CUMULUS

Cumulus NetQ 1.2.1

User Guide

Table of Contents

Introducing Cumulus NetQ

Cumulus NetQ is a fabric-wide, telemetry-based validation system, that enables organizations to validate network state, both during regular operations and for post-mortem diagnostic analysis. Running on Cumulus Linux switches and other certified systems — such as Ubuntu, Red Hat, and CentOS hosts — NetQ captures network data and other state information in real time, allowing cloud architects and network operations teams to operate with visibility over the entire network.

The system uses a three-pronged approach to validating networks:

- **Preventative**

  NetQ easily validates potential network configuration changes in a virtualized environment or lab using check, show and trace algorithms, eliminating the need to check nodes one by one and reducing manual errors before they are rolled into production (one of the main causes of network downtime).

- **Proactive**

  NetQ detects faulty network states that can result in packet loss or connectivity issues, and alerts the user with precise fault location data to allow for faster remediation, greatly improving network agility, and reducing downtime costs.

- **Diagnostic**

  NetQ provides the ability to trace network paths, replay the network state at a time in the past, review fabric-wide event changelogs and diagnose the root cause of state deviations.

This documentation is current as of March 28, 2018 for version 1.2.1. Please visit the Cumulus Networks Web site for the most up to date documentation.

Read the release notes for new features and known issues in this release.

What's New in Cumulus NetQ 1.2.1

Cumulus NetQ 1.2.1 includes updates required for compatibility with Cumulus Linux 3.5.0.

Compatibility with Cumulus Linux

Cumulus NetQ 1.2.1 is compatible with Cumulus Linux versions 3.3.0 through 3.5.z.

What's New in NetQ 1.2.0

NetQ 1.2.0 includes the following new features and enhancements:

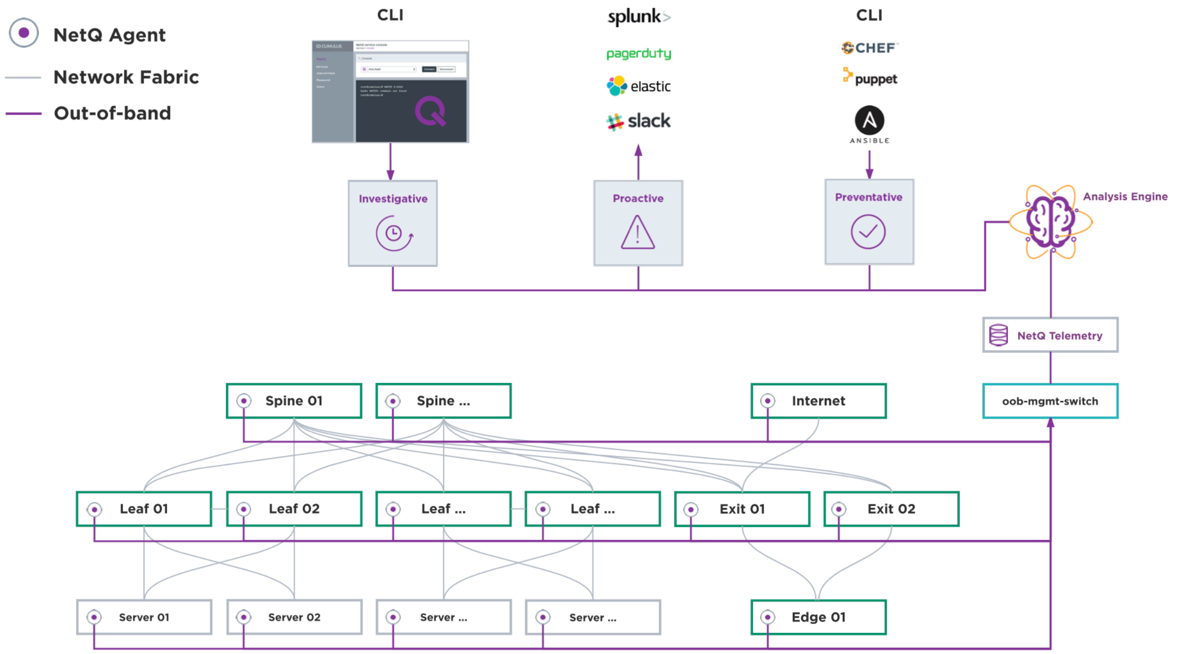
- High availability (see page 25): Configure the NetQ telemetry server in high availability mode for redundancy and better robustness.

NetQ 1.2.0 includes early access support for the following:

- NetQ Query Language (see page 104) (NetQL): Search for even more NetQ data using the SQL-like NetQ Query Language (NetQL). Run your own custom analyses or simply extend NetQ functionality for your specific environment.
- Collecting interface statistics (see page 112): NetQ now provides the ability to collect counters for network interfaces.

For further information regarding bug fixes and known issues present in this release, refer to the release notes.

NetQ Components



NetQ comprises the following components:

- NetQ Agent
- NetQ Telemetry Server
- NetQ Analysis Engine
- NetQ Service Console

Each is described below.

NetQ Agent

The back-end Python agent installed on every monitored *node* in the network — including Cumulus Linux switches, Linux bare-metal hosts and virtual machines, or Docker containers. The agent pushes out data to the NetQ Telemetry Server periodically, and when specific `netlink` events occur. The agent monitors the following objects via `netlink`:

- interfaces
- address (IPv4 and IPv6)
- route (IPv4 and IPv6)
- link
- bridge fdb
- IP neighbor (IPv4 and IPv6)

Further, every 15 seconds, it gathers data for the following protocols:

- Bridging protocols (LLDP, STP, MLAG)
- Routing protocols (BGP, OSPF)
- Network virtualization (LNV, VXLAN data plane)
- Docker containers

It also listens to the Docker event stream to monitor Docker containers running on a host and gathers container networking information such as NAT translations, networks and container IP and MAC addresses.

NetQ Telemetry Server

The database/key-value store where all network information sent from NetQ Agents running on the network is collected, aggregated and queried from.

NetQ Analysis Engine

The NetQ Analysis Engine is the backend engine utilized when querying NetQ via the CLI, service console, or notifier. The engine has two parts:

- The **NetQ Agent Command Line Interface**. The NetQ CLI can be used on every node and can be used on the NetQ Telemetry Server through `netq-shell`.

  > ⚠ The NetQ command line interface runs on x86 and ARM switches and hosts only.

- The **NetQ Notifier**. The notifier runs on the telemetry server. It responds to events pushed by the NetQ Agent, sending alerts to a configured channel, such as Slack, PagerDuty or `syslog`.

NetQ Service Console

The Service Console (see page 44) provides a browser-based window for accessing the NetQ CLI from anywhere.

Getting Started with NetQ

NetQ is comprised of two main install components: the NetQ Telemetry Server, and the `cumulus-netq` metapackage which gets installed on Cumulus Linux switches. Additionally, for host network visibility and containers, you can install host OS-specific metapackages.

This section walks through the basic install and setup steps for installing and running NetQ on the following supported operating systems:

- Cumulus Linux
- Ubuntu 16.04
- Red Hat Enterprise Linux 7
- CentOS 7

✓ Before you get started, you should review the release notes for this version.

Contents

This chapter covers ...

Install the NetQ Telemetry Server

The NetQ Telemetry Server comprises a set of individual Docker containers for each of the various server components that are used by NetQ, for the NetQ CLI used by the service console, and for the service console (see page 44) itself.

It is available in one of two formats:

- VMware ESXi 6.5 virtual machine
- A QCOW/KVM image for use on Ubuntu 16.04 and Red Hat Enterprise Linux 7 hosts

⚠ Cumulus Networks recommends you install the telemetry server on an out-of-band management network to ensure it can monitor in-band network issues without being affected itself. Ideally, you should run the telemetry server on a separate, powerful server for maximum usability and performance. For more information on system requirements, read this chapter (see page 82).

⚠ The NetQ telemetry server containers are completely separate from any containers you may have on the hosts you are monitoring with NetQ. The NetQ containers will not overwrite the host containers and vice versa.

1. Download the NetQ Telemetry Server virtual machine. On the Downloads page, select *NetQ* from the **Product** menu, then click **Download** for the appropriate hypervisor — KVM or VMware.
2. Import the virtual machine into your KVM or VMware hypervisor.
3. Start the NetQ Telemetry Server. There are two default user accounts you can use to log in:
    - The primary username is *admin*, and the default password is *CumulusNetQ!*.
    - The alternate username is *cumulus*, and its password is *CumulusLinux!*.

Once the NetQ Telemetry Server is installed, if you're interested using the telemetry server in high availability (HA) mode, please read the HA mode chapter (see page 25) to learn how to configure the telemetry server instances. For both HA and standalone modes, you need to configure NetQ Notifier.

In addition, if you intend to use NetQ with applications like PagerDuty or Slack, you need to configure those applications to receive notifications from NetQ Notifier.

Note the external IP address of the host where the telemetry server is running, as you need this to correctly configure the NetQ Agent on every node you want to monitor. The telemetry server gets its IP address from DHCP; to get the IP address, run `ifconfig eth0` on the telemetry server.

For HA mode, you need to note the IP addresses of all three instances of the telemetry server.

If you need the telemetry server to have a static IP address, manually assign one:

1. Edit the `/etc/network/interfaces` file:

   ```
   root@ts1:~# vi /etc/network/interfaces
   ```

2. Add the `address` and `gateway` lines to the eth0 configuration, specifying the telemetry server's IP address and the IP address of the gateway:

   ```
   auto eth0
   iface eth0
       address 198.51.100.10
       gateway 198.51.100.1
   ```

3. Save the file and exit.

Install the NetQ Agent

To manage a node with NetQ Agent and send notifications with NetQ Notifier, you need to install an OS-specific metapackage on each node. The node can be a:

- Cumulus Linux switch running version 3.3.0 or later
- Server running Red Hat RHEL 7.1, Ubuntu 16.04 or CentOS 7
- Linux virtual machine running one of the above Linux operating systems

The metapackage contains the NetQ Agent, the NetQ command line interface and the NetQ library, which contains a set of modules used by both the agent and the CLI.

Install the metapackage on each node to monitor, then configure the NetQ Agent on the node.

If your network uses a proxy server for external connections, you should configure a global proxy so `apt-get` can access the metapackage on the Cumulus Networks repository.

Installing on a Cumulus Linux Switch

1. Edit `/etc/apt/sources.list` and add the following line:

   ```
   cumulus@switch:~$ sudo nano /etc/apt/sources.list
   deb http://apps3.cumulusnetworks.com/repos/deb CumulusLinux-3
   netq-latest
   ```

2. Update the local `apt` repository, then install the metapackage on the switch:

   ```
   cumulus@switch:~$ sudo apt-get update && sudo apt-get install
   cumulus-netq
   ```

Installing on an Ubuntu, Red Hat or CentOS Server

To install NetQ on Linux servers running Ubuntu, Red Hat or CentOS, please read the Host Pack documentation.

Configuring the NetQ Agent on a Node

Once you install the NetQ packages and configure the NetQ Telemetry Server, you need to configure NetQ on each Cumulus Linux switch to monitor that node on your network.

1. To ensure useful output, ensure that NTP is running.
2. On the host, after you install the NetQ metapackage, restart `rsyslog` so logs are sent to the correct destination:

   ```
   cumulus@switch:~$ sudo systemctl restart rsyslog
   ```

3. Link the host to the telemetry server you configured above; in the following example, the IP address for the telemetry server host is *198.51.100.10*:

   ```
   cumulus@switch:~$ netq config add server 198.51.100.10
   ```

   This command updated the configuration in the `/etc/netq/netq.yml` file. It also enables the NetQ CLI.

4. Restart the `netq` agent.

```
cumulus@switch:~$ netq config restart agent
```

> ⚠ After starting or restarting the agent, verify that the agent can reach the server by running the following command:
>
> ```
> cumulus@switch:~$ netq config show server
>
> Server          Port    Vrf    Status
> -------------   ------  -----  --------
> 198.51.100.10   6379    mgmt   ok
> ```

Configuring the Agent to Use a VRF

If you want the NetQ Agent to communicate with the telemetry server only via a VRF, including a management VRF, you need to specify the VRF name when configuring the NetQ Agent. For example, if the management VRF is configured and you want the agent to communicate with the telemetry server over it, configure the agent like this:

```
cumulus@switch:~$ netq config add server 198.51.100.10 vrf mgmt
```

You then restart the agent as described in the previous section:

```
cumulus@switch:~$ netq config restart agent
```

Configuring the Agent to Communicate over a Specific Port

By default, NetQ uses port 6379 for communication between the telemetry server and NetQ Agents. If you want the NetQ Agent to communicate with the telemetry server via a different port, you need to specify the port number when configuring the NetQ Agent like this:

```
cumulus@switch:~$ netq config add server 198.51.100.10 port 7379
```

> ✓ If you are using NetQ in high availability mode (see page 25), you can only configure it on port 6379 or 26379.

Removing or Decommissioning an Agent from a Node

You can decommission a NetQ agent on a given node. You may need to do this when you

- RMA the switch or host being monitored
- Change the hostname of the switch or host being monitored
- You move the switch or host being monitored from one data center to another

Early Access Feature

Decommissioning a NetQ Agent is an early access feature in Cumulus NetQ 1.2.

Decommissioning the node removes the agent from the NetQ database. However, the history for this node is preserved in case you need to go back in time to perform a diagnostic investigation.

To decommission the NetQ agent on a node, do the following steps:

1. Enable the EA features:

```
cumulus@switch:~$ netq config add experimental
```

2. Decommission the agent on the hostname specified by *[hostname]*:

```
cumulus@switch:~$ netq decommission [hostname] purge
```

3. Then restart the agent for the change to take effect:

```
cumulus@switch:~$ netq config restart agent
```

Configuring Debug Logging for the NetQ Agent

In order to debug the NetQ Agent, you need to enable debug-level logging:

1. Edit the `/etc/netq/netq.yml` file and add a log_level section for the NetQ Agent:

```
netq-agent:
  log_level: debug
```

2. Restart the NetQ Agent:

```
cumulus@switch:~$ netq config restart agent
```

Configuring NetQ Notifier on the Telemetry Server

NetQ Notifier listens to events from the telemetry server database. When NetQ Notifier is running on the NetQ Telemetry Server, it sends out alerts. NetQ Notifier runs in the NetQ Telemetry Server virtual machine only; the NetQ Agents on the nodes only communicate with it. If the telemetry server is being run in HA mode (see page 25), then the Notifier only runs on the telemetry server that is the master, and the Notifier on the master telemetry server is the only one to accept messages to publish.

NetQ Notifier runs exclusively in a virtual machine; its configuration is stored in the `/etc/netq/netq.yml` file and you control it using `systemd` commands (such as `systemctl stop|start netq-notifier`). The `netq.yml` file also contains the configuration for the NetQ CLI running in the VM.

You need to configure two things for NetQ Notifier:

- The events for which you want to receive notifications/alerts, like sensors or BGP session notifications.
- The integrations for where to send those notifications; by default, they are `rsyslog`, PagerDuty and Slack.

NetQ Notifier sends out alerts based on the configured log level, which is one of the following:

- debug: Used for debugging-related messages.
- info: Used for informational, high-volume messages.
- warning: Used for warning conditions.
- error: Used for error conditions.

The default log level setting is *info*, so NetQ Notifier sends out alerts for info, warning and error conditions.

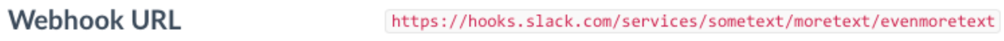
By default, all notifications/alerts are enabled, and logged in `/var/log/netq-notifier.log`. You only need to edit the notifications if there is something you don't want to monitor.

NetQ Notifier is already integrated with `rsyslog`. To integrate with PagerDuty or Slack, you need to specify some parameters.

To configure alerts and integrations on the NetQ Telemetry Server:

1. As the sudo user, open `/etc/netq/netq.yml` in a text editor.

2. Configure the following in the `/etc/netq/netq.yml` file:
    - Change the log level: If you want a more restrictive level than info.
    - Configure application notifications: To customize any notifications, uncomment the relevant section under **netq-notifier Configurations** and make changes accordingly.
    - Configure PagerDuty and Slack integrations. You can see where to input the information for these integrations in the example `netq.yml` file (see page 19) below.
        - For PagerDuty, enter the API access key (also called the authorization token) and the integration key (also called the service_key or routing_key).
        - For Slack, enter the webhook URL. To get the webhook URL, in the Slack dropdown menu, click **Apps & integrations**, then click **Manage** > **Custom Integrations** > **Incoming WebHooks** > select **Add Configuration** > select the channel to receive the notifications such as *#netq-notifier* in the **Post to Channel** dropdown > then click **Add Incoming WebHook integration**. The URL produced by Slack looks similar to the one pictured below:



Webhook URL `https://hooks.slack.com/services/sometext/moretext/evenmoretext`

Copy the URL from the **Webhook URL** field into the `/etc/netq/netq.yml` file under the **Slack Notifications** section. Uncomment the lines in the sections labeled *netq-notifier*, *notifier-integrations* and *notifier-filters*, then add the webhook URL value provided by Slack:

```
netq-notifier:
  log_level: info

...

notifier-integrations:
  - name: notifier-slack-channel-1
    type: slack
    webhook: "https://hooks.slack.com/services/sometext
/moretext/evenmoretext"
    severity: INFO,
    tag: "@netqts-sys"

...

notifier-filters:
  - name: default
    rule:
    output:
      - ALL
```

When you are finished editing the file, save and close it.

3. Stop then start the NetQ Notifier daemon to apply the new configuration:

```
cumulus@netq-appliance:~$ sudo systemctl restart netq-notifier
```

> ⚠ If your webhook does not immediately send a message to your channel, look for errors in syntax. Check the log file located at `/var/log/netq-notifier.log`.

Example /etc/netq/netq.yml Configuration

The following sample `/etc/netq/netq.yml` file is on the NetQ Telemetry Server itself. Note that the `netq.yml` looks different on a switch or host monitored by NetQ; for example, the backend server IP address and port would be uncommented and listed.

> Editing `/etc/netq/config.d` to configure NetQ Notifier or putting other YML files in the `/etc/netq` directory overrides the configuration in `/etc/netq/netq.yml`.

Example /etc/netq/netq.yml configuration file

```
cumulus@netq-appliance:~$ cat /etc/netq/netq.yml
## Netq configuration File.
## Configuration is also read from files in /etc/netq/config.d/ and
have
## precedence over config in /etc/netq/netq.yml.
## ----- Common configurations -----
## Backend Configuration for all netq agents and apps on this host.
##
#backend:
#  server:
#  port: 6379
## ----- netq-agent configurations -----
## Netq Agent Configuration
##
## log_level: Could be debug, info, warning or error. Default is info.
##
#netq-agent:
#  log_level: info
## Docker Agent Configuration
##
## docker_enable: Enable Docker monitoring. Default is True.
## docker_poll_period: Docker poll period in secs. Default is 15 secs.
##
#docker:
#  enable: true
#  poll_period: 15
## ----- netq configurations -----
## Netq configuration
##
## log_level: Could be debug, info, warning or error. Default is info.
##
#netqd:
#  log_level: info
## ----- netq-notifier configurations -----
## Netq Notifier configuration
##
## log_level: Could be debug, info, warning or error. Default is info.
##
#netq-notifier:
#  log_level: info
## Slack Notifications
##
## NetQ Notifier Filter Configuration
##
## NetQ Notifier sends notifications to integrations(syslog, slack or
pagerduty)
## based on the events that are happening across the network.
## Notifications are generated based on the filters that have been
specified in
## "notifier-filters".  NetQ Agents generate an event when something
interesting
## happens on the host (switch or server) its running on. The
Notifier is always
## listening for these events and once it receives an event, it makes
it go
## through a set of filters.
##
## A filter has 3 stages:
## a) Rule: Defines a set of conditions against which an incoming
event is
## matched. Input to this stage is an incoming event and the event is
sent to
## the next stage if there is a match. If there is a match, the event
## information is passed to the action stage. The rule is a
dictionary of
## key-value pairs, where the "key" is an item associated with the
event and
## "value" is the value of that item,
## e.g. type: Link
##      hostname: leaf-01
##      ifname: swp1
## The Default rule, if none is specified or if it is empty, is to
always assume
## a match.
## Notifier-filter rules are matched sequentially and we stop only
when a match
```

```
## is found. You can make the notifier continue matching filters even
if a match
## is found, by adding "terminate_on_match: False" to the filter.
Values
## specified in the rule are matched with those received in a event
using python
## regular expressions  https://docs.python.org/2/library/re.html
## We can also match for message severity and print messages only if
it is above
## the given severity. Message severity levels are: INFO, WARNING,
ERROR and
## CRITICAL in ascending order.
##
## b) Action: action to perform if the "rule" is matched.  The action
stage
## take the event provided by the "rule" stage and generates a message
## dictionary with a message and its severity. Multiple actions can be
## prescribed in the "action" list. "action" is typically a python
function that
## is provided with the tool or a custom one written by the user. If
no action
## is provided, we default to a generic handler which looks at the
event and
## based on the event runs the relevant notification function.
##
## c) output: This stage takes the message dictionary provided by the
action
## stage and sends the message and severity to the right integration
to display
## the message. If the output is None the message is not sent to any
integration
## or syslog. If output is empty, the message is sent only to syslog.
Else the
## message is sent to the list of integrations specified in the
output list and
## syslog. If ALL is specified, the message is sent to all
integrations.
## Integrations are defined in notifier-integrations.
##
## The config file comes with the following default filter:
##
## notifier-filters:
## - name: default
##   rule:
##   output:
##     - ALL
##
## which is an empty rule, empty action and output to all. This
defaults to
## match all rules and then perform the default action which is to
run the
## generic handler mentioned in the action stage above.
```

```
##
## NetQ Integration Configuration
##
## The integrations refer to the external tool where you would like
to receive
## the notification. An integration is added as a list element to
## "notifier-integrations". Each integration must have a "name" and
"type".
## Severity is optional and lets you send messages above that level
to the
## integration. Allowed values are: INFO, WARNING, ERROR, CRITICAL in
increasing
## order. Currently allowed "type" are "slack" and "pagerduty". You
can define
## multiple slack or PD integrations.
##
##For Slack integration, along with a name and "type: slack", you
also need to
## also provide the Incoming Webhook of the channel. The webhook URL
for your
## channel can be found or created in Slack at:
##   Apps -> Custom Integrations -> Incoming Webhooks.
## Tags are optional and are strings that are attached to the end of
th
## notification message.
## E.g.
# notifier-integrations:
# - name: notifier-slack-channel-1
#   type: slack
#   webhook: "https://<slack-webhook1>"
#   severity: INFO,
#   tag: "@slack-tag1"
##
## For pagerDuty, along with name and "type: pagerduty", you also
need to
## provide the "api_access_key" and "api_integration_key" from
Pagerduty.
## A unique API Access Key which can be created on your PagerDuty
website at:
## Configuration -> API Access -> Create New API Key
## An 'Integration Key' can be created/found on your PagerDuty
website at:
## Configuration -> Services -> Add New Service -> New Integration ->
##   Select Integration Type as 'Use our API directly: Events API v2'.
## E.g. pagerduty integration along with slack
# notifier-integrations:
# - name: notifier-slack-channel-1
#   type: slack
#   webhook: "https://<slack-webhook1>"
#   severity: INFO
#   tag: "@slack-tag1"
# - name: notifier-pagerduty
#   type: pagerduty
#   severity: WARNING
#   api_access_key: <API Key>
#   api_integration_key: <API Integration Key>
##
## Customizing Notifications
## Here are some examples on how to customize your notifications:
##
## a) Filter notifications to integrations (Slack or PD) based on
Severity,
## i.e., WARNING to PD, INFO to Slack
# notifier-integrations:
# - name: notifier-slack-channel-1
#   type: slack
#   webhook: "https://<slack-webhook1"
#   severity: INFO  <==== Set the severity type here
#   tag: "@slack-tag1"
# - name: notifier-pagerduty
#   type: pagerduty
#   severity: WARNING <==== Set the severity type here
#   api_access_key: "<API Key>"
#   api_integration_key: "<API Integration Key>"
#
##
## b) Drop all notifications coming from a switch/host say, leaf-01
# notifier-filters:
# - name: leaf-01 drop
#   rule:
#     hostname: leaf-01
#   output:
#     - None
# - name: default
#   rule:
#   output:
#     - ALL
##
## c) Drop all notifications coming from switches whose name starts
with leaf
# notifier-filters:
# - name: leaf drop
#   rule:
#     hostname: "leaf-.*"
#   output:
#     - None
# - name: default
#   rule:
#   output:
#     - ALL
##
## d) Drop all notifications coming from a particular link, e.g. leaf-
01 swp1
# notifier-filters:
```

```
# - name: leaf-01 swp1 drop
#   rule:
#     type: Link
#     hostname: leaf-01
#     ifname: swp1
#   output:
#     - None
# - name: default
#   rule:
#   output:
#    - ALL
##
## e) Send BGP Session state notifications to particular slack channel
## (slack-channel-BGP), rest to another one (slack-channel-catchall)
# notifier-filters:
# - name: BGP slack channel
#   rule:
#     type: BgpSession
#   output:
#     - slack-channel-BGP
# - name: default
#   rule:
#   output:
#     - slack-channel-catchall
##
## f) Send BgpSession notifications based on severity to different
slack channels
# notifier-filters:
# - name: BGP severity slack channel
#   rule:
#     type: BgpSession
#     severity: WARNING
#   output:
#     - slack-channel-BGP-info
# - name: default
#   rule:
#   output:
#     - slack-channel-catchall
##
## g) Drop all temperature related alerts
# notifier-filters:
# - name: temp drop
#   rule:
#     type: Temp
#   output:
#     - None
# - name: default
#   rule:
#   output:
#     - ALL
notifier-filters:
  - name: default
```

```
    rule:
    output:
      - ALL
```

Configuring High Availability Mode

NetQ supports high availability — that is, the ability to continue functioning even in the absence of a single failure of the telemetry server node. To make the NetQ Telemetry Server highly available (*HA mode*), you need to run three instances of the telemetry server. Currently, exactly three instances are supported in HA mode. Of the three instances, one is considered the *master* and is writeable while the other two are read-only *replicas*. Each server instance is mapped to port 6379 on the host. A Redis *sentinel* on each telemetry server host monitors the health of the database cluster and decides which database is the current master. If the master becomes unavailable, the sentinel promotes one of the replicas to become the new master. Each sentinel runs on port 26379.

