Table of Contents

1. Compatibility .............................................................................................................................................. 1

2. Setting up a basic OpenNMS Horizon ........................................................................................................... 2
   2.1. Objectives .................................................................................................................................................. 2
   2.2. Before you begin ......................................................................................................................................... 2
   2.3. Installing on RHEL ...................................................................................................................................... 3
   2.4. Installing on Debian .................................................................................................................................... 7
   2.5. Run with Docker ........................................................................................................................................ 11

3. Installing and Configuring a Minion ............................................................................................................ 18
   3.1. Requirements ............................................................................................................................................ 18
   3.2. Set Up OpenNMS Horizon to allow Minion communication ........................................................................ 18
   3.3. Installing on RHEL .................................................................................................................................... 19
   3.4. Installing on Debian .................................................................................................................................... 22
   3.5. Information about Minion Packages and Configuration ............................................................................ 24
   3.6. Run with Docker ........................................................................................................................................ 24

4. Sentinel .......................................................................................................................................................... 30
   4.1. Before you begin ........................................................................................................................................ 30
   4.2. Installing on RHEL .................................................................................................................................... 30
   4.3. Installing on Debian .................................................................................................................................... 33

5. Minion with custom messaging system ....................................................................................................... 37
   5.1. Setup using Apache Kafka ......................................................................................................................... 37
   5.2. Minion with gRPC Strategy ....................................................................................................................... 42

6. Install other versions than stable .................................................................................................................. 46

7. Setup Minion with a config file .................................................................................................................... 47

8. Running in non-root environments ............................................................................................................... 48
   8.1. Send ICMP as non-root ............................................................................................................................... 48
   8.2. Trap reception as non-root ........................................................................................................................ 48
   8.3. Syslog reception as non-root ...................................................................................................................... 49

9. Use R for statistical computing .................................................................................................................... 50
   9.1. Install R on RHEL ....................................................................................................................................... 50
   9.2. Install R on Debian ..................................................................................................................................... 50

10. Using a different Time Series Storage ......................................................................................................... 51
   10.1. RRDtool ................................................................................................................................................... 51
   10.2. Newts for Time Series data ...................................................................................................................... 54
Chapter 1. Compatibility

OpenNMS Horizon 27.0.3 requires the following component versions:

<table>
<thead>
<tr>
<th>Component</th>
<th>Version Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenNMS Helm</td>
<td>3+</td>
</tr>
<tr>
<td>OpenNMS Integration API</td>
<td>0.2.x</td>
</tr>
<tr>
<td>Cassandra</td>
<td>3.11.+</td>
</tr>
<tr>
<td>Elasticsearch</td>
<td>7.x</td>
</tr>
<tr>
<td>Java Development Kit</td>
<td>OpenJDK 8, OpenJDK 11</td>
</tr>
<tr>
<td>Kafka</td>
<td>1.x - 2.x</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>10.x - 12.x</td>
</tr>
<tr>
<td>RRDTool</td>
<td>1.7.x</td>
</tr>
</tbody>
</table>

RHEL 7 users must complete additional steps to install PostgreSQL 10+. Refer to [PostgreSQL Yum Repository](#) for instructions.
Chapter 2. Setting up a basic OpenNMS Horizon

The OpenNMS Horizon platform can be installed on multiple OS families. This guide provides instructions for installing the platform on Red Hat Enterprise Linux (RHEL)-based and Debian-based operating systems.

2.1. Objectives

- Installing OpenNMS Horizon components on a single node using the built-in JRobin as time series storage
- Setup OpenNMS Horizon on recommended operating systems
- Login the Web User Interface and change the default admin password

2.2. Before you begin

The following abbreviations will be used to refer to their respective entry through this documentation.

