8d13c9af751f0a1a1ada0bde
c/rootfs/var/lib/docker-volumes/netapp/graphite-db/vsphere/sfps-vcsa/hostsystem# ls
sfps-cmp-12  sfps-cmp-13  sfps-cmp-14  solutions-infra-esxi01-mgt1  solutions-infra-esxi02-mgt1
solutions-infra-esxi03-mgt1

root@sfps-
grafana01:/var/lib/docker/plugins/047ac2d0663f75405b42cb0343ab60ef92da3af8d13c9af751f0a1a1ada0bde
c/rootfs/var/lib/docker-volumes/netapp/graphite-db/vsphere/sfps-vcsa/hostsystem# rm -rf
solutions*
root@sfps-
grafana01:/var/lib/docker/plugins/047ac2d0663f75405b42cb0343ab60ef92da3af8d13c9af751f0a1a1ada0bde
c/rootfs/var/lib/docker-volumes/netapp/graphite-db/vsphere/sfps-vcsa/hostsystem# ls
sfps-cmp-12  sfps-cmp-13  sfps-cmp-14
```

Automatically Purging Stale Data

To automate the removal of stale data from the Graphite database, you can use a cron job to run a cleanup script at a set period. The following example runs every day and removes metrics that are over 30 days old that have not had an update:

```
#Add the following cron job (crontab -e)
@daily /root/graphite-whisper-cleanup.sh
```

The contents of the `graphite-whisper-cleanup.sh` script are as follows:

```
root@sfps-grafana01:~# cat graphite-whisper-cleanup.sh
#variable for long pathname
graphitedb=/var/lib/docker/plugins/50cf6ba66948f4c7e329be406d070c25e2bee103b49f36382e768848e807c8
a1/rootfs/var/lib/docker-volumes/netapp/graphite-db/

# how much space to reclaim if we delete files not updated in last 30 days?
# find $graphitedb -name "*wsp" -mtime +30 -exec echo -n -e {}"\0" \; | du -hc --files0-from=-

# delete the files!
find $graphitedb -type f -mtime +30 -name "*wsp" -exec rm '{}' \;

# delete empty directories
find $graphitedb -type d -empty -delete
```

The variable for `graphitedb` needs to be changed for your environment. The path should be structured as `/var/lib/docker/plugins/<Trident ID>/rootfs/var/lib/docker-volumes/netapp/graphite-db/`.

You can find the Trident ID by running the following `find` command:

```
root@sfps-grafana01:~# docker plugin list
ID                  NAME                DESCRIPTION                              ENABLED
5d2382b6be6a        netapp:latest       Trident - NetApp Docker Volume Plugin   true