HA mode is optional.

To begin using HA mode, install the telemetry server image on three separate physical hosts to form a database cluster. Note the IP address of each instance.

Contents

This chapter covers ...

Enabling HA Mode

To configure the HA cluster, perform the following steps. These steps assume there are three telemetry servers, ts01 (the original one which was already configured (see page 10) as the telemetry server), ts02 and ts03, which are assigned IP addresses 10.0.0.5, 10.0.0.6 and 10.0.0.7, respectively. The servers are all assumed to be up and reachable and can communicate with each other.

⚠ When configuring HA mode, you can only specify the IP addresses for the telemetry servers. You cannot use the DNS names here.

1. On each telemetry server, specify the IP address of the master, then both replicas. Wait at least 30 seconds between each instance of the command.

```
cumulus@ts01:~$ netq config ts add server 10.0.0.5 10.0.0.6
10.0.0.7
```

```
cumulus@ts02:~$ netq config ts add server 10.0.0.5 10.0.0.6
10.0.0.7
```

```
cumulus@ts03:~$ netq config ts add server 10.0.0.5 10.0.0.6
10.0.0.7
```

2. Replicate NetQ Notifier on the replica telemetry servers, then restart the netq-notifier service on the replicas:

```
cumulus@ts02:~$ sudo systemctl restart netq-notifier.service
```

```
cumulus@ts03:~$ sudo systemctl restart netq-notifier.service
```

3. Verify that HA mode is configured on the three telemetry servers. Each server should indicate that ts01 (using IP address 10.0.0.5) is the master.

```
cumulus@ts01:~$ netq config ts show server
Server    Role     Master    Replicas            Status    Last
Changed
--------  -------  --------  ------------------  --------
--------------
10.0.0.5  master   10.0.0.5  10.0.0.7, 10.0.0.6  ok        55s
10.0.0.6  replica  10.0.0.5  -                   ok        55s
10.0.0.7  replica  10.0.0.5  -                   ok        55s
```

```
cumulus@ts02:~$ netq config ts show server
Server    Role     Master    Replicas            Status    Last
Changed
--------  -------  --------  ------------------  --------
--------------
10.0.0.5  master   10.0.0.5  10.0.0.7, 10.0.0.6  ok        55s
10.0.0.6  replica  10.0.0.5  -                   ok        55s
10.0.0.7  replica  10.0.0.5  -                   ok        55s
```

```
cumulus@ts03:~$ netq config ts show server
Server    Role     Master    Replicas            Status    Last
Changed
--------  -------  --------  ------------------  --------
--------------
10.0.0.5  master   10.0.0.5  10.0.0.7, 10.0.0.6  ok        55s
10.0.0.6  replica  10.0.0.5  -                   ok        55s
10.0.0.7  replica  10.0.0.5  -                   ok        55s
```

4. Update the agent on each switch and server node to point to the HA cluster, and restart the NetQ Agent on each node:

```
cumulus@switch:~$ netq config add server 10.0.0.5 10.0.0.6
10.0.0.7
Restarting netqd... Success!
cumulus@switch:~$ netq config restart agent
Restarting netq-agent... Success!
```

Checking HA Mode Status

To check the status of the database cluster, run the following command from a telemetry server:

```
cumulus@ts01:~$ netq config ts show server
```

You can also get the detailed output of a specific server in the cluster by specifying that server's IP address:

```
cumulus@ts01:~$ netq config ts show server 10.0.0.7
```

Restarting HA Mode Services

You can restart the `netq-appliance` and `netq-gui` services using:

```
cumulus@ts01:~$ sudo systemctl restart netq-gui.service
cumulus@ts01:~$ sudo systemctl restart netq-appliance.service
```

Changing the Master Telemetry Server

You can change which telemetry server you want to be the master simply by changing the order in which you specify them with the `netq config ts add server` command. You need to run the following command on each telemetry server, waiting at least 30 seconds in between updating the configuration on each server.

For example, notice that the telemetry server *ts01* is the master in the following configuration:

```
cumulus@ts01:~$ netq config ts show server
Server    Role      Master    Replicas            Status    Last
Changed
--------  -------   --------  ------------------  --------
--------------
10.0.0.5  master    10.0.0.5  10.0.0.6, 10.0.0.7  ok        50s
10.0.0.6  replica   10.0.0.5  -                   ok        50s
10.0.0.7  replica   10.0.0.5  -                   ok        50s
```

To make the first replica the new master, run the following command on each telemetry server (you don't need to change anything on the switch and server nodes):

```
cumulus@ts01:~$ netq config ts add server 10.0.0.6 10.0.0.5 10.0.0.7
```

```
cumulus@ts02:~$ netq config ts add server 10.0.0.6 10.0.0.5 10.0.0.7
```

```
cumulus@ts03:~$ netq config ts add server 10.0.0.6 10.0.0.5 10.0.0.7
```

Verify that *ts02* is the new master:

```
cumulus@ts01:~$ netq config ts show server
Server    Role     Master    Replicas            Status    Last
Changed
--------  -------  --------  ------------------  --------
--------------
10.0.0.5  replica  10.0.0.6  -                   ok        28s
10.0.0.6  master   10.0.0.6  10.0.0.7, 10.0.0.5  ok        28s
10.0.0.7  replica  10.0.0.6  -                   ok        28s
```

Replacing a Replica with a New Server

If you need to replace a telemetry server with a different physical system, do the following steps.

> ⚠ Do not try and replace the master server. You can only replace a replica. If you need to replace the master, make it a replica first, as described above.

Consider the following cluster of telemetry servers:

```
cumulus@ts01:~$ netq config ts show server
Server    Role     Master    Replicas            Status    Last
Changed
--------  -------  --------  ------------------  --------
--------------
10.0.0.5  master   10.0.0.5  10.0.0.6, 10.0.0.7  ok        14m:10s
10.0.0.6  replica  10.0.0.5  -                   ok        14m:10s
10.0.0.7  replica  10.0.0.5  -                   ok        14m:10s
```

10.0.0.5 (ts01) is the master, while 10.0.0.6 (ts02) and 10.0.0.7 (ts03) are the replicas. You want to replace ts03 with ts04 (10.0.0.8):

1. Bring up the new telemetry server (ts04) and make sure the connectivity is okay.
2. Bring down the telemetry server you are replacing (ts03):

   ```
   cumulus@ts03:~$ sudo shutdown
   ```

3. Execute the following NetQ command on every telemetry server to create a cluster with the new telemetry server. Wait at least 30 seconds between each instance of the command.

```
cumulus@ts01:~$ netq config ts add server 10.0.0.5 10.0.0.6
10.0.0.8
```

```
cumulus@ts02:~$ netq config ts add server 10.0.0.5 10.0.0.6
10.0.0.8
```

```
cumulus@ts04:~$ netq config ts add server 10.0.0.5 10.0.0.6
10.0.0.8
```

4. Verify the HA status on one of the telemetry servers. The status should be the same on all the three telemetry servers indicating that ts01 (10.0.0.5) is the master:

```
cumulus@ts01:~$ netq config ts show server
Server    Role     Master    Replicas            Status    Last
Changed
--------  -------  --------  ------------------  --------
--------------
10.0.0.5  master   10.0.0.5  10.0.0.6, 10.0.0.8  ok        5m:10s
10.0.0.6  replica  10.0.0.5  -                   ok        5m:10s
10.0.0.8  replica  10.0.0.5  -                   ok        5m:
10s
```

5. Update the agent on each switch and server node to point to the new HA cluster, and restart the NetQ Agent on each node:

```
cumulus@switch:~$ netq config add server 10.0.0.5 10.0.0.6
10.0.0.8
Restarting netqd... Success!
cumulus@switch:~$ netq config restart agent
Restarting netq-agent... Success!
```

Resetting the Database Cluster

You can force a reset of the Redis HA cluster using:

```
cumulus@netq-ts:~$ netq config ts reset-cluster
```

Troubleshooting HA Mode

Relevant Services and Configuration Files

The following `systemd` services are involved in HA mode:

- cts-auth.service: The telemetry server-side service that manages the configuration.
- cts-auth.socket: The telemetry server-side authorization shim socket for the service console.
- cts-backup.service: Runs a cron job to back up the Redis database.
- cts-backup.timer: The timer for the backup service, with a minimum interval of 5 minutes.
- netqd.service: The service for the telemetry server CLI for use locally on the server.
- netq-appliance.service: Starts and stops all telemetry server services **except** for the `ts-gui` service.
- netq-gui.service: Starts and stops telemetry server `ts-gui` service.
- netq-influxdb.service: The service that manages the HA mode InfluxDB.
- netq-notifier.service: Starts and stops the NetQ Notifier service.

The following configuration files are in the `/etc/cts/run/redis` directory:

- redis_6379.conf: Contains the runtime Redis database configuration and state.
- snt1.conf: Contains the runtime Redis sentinel configuration and state.

The following log file is in the `/var/log` directory:

- netqd.log: The logs associated with running the NetQ CLI locally on the machine.

The NetQ Notifier log is:

- /var/log/netq-###.log

Logging configurations are in:

- /etc/rsyslog.d
- /etc/logrotate.d

The following log files are in the `/var/log/cts` directory:

- cts-backup.log
- cts-docker-compose.log
- cts-dockerd.log
- cts-redis.log
- cts-sentinel.log

For more information about the log files, see the Troubleshooting NetQ (see page 114) chapter.

One Replica Must Be Available Always

While HA mode is enabled, if both the replica servers go down, the master database stops accepting writes. This causes the NetQ agents to go into a rotten state.

This serves to avoid having multiple masters in a split-brain condition. Please refer to the section "Example 2: basic setup with three boxes" on the Redis Sentinel page for more details.

Upgrading NetQ

This section covers the process for upgrading NetQ. The upgrade process involves upgrading each of the various components of NetQ (the NetQ Telemetry Server, and both the host and Cumulus Linux agents), and then connecting the upgraded NetQ Telemetry Server to the network.

> ⓘ Cumulus Networks recommends only upgrading NetQ during a network maintenance window.

> ⓘ Events generated during the upgrade process will not be available in the database. Once the upgrade process is complete, the agents will re-sync with the current state of the Host or Cumulus Linux switch with the Telemetry server.

Before upgrading NetQ, consider the following:

- The minimum supported Cumulus Linux version for NetQ 1.2 is 3.3.2.
- You can upgrade to NetQ 1.2 without upgrading Cumulus Linux.

Contents

This chapter covers ...

Upgrade the NetQ Telemetry Server

> ⚠ To install a new instance of NetQ, refer to the Getting Started with NetQ (see page 10) chapter.

1. Back up the current NetQ Telemetry Server data. For instructions, refer to the NetQ backup (see page 95) chapter.
2. Shut down the connectivity from the agents to the current NetQ Telemetry Server.

   > ⓘ This step is required to ensure agents don't attempt to communicate with the Telemetry Server during the maintenance window.

3. Shut down the current NetQ Telemetry Server.
4. Start the new NetQ Telemetry Server.

5. Restore the data to the new NetQ Telemetry Server. For instructions, refer to the NetQ backup (see page 95) chapter.

   > This step can be skipped, if there is no desire to retain the previous data. NetQ agents will re-populate the current data once they connect to the new NetQ Telemetry Server.

6. Validate that the telemetry server is up and running:

```
cumulus@switch:~$ cat /etc/app-release
APPLIANCE_VERSION=1.2.0
```

> ⚠ Cumulus Networks recommends that the NetQ Agents remain disconnected from the NetQ Telemetry Server until they have been upgraded to the current version of NetQ as well.

Upgrade the NetQ Agents

Follow the steps for the relevant OS below to upgrade the NetQ Agents:

Cumulus Linux

1. Open the `/etc/apt/sources.list` file in a text editor.
2. Add the following line, and save the file:

```
cumulus@switch:~$ deb https://apps3.cumulusnetworks.com/repos
/deb CumulusLinux-3 netq-1.2
```

3. Install the `cumulus-netq` metapack and its components:

```
cumulus@switch:~$ sudo apt-get update && apt-get install cumulus-
netq
```

Ubuntu 16.04

1. Use the `wget` tool to retrieve the public key:

```
root@ubuntu:~# wget -O- https://apps3.cumulusnetworks.com/setup
/cumulus-host-ubuntu.pubkey | apt-key add
```

2. Open the `/etc/apt/sources.list` file in a text editor.

3. Add the following line, and save the file:

```
root@ubuntu:~# deb https://apps3.cumulusnetworks.com/repos/deb
xenial netq-1.2
```

4. Install the `cumulus-netq` metapack and its components:

```
root@ubuntu:~# sudo apt-get update && apt-get install cumulus-
netq
```

When you see the following prompt, type *N* to keep your current version:

```
Configuration file '/etc/netq/netq.yml'
 ==> File on system created by you or by a script.
 ==> File also in package provided by package maintainer.
   What would you like to do about it ?  Your options are:
    Y or I  : install the package maintainer's version
    N or O  : keep your currently-installed version
      D     : show the differences between the versions
      Z     : start a shell to examine the situation
```

Red Hat Enterprise Linux 7 / CentOS 7

If you are upgrading from NetQ 1.1 to 1.2 only, you must remove the Cumulus NetQ packages before installing the new version.

```
root@rhel7:~# yum remove netq-apps netq-agent cumulus-netq
```

To install the NetQ Agent on a Red Hat or CentOS host, do the following:

1. Import the public key:

```
root@rhel7:~# rpm --import https://apps3.cumulusnetworks.com
/setup/cumulus-host-el.pubkey
```

2. Open `/etc/yum.repos.d/cumulus-host-el.repo` in a text editor.

3. Define the repository source, and save the file:

```
[cumulus-arch]
name=Cumulus Packages for RHEL
baseurl=https://apps3.cumulusnetworks.com/repos/rpm/el
/$releasever/netq-1.2/$basearch
gpgcheck=1
enabled=1

[cumulus-noarch]
name=Architecture-independent Cumulus packages for RHEL
baseurl=https://apps3.cumulusnetworks.com/repos/rpm/el
/$releasever/netq-1.2/noarch
gpgcheck=1
enabled=1

[cumulus-src]
name=Cumulus source packages for RHEL
baseurl=https://apps3.cumulusnetworks.com/repos/rpm/el
/$releasever/netq-1.2/src
gpgcheck=1
enabled=1
```

4. Install the `cumulus-netq` metapack and its components:

```
root@rhel7:~# yum install cumulus-netq
```

Connect the NetQ Telemetry Server to the Network

1. Once the NetQ Telemetry Server and NetQ agents have been upgraded, connect the NetQ Telemetry Server to the network. For more information, refer to the Getting Started with NetQ (see page 10) chapter.
2. Verify the NetQ Agents are OK, and running NetQ 1.2. The output should show the version as `1.2-cl3u5` for NetQ 1.2:

```
cumulus@switch:~$ netq show agents
```

Getting to Know NetQ

Contents

This chapter covers ...

Using netq example

After you've installed NetQ, running `netq example` gives you some pointers as to how it helps you solve issues across your network.

```
cumulus@oob-mgmt-server:~$ netq example
    check                :  Perform fabric-wide checks
    find-duplicates      :  Find Duplicate IP or MAC
    find-origin          :  Find Origin of Route/MAC
    regexp               :  Using Regular Expressions
    resolve              :  Annotate input with names and interesting info
    startup              :  NetQ Quickstart
    trace                :  Control Path Trace

cumulus@switch:~$ netq example trace

Control Path Trace
==================


Commands
========
   netq trace <mac> [vlan <1-4096>] from <hostname> [vrf <vrf>]
[around <text-time>] [json]
   netq trace <ip> from (<hostname>|<ip-src>) [vrf <vrf>] [around
<text-time>] [json]


Usage
=====
netq trace provides control path tracing (no real packets are sent)
from
```

```
a specified source to a specified destination. The trace covers
complete
end-to-end path tracing including bridged, routed and Vxlan overlay
paths.
ECMP is supported as well as checking for forwarding loops, MTU
consistency
across all paths, and VLAN consistency across all paths. The trace
also
covers that the path from dest to src also exists on each hop.


cumulus@torc-12:~$ netq trace 27.0.0.22 from 27.0.0.21
torc-12 -- torc-12:swp3 -- spine-1:swp5 -- torc-21:lo
        -- torc-12:swp4 -- spine-2:swp5 -- torc-21:lo


When tracing data, only the egress information is shown as this
information
is gathered by looking at the routing table. In this case, there are
two paths
(one through spine01 and one through spine02) because the environment
is
leveraging equal cost routing.


You can trace by MAC as well:
cumulus@leaf1:~$ netq trace 00:02:00:00:00:02 vlan 1009 from leaf1
leaf1 -- leaf1:sw_clag200 -- spine1:sw_clag300 -- edge2
                          -- spine1:sw_clag300 -- edge1:VlA-1
      -- leaf1:sw_clag200 -- spine2:sw_clag300 -- edge1:VlA-1
                          -- spine2:sw_clag300 -- edge2
cumulus@leaf1:~$


Legend
======
Any errors are shown in red. Bridged paths are always in WHITE,
routed paths
in GREEN, the VTEPs are shown in BLUE. A node in error is shown in
RED.
```

And **`netq help`** shows you information about specific commands.

```
cumulus@switch:~$ netq help show interfaces
Commands:
   netq <hostname> show docker container adjacent [interfaces <remote-
physical-interface>] [around <text-time>] [json]
   netq [<hostname>] show docker container name <container-name>
adjacent [interfaces <remote-physical-interface>] [around <text-
time>] [json]
   netq [<hostname>] show interfaces [around <text-time>] [count]
[json]
   netq <hostname> show interfaces <remote-interface> [around <text-
time>] [count] [json]
   netq [<hostname>] show interfaces type
(bond|bridge|eth|loopback|macvlan|swp|vlan|vrf|vxlan) [around <text-
time>] [count] [json]
   netq [<hostname>] show interfaces changes [between <text-time> and
<text-endtime>] [json]
   netq <hostname> show interfaces <remote-interface> changes
[between <text-time> and <text-endtime>] [json]
   netq [<hostname>] show interfaces type
(bond|bridge|eth|loopback|macvlan|swp|vlan|vrf|vxlan) changes
[between <text-time> and <text-endtime>] [json]
```

Getting Information about Network Hardware

You can get information about the hardware on the nodes in the network with `netq show inventory` command. You can get details about the ASIC, motherboard, CPU, license, memory, storage, operating system. To see a shorter summary, use the `brief` option:

```
netq@446c0319c06a:/$ netq show inventory brief
Node       Switch    OS            CPU     ASIC    Ports
--------   --------  ------------- ------  ------  -------
exit01     VX        Cumulus Linux x86_64  N/A     N/A
exit02     VX        Cumulus Linux x86_64  N/A     N/A
leaf01     VX        Cumulus Linux x86_64  N/A     N/A
leaf02     VX        Cumulus Linux x86_64  N/A     N/A
leaf03     VX        Cumulus Linux x86_64  N/A     N/A
leaf04     VX        Cumulus Linux x86_64  N/A     N/A
server01   N/A       Ubuntu        x86_64  N/A     N/A
server02   N/A       Ubuntu        x86_64  N/A     N/A
server03   N/A       Ubuntu        x86_64  N/A     N/A
server04   N/A       Ubuntu        x86_64  N/A     N/A
spine01    VX        Cumulus Linux x86_64  N/A     N/A
spine02    VX        Cumulus Linux x86_64  N/A     N/A
```

Using the NetQ Shell on the NetQ Telemetry Server

If you need to run `netq` commands from the telemetry server, use the NetQ shell. While most other Linux commands can work from this shell, Cumulus Networks recommends you only run `netq` commands here.

```
cumulus@netq-appliance:~$ netq-shell
[<Container: a017716433>]
Welcome to Cumulus (R) Linux (R)

For support and online technical documentation, visit
http://www.cumulusnetworks.com/support

The registered trademark Linux (R) is used pursuant to a sublicense
from LMI, the exclusive licensee of Linux Torvalds, owner of the mark
on a worldwide basis.

TIP: Type `netq` to access NetQ CLI.
netq@017716433d5:/$ netq show agents
Node        Status    Sys Uptime    Agent Uptime
----------  --------  ------------  --------------
exit01      Fresh     3h ago        3h ago
exit02      Fresh     3h ago        3h ago
leaf01      Fresh     3h ago        3h ago
leaf02      Fresh     3h ago        3h ago
server01    Fresh     3h ago        3h ago
server02    Fresh     3h ago        3h ago
server03    Fresh     3h ago        3h ago
server04    Fresh     3h ago        3h ago

...
```

Using the netq resolve Command

Linux commands can be piped through NetQ with the `netq resolve` command, in order to provide more contextual information and colored highlights. For example, to show routes installed by the kernel, you would run the `ip route show proto kernel` command:

```
cumulus@leaf01:~$ ip route show proto kernel
3.0.2.128/26 dev VlanA-1.103  scope link  src 3.0.2.131
3.0.2.128/26 dev VlanA-1-103-v0  scope link  src 3.0.2.129
3.0.2.192/26 dev VlanA-1.104  scope link  src 3.0.2.195
3.0.2.192/26 dev VlanA-1-104-v0  scope link  src 3.0.2.193
3.0.3.0/26 dev VlanA-1.105  scope link  src 3.0.3.3
3.0.3.0/26 dev VlanA-1-105-v0  scope link  src 3.0.3.1
3.0.3.64/26 dev VlanA-1.106  scope link  src 3.0.3.67
3.0.3.64/26 dev VlanA-1-106-v0  scope link  src 3.0.3.65
169.254.0.8/30 dev peerlink-1.4094  scope link  src 169.254.0.10
192.168.0.0/24 dev eth0  scope link  src 192.168.0.15
```

You can enhance the output to display the node names and interfaces by piping the output through `netq resolve` so the output looks like this:

```
cumulus@leaf01:~$ ip route show proto kernel | netq resolve
10.0.0.0/22 (
multiple:
) dev eth0  scope link  src 10.0.0.165 (
cel-smallxp-13
:
eth0
)
3.0.2.128/26 (
server02
 :
torbond1.103
 ) dev VlanA-1.103  scope link  src 3.0.2.131 (
leaf02
 :
VlanA-1.103
 )
3.0.2.128/26 (
server02
 :
torbond1.103
 ) dev VlanA-1-103-v0  scope link  src 3.0.2.129 (
leaf02
 :
VlanA-1-103-v0
 )
3.0.2.192/26 (
leaf02
 :
```

```
VlanA-1-104-v0
 ) dev VlanA-1.104  scope link  src 3.0.2.195 (
leaf02
 :
VlanA-1.104
 )
3.0.2.192/26 (
leaf02
 :
VlanA-1-104-v0
 ) dev VlanA-1-104-v0  scope link  src 3.0.2.193 (
leaf02
 :
VlanA-1-104-v0
 )
3.0.3.0/26 (
server01
 :
torbond1.105
 ) dev VlanA-1.105  scope link  src 3.0.3.3 (
leaf02
 :
VlanA-1.105
 )
3.0.3.0/26 (
server01
 :
torbond1.105
 ) dev VlanA-1-105-v0  scope link  src 3.0.3.1 (
leaf02
 :
VlanA-1-105-v0
 )
3.0.3.64/26 (
server02
 :
torbond1.106
 ) dev VlanA-1.106  scope link  src 3.0.3.67 (
leaf02
 :
VlanA-1.106
 )
3.0.3.64/26 (
server02
 :
```

```
torbond1.106
 ) dev VlanA-1-106-v0  scope link  src 3.0.3.65 (
leaf01
 :
VlanA-1-106-v0
 )
169.254.0.8/30 (
leaf02
 :
peerlink-1.4094
 ) dev peerlink-1.4094  scope link  src 169.254.0.10 (
leaf02
 :
peerlink-1.4094
 )
192.168.0.0/24 (
server02
 :
eth0
 ) dev eth0  scope link  src 192.168.0.15 (
leaf01
 :
eth0
 )
```

Sample Commands for Various Components

NetQ provides network validation for the entire stack, providing algorithmic answers to many questions, both simple and intractable, that pertain to your network fabric.