Table 1. Operating Systems

<table>
<thead>
<tr>
<th>RHEL</th>
<th>Red Hat Enterprise Linux 7 or higher, CentOS 8+ or higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debian</td>
<td>Debian 9 or higher, Ubuntu 16.04 LTS or higher</td>
</tr>
<tr>
<td>OpenJDK 11 Development Kit</td>
<td>Installed OpenJDK 11 Development Kit</td>
</tr>
</tbody>
</table>

* Technically, users can install OpenNMS on CentOS 7, but our convenient opennms meta RPM package, which resolves external things like PostgreSQL, will not work. You need to install Postgres10 by yourself.

2.2.1. What If I’m Running CentOS 7?

OpenNMS requires PostgreSQL as the database before installation. With yum install opennms, the package opennms is like a convenience package and depends on the PostgreSQL package coming with the CentOS Linux distribution. CentOS 7 comes only with PostgreSQL 9. Horizon 25+ and Meridian 2019+ require PostgreSQL 10+.

If you want to install Horizon 25+ or Meridian 2019+ on versions older than CentOS 8, the convenience package with yum install opennms will not work. Instead, you must first install PostgreSQL 10 manually, and then install OpenNMS with yum install opennms-core opennms-webapp-jetty.

We recommend you meet the following requirements:

Table 2. Installation Requirements
Minimal Hardware

2 CPU, 2 GB RAM, 20 GB disk

Operating System

RHEL or Debian in a current version is recommended. Please be aware OpenNMS Horizon is developed and mostly operated on Linux systems.

Internet


DNS Setup

Please make sure your DNS settings for the OpenNMS server are correct and the localhost name can be resolved. If there is an incorrect or missing A Resource Record for the server hostname, OpenNMS might not start correctly. The Java security manager might not initialize and an RMI class loader disabled exception will be shown.

Depending on the installed operating system, the path for OpenNMS Horizon is different. If the instruction refers to \${OPENNMS_HOME}, the path is resolved to the following directories:

Table 3. Directory Structure

<table>
<thead>
<tr>
<th>RHEL</th>
<th>/opt/opennms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debian</td>
<td>/usr/share/opennms</td>
</tr>
</tbody>
</table>

2.3. Installing on RHEL

The following steps will be described:

1. Installation of the opennms meta package which handles all dependencies
2. Initialize PostgreSQL database and configure access
3. Initialize OpenNMS Horizon database and start
4. Log in to the Web User Interface and change default admin password

You must use root permissions to run all commands on the command line interface.

Commands and instructions are specific to RHEL 8. We provide RHEL 7 alternatives where applicable.

Step 1: Install OpenNMS Horizon

Add yum repository and import GPG key

RHEL:

rpm --import https://yum.opennms.org/OPENNMS-GPG-KEY

RHEL 7:

--import https://yum.opennms.org/OPENNMS-GPG-KEY
Installation of OpenNMS Horizon with all built-in dependencies

```bash
dnf -y install opennms
```

**RHEL 7:**

```bash
yum -y install opennms
```

The following packages will be automatically installed:

- `jicmp6` and `jicmp`: Java bridge to allow sending ICMP messages from OpenNMS Horizon repository.
- `opennms-core`: OpenNMS Horizon core services, e.g. Provisiond, Pollerd and Collectd from OpenNMS Horizon repository.
- `opennms-webapp-jetty`: OpenNMS Horizon web application from OpenNMS Horizon repository
- `postgresql`: PostgreSQL database server from distribution repository
- `postgresql-libs`: PostgreSQL database from distribution repository

With the successful installed packages the OpenNMS Horizon is installed in the following directory structure:

```
[root@localhost /opt/opennms]# tree -L 1
.
  ├── opennms
  │   ├── bin
  │   │   └── contrib
  │   ├── data
  │   │   └── deploy
  │   ├── etc
  │   │   └── jetty-webapps
  │   │       ├── lib
  │   │       │   └── logs -> /var/log/opennms
  │   │       └── share -> /var/opennms
  │   └── system
  └── system
```