root@sfps-grafana01:~# docker plugin inspect 5d2382b6be6a | grep Id
        "Id": "5d2382b6be6ad67fb873ae6f02b9af042ff32029b3b4dfd176eecbb5b8e3af40",
```

Appendix B: SFCollector Statistics

Table 1 lists the (potentially non-exhaustive) statistics that SFCollector uses.

Table 1) SFCollector statistics.

API	Statistic Name	Description	Calc.	Type	Ver.
clusterStats	actualIOPS	Current actual IOPS for the entire cluster in the last 500ms	Point in time	Integer	9,10
	clientQueueDepth	Number of outstanding read and write operations to the cluster	N/A	Integer	9,10
	clusterUtilization	Cluster capacity being utilized	N/A	Float	9,10
	latencyUSec	Average time, in microseconds, to complete operations to a cluster in the last 500ms	Point in time	Integer	9,10
	normalizedIOPS	Average number of IOPS for the entire cluster in the last 500ms	Point in time	Integer	10
	readBytes	Total cumulative bytes read from the cluster since the creation of the cluster	Monotonic	Integer	9,10
	readBytesLastSample	Total number of bytes read from the cluster during the last sample period	Point in time	Integer	9,10
	readLatencyUSec	Average time, in microseconds, to complete read operations to the cluster in the last 500ms	Point in time	Integer	9,10
	readOps	Total cumulative read operations to the cluster since the creation of the cluster	Monotonic	Integer	9,10
	readOpsLastSample	Total number of read operations during the last sample period	Point in time	Integer	9,10
	unalignedReads	Total cumulative unaligned read operations to a cluster since the creation of the cluster	Monotonic	Integer	9,10

API	Statistic Name	Description	Calc.	Type	Ver.
	unalignedWrites	Total cumulative unaligned write operations to a cluster since the creation of the cluster	Monotonic	Integer	9,10
	writeLatencyUSec	Average time, in microseconds, to complete write operations to the cluster in the last 500ms	Point in time	Integer	9,10
	writeOps	Total cumulative write operations to the cluster since the creation of the cluster	Monotonic	Integer	9,10
	writeOpsLastSample	Total number of write operations during the last sample period	Point in time	Integer	9,10
	writeBytes	Total cumulative bytes written to the cluster since the creation of the cluster	Monotonic	Integer	9,10
	writeBytesLastSample	Total number of bytes write from the cluster during the previous sample period	Point in time	Integer	9,10
clusterCapacity	activeBlockSpace	Amount of space on the block drives, and including additional information such as metadata entries and space that can be cleaned up	N/A	Integer	9,10
	activeSessions	Number of active iSCSI sessions	N/A	Integer	9,10
	averageIOPS	Average IOPS for the cluster since midnight UTC	N/A	Integer	9,10
	ClusterRecentIOSize	Average size of IOPS to all volumes in the cluster	N/A	Integer	9,10
	currentIOPS	Average IOPS for all volumes in the cluster over the last five seconds	N/A	Integer	9,10
	maxIOPS	Estimated maximum IOPS capability of the current cluster	N/A	Integer	9,10

API	Statistic Name	Description	Calc.	Type	Ver.
	`maxOverProvisionableSpace`	Maximum amount of provisionable space	N/A	Integer	9,10
	`maxProvisionedSpace`	Total amount of provisionable space if all volumes are filled to 100%	N/A	Integer	9,10
	`maxUsedMetadataSpace`	Number of bytes on volume drives that are used to store metadata	N/A	Integer	9,10
	`maxUsedSpace`	Total amount of space on all active block drives	N/A	Integer	9,10
	`nonZeroBlock`	Total number of 4KiB blocks that contain data after the last garbage collection	N/A	Integer	9,10
	`peakActiveSessions`	Peak number of iSCSI connections since midnight UTC	N/A	Integer	9,10
	`peakIOPS`	Highest value for `currentIOPS` since midnight UTC	N/A	Integer	9,10
	`provisionedSpace`	Total amount of space that is provisioned in all volumes on the cluster	N/A	Integer	9,10
	`totalOps`	Total number of I/O operations that are performed throughout the lifetime of the cluster	N/A	Integer	9,10
	`uniqueBlocks`	Total number of blocks that are stored on the block drives, including replicated blocks	N/A	Integer	9,10
	`uniqueBlocksUsedSpace`	Total amount of data that the `uniqueBlocks` take up on the block drives	N/A	Integer	9,10
	`usedMetadataSpace`	Total number of bytes on volume drives that are used to store metadata	N/A	Integer	9,10
	`usedMetadataSpaceInSnapshots`	Number of bytes on volumes drives that are used for storing unique data in snapshots; provides an estimate of how much metadata	N/A	Integer	9,10

API	Statistic Name	Description	Calc.	Type	Ver.
		space would be regained by deleting all snapshots on the system			
	usedSpace	Total amount of space that is used by all block drives in the system	N/A	Integer	9,10
	zeroBlocks	Total number of empty 4KiB blocks without data after the last round of garbage collection.	N/A	Integer	9,10
nodeStats	cpu	CPU usage in percent (%)	N/A	Integer	9,10