Component	Problem	Solution
Host	Where is this container located? Open ports? What image is being used? Which containers are part of this service? How are they connected?	netq show docker container netq show docker container service
Overlay	Is my overlay configured correctly? Can A reach B? Is my control plane configured correctly?	netq check|show vxlan netq check evpn|lnv netq trace overlay

Component	Problem	Solution
L3	Is OSPF working as expected? Is BGP working as expected? Can IP A reach IP B?	netq check|show ospf netq check|show bgp netq trace l3
L2	Is MLAG configured correctly? Is there an STP loop? Is VLAN or MTU misconfigured? How does MAC A reach B?	netq check|show clag netq show stp netq check|show vlan netq check mtu netq trace L2
OS	Are all switches licensed correctly? Do all switches have NetQ agents running?	netq check license netq check|show agents
Interfaces	Is my link down? Are all bond links up? What optics am I using? What's the peer for this port? Which ports are empty? Is there a link mismatch? Are links flapping?	netq show|check interfaces
Hardware	Have any components crashed? What switches do I have in the network?	netq check sensors netq show sensors all netq show inventory brief

Understanding Timestamps in NetQ

Every event or entry in the NetQ database is stored with a timestamp of when the event was captured by the NetQ agent on the node. This timestamp is based on time on the node where the agent is running, and is pushed in UTC format. Thus, it is important to ensure that all nodes are NTP synchronized (see page 66) . Without this NTP sync, events may be displayed out of order or, worse, not displayed when looking for events that occurred at a particular time or within a time window.

Interface state, IP addresses, routes, ARP/ND table (IP neighbor) entries and MAC table entries carry a timestamp that represents the time the event happened (such as when a route is deleted or an interface comes up) — *except* the first time the NetQ agent is run. If the network has been running and stable when a NetQ agent is brought up for the first time, then this time reflects when the agent was started. Subsequent changes to these objects are captured with an accurate time of when the event happened.

Data that is captured and saved based on polling, and just about all other data in the NetQ database, including control plane state (such as BGP or MLAG), has a timestamp of when the information was *captured* rather than when the event *actually happened*, though NetQ does try to compensate for it if the data extracted provides additional information to compute a more precise time of the event; for example, BGP uptime can be used to determine when the event actually happened in conjunction with the timestamp.

When retrieving the timestamp, JSON output always returns the time in microseconds since the epoch. Non-JSON output displays how long ago in the past the event occurred. The closer the event is to the present, the more granular is the time shown. For example, if an event happened less than an hour ago, NetQ displays the information with a timestamp with microseconds of granularity. However, the farther you are from the event, this granularity is coarser. This is shown in the two outputs below:

```
cumulus@leaf01:mgmt-vrf:~$ netq leaf01 show interfaces swp51
Matching link records are:
Node             Interface        Type     State
Details                     Last Changed
---------------- ---------------- -------- -----
--------------------------- --------------
leaf01           swp51            swp      up    LLDP: spine01:
swp1,         2h ago
                                                 MTU: 1500

cumulus@leaf01:mgmt-vrf:~$ netq leaf01 show interfaces swp52
Matching link records are:
Node             Interface        Type     State
Details                     Last Changed
---------------- ---------------- -------- -----
--------------------------- --------------
leaf01           swp52            swp      up    LLDP: spine02:
swp1,         2h ago
                                                 MTU: 1500
```

⚠ Remember that the time stored in the database is the one with microseconds since the epoch and is what is returned (as a float) in the JSON output.

One more important point to note. If a NetQ agent is restarted on a node, it doesn't update all the timestamps for existing objects to this new restart time. Those times are preserved to those at the agent's original start time, unless the node is rebooted between the agent stopping and restarting; in which case, the time is once again the time of agent restart.

NetQ Service Console

The NetQ Telemetry Server provides access to the NetQ Service Console, a graphical user interface (GUI) for NetQ. The service console provides a command line interface for running NetQ commands.

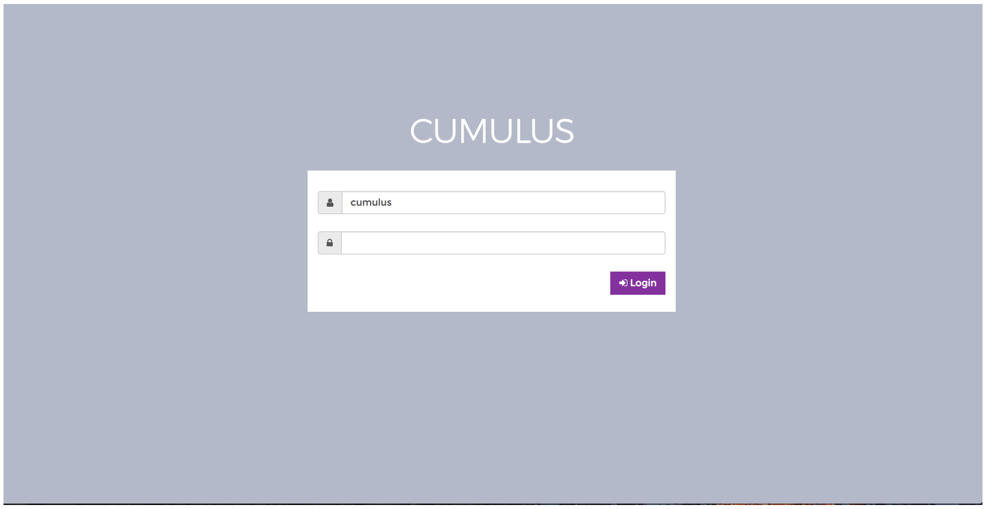
> ⓘ The Cumulus NetQ Service Console utilizes elements of Portainer. You can read the Portainer license file here.

Contents

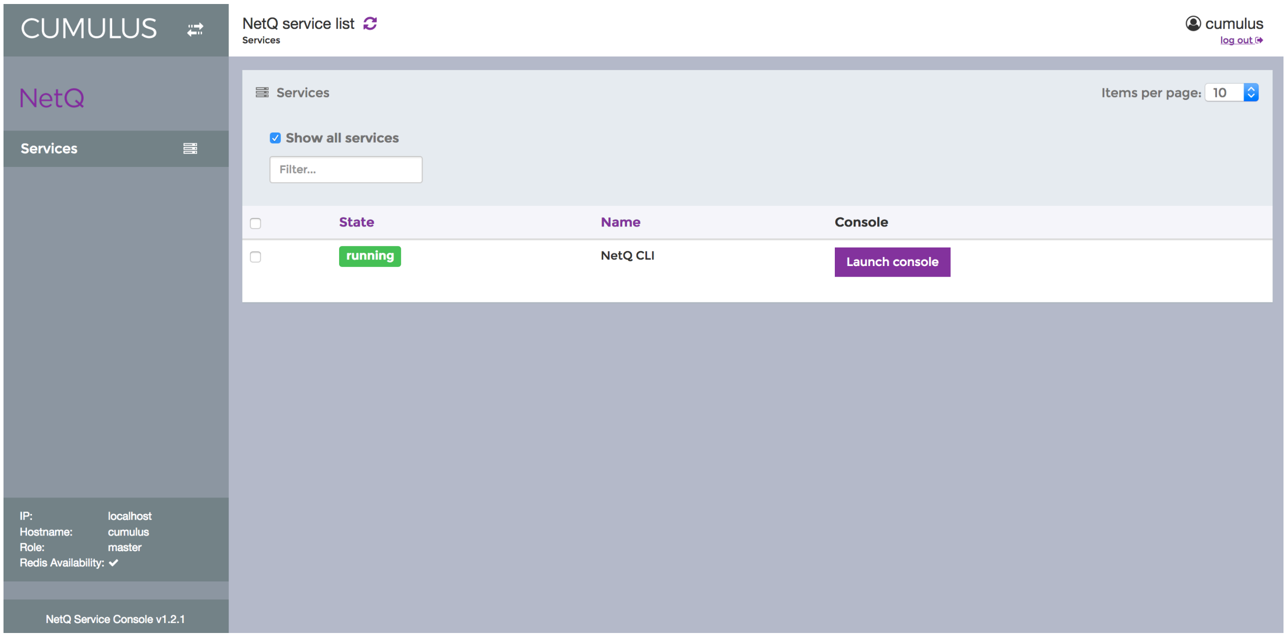
This chapter covers ...

Connecting to the Service Console

To connect to the service console, open a browser, and go to the IP address of the telemetry server (see page 10). The default port is 9000 (http://172.28.128.20:9000).



You are prompted to log in with the username and password for the service console. You can use the same credentials that you use to access the telemetry server VM. The service console user accounts are managed in the telemetry server itself, just like any Linux user account.



Services

Items per page: 10

☑ Show all services

Filter...

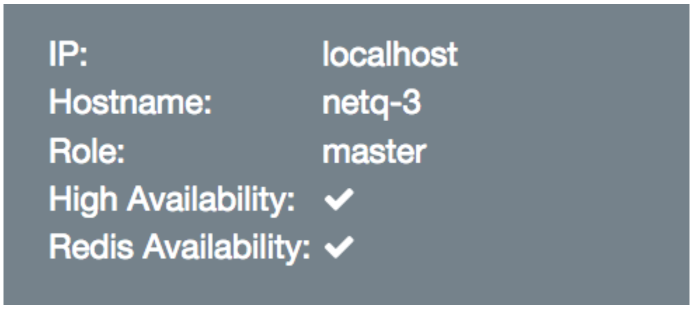
□	State	Name	Console
□	running	NetQ CLI	Launch console

IP:	localhost
Hostname:	cumulus
Role:	master
Redis Availability:	✓

NetQ Service Console v1.2.1

Getting Service Console Information

The lower lefthand corner of the service console window displays information about the telemetry server:



IP:	localhost
Hostname:	netq-3
Role:	master
High Availability:	✓
Redis Availability:	✓

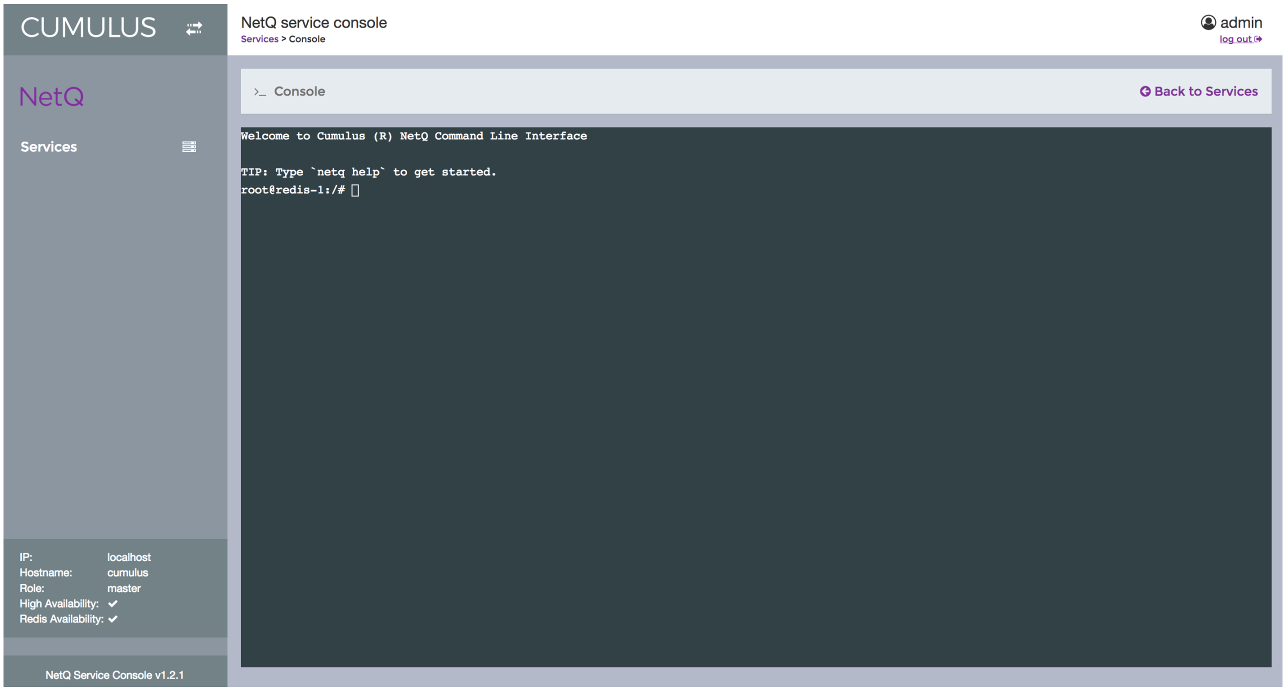
- **IP**: The IP address of the telemetry server VM. In the default configuration, the IP field is empty. To have this field display the IP address, edit `/etc/cts/redis/host.conf` and set the `HOST_IP` variable to the telemetry server's IP address, then restart the `netq-gui` service with `sudo systemctl restart netq-gui.service`.
- **Hostname**: The hostname of the telemetry server VM. The hostname is based on the *%H* environment value in the `systemd` service configuration. If you change the hostname, you should restart the `netq-gui` service so the new hostname displays in the service console.
- **Role**: The role that the NetQ database is in, which currently can be *master* or *replica*, if high availability (HA) mode (see page 25) is enabled. If it's not enabled, *master* appears here. If the role is set to *replica*, this indicates that the node is part of an HA cluster, since there is no replica in a non-HA environment.
- **High Availability**: A check mark appears if high availability mode (see page 25) is enabled and the current node is the *master* node. This also determines that the master referred to in the role above is also the master for the Redis cluster in HA mode.
- **Redis availability**: Indicates whether or not the Redis database on the telemetry server VM is reachable.

Accessing the NetQ Command Line

The service console runs within the NetQ CLI container. You can use it to connect to the NetQ command line locally within the container. You can also use it to access the container's `/etc/cts/netq` directory to edit or add configuration files under /`config.d`.

However, you cannot use it to connect to the NetQ CLI on a remote system; neither can you access the container's `systemd` services nor alter anything else in the container. The filesystem exposed in the console window is actually the container's filesystem.

In the Services window of the console, click **Launch console**.

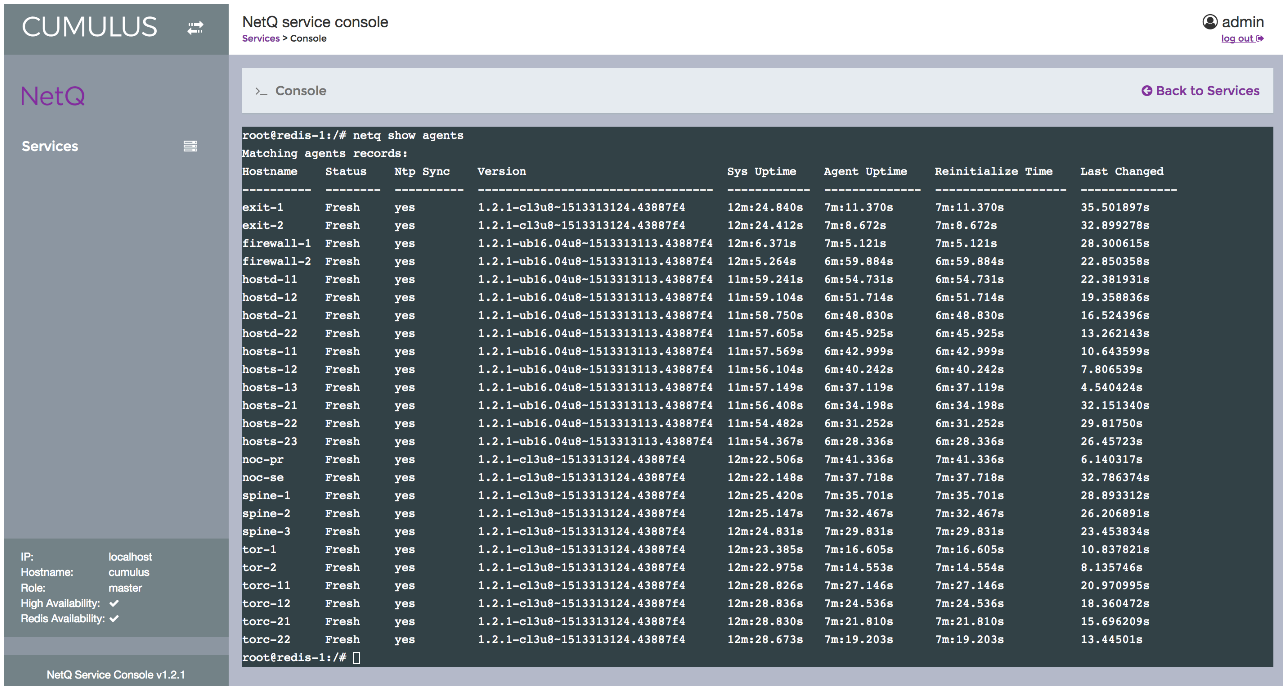


IP: localhost
Hostname: cumulus
Role: master
High Availability: ✓
Redis Availability: ✓

```
Welcome to Cumulus (R) NetQ Command Line Interface

TIP: Type `netq help` to get started.
root@redis-1:/# 
```

You can run any NetQ check and show commands within the console, such as `netq show agents`:



IP: localhost
Hostname: cumulus
Role: master
High Availability: ✓
Redis Availability: ✓

```
root@redis-1:/# netq show agents
Matching agents records:
Hostname    Status    Ntp Sync    Version                             Sys Uptime    Agent Uptime    Reinitialize Time    Last Changed
----------  --------  ----------  ----------------------------------  ------------  --------------  -------------------  --------------
exit-1      Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:24.840s   7m:11.370s      7m:11.370s           35.501897s
exit-2      Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:24.412s   7m:8.672s       7m:8.672s            32.899278s
firewall-1  Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  12m:6.371s    7m:5.121s       7m:5.121s            28.300615s
firewall-2  Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  12m:5.264s    6m:59.884s      6m:59.884s           22.850358s
hostd-11    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:59.241s   6m:54.731s      6m:54.731s           22.381931s
hostd-12    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:59.104s   6m:51.714s      6m:51.714s           19.358836s
hostd-21    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:58.750s   6m:48.830s      6m:48.830s           16.524396s
hostd-22    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:57.605s   6m:45.925s      6m:45.925s           13.262143s
hosts-11    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:57.569s   6m:42.999s      6m:42.999s           10.643599s
hosts-12    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:56.104s   6m:40.242s      6m:40.242s           7.806539s
hosts-13    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:57.149s   6m:37.119s      6m:37.119s           4.540424s
hosts-21    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:56.408s   6m:34.198s      6m:34.198s           32.151340s
hosts-22    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:54.482s   6m:31.252s      6m:31.252s           29.81750s
hosts-23    Fresh     yes         1.2.1-ub16.04u8~1513313113.43887f4  11m:54.367s   6m:28.336s      6m:28.336s           26.45723s
noc-pr      Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:22.506s   7m:41.336s      7m:41.336s           6.140317s
noc-se      Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:22.148s   7m:37.718s      7m:37.718s           32.786374s
spine-1     Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:25.420s   7m:35.701s      7m:35.701s           28.893312s
spine-2     Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:25.147s   7m:32.467s      7m:32.467s           26.206891s
spine-3     Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:24.831s   7m:29.831s      7m:29.831s           23.453834s
tor-1       Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:23.385s   7m:16.605s      7m:16.605s           10.837821s
tor-2       Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:22.975s   7m:14.553s      7m:14.554s           8.135746s
torc-11     Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:28.826s   7m:27.146s      7m:27.146s           20.970995s
torc-12     Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:28.836s   7m:24.536s      7m:24.536s           18.360472s
torc-21     Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:28.830s   7m:21.810s      7m:21.810s           15.696209s
torc-22     Fresh     yes         1.2.1-cl3u8~1513313124.43887f4      12m:28.673s   7m:19.203s      7m:19.203s           13.44501s
root@redis-1:/# 
```

When you're finished with the session, click **Back to Services** to close the console.

Taking Preventative Steps with Your Network

NetQ provides quality assurance capabilities to detect erroneous or undesired network configurations before the changes are rolled into production. NetQ can be used to test existing or design topologies, validate configuration changes, and review the state of the network in real time, allowing it to integrate effectively with CI/CD environments. NetQ commands can also be run in an automation tool; depending on the outcome of the automation tests, the script can either continue the deployment, or roll back the changes until the issues are addressed.

In addition, NetQ Virtual (see page 94) provides users with a Cumulus VX topology to serve as a virtual representation of your production network; once the network is verified in NetQ Virtual, the topology can then be rolled into production.