We recommend disabling the OpenNMS Horizon repository after installation to prevent unwanted upgrades while it is running. OpenNMS Horizon requires some manual steps upon upgrade configuration files or migrate database schemas to a new version. For this reason, it is recommended to exclude the OpenNMS Horizon packages from update except when you are planning on performing an upgrade.

```bash
dnf config-manager --disable opennms-repo-stable-*
```
**RHEL 7:**

```bash
yum config-manager --disable opennms-repo-stable -*
```

**Step 2: Initialize and set up PostgreSQL**

*Initialization of the PostgreSQL database*

```bash
postgresql-setup --initdb --unit postgresql
```

*System startup configuration for PostgreSQL*

```bash
systemctl enable postgresql
```

*Startup PostgreSQL database*

```bash
systemctl start postgresql
```

*Create an opennms database user with a password and create an opennms database which is owned by the user opennms*

```bash
su - postgres
createuser -P opennms
createdb -O opennms opennms
```

*Set a password for Postgres super user*

```bash
psql -c "ALTER USER postgres WITH PASSWORD 'YOUR-POSTGRES-PASSWORD';"
exit
```

---

The super user is required to be able to initialize and change the database schema for installation and updates.

*Change the access policy for PostgreSQL*

```bash
vi /var/lib/pgsql/data/pg_hba.conf
```

*Allow OpenNMS Horizon accessing the database over the local network with a MD5 hashed password*

<table>
<thead>
<tr>
<th>host</th>
<th>all</th>
<th>all</th>
<th>127.0.0.1/32</th>
<th>md5 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>host</td>
<td>all</td>
<td>all</td>
<td>::1/128</td>
<td>md5 1</td>
</tr>
</tbody>
</table>

① Change method from `ident` to `md5` for IPv4 and IPv6 on localhost.
Apply configuration changes for PostgreSQL

```
systemctl reload postgresql
```

Configure database access in OpenNMS Horizon

```
vi ${OPENNMS_HOME}/etc/opennms-datasources.xml
```

Set credentials to access the PostgreSQL database

```
<jdbc-data-source name="opennms"
   database-name="opennms"
   class-name="org.postgresql.Driver"
   url="jdbc:postgresql://localhost:5432/opennms"
   user-name="** YOUR-OPENNMS-USERNAME **"
   password="** YOUR-OPENNMS-PASSWORD **" />

<jdbc-data-source name="opennms-admin"
   database-name="template1"
   class-name="org.postgresql.Driver"
   url="jdbc:postgresql://localhost:5432/template1"
   user-name="postgres"
   password="** YOUR-POSTGRES-PASSWORD **" />
```

① Set the database name OpenNMS Horizon should use
② Set the user name to access the opennms database table
③ Set the password to access the opennms database table
④ Set the postgres user for administrative access to PostgreSQL
⑤ Set the password for administrative access to PostgreSQL

Step 3: Initialize and start OpenNMS Horizon

Detect of Java environment and persist in /opt/opennms/etc/java.conf

```
${OPENNMS_HOME}/bin/runjava -s
```

Initialize the database and detect system libraries persisted in /opt/opennms/etc/libraries.properties

```
${OPENNMS_HOME}/bin/install -dis
```

Configure systemd to start OpenNMS Horizon on system boot

```
systemctl enable opennms
```
Start OpenNMS Horizon

```sh
systemctl start opennms
```

Allow connection to the Web UI from your network

```sh
firewall-cmd --permanent --add-port=8980/tcp
systemctl reload firewalld
```

If you want to receive SNMP Traps or Syslog messages you have to allow incoming traffic on your host firewall as well. By default OpenNMS SNMP trap daemon is listening on 162/udp and Syslog daemon is listening on 10514/udp. The SNMP Trap daemon is enabled by default, the OpenNMS Syslog daemon is disabled.

Step 4: First Login and change default password

After starting OpenNMS the web application can be accessed on `http://<ip-or-fqdn-of-your-server>:8980/opennms`. The default login user is `admin` and the password is initialized to `admin`.