	cBytesIn	Bytes in on the cluster interface	N/A	Integer	9,10
	cBytesOut	Bytes out on the cluster interface	N/A	Integer	9,10
	sBytesIn	Bytes in on the storage interface	N/A	Integer	9,10
	sBytesOut	Bytes out on the storage interface	N/A	Integer	9,10
	mBytesIn	Bytes in on the management interface	N/A	Integer	9,10
	mBytesOut	Bytes out on the management interface	N/A	Integer	9,10
	networkUtilizationCluster	Network interface utilization (%) for the cluster network interface	N/A	Integer	9,10
	networkUtilizationStorage	Network interface utilization (%) for the storage network interface	N/A	Integer	9,10
	readOps	Monotonically increasing value of the total read operations to a node	N/A	Integer	10
	usedMemory	Total usage in bytes	N/A	Integer	9,10
	writeOps	Monotonically increasing value of the total write operations to a node	N/A	Integer	10
volumeStats	accountID	ID of the account of the volume owner	N/A	Integer	9,10

API	Statistic Name	Description	Calc.	Type	Ver.
	`actualIOPS`	Current actual IOPS to the volume in the last 500ms	Point in time	Integer	9,10
	`averageIOPSize`	Average size in bytes of the recent I/O to the volume in the last 500ms	Point in time	Integer	9,10
	`burstIOPSCredit`	Total number of IOPS credits available	N/A	Integer	9,10
	`clientQueueDepth`	Number of outstanding read and write operations to the volume	N/A	Integer	9,10
	`latencyUSec`	Average time, in microseconds, to complete operations to the volume in the last 500ms	Point in time	Integer	9,10
	`readBytes`	Total cumulative bytes read from the volume since the creation of the volume	Monotonic	Integer	9,10
	`readBytesLastSample`	Total number of bytes read from the volume during the last sample period	Point in time	Integer	9,10
	`readLatencyUSec`	Average time, in microseconds, to complete read operations to the volume in the last 500ms.	Point in time	Integer	9,10
	`readOps`	Total cumulative read operations to the volume since the creation of the volume	Monotonic	Integer	9,10
	`readOpsLastSample`	Total number of read operations during the last sample period.	Point in time	Integer	9,10
	`throttle`	A floating value between 0 and 1 that represents how much the system is throttling clients below their `maxIOPS` due to replication of data, transient errors, and snapshots created	N/A	Float	9,10

API	Statistic Name	Description	Calc.	Type	Ver.
	unalignedReads	Total cumulative unaligned read operations to a volume since the creation of the volume	Monotonic	Integer	9,10
	unalignedWrites	Total cumulative unaligned write operations to a volume since the creation of the volume	Monotonic	Integer	9,10
	volumeUtilization	Floating value that describes how much the client is using the volume: 0 = the client is not using the volume; 1 = the client is using their maximum IOPS; >1 = the client is using their burst IOPS	N/A	Float	9,10
	writeLatencyUSec	Average time, in microseconds, to complete write operations to the volume in the last 500ms	Point in time	Integer	9,10
	writeOps	Total cumulative write operations to the volume since the creation of the volume	Monotonic	Integer	9,10
	writeOpsLastSample	Total number of write operations during the last sample period	Point in time	Integer	9,10
	writeBytes	Total cumulative bytes write from the volume since the creation of the volume	Monotonic	Integer	9,10
	writeBytesLastSample	Total number of bytes write from the volume during the last sample period	Point in time	Integer	9,10
	zeroBlocks	Total number of empty 4KiB blocks without data after the last round of garbage collection.	N/A	Integer	9,10

Where to Find Additional Information

To learn more about the information that is described in this document, see the following documents or websites:

- Updates to the HCICollector can be found at https://github.com/jedimt/hcicollector
- This blog has some excellent troubleshooting steps for a Graphite + Grafana configuration: http://dieter.plaetinck.be/post/25-graphite-grafana-statsd-gotchas
- How to install Docker https://docs.docker.com/engine/installation/linux/ubuntu
- Trident quick start https://netapp-trident.readthedocs.io/en/stable-v18.04/docker/index.html
- Composing a Graphite server with Docker https://thepracticalsysadmin.com/composing-a-graphite-server-with-docker/
- SolidFire Collector for Graphite https://github.com/cbiebers/solidfire-graphite-collector
- vSphere Graphite collector https://github.com/cblomart/vsphere-graphite
- VMware Software Development Kit—PerformanceManager http://pubs.vmware.com/vsphere-6-5/topic/com.vmware.wssdk.apiref.doc/vim.PerformanceManager.html
- NetApp Product Documentation https://www.netapp.com/us/documentation/index.aspx

Version History

Version	Date	Document Version History
Version 1.0	May 2018	Initial release

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.