Contents

This chapter covers ...

netq check and netq show

The `netq check` and `netq show` commands validate network state before and after configuration changes. Based on results returned by NetQ, you or your automation script can either roll back the configuration change or continue deploying it:

```
cumulus@leaf01:~$ netq check
    agents   :  netq agent
    bgp      :  BGP info
    clag     :  Multi-chassis LAG (CLAG) info
    license  :  License
    lnv      :  Lightweight Network Virtualization info
    mtu      :  Link MTU
    ospf     :  OSPF info
    sensors  :  Temperature/Fan/PSU sensors
    vlan     :  VLAN
    vxlan    :  VxLAN dataplane info
```

Here are some example check commands:

```
cumulus@leaf01:~$ netq check agents
```

```
Checked nodes: 25, Rotten nodes: 0
```

NetQ check enables users to review the state of the network at specific moments in time by specifying the `around text-time` option.

```
cumulus@leaf01:~$ netq check bgp vrf DataVrf1081
Total Nodes: 25, Failed Nodes: 1, Total Sessions: 52 , Failed
Sessions: 0
```

```
cumulus@leaf01:~$ netq check lnv around 10m
Checked Nodes: 9, Warning Nodes: 0, Failed Nodes: 0
```

```
cumulus@leaf01:~$ netq check sensors around 14m
Total Nodes: 25, Failed Nodes: 0, Checked Sensors: 221, Failed
Sensors: 0
```

The `netq show` command displays a wide variety of content from the network:

```
cumulus@leaf01:~$ netq show
    agents      :  netq agent
    bgp         :  BGP info
    changes     :  How this infomation has changed with time
    clag        :  Multi-chassis LAG (CLAG) info
    docker      :  Docker Info
    interfaces  :  Network interface
    inventory   :  Inventory information
    ip          :  IPv4 related info
    ipv6        :  IPv6 related info
    lldp        :  LLDP based neighbor info
    lnv         :  Lightweight Network Virtualization info
    macs        :  Mac table entries
    sensors     :  Temperature/Fan/PSU sensors
    services    :  System services
```

netq show agents

To get the health of the NetQ agents running in the fabric, run `netq show agents`. A *Fresh* status indicates the agent is running as expected. The agent sends a heartbeat every 30 seconds, and if 3 consecutive heartbeats are missed, its status changes to *Rotten*.

```
cumulus@leaf01:~$ netq show agents

Node                 Status     Sys Uptime     Agent Uptime
```

```
---------------  --------  ------------  --------------
leaf01           Fresh     2h ago        2h ago
leaf02           Fresh     2h ago        2h ago
leaf03           Fresh     2h ago        2h ago
leaf04           Fresh     2h ago        2h ago
oob-mgmt-server  Fresh     2h ago        2h ago
server01         Fresh     2h ago        2h ago
server02         Fresh     2h ago        2h ago
server03         Fresh     2h ago        2h ago
server04         Fresh     2h ago        2h ago
spine01          Fresh     2h ago        2h ago
spine02          Fresh     2h ago        2h ago
```

Using NetQ with Automation

Using NetQ for preventative care of your network pairs well with automation scripts and playbooks to prevent errors on your network before deploying the configuration to production.

NetQ works with Ansible, Chef and Puppet.

For example, you can use NetQ in your Ansible playbook to help you configure your network topology. The playbook could pull in BGP data in JSON format before it starts creating the topology:

```
- hosts: localhost leaf spine
  gather_facts: False
  tasks:
     - name: Gather BGP Adjanceny info in JSON format
       local_action: command netq show bgp json
       register: result
       #delegate_to: localhost
       run_once: true
```

Based on the outcome, the playbook can then respond appropriately. Later, it can check IP addresses to verify the connections:

```
#ipv6 address check
     - name: run ipv6check on broken_dict
       command: netq show ipv6 addresses {{item.key}} {{item.value}}
json
       with_dict: "{{broken_dict}}"
       register: command_outputs
       delegate_to: localhost
       run_once: true
```

Using NetQ Virtual

The NetQ Virtual environment provides another way for you to verify your network configuration before deploying it into production. For more information, see Using NetQ Virtual Environments (see page 94).

Proactively Monitoring the Network Fabric

NetQ continually and algorithmically checks for various network events (see below) and sends real-time alerts via *NetQ Notifier* to notify users that a network event occurs. When alerted, you can determine precisely where the fault occurred so you can remediate quickly.

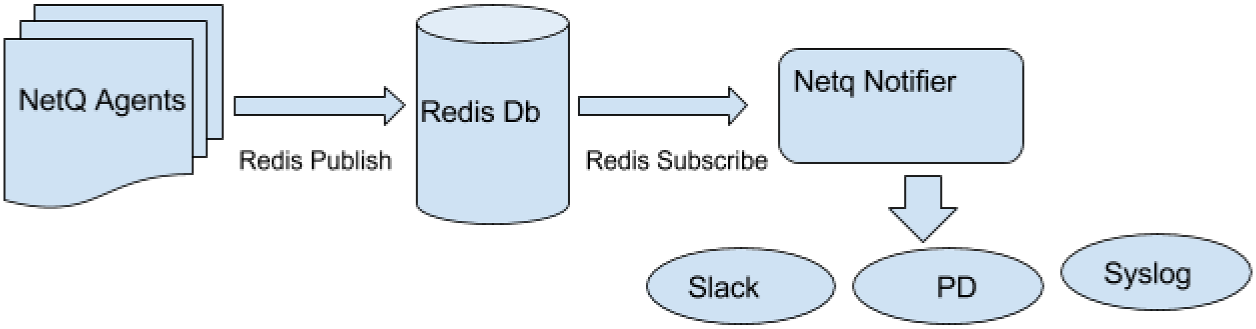
You can create filters for how to handle notifications and you can also ignore notifications.

Contents

This chapter covers ...

NetQ Notifier

The NetQ Notifier's role within the NetQ suite of applications is to deliver alerts to users through mediums such as Slack and syslog, informing users of network events.



Notifications can be generated for the following network events:

- Agent node state

- Backend connections
- Fan
- License
- NTP
- OS
- Port
- PSU
- Services
- Temperature

When a notification arrives, what should you do next? Typically, you could run `netq check` commands; see Performing Network Diagnostics (see page 78) for more information. For a thorough example, read about troubleshooting MLAG node failures (see page 70).

Log Message Format

Messages have the following structure:

```
<timestamp> <node> <service>[PID]: <level> <type>: <message>
```

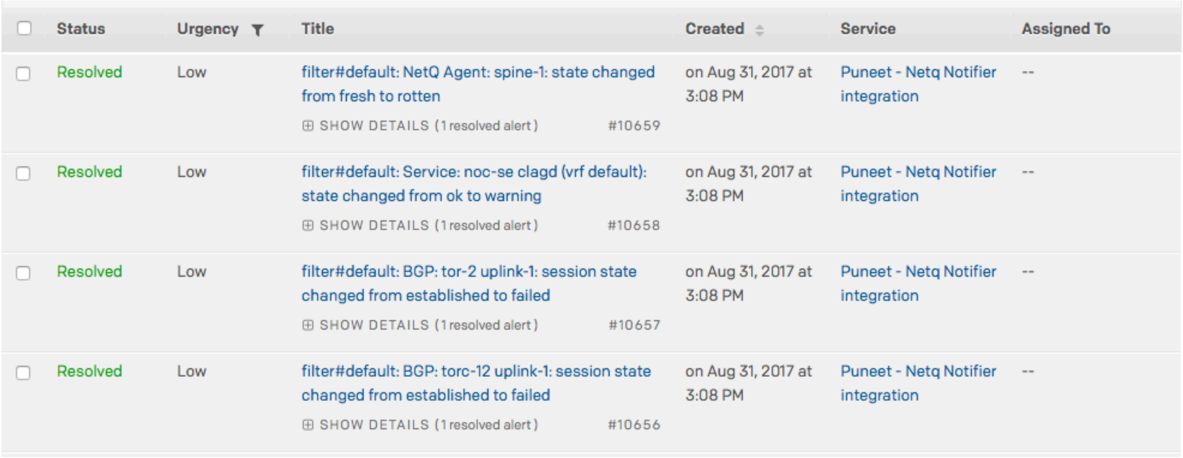
For example:

```
2017-08-28T22:43:32.794669+00:00 spine01 netq-notifier[13232]: INFO:
filter#default: BGP: leaf01 peerlink-1.4094: session state changed
from failed to established
```

Supported Integrations

NetQ supports the ability to send notifications to the following applications:

- **PagerDuty**: NetQ Notifier sends notifications to PagerDuty as PagerDuty events.



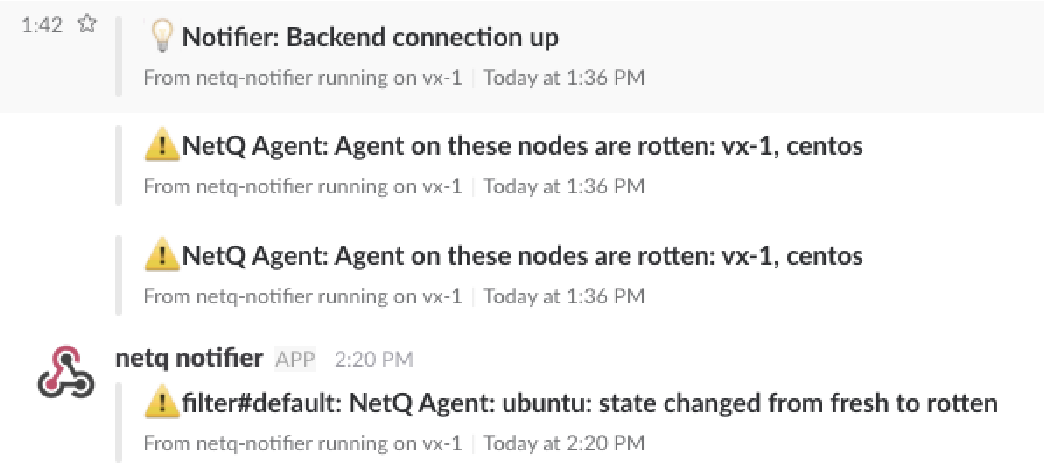
□	Status	Urgency	Title	Created	Service	Assigned To
□	Resolved	Low	filter#default: NetQ Agent: spine-1: state changed from fresh to rotten ⊞ SHOW DETAILS (1 resolved alert) #10659	on Aug 31, 2017 at 3:08 PM	Puneet - Netq Notifier integration	--
□	Resolved	Low	filter#default: Service: noc-se clagd (vrf default): state changed from ok to warning ⊞ SHOW DETAILS (1 resolved alert) #10658	on Aug 31, 2017 at 3:08 PM	Puneet - Netq Notifier integration	--
□	Resolved	Low	filter#default: BGP: tor-2 uplink-1: session state changed from established to failed ⊞ SHOW DETAILS (1 resolved alert) #10657	on Aug 31, 2017 at 3:08 PM	Puneet - Netq Notifier integration	--
□	Resolved	Low	filter#default: BGP: torc-12 uplink-1: session state changed from established to failed ⊞ SHOW DETAILS (1 resolved alert) #10656	on Aug 31, 2017 at 3:08 PM	Puneet - Netq Notifier integration	--

If NetQ generates multiple notifications, on the order of 50/second (which could happen when a node reboots or when one peer in an MLAG pair disconnects), PagerDuty does not see all these notifications. You may see warnings in the `netq-notifier.log` file like this:

```
2017-09-20T20:39:48.222458+00:00 rdsq1 netq-notifier[1]:
WARNING: Notifier: notifier-pagerduty: Request failed
with exception: Code: 429, msg: {"status":"throttle
exceeded","message":"Requests for this service are
arriving too quickly.  Please retry later."}
```

This is a known limitation in PagerDuty at this time.

- **Slack**: NetQ Notifier sends notifications to Slack as incoming webhooks for a Slack channel you configure. For example:



1:42

Notifier: Backend connection up
From netq-notifier running on vx-1 | Today at 1:36 PM

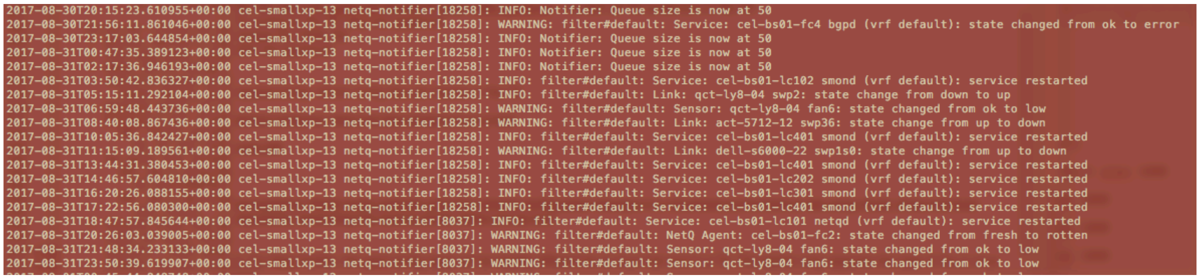
⚠ NetQ Agent: Agent on these nodes are rotten: vx-1, centos
From netq-notifier running on vx-1 | Today at 1:36 PM

⚠ NetQ Agent: Agent on these nodes are rotten: vx-1, centos
From netq-notifier running on vx-1 | Today at 1:36 PM

netq notifier APP 2:20 PM

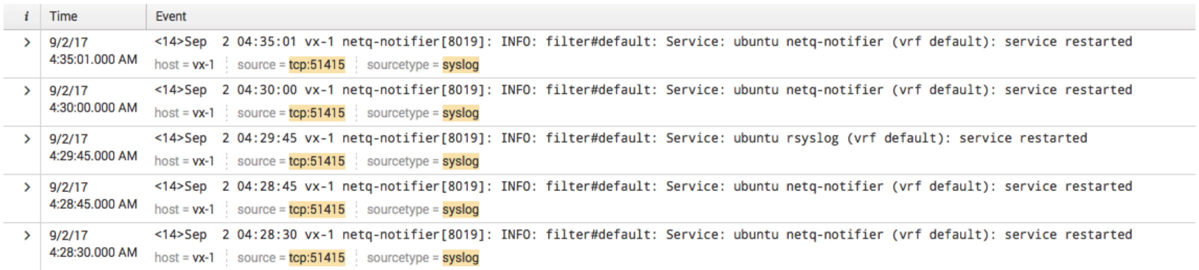
⚠ filter#default: NetQ Agent: ubuntu: state changed from fresh to rotten
From netq-notifier running on vx-1 | Today at 2:20 PM

- **rsyslog:** Using `rsyslog`, NetQ Notifier sends alerts and events to the `/var/log/netq-notifier.log` file by default, but notifications can also be sent to ELK/Logstash or Splunk.



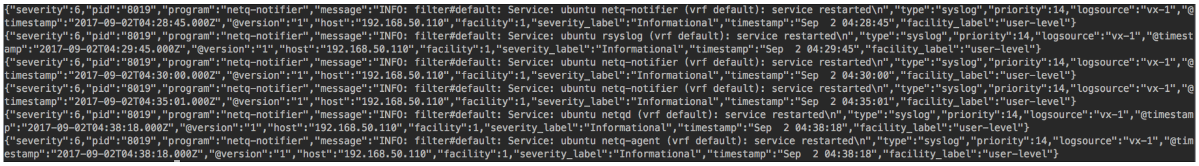
```
2017-08-30T20:15:23.610955+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: Notifier: Queue size is now at 50
2017-08-30T21:56:11.861046+00:00 cel-smallxp-13 netq-notifier[18258]: WARNING: filter#default: Service: cel-bs01-fc4 bgpd (vrf default): state changed from ok to error
2017-08-30T23:17:03.644854+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: Notifier: Queue size is now at 50
2017-08-31T00:47:35.389123+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: Notifier: Queue size is now at 50
2017-08-31T02:17:36.946193+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: Notifier: Queue size is now at 50
2017-08-31T03:50:42.836327+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: filter#default: Service: cel-bs01-lc102 smond (vrf default): service restarted
2017-08-31T05:15:11.292104+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: filter#default: Link: qct-ly8-04 swp2: state change from down to up
2017-08-31T06:59:48.443736+00:00 cel-smallxp-13 netq-notifier[18258]: WARNING: filter#default: Sensor: qct-ly8-04 fan6: state changed from ok to low
2017-08-31T08:40:08.867436+00:00 cel-smallxp-13 netq-notifier[18258]: WARNING: filter#default: Link: act-5712-12 swp36: state change from up to down
2017-08-31T10:05:36.842427+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: filter#default: Service: cel-bs01-lc401 smond (vrf default): service restarted
2017-08-31T11:15:09.189561+00:00 cel-smallxp-13 netq-notifier[18258]: WARNING: filter#default: Link: dell-s6000-22 swp1s0: state change from up to down
2017-08-31T13:44:31.380453+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: filter#default: Service: cel-bs01-lc401 smond (vrf default): service restarted
2017-08-31T14:46:57.604810+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: filter#default: Service: cel-bs01-lc202 smond (vrf default): service restarted
2017-08-31T16:20:26.088155+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: filter#default: Service: cel-bs01-lc301 smond (vrf default): service restarted
2017-08-31T17:22:56.080300+00:00 cel-smallxp-13 netq-notifier[18258]: INFO: filter#default: Service: cel-bs01-lc401 smond (vrf default): service restarted
2017-08-31T18:47:57.845644+00:00 cel-smallxp-13 netq-notifier[8037]: INFO: filter#default: Service: cel-bs01-lc101 netqd (vrf default): service restarted
2017-08-31T20:26:03.039005+00:00 cel-smallxp-13 netq-notifier[8037]: WARNING: filter#default: NetQ Agent: cel-bs01-fc2: state changed from fresh to rotten
2017-08-31T21:48:34.233133+00:00 cel-smallxp-13 netq-notifier[8037]: WARNING: filter#default: Sensor: qct-ly8-04 fan6: state changed from ok to low
2017-08-31T23:50:39.619907+00:00 cel-smallxp-13 netq-notifier[8037]: WARNING: filter#default: Sensor: qct-ly8-04 fan6: state changed from ok to low
```

- **Splunk**: NetQ integrates with Splunk using `rsyslog`, a standard mechanism to capture log files in Linux. Splunk provides plugins to handle `rsyslog` inputs.



i	Time	Event
>	9/2/17 4:35:01.000 AM	<14>Sep 2 04:35:01 vx-1 netq-notifier[8019]: INFO: filter#default: Service: ubuntu netq-notifier (vrf default): service restarted host = vx-1 source = tcp:51415 sourcetype = syslog
>	9/2/17 4:30:00.000 AM	<14>Sep 2 04:30:00 vx-1 netq-notifier[8019]: INFO: filter#default: Service: ubuntu netq-notifier (vrf default): service restarted host = vx-1 source = tcp:51415 sourcetype = syslog
>	9/2/17 4:29:45.000 AM	<14>Sep 2 04:29:45 vx-1 netq-notifier[8019]: INFO: filter#default: Service: ubuntu rsyslog (vrf default): service restarted host = vx-1 source = tcp:51415 sourcetype = syslog
>	9/2/17 4:28:45.000 AM	<14>Sep 2 04:28:45 vx-1 netq-notifier[8019]: INFO: filter#default: Service: ubuntu netq-notifier (vrf default): service restarted host = vx-1 source = tcp:51415 sourcetype = syslog
>	9/2/17 4:28:30.000 AM	<14>Sep 2 04:28:30 vx-1 netq-notifier[8019]: INFO: filter#default: Service: ubuntu netq-notifier (vrf default): service restarted host = vx-1 source = tcp:51415 sourcetype = syslog

- **ELK/Logstash**: NetQ integrates with ELK/Logstash using `rsyslog`. ELK also provides plugins to handle `rsyslog` inputs.



```
{"severity":6,"pid":"8019","program":"netq-notifier","message":"INFO: filter#default: Service: ubuntu netq-notifier (vrf default): service restarted\n","type":"syslog","priority":14,"logsource":"vx-1","@
timestamp":"2017-09-02T04:28:45.000Z","@version":"1","host":"192.168.50.110","facility":1,"severity_label":"Informational","timestamp":"Sep  2 04:28:45","facility_label":"user-level"}
{"severity":6,"pid":"8019","program":"netq-notifier","message":"INFO: filter#default: Service: ubuntu rsyslog (vrf default): service restarted\n","type":"syslog","priority":14,"logsource":"vx-1","@timest
amp":"2017-09-02T04:29:45.000Z","@version":"1","host":"192.168.50.110","facility":1,"severity_label":"Informational","timestamp":"Sep  2 04:29:45","facility_label":"user-level"}
{"severity":6,"pid":"8019","program":"netq-notifier","message":"INFO: filter#default: Service: ubuntu netq-notifier (vrf default): service restarted\n","type":"syslog","priority":14,"logsource":"vx-1","@
timestamp":"2017-09-02T04:30:00.000Z","@version":"1","host":"192.168.50.110","facility":1,"severity_label":"Informational","timestamp":"Sep  2 04:30:00","facility_label":"user-level"}
{"severity":6,"pid":"8019","program":"netq-notifier","message":"INFO: filter#default: Service: ubuntu netq-notifier (vrf default): service restarted\n","type":"syslog","priority":14,"logsource":"vx-1","@
timestamp":"2017-09-02T04:35:01.000Z","@version":"1","host":"192.168.50.110","facility":1,"severity_label":"Informational","timestamp":"Sep  2 04:35:01","facility_label":"user-level"}
{"severity":6,"pid":"8019","program":"netq-notifier","message":"INFO: filter#default: Service: ubuntu netqd (vrf default): service restarted\n","type":"syslog","priority":14,"logsource":"vx-1","@timestam
p":"2017-09-02T04:38:18.000Z","@version":"1","host":"192.168.50.110","facility":1,"severity_label":"Informational","timestamp":"Sep  2 04:38:18","facility_label":"user-level"}
{"severity":6,"pid":"8019","program":"netq-notifier","message":"INFO: filter#default: Service: ubuntu netq-agent (vrf default): service restarted\n","type":"syslog","priority":14,"logsource":"vx-1","@tim
estamp":"2017-09-02T04:38:18.000Z","@version":"1","host":"192.168.50.110","facility":1,"severity_label":"Informational","timestamp":"Sep  2 04:38:18","facility_label":"user-level"}
```

Configuring an Integration

You need to define to which applications NetQ sends notifications. By default, NetQ sends notifications only to `syslog`.

To configure PagerDuty or Slack, you need to edit the `/etc/netq/netq.yml` configuration file.

```
cumulus@switch:~$ sudo nano /etc/netq/netq.yml

...

## a) Filter notifications to integrations (Slack or PD) based on
Severity,
## i.e., WARNING to PD, INFO to Slack
# notifier-integrations:
# - name: notifier-slack-channel-1
#   type: slack
#   webhook: "https://<slack-webhook1"
#   severity: INFO  <==== Set the severity type here
#   tag: "<@slack-tag1>"
# - name: notifier-pagerduty
#   type: pagerduty
#   severity: WARNING <==== Set the severity type here
#   api_access_key: "<API Key>"
#   api_integration_key: "<API Integration Key>"
#

...
```

For Slack notifications, the contents of *tag* is added to the notification message to be sent, which is useful for setting alerts for notifications within Slack.

> In order to tag users, enclose the username and "@" sign in angled brackets, like this: *<@cumulus>*
> .

You need to do some extra steps to be able to export NetQ data to ELK (see page 64) or Splunk (see page 65) (see below).

After you modify the NetQ configuration, you must restart the `netq-notifier` service on the telemetry server:

```
cumulus@switch:~$ sudo systemctl restart netq-notifier.service
```

Filtering Notifications

By default, NetQ sends all notifications in response to network events. You can filter this according to your needs.