1. Open in your browser `http://<ip-or-fqdn-of-your-server>:8980/opennms`
2. Login with with admin/admin
3. Click in main navigation menu on "admin → Change Password → Change Password"
4. Set as current password `admin` and set a new password and confirm your newly set password
5. Click "Submit"
6. Logout and login with your new password

Next Steps

Additional information can be found in these follow up documents:

- Getting Started Guide

  Learn the first steps to setup, configure, and maintain an OpenNMS Horizon.

- Reference Guide

  Find in-depth information on the detecters, monitors, collectors, and configuration files used by the OpenNMS Horizon platform.

2.4. Installing on Debian

The following steps will be described:

1. Installation of the `opennms` meta package which handles all dependencies
2. Initialize PostgreSQL database and configure access
3. Initialize OpenNMS Horizon database and start
4. Log in to the Web User Interface and change default admin password

All commands on the command line interface need to be executed with root permissions.

**Step 1: Install OpenNMS Horizon**

*Add apt repository in /etc/apt/sources.list.d/opennms.list and add GPG key*

```shell
cat << EOF | sudo tee /etc/apt/sources.list.d/opennms.list
deb https://debian.opennms.org stable main
deb-src https://debian.opennms.org stable main
EOF
wget -O - https://debian.opennms.org/OPENNMS-GPG-KEY | apt-key add -
apt update
```

**Installation of OpenNMS Horizon with all built-in dependencies**

```shell
apt -y install opennms
```

The following packages are required by the opennms package and will be automatically installed:

- `jicmp6` and `jicmp`: Java bridge to allow sending ICMP messages from OpenNMS repository.
- `opennms-core`: OpenNMS core services, e.g. Provisiond, Pollerd and Collectd from OpenNMS repository.
- `opennms-webapp-jetty`: OpenNMS web application from OpenNMS repository
- `postgresql`: PostgreSQL database server from distribution repository
- `postgresql-libs`: PostgreSQL database from distribution repository

With the successful installed packages the OpenNMS Horizon is installed in the following directory structure:

```
[root@localhost /usr/share/opennms]# tree -L 1
.
  ├── opennms
  │    ├── bin
  │    │    ├── data
  │    │    └── deploy
  │    │    └── etc -> /etc/opennms
  │    │    └── instances
  │    │    └── jetty-webapps
  │    │    └── lib -> ../java/opennms
  │    │    └── logs -> /var/log/opennms
  │    │    └── share -> /var/lib/opennms
  │    │    └── system
```
We recommend disabling the OpenNMS Horizon repository after installation to prevent unwanted upgrades while it is running. OpenNMS Horizon requires some manual steps upon upgrade configuration files or migrate database schemas to a new version. For this reason, it is recommended to exclude the OpenNMS Horizon packages from update except when you are planning on performing an upgrade.

```
apt-mark hold libopennms-java \
   libopennmsdeps-java \
   opennms-common \
   opennms-db
```

**Step 2: Initialize and setup PostgreSQL**

The Debian package installs the PostgreSQL database and is already initialized. The PostgreSQL service is already added in the runlevel configuration for system startup.

**Startup PostgreSQL database**

```
systemctl start postgresql
```

Create an opennms database user with a password and create an opennms database which is owned by the user opennms

```
su - postgres
createuser -P opennms
createdb -O opennms opennms
```

Set a password for Postgres super user

```
psql -c "ALTER USER postgres WITH PASSWORD 'YOUR-POSTGRES-PASSWORD';"
exit
```

The super user is required to be able to initialize and change the database schema for installation and updates.

**Configure database access in OpenNMS Horizon**

```
vi ${OPENNMS_HOME}/etc/opennms-datasources.xml
```
Set credentials to access the PostgreSQL database

```xml
<jdbc-data-source name="opennms"
    database-name="opennms"①
class-name="org.postgresql.Driver"
url="jdbc:postgresql://localhost:5432/opennms"
user-name="** YOUR-OPENNMS-USERNAME **"②
password="** YOUR-OPENNMS-PASSWORD **" />

<jdbc-data-source name="opennms-admin"
database-name="template1"
class-name="org.postgresql.Driver"
url="jdbc:postgresql://localhost:5432/template1"
user-name="postgres"④
password="** YOUR-POSTGRES-PASSWORD **" />
```