A filter has three components, a *rule*, an *action* and *output*:

- **Rule**: A set of conditions against which an incoming event is matched. If an incoming event matches the rule, the event information is passed to the action. The rule is a dictionary of key-value pairs, where the "key" is an item associated with the event and "value" is the value of that item. For example:
  rule:
  hostname: leaf01
  ifname: swp1

  If the default rule is not specified or if it is empty, a match always results. You can make NetQ Notifier continue matching filters even if a match is found, by adding *terminate_on_match: False* to the filter. Values specified in the rule are matched with those received in a event using Python regular expressions. NetQ also matches for message severity and sends a notification only if the event is above the given severity. Message severity levels are: INFO, WARNING, ERROR and CRITICAL in ascending order.
- **Action**: The action to perform if the rule matches. The action takes the event provided by the rule stage and generates a message dictionary with a message and its severity. Multiple actions can be prescribed in the action list. An action is typically a Python function that is provided with NetQ or you can write a custom one yourself. If no action is provided, NetQ defaults to a generic handler that looks at the event, and based on that event runs the relevant notification function.
- **Output**: The integrations that will receive the notification. The output contains the message and severity. If the output is *None* the notification is not sent to any integration, including `syslog`. If the output is empty, the message is sent only to `syslog`. Otherwise, the notification is sent to the list of integrations specified in the output list as well as to `syslog`. If ALL is specified, the notification is sent to all integrations.

For example, to send BGP session state notifications to particular Slack channel, in this case, *slack-channel-BGP*, do the following:

```
cumulus@switch:~$ sudo nano /etc/netq/netq.yml

...

## e) Send BGP Session state notifications to particular slack channel
## (slack-channel-BGP), rest to another one (slack-channel-catchall)
# notifier-filters:
# - name: BGP slack channel
# rule:
# type: BgpSession
# output:
# - slack-channel-BGP


...
```

To drop notifications, set the output to None for the given rule in the `/etc/netq/netq.yml` file. For example, you can drop all notifications from leaf01 by configuring the following:

```
cumulus@switch:~$ sudo nano /etc/netq/netq.yml

...

## b) Drop all notifications coming from a switch/host say, leaf01
# notifier-filters:
# - name: leaf01 drop
#   rule:
#     hostname: leaf01
#   output:
#     - None
# - name: default
#   rule:
#   output:
#     - ALL

...
```

Example netq.yml File

/etc/netq/netq.yml file contents

```
cumulus@switch:~$ cat /etc/netq/netq.yml
## Netq configuration File.
## Configuration is also read from files in /etc/netq/config.d/ and
have
## precedence over config in /etc/netq/netq.yml.
## ----- Common configurations -----
## Backend Configuration for all netq agents and apps on this host.
##
backend:
  server: 10.0.0.165
#  port: 6379
## ----- netq-agent configurations -----
## Netq Agent Configuration
##
## log_level: Could be debug, info, warning or error. Default is info.
##
#netq-agent:
#  log_level: info
## Docker Agent Configuration
##
## docker_enable: Enable Docker monitoring. Default is True.
## docker_poll_period: Docker poll period in secs. Default is 15 secs.
##
#docker:
#  enable: true
#  poll_period: 15
## ----- netq configurations -----
## Netq configuration
##
## log_level: Could be debug, info, warning or error. Default is info.
##
#netqd:
#  log_level: info
## ----- netq-notifier configurations -----
## Netq Notifier Configuration
##
## log_level: Could be debug, info, warning or error. Default is info.
##
# netq-notifier:
#  log_level: debug
## NetQ Notifier Filter Configuration
##
## NetQ Notifier sends notifications to integrations(syslog, slack or
pagerduty)
## based on the events that are happening across the network.
## Notifications are generated based on the filters that have been
specified in
## "notifier-filters".  NetQ Agents generate an event when something
interesting
## happens on the host (switch or server) its running on. The
Notifier is always
## listening for these events and once it receives an event, it makes
it go
## through a set of filters.
##
## A filter has 3 stages:
## a) Rule: Defines a set of conditions against which an incoming
event is
## matched. Input to this stage is an incoming event and the event is
sent to
## the next stage if there is a match. If there is a match, the event
## information is passed to the action stage. The rule is a
dictionary of
```

```
## key-value pairs, where the "key" is an item associated with the
event and
## "value" is the value of that item,
## e.g. type: Link
##      hostname: leaf-01
##      ifname: swp1
## The Default rule, if none is specified or if it is empty, is to
always assume
## a match.
## Notifier-filter rules are matched sequentially and we stop only
when a match
## is found. You can make the notifier continue matching filters even
if a match
## is found, by adding "terminate_on_match: False" to the filter.
Values
## specified in the rule are matched with those received in a event
using python
## regular expressions  https://docs.python.org/2/library/re.html
## We can also match for message severity and print messages only if
it is above
## the given severity. Message severity levels are: INFO, WARNING,
ERROR and
## CRITICAL in ascending order.
##
## b) Action: action to perform if the "rule" is matched.  The action
stage
## take the event provided by the "rule" stage and generates a message
## dictionary with a message and its severity. Multiple actions can be
## prescribed in the "action" list. "action" is typically a python
function that
## is provided with the tool or a custom one written by the user. If
no action
## is provided, we default to a generic handler which looks at the
event and
## based on the event runs the relevant notification function.
##
## c) output: This stage takes the message dictionary provided by the
action
## stage and sends the message and severity to the right integration
to display
## the message. If the output is None the message is not sent to any
integration
## or syslog. If output is empty, the message is sent only to syslog.
Else the
## message is sent to the list of integrations specified in the
output list and
## syslog. If ALL is specified, the message is sent to all
integrations.
## Integrations are defined in notifier-integrations.
##
## The config file comes with the following default filter:
##
```

```
## notifier-filters:
## - name: default
##   rule:
##   output:
##     - ALL
##
## which is an empty rule, empty action and output to all. This
defaults to
## match all rules and then perform the default action which is to
run the
## generic handler mentioned in the action stage above.
##
## NetQ Integration Configuration
##
## The integrations refer to the external tool where you would like
to receive
## the notification. An integration is added as a list element to
## "notifier-integrations". Each integration must have a "name" and
"type".
## Severity is optional and lets you send messages above that level
to the
## integration. Allowed values are: INFO, WARNING, ERROR, CRITICAL in
increasing
## order. Currently allowed "type" are "slack" and "pagerduty". You
can define
## multiple slack or PD integrations.
##
##For Slack integration, along with a name and "type: slack", you
also need to
## also provide the Incoming Webhook of the channel. The webhook URL
for your
## channel can be found or created in Slack at:
##   Apps -> Custom Integrations -> Incoming Webhooks.
## Tags are optional and are strings that are attached to the end of
th
## notification message.
## E.g.
# notifier-integrations:
# - name: notifier-slack-channel-1
#   type: slack
#   webhook: "https://<slack-webhook1>"
#   severity: INFO,
#   tag: "@slack-tag1"
##
## For pagerDuty, along with name and "type: pagerduty", you also
need to
## provide the "api_access_key" and "api_integration_key" from
Pagerduty.
## A unique API Access Key which can be created on your PagerDuty
website at:
## Configuration -> API Access -> Create New API Key
## An 'Integration Key' can be created/found on your PagerDuty
website at:
## Configuration -> Services -> Add New Service -> New Integration ->
##   Select Integration Type as 'Use our API directly: Events API v2'.
## E.g. pagerduty integration along with slack
# notifier-integrations:
# - name: notifier-slack-channel-1
#   type: slack
#   webhook: "https://<slack-webhook1>"
#   severity: INFO
#   tag: "@slack-tag1"
# - name: notifier-pagerduty
#   type: pagerduty
#   severity: WARNING
#   api_access_key: <API Key>
#   api_integration_key: <API Integration Key>
##
## Customizing Notifications
## Here are some examples on how to customize your notifications:
##
## a) Filter notifications to integrations (Slack or PD) based on
Severity,
## i.e., WARNING to PD, INFO to Slack
# notifier-integrations:
# - name: notifier-slack-channel-1
#   type: slack
#   webhook: "https://<slack-webhook1"
#   severity: INFO  <==== Set the severity type here
#   tag: "@slack-tag1"
# - name: notifier-pagerduty
#   type: pagerduty
#   severity: WARNING <==== Set the severity type here
#   api_access_key: "<API Key>"
#   api_integration_key: "<API Integration Key>"
#
##
## b) Drop all notifications coming from a switch/host say, leaf-01
# notifier-filters:
# - name: leaf-01 drop
#   rule:
#     hostname: leaf-01
#   output:
#     - None
# - name: default
#   rule:
#   output:
#     - ALL
##
## c) Drop all notifications coming from switches whose name starts
with leaf
# notifier-filters:
# - name: leaf drop
#   rule:
#     hostname: "leaf-.*"
#   output:
#     - None
# - name: default
#   rule:
#   output:
#     - ALL
##
## d) Drop all notifications coming from a particular link, e.g. leaf-
01 swp1
# notifier-filters:
# - name: leaf-01 swp1 drop
#   rule:
#     type: Link
#     hostname: leaf-01
#     ifname: swp1
#   output:
#     - None
# - name: default
#   rule:
#   output:
#    - ALL
##
## e) Send BGP Session state notifications to particular slack channel
## (slack-channel-BGP), rest to another one (slack-channel-catchall)
# notifier-filters:
# - name: BGP slack channel
#   rule:
#     type: BgpSession
#   output:
#     - slack-channel-BGP
# - name: default
#   rule:
#   output:
#     - slack-channel-catchall
##
## f) Send BgpSession notifications based on severity to different
slack channels
# notifier-filters:
# - name: BGP severity slack channel
#   rule:
#     type: BgpSession
#     severity: WARNING
#   output:
#     - slack-channel-BGP-info
# - name: default
#   rule:
#   output:
#     - slack-channel-catchall
##
## g) Drop all temperature related alerts
```

```
# notifier-filters:
# - name: temp drop
#   rule:
#     type: Temp
#   output:
#     - None
# - name: default
#   rule:
#   output:
#     - ALL
notifier-filters:
  - name: default
    rule:
    output:
      - ALL
```

Exporting to ELK

To export NetQ Notifier data to ELK via Logstash, on the host running the NetQ Telemetry Server and NetQ Notifier, configure the notifier to send the logs to a Logstash instance. In the following example, Logstash is on a host with the IP address 192.168.50.30, using port 51414:

```
# rsyslog - logstash configuration
sed -i '/$netq_notifier_log/a if $programname == "netq-notifier" then
@@192.168.50.30:51414' /etc/rsyslog.d\
/50-netq-notifier.conf
```

Then restart `rsyslog`:

```
root@ts_host:~# systemctl restart rsyslog
```

On the server running Logstash, create a file in `/etc/logstash/conf.d/` called `notifier_logstash.conf`, and paste in the following text, using the IP address and port you specified earlier:

```
root@ts_host:~# vi /etc/logstash/conf.d/notifier_logstash.conf

input {
    syslog {
        type => syslog
        port =>
51414
    }
}
output {
    file {
        path => "/tmp/logstash_notifier.
log"
```

```
    }
}
```

Then restart Logstash:

```
root@logstash_host:~# systemctl restart logstash
```

NetQ Notifier logs now appear in `/tmp/logstash_notifier.log` on the Logstash host.

Exporting to Splunk

To export NetQ Notifier data to Splunk, on the host running the NetQ Telemetry Server and NetQ Notifier, configure the notifier to send the logs to Splunk. In the following example, Splunk is on a host with the IP address 192.168.50.30, using port 51414:

```
# rsyslog - splunk configuration
sed -i ‘/$netq_notifier_log/a if $programname == “netq-notifier” then
@@192.168.50.30:51415’ /etc/rsyslog.d\
/50-netq-notifier.conf
```

Then restart `rsyslog`:

```
root@ts_host:~# systemctl restart rsyslog
```

To configure Splunk, do the following:

1. In Splunk in a browser, choose **Add Data** > **monitor** > **TCP** > **Port**, and set it to *51415*.
2. Click **Next**, then choose **Source Type (syslog)** > **Review** > **Done**.

NetQ Notifier messages now appear in Splunk.

Precisely Locating an Issue on the Network

NetQ helps you locate exactly where you have an issue on your network. Use `netq check` or `netq trace` to locate a fault, then run `netq show changes` to see what could have caused it.

For example, checking the state of the VLANs on your network, you can see where some nodes have mismatched VLANs with their peers:

```
cumulus@leaf01:~$ netq check vlan
Checked Nodes: 25, Checked Links: 775, Failed Nodes: 3, Failed Links: 6 Vlan
and/or PVID mismatch found on following links
Hostname Interface Vlans Peer Peer Interface Peer Vlans Error
-------- ----------- ----------------- ------- ----------------
----------------- -----------------
server01 torbond1 103-106,1000-1005 leaf02 hostbond2 101-106,1000-1005 VLAN
set Mismatch
```

```
server01 torbond1 103-106,1000-1005 leaf01 hostbond2 101-106,1000-1005 VLAN
set Mismatch
server02 torbond1 102-106,1000-1005 leaf02 hostbond3 101-106,1000-1005 VLAN
set Mismatch
server02 torbond1 102-106,1000-1005 leaf01 hostbond3 101-106,1000-1005 VLAN
set Mismatch
server03 torbond1 102-106,1000-1005 leaf04 hostbond2 101-106,1000-1005 VLAN
set Mismatch
server03 torbond1 102-106,1000-1005 leaf03 hostbond2 101-106,1000-1005 VLAN
set Mismatch
```

Detecting Out of Sync Nodes

NetQ includes commands to assist in determining if any nodes are out of sync. Use `netq check ntp` to determine if any nodes are out of sync, and `netq show services ntp` and `netq show ntp` to review the records:

```
cumulus@switch:~$ netq check ntp
Total Nodes: 18, Checked Nodes: 18, Rotten Nodes: 7, Unknown Nodes:
0, failed NTP Nodes: 8
Hostname        NTP Sync    Connect Time
--------------  ----------  -------------------
act-5712-12     Rotten      2017-09-01 09:15:30
act-6712-06     Rotten      2017-09-01 09:16:02
act-7712-04     Rotten      2017-09-01 09:16:05
cel-smallxp-13  no          2017-08-26 01:15:00
dell-s4000-10   Rotten      2017-09-01 09:14:53
dell-s6000-22   Rotten      2017-09-01 09:15:29
mlx-2410-02     Rotten      2017-09-01 09:16:23
qct-ly8-04      Rotten      2017-09-01 09:14:56
```

```
cumulus@switch:~$ netq show services ntp
Matching services records are:
Node             Service       PID  VRF      Enabled    Active
Monitored    Status    Up Time    Last Changed
---------------  ---------  -----  -------  ---------  --------
-----------  --------  ---------  --------------
leaf01           ntp           913  default  yes        yes
no           ok        2h ago     2h ago
leaf02           ntp           911  default  yes        yes
no           ok        2h ago     2h ago
leaf03           ntp           909  default  yes        yes
no           ok        2h ago     2h ago
leaf04           ntp           910  default  yes        yes
no           ok        2h ago     2h ago
oob-mgmt-server  ntp           729  default  yes        yes
no           ok        2h ago     2h ago
```

```
spine01          ntp          909  default  yes        yes
no           ok       2h ago     2h ago
spine02          ntp          909  default  yes        yes
no           ok       2h ago     2h ago
```

```
cumulus@switch:~$ netq show ntp
Hostname        NTP Sync    Current Server    Stratum
--------------  ----------  ----------------  ---------
act-5712-12     -           -                 -
act-6712-06     -           -                 -
act-7712-04     -           -                 -
cel-bs01-fc1    yes         chimera.buffero   2
cel-bs01-fc2    yes         104.156.99.226    2
cel-bs01-fc4    yes         104.156.99.226    2
cel-bs01-lc101  yes         chimera.buffero   2
cel-bs01-lc102  yes         secure.visionne   2
cel-bs01-lc201  yes         chimera.buffero   2
cel-bs01-lc202  yes         secure.visionne   2
cel-bs01-lc301  yes         chimera.buffero   2
cel-bs01-lc401  yes         104.156.99.226    2
cel-bs01-lc402  yes         chimera.buffero   2
cel-smallxp-13  no          -                 16
dell-s4000-10   -           -                 -
dell-s6000-22   -           -                 -
mlx-2410-02     -           -                 -
qct-ly8-04      -           -                 -
{code}
```

> These commands require `systemd` in order to run correctly.

Extending NetQ with Custom Services Using curl

You can extend NetQ to monitor parameters beyond what it monitors by default. For example, you can create a service that runs a series of pings to a known host or between two known hosts to ensure that connectivity is valid. Or you can create a service that curls a URL and sends the output to `/dev/null`. This method works with the NetQ time machine (see page 81) capability regarding `netq show services`.

1. As the sudo user on a node running the NetQ agent, edit the `/etc/netq/config.d/netq-agent-commands.yml` file.
2. Create the custom service. In the example below, the new service is called *web*. You need to specify:
    - The *period* in seconds.
    - The *key* that identifies the name of the service.
    - The command will *run* always. If you do not specify *always* here, you must enable the service manually using `systemctl`.

- The *command* to run. In this case we are using `curl` to ping a web server.

```
cumulus@leaf01:~$ sudo vi /etc/netq/config.d/netq-agent-commands.
yml

user-commands:
  - service: 'misc'
    commands:
      - period: "60"
        key: "config-interfaces"
        command: "/bin/cat /etc/network/interfaces"
      - period: "60"
        key: "config-ntp"
        command: "/bin/cat /etc/ntp.conf"
  - service: "zebra"
    commands:
      - period: "60"
        key: "config-quagga"
        command: ["/usr/bin/vtysh", "-c", "show running-config"]

  - service: "web"
    commands:
      - period: "60"
        key: "webping"
        run: "always"
        command: ['/usr/bin/curl https://cumulusnetworks.com/ -o
/dev/null']
```

3. After you save and close the file, restart the NetQ agent:

```
cumulus@leaf01:~$ netq config agent restart
```

4. You can verify the command is running by checking the `/var/run/netq-agent-running.json` file:

```
cumulus@leaf01:~$ cat /var/run/netq-agent-running.json
{"commands": [{"service": "smond", "always": false, "period":
30, "callback": {}, "command": "/usr/sbin/smonctl -j", "key":
"smonctl-json"}, {"service": "misc", "always": false, "period":
30, "callback": {}, "command": "/usr/sbin/switchd -lic", "key":
"cl-license"}, {"service": "misc", "always": false, "period":
30, "callback": {}, "command": null, "key": "ports"},
{"service": "misc", "always": false, "period": 60, "callback":
null, "command": "/bin/cat /etc/network/interfaces", "key":
"config-interfaces"}, {"service": "misc", "always": false,
"period": 60, "callback": null, "command": "/bin/cat /etc/ntp.
conf", "key": "config-ntp"}, {"service": "lldpd", "always":
false, "period": 30, "callback": {}, "command": "/usr/sbin
/lldpctl -f json", "key": "lldp-neighbor-json"}, {"service":
"mstpd", "always": false, "period": 15, "callback": {},
"command": "/sbin/mstpctl showall json", "key": "mstpctl-bridge-
json"}], "backend": {"server": "10.0.0.165"}}
```

5. And you can see the service is running on the host when you run `netq show services`:

```
cumulus@leaf01:~$ netq show services web
```

Exporting NetQ Data

Data from the NetQ Telemetry Server can be exported in a number of ways. First, you can use the `json` option to output check and show commands to JSON format for parsing in other applications.

For example, you can check the state of BGP on your network with `netq check bgp`:

```
cumulus@leaf01:~$ netq check bgp
Total Nodes: 25, Failed Nodes: 2, Total Sessions: 228 , Failed
Sessions: 2,
Node       Peer Name  Peer Hostname Reason       Time
---------- ---------- ------------- ------------ -------
exit01     swp6.2     spine01       Rotten Agent 15h ago
spine01    swp3.2     exit01        Idle         15h ago
```

When you show the output in JSON format, this same command looks like this:

```
cumulus@leaf01:~$ netq check bgp json
{
    "failedNodes": [
        {
            "node": "exit-1",
            "reason": "Idle",
            "peerId": "firewall-1",
            "neighbor": "swp6.2",
            "time": "15h ago"
        },
        {
            "node": "firewall-1",
            "reason": "Idle",
            "peerId": "exit-1",
            "neighbor": "swp3.2",
            "time": "15h ago"
        }
    ],
    "summary": {
        "checkedNodeCount": 25,
        "failedSessionCount": 2,
        "failedNodeCount": 2,
        "totalSessionCount": 228
    }
}
```

MLAG Troubleshooting with NetQ

This chapter outlines a few scenarios that illustrate how you use NetQ to troubleshoot MLAG on Cumulus Linux switches. Each starts with a log message that indicates the current of MLAG state.

NetQ can monitor many aspects of an MLAG configuration, including:

- Verifying the current state of all nodes
- Verifying the dual connectivity state
- Checking that the peer link is part of the bridge
- Verifying whether MLAG bonds are not bridge members
- Verifying whether the VXLAN interface is not a bridge member
- Checking for remote-side service failures caused by `systemctl`
- Checking for VLAN-VNI mapping mismatches
- Checking for layer 3 MTU mismatches on peerlink subinterfaces
- Checking for VXLAN active-active address inconsistencies
- Verifying that STP priorities are the same across both peers

Contents

This chapter covers ...

All Nodes Are Up

When the MLAG configuration is running smoothly, NetQ Notifier sends out a message that all nodes are up:

```
2017-05-22T23:13:09.683429+00:00 noc-pr netq-notifier[5501]: INFO:
CLAG: All nodes are up
```

Running `netq show clag` confirms this:

```
cumulus@noc-pr:~$ netq show clag
Matching CLAG session records are:
```

```
Node             Peer             SysMac            State Backup
#Bonds #Dual Last Changed
---------------- ---------------- ----------------- ----- ------
------ ----- --------------
mlx-2700-03      torc-11(P)       44:38:39:ff:ff:01 up    up
8      8     26s ago
noc-pr(P)        noc-se           00:01:01:10:00:01 up    up
9      9     39m ago
noc-se           noc-pr(P)        00:01:01:10:00:01 up    up
9      9     40m ago
torc-11(P)       mlx-2700-03      44:38:39:ff:ff:01 up    up
8      8     27s ago
torc-21(P)       torc-22          44:38:39:ff:ff:02 up    up
8      8     2h ago
torc-22          torc-21(P)       44:38:39:ff:ff:02 up    up
8      8     2h ago
```

You can also verify a specific node is up:

```
cumulus@noc-pr:~$ netq mlx-2700-03 show clag
Matching CLAG session records are:
Node             Peer             SysMac            State Backup
#Bonds #Dual Last Changed
---------------- ---------------- ----------------- ----- ------
------ ----- --------------
mlx-2700-03      torc-11(P)       44:38:39:ff:ff:01 up    up
8      8     45s ago
```

Similarly, checking the MLAG state with NetQ also confirms this:

```
cumulus@noc-pr:~$ netq check clag
Checked Nodes: 6, Failed Nodes: 0
```

When you're directly on the switch, you can run `clagctl` to get the state:

```
cumulus@mlx-2700-03:/var/log# sudo clagctl

The peer is alive
Peer Priority, ID, and Role: 4096 00:02:00:00:00:4e primary
Our Priority, ID, and Role: 8192 44:38:39:00:a5:38 secondary
Peer Interface and IP: peerlink-3.4094 169.254.0.9
VxLAN Anycast IP: 36.0.0.20
Backup IP: 27.0.0.20 (active)
System MAC: 44:38:39:ff:ff:01

CLAG Interfaces
```

```
Our Interface    Peer Interface    CLAG Id Conflicts            Proto-
Down Reason
---------------- ---------------- ------- --------------------
-----------------
vx-38            vx-38             -       -                    -
vx-33            vx-33             -       -                    -
hostbond4        hostbond4         1       -                    -
hostbond5        hostbond5         2       -                    -
vx-37            vx-37             -       -                    -
vx-36            vx-36             -       -                    -
vx-35            vx-35             -       -                    -
vx-34            vx-34             -       -                    -
```

Dual-connected Bond Is Down

When dual connectivity is lost in an MLAG configuration, you'll receive messages from NetQ Notifier similar to the following:

```
2017-05-22T23:14:40.290918+00:00 noc-pr netq-notifier[5501]: WARNING:
LINK: 1 link(s) are down. They are: mlx-2700-03 hostbond5
2017-05-22T23:14:53.081480+00:00 noc-pr netq-notifier[5501]: WARNING:
CLAG: 1 node(s) have failures. They are: mlx-2700-03
2017-05-22T23:14:58.161267+00:00 noc-pr netq-notifier[5501]: WARNING:
CLAG: 2 node(s) have failures. They are: mlx-2700-03, torc-11
```

To begin your investigation, show the status of the `clagd` service:

```
cumulus@noc-pr:~$ netq mlx-2700-03 show services clagd

Matching services records are:
Hostname    Service   PID   VRF     Enabled   Active   Monitored
Status   Up Time   Last Changed
----------- --------- ----- ------- --------- -------- -----------
-------- --------- --------------
mlx-2700-03 clagd     5802  default yes       yes      yes
warning  1h ago    2m ago
```

Checking the MLAG status provides the reason for the failure:

```
cumulus@noc-pr:~$ netq check clag
Checked Nodes: 6, Warning Nodes: 2
Node             Reason
----------------
----------------------------------------------------------------------
----
mlx-2700-03      Link Down: hostbond5
torc-11          Singly Attached Bonds: hostbond5
```

You can retrieve the output in JSON format for importing the output into another tool:

```
cumulus@noc-pr:~$ netq check clag json
{
"warningNodes": [
{ "node": "mlx-2700-03", "reason": "Link Down: hostbond5" }
,
{ "node": "torc-11", "reason": "Singly Attached Bonds: hostbond5" }
],
"failedNodes": [],
"summary":
{ "checkedNodeCount": 6, "failedNodeCount": 0, "warningNodeCount": 2 }
}
```

After you fix the issue, you can show the MLAG state to see if all the nodes are up. The notifications from NetQ Notifier indicate all nodes are UP, and the `netq check` flag also indicates there are no failures.

```
cumulus@noc-pr:~$ netq show clag
Matching CLAG session records are:
Node             Peer             SysMac            State Backup
#Bonds #Dual Last Changed
---------------- ---------------- ----------------- ----- ------
------ ----- --------------
mlx-2700-03      torc-11(P)       44:38:39:ff:ff:01 up    up
8      7     52s ago
noc-pr(P)        noc-se           00:01:01:10:00:01 up    up
9      9     27m ago
noc-se           noc-pr(P)        00:01:01:10:00:01 up    up
9      9     27m ago
torc-11(P)       mlx-2700-03      44:38:39:ff:ff:01 up    up
8      7     50s ago
torc-21(P)       torc-22          44:38:39:ff:ff:02 up    up
8      8     1h ago
torc-22          torc-21(P)       44:38:39:ff:ff:02 up    up
8      8     1h ago
```

When you're directly on the switch, you can run `clagctl` to get the state:

```
cumulus@mlx-2700-03:/var/log# sudo clagctl

The peer is alive
Peer Priority, ID, and Role: 4096 00:02:00:00:00:4e primary
Our Priority, ID, and Role: 8192 44:38:39:00:a5:38 secondary
Peer Interface and IP: peerlink-3.4094 169.254.0.9
VxLAN Anycast IP: 36.0.0.20
Backup IP: 27.0.0.20 (active)
System MAC: 44:38:39:ff:ff:01
```

```
CLAG Interfaces
Our Interface    Peer Interface   CLAG Id Conflicts            Proto-
Down Reason
---------------- ---------------- ------- --------------------
-----------------
vx-38            vx-38            -       -                    -
vx-33            vx-33            -       -                    -
hostbond4        hostbond4        1       -                    -
hostbond5        -                2       -                    -
vx-37            vx-37            -       -                    -
vx-36            vx-36            -       -                    -
vx-35            vx-35            -       -                    -
vx-34            vx-34            -       -                    -
```

VXLAN Active-active Device or Interface Is Down

When a VXLAN active-active device or interface in an MLAG configuration is down, log messages also include VXLAN and LNV checks.

```
2017-05-22T23:16:51.517522+00:00 noc-pr netq-notifier[5501]: WARNING:
VXLAN: 2 node(s) have failures. They are: mlx-2700-03, torc-11
2017-05-22T23:16:51.525403+00:00 noc-pr netq-notifier[5501]: WARNING:
LINK: 2 link(s) are down. They are: torc-11 vx-37, mlx-2700-03 vx-37
2017-05-22T23:16:54.194681+00:00 noc-pr netq-notifier[5501]: WARNING:
LNV: 1 node(s) have failures. They are: torc-22
2017-05-22T23:16:59.448755+00:00 noc-pr netq-notifier[5501]: WARNING:
LNV: 3 node(s) have failures. They are: tor-2, torc-21, torc-22
2017-05-22T23:17:04.703044+00:00 noc-pr netq-notifier[5501]: WARNING:
CLAG: 2 node(s) have failures. They are: mlx-2700-03, torc-11
```

To begin your investigation, show the status of the `clagd` service:

```
cumulus@noc-pr:~$ netq mlx-2700-03 show service clagd
Matching services records are:
Node        Service   PID   VRF     Enabled   Active   Monitored
Status   Up Time   Last Changed
----------- --------- ----- ------- --------- -------- -----------
-------- --------- --------------
mlx-2700-03 clagd     5802  default yes       yes      yes
error    2h ago    3m ago
```

Checking the MLAG status provides the reason for the failure:

```
cumulus@noc-pr:~$ netq check clag
Checked Nodes: 6, Warning Nodes: 2, Failed Nodes: 2
Node             Reason
```

```
----------------
----------------------------------------------------------------------
----
mlx-2700-03      Protodown Bonds: vx-37:vxlan-single
torc-11          Protodown Bonds: vx-37:vxlan-single
```

You can retrieve the output in JSON format for importing the output into another tool:

```
cumulus@noc-pr:~$ netq check clag json
{
"failedNodes": [
{ "node": "mlx-2700-03", "reason": "Protodown Bonds: vx-37:vxlan-
single" }
,
{ "node": "torc-11", "reason": "Protodown Bonds: vx-37:vxlan-single" }
],
"summary":
{ "checkedNodeCount": 6, "failedNodeCount": 2, "warningNodeCount": 2 }
}
```

After you fix the issue, you can show the MLAG state to see if all the nodes are up:

```
cumulus@noc-pr:~$ netq show clag
Matching CLAG session records are:
Node             Peer             SysMac            State Backup
#Bonds #Dual Last Changed
---------------- ---------------- ----------------- ----- ------
------ ----- --------------
mlx-2700-03      torc-11(P)       44:38:39:ff:ff:01 up    up
8      7     52s ago
noc-pr(P)        noc-se           00:01:01:10:00:01 up    up
9      9     27m ago
noc-se           noc-pr(P)        00:01:01:10:00:01 up    up
9      9     27m ago
torc-11(P)       mlx-2700-03      44:38:39:ff:ff:01 up    up
8      7     50s ago
torc-21(P)       torc-22          44:38:39:ff:ff:02 up    up
8      8     1h ago
torc-22          torc-21(P)       44:38:39:ff:ff:02 up    up
8      8     1h ago
```

When you're directly on the switch, you can run `clagctl` to get the state:

```
cumulus@mlx-2700-03:/var/log# sudo clagctl

The peer is alive
Peer Priority, ID, and Role: 4096 00:02:00:00:00:4e primary
```

```
Our Priority, ID, and Role: 8192 44:38:39:00:a5:38 secondary
Peer Interface and IP: peerlink-3.4094 169.254.0.9
VxLAN Anycast IP: 36.0.0.20
Backup IP: 27.0.0.20 (active)
System MAC: 44:38:39:ff:ff:01

CLAG Interfaces
Our Interface    Peer Interface   CLAG Id Conflicts            Proto-
Down Reason
---------------- ---------------- ------- --------------------
-----------------
vx-38            vx-38            -       -                    -
vx-33            vx-33            -       -                    -
hostbond4        hostbond4        1       -                    -
hostbond5        hostbond5        2       -                    -
vx-37            -                -       -                    vxlan-
single
vx-36            vx-36            -       -                    -
vx-35            vx-35            -       -                    -
vx-34            vx-34            -       -                    -
```

Remote-side clagd Stopped by systemctl Command

In the event the `clagd` service is stopped via the `systemctl` command, NetQ Notifier sends messages similar to the following:

```
2017-05-22T23:51:19.539033+00:00 noc-pr netq-notifier[5501]: WARNING:
VXLAN: 1 node(s) have failures. They are: torc-11
2017-05-22T23:51:19.622379+00:00 noc-pr netq-notifier[5501]: WARNING:
LINK: 2 link(s) flapped and are down. They are: torc-11 hostbond5,
torc-11 hostbond4
2017-05-22T23:51:19.622922+00:00 noc-pr netq-notifier[5501]: WARNING:
LINK: 23 link(s) are down. They are: torc-11 VlanA-1-104-v0, torc-11
VlanA-1-101-v0, torc-11 VlanA-1, torc-11 vx-33, torc-11 vx-36, torc-
11 vx-37, torc-11 vx-34, torc-11 vx-35, torc-11 swp7, torc-11 VlanA-1-
102-v0, torc-11 VlanA-1-103-v0, torc-11 VlanA-1-100-v0, torc-11 VlanA-
1-106-v0, torc-11 swp8, torc-11 VlanA-1.106, torc-11 VlanA-1.105,
torc-11 VlanA-1.104, torc-11 VlanA-1.103, torc-11 VlanA-1.102, torc-
11 VlanA-1.101, torc-11 VlanA-1.100, torc-11 VlanA-1-105-v0, torc-11
vx-38
2017-05-22T23:51:27.696572+00:00 noc-pr netq-notifier[5501]: INFO:
LINK: 15 link(s) are up. They are: torc-11 VlanA-1.106, torc-11 VlanA-
1-104-v0, torc-11 VlanA-1.104, torc-11 VlanA-1.103, torc-11 VlanA-
1.101, torc-11 VlanA-1-100-v0, torc-11 VlanA-1.100, torc-11 VlanA-
1.102, torc-11 VlanA-1-101-v0, torc-11 VlanA-1-102-v0, torc-11 VlanA-
1.105, torc-11 VlanA-1-103-v0, torc-11 VlanA-1-106-v0, torc-11 VlanA-
1, torc-11 VlanA-1-105-v0
2017-05-22T23:51:30.863789+00:00 noc-pr netq-notifier[5501]: WARNING:
LNV: 1 node(s) have failures. They are: torc-11
```

```
2017-05-22T23:51:36.156708+00:00 noc-pr netq-notifier[5501]: WARNING:
CLAG: 2 node(s) have failures. They are: mlx-2700-03, torc-11
2017-05-22T23:51:36.183638+00:00 noc-pr netq-notifier[5501]: WARNING:
LNV: 2 node(s) have failures. They are: spine-2, torc-11
2017-05-22T23:51:41.444670+00:00 noc-pr netq-notifier[5501]: WARNING:
LNV: 1 node(s) have failures. They are: torc-11
```

Showing the MLAG state reveals which nodes are down:

```
cumulus@noc-pr:~$ netq show clag
Matching CLAG session records are:
Node             Peer             SysMac            State Backup
#Bonds #Dual Last Changed
---------------- ---------------- ----------------- ----- ------
------ ----- --------------
mlx-2700-03                       44:38:39:ff:ff:01 down  down
8      0     33s ago
noc-pr(P)        noc-se           00:01:01:10:00:01 up    up
9      9     1h ago
noc-se           noc-pr(P)        00:01:01:10:00:01 up    up
9      9     1h ago
torc-11                           44:38:39:ff:ff:01 down  n/a
0      0     32s ago
torc-21(P)       torc-22          44:38:39:ff:ff:02 up    up
8      8     2h ago
torc-22          torc-21(P)       44:38:39:ff:ff:02 up    up
8      8     2h ago
```

Checking the MLAG status provides the reason for the failure:

```
cumulus@noc-pr:~$ netq check clag
Checked Nodes: 6, Warning Nodes: 1, Failed Nodes: 2
Node             Reason
----------------
----------------------------------------------------------------------
----
mlx-2700-03      Peer Connectivity failed
torc-11          Peer Connectivity failed
```

You can retrieve the output in JSON format for importing the output into another tool:

```
cumulus@noc-pr:~$ netq check clag json
{
"failedNodes": [
{ "node": "mlx-2700-03", "reason": "Peer Connectivity failed" }
,
{ "node": "torc-11", "reason": "Peer Connectivity failed" }
],
"summary":
{ "checkedNodeCount": 6, "failedNodeCount": 2, "warningNodeCount": 1 }
}
```

When you're directly on the switch, you can run `clagctl` to get the state:

```
root@mlx-2700-03:/var/log# clagctl

The peer is not alive
Our Priority, ID, and Role: 8192 44:38:39:00:a5:38 primary
Peer Interface and IP: peerlink-3.4094 169.254.0.9
VxLAN Anycast IP: 36.0.0.20
Backup IP: 27.0.0.20 (inactive)
System MAC: 44:38:39:ff:ff:01

CLAG Interfaces
Our Interface    Peer Interface   CLAG Id Conflicts            Proto-
Down Reason
---------------- ---------------- ------- --------------------
-----------------
vx-38            -                -       -                    -
vx-33            -                -       -                    -
hostbond4        -                1       -                    -
hostbond5        -                2       -                    -
vx-37            -                -       -                    -
vx-36            -                -       -                    -
vx-35            -                -       -                    -
vx-34            -                -       -                    -
```

Performing Network Diagnostics

NetQ provides users with the ability to go back in time to replay the network state, see fabric-wide event changelogs and root cause state deviations. The NetQ Telemetry Server maintains data collected by NetQ agents in a time-series database, making fabric-wide events available for analysis. This enables you to replay and analyze network-wide events for better visibility and to correlate patterns. This allows for root-cause analysis and optimization of network configs for the future.

Contents

This chapter covers ...

Diagnosing an Event after It Occurs

NetQ provides a number of commands to enable you to diagnose past events.

NetQ Notifier records network events and sends them to `syslog`, or another third-party service like PagerDuty or Slack. You can use `netq show changes` to look for any changes made to the runtime configuration that may have triggered the alert, then use `netq trace` to track the connection between the nodes.

The `netq trace` command traces the route of an IP or MAC address from one endpoint to another. It works across bridged, routed and VXLAN connections, computing the path using available data instead of sending real traffic — this way, it can be run from anywhere. It performs MTU and VLAN consistency checks for every link along the path.

For example, say you get an alert about a BGP session failure. You can quickly run `netq check bgp` to determine what sessions failed:

```
cumulus@leaf01:~$ netq check bgp
Total Nodes: 25, Failed Nodes: 4, Total Sessions: 228 , Failed
Sessions: 6,
Node        Neighbor    Peer ID     Reason    Time
----------  ----------  ----------  --------  -------
exit01      swp7.2      spine02     Idle      53m ago
exit01      swp7.3      spine02     Idle      53m ago
exit02      swp6.4      spine01     Idle      53m ago
spine01     swp4.4      exit02      Idle      53m ago
spine02     swp3.2      exit01      Idle      53m ago
spine02     swp3.3      exit01      Idle      53m ago
```

You can run a trace from spine01 to leaf02, which has the IP address 10.1.20.252:

```
cumulus@leaf01:~$ netq trace 10.1.20.252 from spine01 around 5m
spine01 -- spine01:swp1 -- leaf01:vlan20
        -- spine01:swp2 -- leaf02:vlan20
```

Then you can check what's changed on the network to help you identify the problem. Notice the nodes in a *Failed* state filter to the top of the list:

```
cumulus@leaf01:~$ netq show bgp changes
Matching BGP Session records are:
Node             Neighbor                     VRF
ASN        Peer ASN   State  PfxRx        DbState  Last Changed
---------------- ---------------------------- ----------------
---------- ---------- ------ ------------ -------- ------------
leaf04           swp52(spine02)               default
64516      65000      Estd   6            Add      5h ago
leaf03           swp52(spine02)               default
64515      65000      Estd   5            Add      5h ago
leaf01           swp52(spine02)               default
64513      65000      Estd   5            Add      5h ago
leaf02           swp52(spine02)               default
64514      65000      Estd   6            Add      5h ago
spine02          swp2(leaf02)                 default
65000      64514      Estd   2            Add      5h ago
spine02          swp3(leaf03)                 default
65000      64515      Estd   2            Add      5h ago
spine02          swp1(leaf01)                 default
65000      64513      Estd   2            Add      5h ago
spine02          swp4(leaf04)                 default
65000      64516      Estd   2            Add      5h ago
leaf04           swp51(spine01)               default
64516      65000      Estd   6            Add      5h ago
spine01          swp2(leaf02)                 default
65000      64514      Estd   2            Add      5h ago
leaf02           swp51(spine01)               default
64514      65000      Estd   6            Add      5h ago
leaf01           swp51(spine01)               default
64513      65000      Estd   5            Add      5h ago
spine01          swp1(leaf01)                 default
65000      64513      Estd   2            Add      5h ago
spine01          swp4(leaf04)                 default
65000      64516      Estd   2            Add      5h ago
leaf03           swp51(spine01)               default
64515      65000      Estd   5            Add      5h ago
spine01          swp3(leaf03)                 default
65000      64515      Estd   2            Add      5h ago
```

Using NetQ as a Time Machine

With NetQ, you can travel back to a specific point in time or a range of times to help you isolate errors and issues.

For example, if you think you had an issue with your sensors last night, you can check the sensors on all your nodes around the time you think the issue occurred:

```
cumulus@leaf01:~$ netq check sensors around 12h
Total Nodes: 25, Failed Nodes: 0, Checked Sensors: 221, Failed Sensors:
0
```

Or you can specify a range of times using the **`between`** option. The units of time you can specify are second (*s*), minutes (*m*), hours (*h*) and days (*d*). Always specify the most recent time first, then the more distant time. For example, to see the changes made to the network between the past minute and 5 minutes ago, you'd run:

```
cumulus@leaf01:~$ netq show changes between 1m and 5m
No changes to specified interfaces found
No changes to interface addresses found
Matching MAC table records are:
Origin MAC                  VLAN     Node Name        Egress
Port      DbState Last Changed
------ -------------------- -------- ----------------
---------------- ------- --------------
1      44:38:39:00:00:17    20       leaf02           bond-
swp1         Add      3m ago
1      44:38:39:00:00:17    20       leaf01           bond-
swp1         Add      3m ago
1      44:38:39:00:00:32    20       leaf03           bond-
swp2         Add      4m ago
1      44:38:39:00:00:32    20       leaf04           bond-
swp2         Add      4m ago
1      44:38:39:00:00:15    20       leaf01           bond-
swp2         Del      4m ago
1      44:38:39:00:00:15    20       leaf02           bond-
swp2         Del      4m ago
1      44:38:39:00:00:32    20       leaf03           bond-
swp2         Del      4m ago
1      44:38:39:00:00:32    20       leaf04           bond-
swp2         Del      4m ago
1      44:38:39:00:00:17    20       leaf02           bond-
swp1         Del      4m ago
```

```
1      44:38:39:00:00:17    20       leaf01           bond-
swp1        Del     4m ago
Matching IP route records are:
Origin Table            IP
Node             Nexthops                 DbState        Last Changed
------ ---------------- --------------------------------
---------------- ------------------------ -------------- ------------
0      default          ff02::1:ff00:5c/128
spine01          swp1                     Del            3m ago
0      default          ff02::1:ff00:12/128
leaf02           eth0                     Del            3m ago
No changes to IP neighbor table found
No changes to BGP sessions found
No changes to CLAG session found
No changes to LNV session found
```

You can travel back in time 5 minutes and run a trace from spine02 to exit01, which has the IP address 27.0.0.1:

```
cumulus@leaf01:~$ netq trace 27.0.0.1 from spine02 around 5m
Detected Routing Loop. Node exit01 (now via Local Node exit01 and
Ports swp6 <==> Remote  Node/s spine01 and Ports swp3) visited twice.
Detected Routing Loop. Node spine02 (now via mac:00:02:00:00:00:15)
visited twice.
spine02 -- spine02:swp3 -- exit01:swp6.4 -- exit01:swp3 -- exit01
                        -- spine02:swp7  -- spine02
```

How Far Back in Time Can You Travel?

The NetQ Telemetry Server stores an amount of data limited by a few factors:

- The size of the network: The larger the network, the more complex it is because of the number of routes and nodes.
- The amount of memory in the telemetry server. The more memory, the more data you can retrieve.
- The types of nodes you are monitoring with NetQ. You can monitor just network switches, or switches and hosts, or switches, hosts and containers.
- The number of changes in the network over time.

In general, you can expect to be able to query to a point back in time follows:

Using NetQ to Monitor ...	Data Point	Small Network	Medium Network	Large Network
Switches only	Telemetry server memory minimum	8G	16G	24G
	Years of data retrievable	25.5	17.4	15.6
Switches and Linux hosts		16G	32G	48G

Using NetQ to Monitor ...	Data Point	Small Network	Medium Network	Large Network
	Telemetry server memory minimum			
	Years of data retrievable	4.3	2.7	2.4
Switches, Linux hosts and containers	Telemetry server memory minimum	32G	64G	96G
	Years of data retrievable	2.9	1.5	1.2

The sizing numbers in this table rely on the following assumptions and definitions:

- The types of configuration and operational data being recorded:
  - Switches and hosts: Interfaces; MLAG; LLDP-enabled links; IPv4/v6 addresses, neighbors and routes; BGP sessions; link flaps per day; IPv4/v6 route flaps per day; BGP and MLAG session flaps.
  - Containers: Exposed ports, networks, container flaps per day.
- A small network has 20 racks with 40 leaf nodes, 10 spine nodes and 40 hosts per rack.
- A medium network has 60 racks with 120 leaf nodes, 30 spine nodes and 40 hosts per rack.
- A large network has 100 racks with 200 leaf nodes, 50 spine nodes and 40 hosts per rack.
- The hosts are dual-attached.
- The network is oversubscribed 4:1.
- Adding more memory to the telemetry server allows you to go back even further in time, in a near linear fashion. So doubling the memory should double the range.

Using trace in a VRF

The `netq trace` command works with VRFs as well:

```
cumulus@leaf01:~$ netq trace 10.1.20.252 from spine01 vrf default
around 5m
spine01 -- spine01:swp1 -- leaf01:vlan20
        -- spine01:swp2 -- leaf02:vlan20
```

Monitoring the Physical Layer

NetQ provides the ability to monitor at layer 1 — the physical cabling connecting the nodes of the network fabric. This includes the ability to:

- Manage the inventory: show all optics, determine all the plugged and empty ports, figure out optics expenses by auditing by vendor
- Validate configurations: check peer connections, discover any misconfigured ports, peers, or unsupported modules, check for link flaps
- Investigate errors: including CRC errors

NetQ uses LLDP to collect port information. It can also identify peer ports for DACs and AOCs without using LLDP or even if the link is not UP.

Managing the Layer 1 Inventory

NetQ provides detailed information about the cabling on a given node:

```
cumulus@cel-smallxp-13:~$ netq show interfaces physical
Matching cables records are:
Hostname         Interface State Speed   AutoNeg Module
Vendor           Part No          Last Changed
---------------- --------- ----- ------- ------- ---------
---------------- ---------------- --------------
act-5712-12      swp36     down  1G      off     SFP
AVAGO            AFBR-5715PZ-JU1  9:06:10 ago
act-5712-12      swp27     up    10G     off     SFP
OEM              SFP-10GB-LR      17:13:23 ago
act-5712-12      swp13     up    10G     off     SFP
JDSU             PLRXPLSCS4322N   17:13:44 ago
act-5712-12      swp52     up    40G     off     QSFP+
Mellanox         MC2210130-002    17:13:28 ago
act-5712-12      swp34     down  10G     off     empty     n
/a              n/a              17:13:47 ago
act-5712-12      swp37     up    1G      off     SFP       FINISAR
CORP.    FCLF8522P2BTL    17:13:48 ago
act-5712-12      swp17     up    1G      off     SFP       FINISAR
CORP.    FTLF1318P3BTL    17:13:42 ago
act-5712-12      swp35     down  1G      off     SFP       CISCO-
AGILENT    QFBR-5766LP      9:06:10 ago
act-5712-12      eth0      up    1G      on      RJ45      n
/a              n/a              17:13:51 ago
act-5712-12      swp8      up    10G     off     SFP
Mellanox         MC2609130-003    17:13:54 ago
act-5712-12      swp51s3   up    10G     off     QSFP+
CISCO            AFBR-7IER05Z-CS1 17:13:32 ago
act-5712-12      swp50s2   up    10G     off     QSFP+
Mellanox         MC2609130-003    17:13:39 ago
```

```
act-5712-12      swp21     up    10G     off     SFP
FIBERSTORE       SFP-10GLR-31     17:13:27 ago
act-5712-12      swp42     up    1G      off     SFP
OEM              SFP-GLC-T        17:13:17 ago
act-5712-12      swp5      up    10G     off     SFP
Mellanox         MC2609130-003    17:13:41 ago
act-5712-12      swp39     up    1G      off     SFP       FINISAR
CORP.    FCLF8522P2BTL    17:13:55 ago
act-5712-12      swp7      up    10G     off     SFP
Mellanox         MC2609130-003    17:13:52 ago
act-5712-12      swp45     up    10G     off     SFP
Mellanox         MC3309130-001    17:13:14 ago
act-5712-12      swp9      up    10G     off     SFP       CISCO-
AVAGO      AFBR-7IER05Z-CS1 17:13:54 ago
act-5712-12      swp48     up    10G     off     SFP
Mellanox         MC3309130-001    17:13:19 ago
act-5712-12      swp2      down  1G      off     SFP       FINISAR
CORP.    FCLF8520P2BTL    13:04:25 ago
act-5712-12      swp41     up    1G      off     SFP       FINISAR
CORP.    FCLF8522P2BTL    17:13:17 ago
act-5712-12      swp50s3   up    10G     off     QSFP+
Mellanox         MC2609130-003    17:13:40 ago

...
```

By running the `netq NODE show interfaces physical module` command, you can see detailed information about the modules on a given node:

```
cumulus@cel-smallxp-13:~$ netq act-5712-12 show interfaces physical
module
Matching cables records are:
Hostname         Interface Module    Vendor           Part
No          Serial No        Transceiver      Connector        Length
Last Changed
---------------- --------- --------- ----------------
---------------- ---------------- ---------------- ----------------
------ --------------
act-5712-12      swp36     SFP       AVAGO            AFBR-5715PZ-
JU1  AM1113SK1A6      1000Base-SX,Mult LC                550m,  9:10:
28 ago

imode,                            270m

50um (M5),Multim

ode,

62.5um (M6),Shor

twave laser w/o
```

```
OFC (SN),interme

diate distance (

I)
act-5712-12      swp27     SFP       OEM              SFP-10GB-
LR      ACSLR130408      10G Base-LR      LC               10km,  17:
17:41 ago

10000m
act-5712-12      swp13     SFP       JDSU
PLRXPLSCS4322N   CG03UF45M        10G Base-SR,Mult LC
80m,   17:18:02 ago

imode,                            30m,

50um (M5),Multim                  300m

ode,

62.5um (M6),Shor

twave laser w/o

OFC (SN),interme

diate distance (

I)
act-5712-12      swp52     QSFP+     Mellanox         MC2210130-
002    MT1539VS03755    40G Base-CR4     n/a              2m     17:
17:46 ago
act-5712-12      swp34     empty     n/a              n
/a              n/a              n/a              n/a              n
/a    17:18:05 ago
act-5712-12      swp37     SFP       FINISAR CORP.
FCLF8522P2BTL    PTN1VH2          1000Base-T       RJ45
100m   17:18:05 ago
act-5712-12      swp17     SFP       FINISAR CORP.
FTLF1318P3BTL    PUC00GG          1000Base-LX,Long LC
10km,  17:17:59 ago

wave laser (LC),                  10000m

Longwave laser (

LL),Single Mode

(SM),long distan

ce (L)
```

```
act-5712-12      swp35     SFP       CISCO-AGILENT    QFBR-
5766LP      AGS10335337      1000Base-SX      LC               550m,
9:10:28 ago

270m
act-5712-12      eth0      RJ45      n/a              n
/a              n/a              n/a              n/a              n
/a    17:18:09 ago
act-5712-12      swp8      SFP       Mellanox         MC2609130-
003     MT1507VS05177    1000Base-CX,Copp Copper pigtail   3m     17:
18:12 ago

er Passive,Twin

Axial Pair (TW)
act-5712-12      swp51s3   QSFP+     CISCO            AFBR-7IER05Z-
CS1 AVE1823402U      n/a             n/a              5m     17:17:
49 ago
act-5712-12      swp50s2   QSFP+     Mellanox         MC2609130-
003     MT1507VS05177    40G Base-CR4,Twi n/a              3m     17:
17:57 ago

n Axial Pair (TW

)
...
```

To see empty ports on a node, use the `netq NODE show interfaces physical empty` command:

```
cumulus@cel-smallxp-13:~$ netq act-5712-12 show interfaces physical
empty
Matching cables records are:
Hostname         Interface State Speed   AutoNeg Module
Vendor           Part No          Last Changed
---------------- --------- ----- ------- ------- ---------
---------------- ---------------- --------------
act-5712-12      swp34     down  10G     off     empty     n
/a              n/a              17:19:10 ago
act-5712-12      swp4      down  10G     off     empty     n
/a              n/a              17:19:14 ago
act-5712-12      swp46     down  10G     off     empty     n
/a              n/a              17:18:42 ago
act-5712-12      swp32     down  10G     off     empty     n
/a              n/a              17:19:03 ago
act-5712-12      swp3      down  10G     off     empty     n
/a              n/a              17:19:15 ago
act-5712-12      swp31     down  10G     off     empty     n
/a              n/a              17:19:12 ago
```

Similarly, to see plugged in ports, run the `netq NODE show interfaces physical plugged` command:

```
cumulus@cel-smallxp-13:~$ netq act-5712-12 show interfaces physical
plugged
Matching cables records are:
Hostname         Interface State Speed   AutoNeg Module
Vendor           Part No           Last Changed
---------------- --------- ----- ------- ------- ---------
---------------- --------------- --------------
act-5712-12      swp36     down  1G      off     SFP
AVAGO            AFBR-5715PZ-JU1  9:12:54 ago
act-5712-12      swp27     up    10G     off     SFP
OEM              SFP-10GB-LR      17:20:07 ago
act-5712-12      swp13     up    10G     off     SFP
JDSU             PLRXPLSCS4322N   17:20:28 ago
act-5712-12      swp52     up    40G     off     QSFP+
Mellanox         MC2210130-002    17:20:12 ago
act-5712-12      swp37     up    1G      off     SFP       FINISAR
CORP.    FCLF8522P2BTL    17:20:32 ago
act-5712-12      swp17     up    1G      off     SFP       FINISAR
CORP.    FTLF1318P3BTL    17:20:26 ago
act-5712-12      swp35     down  1G      off     SFP       CISCO-
AGILENT    QFBR-5766LP      9:12:54 ago
act-5712-12      eth0      up    1G      on      RJ45      n
/a              n/a              17:20:35 ago
act-5712-12      swp8      up    10G     off     SFP
Mellanox         MC2609130-003    17:20:38 ago
act-5712-12      swp51s3   up    10G     off     QSFP+
CISCO            AFBR-7IER05Z-CS1 17:20:16 ago
act-5712-12      swp50s2   up    10G     off     QSFP+
Mellanox         MC2609130-003    17:20:23 ago
act-5712-12      swp21     up    10G     off     SFP
FIBERSTORE       SFP-10GLR-31     17:20:11 ago
act-5712-12      swp42     up    1G      off     SFP
OEM              SFP-GLC-T        17:20:01 ago
act-5712-12      swp5      up    10G     off     SFP
Mellanox         MC2609130-003    17:20:25 ago
act-5712-12      swp39     up    1G      off     SFP       FINISAR
CORP.    FCLF8522P2BTL    17:20:39 ago
act-5712-12      swp7      up    10G     off     SFP
Mellanox         MC2609130-003    17:20:36 ago
act-5712-12      swp45     up    10G     off     SFP
Mellanox         MC3309130-001    17:19:58 ago
act-5712-12      swp9      up    10G     off     SFP       CISCO-
AVAGO      AFBR-7IER05Z-CS1 17:20:38 ago
act-5712-12      swp48     up    10G     off     SFP
Mellanox         MC3309130-001    17:20:03 ago
act-5712-12      swp2      down  1G      off     SFP       FINISAR
CORP.    FCLF8520P2BTL    13:11:09 ago
```

```
act-5712-12      swp41     up    1G      off     SFP       FINISAR
CORP.    FCLF8522P2BTL    17:20:01 ago
act-5712-12      swp50s3   up    10G     off     QSFP+
Mellanox         MC2609130-003    17:20:24 ago
act-5712-12      swp43     up    10G     off     SFP
OEM              SFP-H10GB-CU1M   17:20:02 ago
act-5712-12      swp40     up    1G      off     SFP       FINISAR
CORP.    FCLF8522P2BTL    17:20:00 ago
act-5712-12      swp24     up    1G      off     SFP       FINISAR
CORP.    FTLF1318P3BTL    17:20:08 ago


...
```

By searching on specific vendors, you can run a cost analysis of your network:

```
cumulus@cel-smallxp-13:~$ netq act-5712-12 show interfaces physical
vendor AVAGO
Matching cables records are:
Hostname         Interface State Speed   AutoNeg Module
Vendor           Part No          Last Changed
---------------- --------- ----- ------- ------- ---------
---------------- --------------- -------------
act-5712-12      swp36     down  1G      off     SFP
AVAGO            AFBR-5715PZ-JU1   9:13:53 ago
act-5712-12      swp29     up    1G      off     SFP
AVAGO            AFCT-5715PZ-JU1  17:21:04 ago
```

You can also search on part numbers using `netq NODE show interfaces physical model PARTNUMBER`:

```
cumulus@cel-smallxp-13:~$ netq act-5712-12 show interfaces physical
model SFP-H10GB-CU1M
Matching cables records are:
Hostname         Interface State Speed   AutoNeg Module
Vendor           Part No          Last Changed
---------------- --------- ----- ------- ------- ---------
---------------- --------------- -------------
act-5712-12      swp43     up    10G     off     SFP
OEM              SFP-H10GB-CU1M   17:22:10 ago
act-5712-12      swp44     up    10G     off     SFP
OEM              SFP-H10GB-CU1M   17:22:06 ago
act-5712-12      swp14     up    10G     off     SFP
OEM              SFP-H10GB-CU1M   17:22:36 ago
```

Checking Peer Connections

NetQ checks peer connections using LLDP. For DACs and AOCs, NetQ determines the peers using their serial numbers in the port EEPROMs, even if the link is not UP.

```
cumulus@cel-smallxp-13:~$ netq act-5712-12 show interfaces physical
peer
Matching cables records are:
Hostname         Interface Peer Hostname    Peer Interface State
Message
---------------- --------- ---------------- -------------- -----
----------------------------
act-5712-12      swp27     act-5712-12      swp53s0
up
act-5712-12      swp13     cel-red-08       swp6
up
act-5712-12      swp52     dell-s6000-22    swp32
up
act-5712-12      swp34                                     down  Port
cage empty
act-5712-12      swp37     dell-s4000-10    swp37
up
act-5712-12      swp17     cel-red-08       swp1
up


...

act-5712-12      swp11     act-5712-12      swp51s1
up
act-5712-12      swp10     act-5712-12      swp51s2
up
act-5712-12      swp3                                      down  Port
cage empty
act-5712-12      swp49     act-6712-06      swp32
up
act-5712-12      swp12     act-5712-12      swp51s3
up
act-5712-12      swp23     cel-red-08       swp5
up
act-5712-12      swp31                                     down  Port
cage empty
act-5712-12      swp38     dell-s4000-10    swp38
up
act-5712-12      swp47     cel-red-08       swp45
up
act-5712-12      swp51s0   act-5712-12      swp9
up
```

```
act-5712-12      swp50s1   act-5712-12      swp7
up
act-5712-12      swp53s2                                   down  Peer
port unknown
act-5712-12      swp53s3                                   down  Peer
port unknown
act-5712-12      swp25                                     down  Peer
port unknown
...
```

You can get peer data for a specific port:

```
cumulus@cel-smallxp-13:~$ netq cel-smallxp-13 show interfaces
physical swp31 peer
Matching cables records are:
Hostname         Interface Peer Hostname     Peer Interface State
Message
---------------- --------- ---------------- -------------- -----
----------------------------
cel-smallxp-13   swp31     cel-smallxp-13   swp32          up
```

Layer 1 Configuration Checks

You can verify that the following configurations are the same on both ends of two peer interfaces:

- Admin state
- Operational state
- Autonegotiation setting
- Link speed

You can also determine whether a link is flapping or if verify whether both peers are the correct peers. If NetQ can't determine the peer, the port is marked as *unverified*.

To do a layer 1 configuration check, you run the `netq check interfaces` command, which only checks physical interfaces, not bridges, bonds or other software constructs.

```
cumulus@cel-smallxp-13:~$ netq check interfaces
Checked Nodes: 18, Failed Nodes: 8
Checked Ports: 741, Failed Ports: 1, Unverified Ports: 414
Hostname         Interface Peer Hostname     Peer Interface Message
---------------- --------- ---------------- --------------
--------------------------------
act-5712-12                -                -              Rotten
Agent
act-6712-06                -                -              Rotten
Agent
act-7712-04                -                -              Rotten
Agent
```

```
cel-smallxp-13   swp2      cel-smallxp-13   swp1           State
mismatch (up, down)
dell-s4000-10              -                -              Rotten
Agent
dell-s6000-22              -                -              Rotten
Agent
mlx-2410-02                -                -              Rotten
Agent
qct-ly8-04                 -                -              Rotten
Agent
```

Use the *and* keyword to check the connections between two peers:

```
cumulus@cel-smallxp-13:~$ netq check interfaces cel-smallxp-13 swp2
and mlx-2410-02 swp54
Checked Nodes: 1, Failed Nodes: 1
Checked Ports: 1, Failed Ports: 1, Unverified Ports: 0
Hostname         Interface Peer Hostname    Peer Interface Message
---------------- --------- ---------------- --------------
--------------------------------
cel-smallxp-13   swp2      mlx-2410-02      swp54          Incorrect
peer specified. Real p
                                                           eer is cel-
smallxp-13 swp1
cumulus@cel-smallxp-13:~$ netq check interfaces cel-smallxp-13 swp1
and mlx-2410-02 swp54
Checked Nodes: 1, Failed Nodes: 0
Checked Ports: 1, Failed Ports: 0, Unverified Ports: 0
```

If a link is flapping, NetQ indicates this in a message:

```
cumulus@cel-smallxp-13:~$ netq check interfaces
Checked Nodes: 18, Failed Nodes: 8
Checked Ports: 741, Failed Ports: 1, Unverified Ports: 414
Hostname         Interface Peer Hostname    Peer Interface Message
---------------- --------- ---------------- --------------
--------------------------------
dell-s6000-22              -                -              Link
flapped 11 times in last 5

mins
```

Monitoring Linux Hosts with NetQ

Running NetQ on Linux hosts provides unprecedented network visibility, giving the network operator a complete view of the entire infastrucutre’s network connectivity instead of just from the network devices.

The NetQ Agent is supported on the following Linux hosts:

- CentOS 7
- Red Hat Enterprise Linux 7.1
- Ubuntu 16.04

You need to install the OS-specific NetQ metapack on every host you want to monitor with NetQ. For more information, see the Host Pack user guide.

Monitoring Container Environments with NetQ

The NetQ Agent monitors Docker and Mesos Universal Container Runtime containers the same way it monitors physical servers (see page 92). There is no special implementation. The NetQ Agent pulls Docker data from the container as it would pull data from a Cumulus Linux switch or Linux host.

For more information, see the Host Pack user guide.

Using NetQ Virtual Environments

You can try out NetQ in two different virtual environments. These environments enable you to try out NetQ on your own, or to test/validate updates to your network before deploying them into production. They are:

- Cumulus in the Cloud, which is a virtual data center that includes the NetQ telemetry server for monitoring your Cumulus in the Cloud instance.
- The Cumulus Networks GitHub site has a virtual NetQ demo environment. The environment uses a series of Cumulus VX virtual machines built using the Cumulus Networks reference topology, which requires Vagrant and a hypervisor like VirtualBox. The GitHub site provides information on downloading and installing the hypervisor.

Restoring from Backups with NetQ

NetQ automatically takes snapshots of the NetQ Telemetry Server at five minute intervals. These snapshots can be used to restore to a previous configuration, or to diagnose existing issues with the configuration. For information regarding how long snapshot data is stored, refer to the How Far Back in Time Can You Travel (see page 82) section.

> ⚠ There are no configuration steps required for setting up backups. NetQ snapshots occur automatically.

Backup Locations

Backup snapshots can be found in two file locations on the NetQ Telemetry Server:

- `/var/log/backup`: The latest, or master, snapshot.
- `/var/backup`: Directory of previous snapshots.

Use Cases

There are several use-cases in which restoring from a snapshot may be warranted. These include:

- Upgrading the physical server to increase available resources.
- Migrating from one physical server to another.
- A NetQ Telemetry Server crash.

Restoring from a Snapshot

The following steps outline the process for restoring the NetQ Telemetry Server from a snapshot:

1. Extract the GZip snapshot you wish to restore into a file called `appendonly.aof`. The example command below uses the master snapshot:

   ```
   root@cumulus:~# gzip -d < /var/backup/appendonly.aof_master_2017-
   06-06_054601.gz > appendonly.aof
   ```

   The snapshot filename has several parts:

   - `appendonly.aof`: The base file name.
   - `_master_`: Defines this file as the current master snapshot.
   - `2017-06-06_054601`: The date and time the snapshot was taken.
2. Shutdown the NetQ stack:

```
root@cumulus:~# sudo systemctl stop netq-appliance
```

3. Copy the extracted `appendonly.aof` file into the data directory:

```
root@cumulus:~# cp appendonly.aof /var/data/redis/master
/appendonly.aof
```

4. Remove the `dump.rmb` file from the master directory, if the file is present:

```
root@cumulus:~# rm -f /var/data/redis/master/dump.rdb
```

5. Use the `grep` command to confirm the Redis configuration is still set correctly:

```
root@cumulus:~# grep appendonly /etc/cts/redis/*conf
/etc/cts/redis/redis.conf:appendonly yes
/etc/cts/redis/redis.conf:appendfilename "appendonly.aof"
root@cumulus:~# grep 'save ""' /etc/cts/redis/*conf
/etc/cts/redis/redis.conf:save ""
```

6. Restart the NetQ Stack:

```
root@cumulus:~# sudo systemctl start netq-appliance
```

Early Access Features

NetQ has early access features that provide advanced access to new functionality before it becomes generally available. The following features are early access in NetQ 1.2:

In NetQ 1.2, early access features are bundled into the `netq-apps` package; there is no specific EA package like there typically is with Cumulus Linux.

You enable early access features by running the `netq config add` command. You disable the early access features by running the `netq config del` command.

Chassis Integration

NetQ can run within a Facebook Backpack chassis, Cumulus Express CX-10256-S chassis or Edgecore OMP-800 chassis, but it is considered to be an early access (see page 97) feature.

Keep the following issues in mind if you intend to use NetQ with a chassis:

- You must assign a unique hostname to every node that runs the NetQ Agent. By default, all the fabric cards in the chassis have the same hostname.
- The NetQ Agent must be installed on every line card.
- No information is returned about the ASIC when you run `netq show inventory asic`. This is a known issue.
- Since the chassis sensor information is shared among, every line card and fabric card can report the same sensor data. By default, sensor data is disabled on a chassis. To enable sensor data on a line card, edit `/etc/netq/netq.yml` or `/etc/netq/config.d/user.yml` and set the `send_chassis_sensor_data` keyword to *true*, then restart the NetQ Agent with `netq config agent restart`. This prevents any duplication of data in the NetQ database.

```
cumulus@chassis-lc101:~$ sudo nano /etc/netq/netq.yml

...

netq-agent:
  send_chassis_sensor_data: true

...
```

Extending NetQ with Custom Commands

NetQ provides the ability to codify playbooks and extend NetQ with custom commands for use cases specific to your network.

The summary of steps required to do this is a follows:

- The extensions must be written in Python or Cython.
- The commands need to be added must use `network doctopt`.

- The .py file (or the compiled .so if using Cython) is now copied to /usr/lib/python2.7/dist-packages /netq_apps/modules/addons.
- Enable the add-ons with the `netq config add addons` command
- Check that your command works by typing `netq <TAB>`

Contents

This chapter covers ...

Sample File with Custom Command

To help you get started, here is the Hello World of NetQ command extension:

Sample Hello World

```
'''
hello: A netq app hello world module
Usage:
   netq hello [json]
Options:
   hello                          : Hello world experimental
'''
import json
from netq_apps.modules import NetqModule, RC_SUCCESS, RC_FAIL
app = NetqModule()

@app.route('hello')
def cli_hello_world(cli, netq):
    '''My very own hello'''
    jsonify = cli.get('json')
    if jsonify:
       print json.dumps({'greeting': 'Hello World'})
    else:
       print 'Hello World'
    return RC_SUCCESS
```

Let's break down each part of the code.

Command Specification With Help

The lines at the start of the file within the triple quotes (''') constitute what is called the *docstring* of the file or module. `network-docopt`, the Python library that builds the command parser for NetQ, uses the information provided in the *docstring*. Specifically, everything between **Usage** and **Options** is considered a command specification. In this case, `netq hello` is the only command specified in the file. The command MUST start with the word `netq`. Every `netq` command follows the following structure:

```
netq [<hostname>] <verb> <object> <filters>
```

For example, here is the sample for `show vlan`:

```
netq [<hostname>] show vlan [<1-4096>] [around <text-time>] [json]
```

The *<hostname>* option is used to filter results to just the specified host; hostname can also be a regular expression. The *<verb>* is *show*, the *<object>* is *vlan* and the remaining parameters are filters to viewing the data.

For example, if you wanted to extend hello world by passing an optional greeting, modify the usage to be:

```
netq hello <text-greeting>
```

`network-docopt` understands a few parameter types and validates them before passing them to your code. Some common ones are:

- **<hostname>**: A host known to NetQ
- **<remote-interface>**: An interface on the specified host known to NetQ
- **<text>**: Any free text, but has to be a single word or delimited within quotes
- **<ip>**, **<ip/prefixlen>**: IPv4 or IPv6 address, with prefix length in the second case
- **<ipv4>**, **<ipv4/prefixlen>**: IPv4 address, with prefix length in the second case
- **<ipv6>**, **<ipv6/prefixlen>**: IPv6 address, with prefix length in the second case
- **<wildcard>**: All the remaining text
- Valid number range: Such as **<1-4096>** to limit the allowed range

So in the VLAN example above, specifying a VLAN value outside the 1-4096 range results in an error, with command unknown and a help message indicating that you need to specify a value between 1 and 4096. For hosts and interfaces used with *<hostname>* and *<remote-interface>*, NetQ automatically provides tab completion.

To display meaningful help associated with a keyword, add the help for the command via the **Options** section. In the example code above, the object *hello* has the help text "Hello world experimental". This text is displayed when the user types `netq <TAB>`, as shown in the following example:

```
cumulus@switch:~$ netq
<hostname> : Type first char of netq host for dynamic completion
check : Perform fabric-wide checks
config : Configuration
example : Show examples of usage and workflow
hello : Hello world experimental
help : Show usage info
resolve : Annotate input with names and interesting info
show : Show fabric-wide info about specified object
trace : Control Path Trace
cumulus@torc-11:mgmt-vrf:~$ netq
```

⚠ Any help you provide here overrides the help provided for the keyword by a module loaded previously.

Associating the Command with the Function

After configuring the command, you need to associate or *bind* that command with the function to be called when a user runs the command. This is done by using decorators to functions similar to how other CLI builders or web servers work.

First, create an instance of the class `NetqModule()` called *app*. Then associate the function to the appropriate command via the decorator **`@app.route`**. As shown in the example above, the function **`cli_hello_world()`** is decorated to indicate that it is the function to call for the command **`hello`**. The function takes two parameters: *cli* and *netq*. Usage of these parameters is discussed in the next section.

Keep in mind the following when matching the command to the function:

- If a prior binding has already been assigned to a command, the newer binding will fail. By default, modules in the core NetQ code take precedence over early access modules, which take precedence over the modules defined in addons directory.
- The command string can be as small as possible. For example, the commands **`netq hello json`** and **`netq hello`** can be handled by different functions or by the same function. The NetQ command parser does a longest match first to determine which of the competing functions is assigned to execute a command. The command parser supports up to three string matches. In other words, **`show ip address`** is supported, but **`show ip address json`** is not. Such longer command strings bound to a function either silently fail or a shorter string version is matched.

Using the cli and netq Parameters

The function that is called to execute a command expects to received two parameters, *cli* and *netq*, in the order shown in the example above.

cli is a dictionary containing the parameters provided by the user on the command line. *netq* contains the timestamps provided by the user, if any. Any other object within NetQ can be ignored. The timestamps are provided to query NetQ objects around a specific time or in a time window.

The example shows how to extract the value provided by the user at the command line from *cli*. Since *json* is a keyword, getting the key *json* from *cli* lets you to determine if the user specified *json* at the command line or not. If the user did not specify *json* at the command line, **`cli.get('json')`** returns *None*, whereas if the user did specify *json*, then `cli.get('json')` returns the string "json". Thus, if the user wants to specify a parameter along with a keyword, for example, as shown in `netq show macs [vlan <1-4096>]`, then the value of the VLAN to search for a MAC address can be found using `cli.get('<1-4096>')`, not via `cli.get('vlan')`.

Return Values

The function returns either *RC_SUCCESS* if successful or *RC_FAIL* if not. The code snippet shows how to import these values from the standard NetQ libraries.

Querying the NetQ Database

While the code snippet above was sufficient to illustrate the general skeleton, if you want to extend the commands, you typically will want to add meaningful functionality such as querying the database and displaying some more meaningful information. For example, consider a new command called `show ip-routes`, which displays the route information available in the database, but with a different set of fields than shown via `show ip routes`. The code to do so is shown below.

```
"""
routes.py: NetQ app module for processing IPv4/v6 routes
Usage:
   netq <hostname> show myroutes [vrf <vrf>] [json]
Options:
   myroutes                               : IPv4/v6 routes
"""
from __future__ import absolute_import
from collections import OrderedDict

from netq_apps.modules import NetqModule, RC_SUCCESS
from netq_apps.cmd.netq import netq_show

from netq_lib.orm.redisdb.models import Route

app = NetqModule()

@app.route('show myroutes')
@netq_show
def cli_show_myroutes(cli, netq, context):
    '''MY very own show routes'''
    hostname = cli.get('<hostname>') or '*'
    vrf = cli.get('<vrf>') or '*'
    context.col_sizes = [16, 8, 32, 26, 16]
    entries = Route.query.filter(timestamp=netq.start_time,
                                 endtimestamp=netq.end_time,
                                 hostname=hostname, vrf=vrf)
    for entry in entries:
        out = OrderedDict()
        if isinstance(entry, tuple):
            route = entry[0]
        else:
            route = entry
        if not route.nexthops:
            route.nexthops = [['None', 'Local']]
        nexthops = ', '.join(
            '%s: %s' % (nh[0], nh[1]) if nh[0] != 'None' else '%s' %
nh[1]
            for nh in sorted(route.nexthops)
        )

        out['Hostname'] = route.hostname
        out['Protocol'] = route.protocol
        out['Prefix'] = route.prefix
        out['Nexthops'] = nexthops
        out['Last Changed'] = route.timestamp
        yield out
```

Much of this code is similar to the hello world example, but the new items are discussed below.

The Imports

There are two additional imports, one for *netq_show* and the other for *Route*.

netq_show

netq_show is the decorator that takes care of wrapping the output in a format native to NetQ. For example, it generates the JSON for you automatically, so that you don't have to write a JSON output generator just to support JSON and you don't have to worry about supporting the tabular format, displaying rotten nodes in a different color and so on. All you have to do is generate output in the form of an `OrderedDict` and `yield` for every entry. The `OrderedDict` ensures that the columns are displayed in the order provided in the code. The column headers are generated from the dictionary key, as are the JSON keys.

By wrapping the code with the *netq_show*, all these display complexities are covered for you.

Route

Route is the database object that holds all the pertinent information about a route. Its contents are defined in the `/usr/lib/python2.7/dist-packages/netq_lib/orm/redisdb/models.py` file. There are other database objects defined in the file, but this example only involves the *Route* object.

The Function Handler

The function that satisfies the command `show myroutes` is *cli_show_myroutes*, and because of the decorator, takes an additional input parameter, *context*. It's mainly used to pass things between the main NetQ command module and the specific modules, such as this one. This particular case uses the *context* to update the column sizes to be used in the display.

The Query Functions

The meat of the code is the query. Objects are queried using the model of *<object>.query.<query function>*. T his particular example uses *filter* as the query function, as shown by the `Route.query.filter()` call. The filter function produces output filtered by the parameters specified in the keyword arguments passed. For example, the *hostname* keyword argument restricts the results returned by the query function to only those on the specified host. The list of keys that can be specified for an object are listed under the object's definition in the aforementioned `models.py` file under the function `key_fmt()`. A look at that function for the *Route* object shows that the key fields are: hostname, prefix, route type, routing table id, ipv4/v6 route and, If the entry is originated on this node, the protocol that added this route and the VRF name qualifier. The values returned include all the key fields plus the fields shown in the `val_fmt()` function for the object.

The other useful query functions are:

- `query.get()`: which returns just the first element matching the parameters specified.
- `query.latest()`: which returns the latest element matching the parameters specified, and does not take any time parameters.
- `query.count()`: which returns a count of the matching elements instead of the elements themselves.

The filter query functions return an iterator and thus is lazy about retrieving data from the back end. You can stop whenever you want in the iteration. `query.get()` and `query.latest()` both return a single object of the type the query is on while `query.count()` returns an integer.

Debugging

Inevitably when writing code, coding errors need to be debugged and the fixes tried again. When a module doesn't load or returns an error, it is reported in the `netqd.log`, usually kept under `/var/log` (unless you modified the location). Deploying the module on one node doesn't mean it is automatically available on all nodes. You must copy it to all the required nodes.

To reload the modules after making fixes, run the command `netq config reload parser`.

Caveats

This feature is an early access feature, and must be treated as such. There may be obscure failures which will require Cumulus Networks engineering intervention to investigate. Finally, please save the modules you write. If you reinstall the `netq-apps` package, your modules may get overwritten when you install the new package. One of the next releases of NetQ should provide the ability to store these modules under `/usr/local/lib`, to keep them from being affected by package management.

Querying the NetQ Database

You can query for even more NetQ data using the SQL-like NetQ Query Language (NetQL) so you can conduct your own custom analysis or otherwise extend NetQ functionality for your specific environment without having to write your own custom code. NetQL directly queries the NetQ database for data that isn't exposed via the check, show and trace commands.

> **Early Access Feature**
>
> NetQL is an early access feature in Cumulus NetQ 1.2.

Contents

This chapter covers ...

Commands

- netq query
- netq config add|del experimental

Enabling NetQL

Since NetQL is an early access feature, you must enable the experimental option of the NetQ CLI:

```
cumulus@switch:~$ netq config add experimental
```

Usage

NetQL is a generic structured query language modeled on SQL. The general command syntax is:

```
cumulus@switch:~$ netq query 'SELECT <fields> FROM <tables> WHERE
<conditions> GROUP BY <fields> ORDER BY <fields>[asc|desc]' [json]
```

NetQL supports tab completion. When you press the TAB key after typing *FROM*, a list of objects appears from which you can select.

Between the SELECT, FROM, WHERE, GROUP BY and ORDER BY keywords are the following variables:

Variable	Definition
<fields>	One or more key or non-key fields from one of the NetQ database tables.
<tables>	One or more tables in the NetQ database.
<conditions>	Qualifiers to the data being queried.

These items are defined below.

The following is a real-world example:

```
cumulus@switch:~$ netq query 'SELECT hostname, peer_name,
peer_hostname, asn, peer_asn, state FROM BgpSession'
hostname    peer_name        peer_hostname    asn     peer_asn
state
----------  ---------------  ---------------  ------  ----------
-----------
leaf01      swp3             spine01          655536  655435
Established
leaf01      swp6             firewall01       655536  655538
Established
leaf01      swp7             firewall02       655536  655539
Established
leaf01      swp4             spine02          655536  655435
Established
leaf01      swp5             spine03          655536  655435
Established
leaf01      swp6.4           firewall01       655536  655538
Established


...
```

The keywords are not case sensitive, so you can use *SELECT*, *Select* or *select*. The all caps usage is for easier parsing of the queries.

Tables and Fields

One example field is *hostname*, which is present in every table. Example tables include Route, Link and BgpSession.

⚠ At this time, you cannot have multiple copies of the same table.

You can get a list of all the tables known to NetQ by running this command:

```
cumulus@switch:~$ netq query show tables
Class                Key Fields
-------------------
----------------------------------------------------------------------
-----------------
ASIC                 hostname, vendor, model, model_id, core_bw, ports
Address              hostname, ifname, prefix, mask, is_ipv6, vrf
BgpSession           hostname, peer_name, asn, vrf
Board                hostname, vendor, model, base_mac, part_number,
mfg_date, serial_number, label_revision
CPU                  hostname, arch, nos, model, max_freq, mem_total
ClagSession          hostname, clag_sysmac
Description          hostname, objtype, descrid
```

```
Disk                 hostname, name, size, d_type, vendor, transport,
rev, model

...
```

You can get a list of all the fields in a table by running this command:

```
cumulus@switch:~$ netq query show fields BgpSession
Key Fields                           Value Fields
------------------------------------
----------------------------------------------------------------
hostname, peer_name, asn, vrf        state, peer_router_id, peer_asn,
peer_hostname, reason,
                                     ipv4_pfx_rcvd, ipv6_pfx_rcvd,
evpn_pfx_rcvd, timestamp,
                                     last_reset_time, conn_estd,
conn_dropped, upd8_rx, vrfid,
                                     upd8_tx, up_time, tx_families,
objid, rx_families, active,
                                     deleted
```

An example query on a single table is:

```
cumulus@switch:~$ netq query 'SELECT hostname, peer_name,
peer_hostname, asn, peer_asn, state FROM BgpSession'
hostname    peer_name        peer_hostname    asn      peer_asn
state
----------  ---------------  ---------------  ------   ----------
-----------
exit01      swp3             spine01          655536   655435
Established
exit01      swp6             firewall01       655536   655538
Established
exit01      swp7             firewall02       655536   655539
Established
exit01      swp4             spine02          655536   655435
Established
exit01      swp5             spine03          655536   655435
Established
exit01      swp6.4           firewall01       655536   655538
Established

...
```

NetQL displays the values of the specified fields in tabular output.

Conditions

Conditions select what data is presented. An example of a condition is *hostname="leaf01"*. Use double quotes ("") for the specific values you want to match on. You can also use != to indicate non-matching entries.

AND is the only condition supported currently. You cannot perform queries using parenthesized conditions at this time.

An example conditional query is:

```
cumulus@switch:~$ netq query 'SELECT hostname, peer_name,
peer_hostname, asn, peer_asn, state FROM BgpSession WHERE hostname="
*1" AND peer_name="swp3*"'
hostname    peer_name    peer_hostname    asn     peer_asn    state
----------  -----------  ---------------  ------  ----------
-----------
exit01      swp3         spine01          655536  655435
Established
exit01      swp3.4       spine01          655536  655435
Established
exit01      swp3.2       spine01          655536  655435
Established
exit01      swp3.3       spine01          655536  655435
Established
spine01     swp3         leaf01           655435  655561
Established
spine01     swp3.4       leaf01           655435  655561
Established
spine01     swp3.2       leaf01           655435  655561
Established
spine01     swp3.3       leaf01           655435  655561
Established
leaf01      swp3         spine01          655559  655435
Established
leaf01      swp3.4       spine01          655559  655435
Established
leaf01      swp3.2       spine01          655559  655435
Established
leaf01      swp3.3       spine01          655559  655435
Established
leaf01      swp3         spine01          655561  655435
Established
leaf01      swp3.4       spine01          655561  655435
Established
leaf01      swp3.2       spine01          655561  655435
Established
leaf01      swp3.3       spine01          655561  655435
Established
leaf02      swp3         spine01          655563  655435
Established
```

```
leaf02      swp3.4       spine01          655563   655435
Established
leaf02      swp3.2       spine01          655563   655435
Established
leaf02      swp3.3       spine01          655563   655435
Established
```

Grouping Results

When you want to see not only the value of a field, but also the aggregated output such as a count or sum, you must specify on which field to aggregate the data. For example, to get the number of peer ASNs for each host, the query is:

```
cumulus@switch:~$ netq query 'SELECT hostname, count(peer_asn) FROM
BgpSession GROUP BY hostname'
hostname      count(peer_asn)
----------  -----------------
exit01                     20
exit02                     20
spine01                    32
spine02                    32
spine03                    32
leaf01                     12
leaf02                     12
leaf03                     13
leaf04                     13
leaf05                     13
leaf06                     13
```

Ordering Results

You can specify which columns you want the output sorted on using the "ORDER BY" clause of the query. The general format of the ORDER BY clause is:

```
ORDER BY <field1> [ASC|DESC] [<field2> [ASC|DESC]...]
```

As an example, the output of the query in the previous section can be sorted by the COUNT followed by hostname, as follows:

```
cumulus@switch:~$ etq query 'SELECT hostname, COUNT(peer_asn) FROM
BgpSession GROUP BY hostname ORDER BY COUNT(peer_asn)'
hostname      count(peer_asn)
----------  -----------------
leaf01                     12
leaf02                     12
leaf03                     13
```

```
leaf04                     13
leaf05                     13
leaf06                     13
exit02                     20
exit01                     20
spine01                    32
spine03                    32
```

This sorts the count in ascending order, which is the default and does not have to be specified. To sort by descending order, use the DESC keyword, as follows:

```
cumulus@switch:~$ netq query 'SELECT hostname, COUNT(peer_asn) FROM
BgpSession GROUP BY hostname ORDER BY count(peer_asn) DESC, hostname'
hostname      count(peer_asn)
----------  -----------------
spine01                    32
spine02                    32
spine03                    32
exit01                     20
exit02                     20
leaf03                     13
leaf04                     13
leaf05                     13
leaf06                     13
leaf01                     12
leaf02                     12
```

The DESC keyword applies only to the field preceding it. Thus, in the example above, the output is sorted by the nodes with the most peer ASNs, and nodes with the same number of peer ASNs are sorted based on the ascending alphabetical sort of the hostname. If you want the hostnames to be also sorted in reverse alphabetical order, follow the hostname field also with the DESC keyword, as follows:

```
cumulus@switch:~$ netq query 'SELECT hostname, COUNT(peer_asn) FROM
BgpSession GROUP BY hostname ORDER BY count(peer_asn) DESC, hostname
DESC'
hostname      count(peer_asn)
----------  -----------------
spine03                    32
spine02                    32
spine01                    32
exit02                     20
exit01                     20
leaf06                     13
leaf05                     13
leaf04                     13
leaf03                     13
leaf02                     12
leaf01                     12
```

The `distinct` keyword, when used with `count`, counts only distinct or unique values. For example, the following queries show the total number of ASNs in use in the fabric, the number of distinct ASNs, and then the list of each ASN:

```
cumulus@switch:~$ netq query 'SELECT COUNT(peer_asn) FROM BgpSession'
  count(peer_asn)
-----------------
              228
cumulus@switch:~$ netq query 'SELECT COUNT(distinct peer_asn) FROM
BgpSession'
  count(distinct peer_asn)
--------------------------
                        11
cumulus@switch:~$ netq query 'SELECT set(peer_asn) FROM BgpSession'
set(peer_asn)
----------------------------------------------------------------------
----------------------------------
set([655435L, 655559L, 655560L, 655561L, 655562L, 655563L, 655564L,
655536L, 655537L, 655538L, 655539L])
```

Regular Expressions

You can use any regular expression that Redis supports. They include, but are not limited to, the following examples:

- h?llo matches hello, hallo and hxllo
- h*llo matches hllo and heeeello
- h[ae]llo matches hello and hallo, but not hillo
- h[^e]llo matches hallo, hbllo, ... but not hello
- h[a-b]llo matches hallo and hbllo

For example:

```
cumulus@switch:~$ netq query 'SELECT hostname, peer_name,
peer_hostname, asn, peer_asn, state FROM BgpSession WHERE hostname="
*1" AND peer_name="swp[34]"'
hostname    peer_name    peer_hostname    asn     peer_asn    state
----------  -----------  ---------------  ------  ----------
-----------
exit01      swp3         spine01          655536  655435
Established
exit01      swp4         spine02          655536  655435
Established
firewall01  swp4         exit02           655538  655537
Established
firewall01  swp3         exit01           655538  655536
Established
```

```
spine01     swp3         leaf01            655435  655561
Established
spine01     swp4         leaf02            655435  655562
Established
leaf01      swp3         spine01           655559  655435
Established
leaf01      swp4         spine02           655559  655435
Established
```

JSON Output

Any command's output can be returned in JSON format by ending the command with the optional `json` keyword, as follows:

```
cumulus@switch:~$ netq query 'select count(peer_name) from
BgpSession' json
  [
    {
        "count(peer_name)":25
    }
  ]
```

Collecting Interface Statistics

The NetQ Agent collects interface counters from `/proc/net/dev` and pushes them to the NetQ Telemetry Server, where they are stored in a container running an InfluxDB database. Only counters for physical interfaces are collected; NetQ does not collect counters for non-physical interfaces like bonds, bridges and VXLANs.

The NetQ Agent uses the `netq-stats-pushd` service to collect counters and push them to the database on the telemetry server. The service collects counters every 15 seconds.

The counters that are collected include:

- rx_bytes, rx_drop, rx_errs, rx_frame, rx_multicast, rx_packets
- tx_bytes, tx_carrier, tx_colls, tx_drop, tx_errs, tx_packets

Early Access Feature

Collecting counters is an early access feature in Cumulus NetQ 1.2.

Contents

This chapter covers ...

Configuring Counter Collection

The InfluxDB database is installed in its own container by default on the telemetry server. The `netq-stats-pushd` service is also installed, but must be enabled. You also need to enable counter collection on every node for which you want to gather statistics.

To enable and start the `netq-stats-pushd` service on the telemetry server, run:

```
cumulus@ts:~$ sudo systemctl enable netq-stats-pushd.service
cumulus@ts:~$ sudo systemctl start netq-stats-pushd.service
```

To check the status of the service, use systemd:

```
cumulus@ts:~$ sudo systemctl status netq-stats-pushd.service
 netq-stats-pushd.service - NetQ Stats Storage daemon
   Loaded: loaded (/lib/systemd/system/netq-stats-pushd.service;
enabled)
   Active: active (running) since Mon 2017-11-27 00:51:09 UTC; 6s ago
 Main PID: 30550 (netq-stats-push)
```

On every node you want to monitor, enable counter collection, then restart the NetQ Agent:

```
cumulus@ts:~$ netq config add stats
cumulus@ts:~$ netq config restart agent
```

Once the agent is restarted, the `netq-stats-pushd` service starts collecting interface statistics and pushes them to the database on the telemetry server.

Troubelshooting

The primary log files for the telemetry server are:

- /var/log/cts/cts-influxdb.log
- /var/log/netq-stats-pushd.log

On each node, check the NetQ Agent log file: `/var/log/netq-agent.log`.

Disabling Counter Collection

To disable counter collection on a node, run the following commands:

```
cumulus@switch:~$ netq config del stats
cumulus@switch:~$ netq config restart agent
```

Disabling this feature does not purge the data already collected from the database.

Once all nodes have stopped pushing statistics, you can stop and disable the `netq-stats-pushd` service on the telemetry server:

```
cumulus@ts:~$ sudo systemctl stop netq-stats-pushd.service
cumulus@ts:~$ sudo systemctl disable netq-stats-pushd.service
```

Troubleshooting NetQ

To aid in troubleshooting issues with NetQ, there are several configuration and log files on the **telemetry server** that can provide insight into the root cause of the issue:

File	Description
`/etc/netq/netq.yml`	The NetQ Telemetry Server configuration file.
`/var/log/cts/cts-backup.log`	Database service backup log file.
`/var/log/cts/cts-redis.log`	The Redis log file.
`/var/log/cts/cts-sentinel.log`	The Redis sentinel log file.
`/var/log/cts/cts-dockerd.log`	The Docker daemon log file.
`/var/log/cts/cts-docker-compose.log`	The backup log file.
`/var/log/netqd.log`	The NetQ daemon log file for the NetQ CLI.
`/var/log/netq-notifier.log`	The NetQ Notifier log file.

A **node** running the NetQ Agent has the following configuration and log files:

File	Description
`/etc/netq/netq.yml`	The NetQ configuration file.
`/var/log/netq-agent.log`	The NetQ Agent log file.
`/etc/netq/config.d/netq-agent-commands.yml`	Contains key-value command pairs and relevant custom configuration settings.
`/run/netq-agent-running.json`	Contains the full command list that will be pushed when the agent starts.

Checking Agent Health

Checking the health of the NetQ agents is a good way to start troubleshooting NetQ on your network. If any agents are rotten, meaning three heartbeats in a row were not sent, then you can investigate the rotten node. In the example below, the NetQ Agent on server01 is rotten, so you know where to start looking for problems:

```
netq@446c0319c06a:/$ netq check agents
Checked nodes: 12,

Rotten nodes: 1
netq@446c0319c06a:/$ netq show agents
Node      Status    Sys Uptime    Agent Uptime
--------  --------  ------------  --------------
exit01
Fresh
     8h ago        4h ago
exit02
Fresh
     8h ago        4h ago
leaf01
Fresh
     8h ago        4h ago
leaf02
Fresh
     8h ago        4h ago
leaf03
Fresh
     8h ago        4h ago
leaf04
Fresh
     8h ago        4h ago
server01
Rotten
    4h ago        4h ago
server02
Fresh
     4h ago        4h ago
server03
Fresh
     4h ago        4h ago
server04
Fresh
     4h ago        4h ago
spine01
Fresh
     8h ago        4h ago
```

```
spine02
Fresh
     8h ago        4h ago
```

Error Configuring the Telemetry Server on a Node

If you get an error when your run the `netq config add server` command on a node, it's usually due to one of two reasons:

- The hostname or IP address for the telemetry server was input incorrectly when you ran `netq config add server`. Check what you input and try again.
- The telemetry server isn't responding. Try pinging the IP address you entered and see if the ping works.

cts-support

The `cts-support` command generates an archive of useful information for troubleshooting issues with NetQ. It is an extension of the `cl-support` command in Cumulus Linux. It provides information about the telemetry server configuration and runtime statistics as well as output from the `docker ps` command. The Cumulus Networks support team may request the output of this command when assisting with any issues that you could not solve with your own troubleshooting. Run the following command on the telemetry server:

```
cumulus@ts:~$ cts-support
```

Index