① Set the database name OpenNMS Horizon should use
② Set the user name to access the opennms database table
③ Set the password to access the opennms database table
④ Set the postgres user for administrative access to PostgreSQL
⑤ Set the password for administrative access to PostgreSQL

Step 3: Initialize and start OpenNMS Horizon

*Detect of Java environment and persist in /usr/share/opennms/etc/java.conf*

```
${OPENNMS_HOME}/bin/runjava -s
```

*Initialize the database and detect system libraries persisted in /opt/opennms/etc/libraries.properties*

```
${OPENNMS_HOME}/bin/install -dis
```

*Configure systemd to start OpenNMS Horizon on system boot*

```
systemctl enable opennms
```

*Start OpenNMS Horizon*

```
systemctl start opennms
```

If you want to receive SNMP Traps or Syslog messages you have to allow incoming traffic on your host firewall as well. By default OpenNMS SNMP trap daemon is listening on 162/udp and Syslog daemon is listening on 10514/udp. The SNMP Trap daemon is enabled by default, the OpenNMS Syslog daemon is disabled.
Step 4: First Login and change default password

After starting OpenNMS the web application can be accessed on http://<ip-or-fqdn-of-your-server>:8980/opennms. The default login user is admin and the password is initialized to admin.

1. Open in your browser http://<ip-or-fqdn-of-your-server>:8980/opennms
2. Login with with admin/admin
3. Click in main navigation menu on "admin → Change Password → Change Password"
4. Set as current password admin and set a new password and confirm your newly set password
5. Click "Submit"
6. Logout and login with your new password

Next Steps

Additional information can be found in these follow up documents:

- Getting Started Guide
  Learn the first steps to setup, configure, and maintain an OpenNMS Horizon.
- Reference Guide
  Find in-depth information on the detectors, monitors, collectors, and configuration files used by the OpenNMS Horizon platform.

2.5. Run with Docker

Modern infrastructure allows you to deploy and run workloads in containers. OpenNMS Horizon provides and publishes container images on DockerHub.

| We don’t install all available plugins in our published Docker image. If you want to customize and maintain your own image, you can find the Dockerfiles in our source repository. |

2.5.1. Objectives

- Run OpenNMS Horizon using Docker Compose with a basic setup and PostgreSQL on your local system as a quickstart
- Persist RRD files from OpenNMS Horizon and PostgreSQL in a volume
- Introduce a reference with all available configuration and mount conventions for more advanced setups

2.5.2. Before you begin

You must have at least the following components installed:
2.5.3. Quickstart service stack

Step 1: Create service stack for PostgreSQL and OpenNMS Horizon

The first section describes how to set up OpenNMS Horizon service stack in a docker-compose.yml file. Create a project directory with `mkdir opennms-horizon` and create a docker-compose.yml file in that directory with the following content:
---

version: '3'

volumes:
  data-postgres: {} ①
  data-opennms: {} ②

services:
  database:
    image: postgres:12 ④
    container_name: database ⑤
    environment:
      - TZ=Europe/Berlin
      - POSTGRES_USER=postgres
      - POSTGRES_PASSWORD=postgres
    volumes:
      - data-postgres:/var/lib/postgresql/data
    healthcheck:
      test: [ "CMD-SHELL", "pg_isready -U postgres" ]
      interval: 10s
      timeout: 30s
      retries: 3

horizon:
  image: opennms/horizon:27.0.3 ⑨
  container_name: horizon
  environment:
    - TZ=Europe/Berlin
    - POSTGRES_HOST=database
    - POSTGRES_PORT=5432
    - POSTGRES_USER=postgres
    - POSTGRES_PASSWORD=postgres
    - OPENNMS_DBNAME=opennms
    - OPENNMS_DBUSER=opennms
    - OPENNMS_DBPASS=opennms
  volumes:
    - data-opennms:/opt/opennms/share/rrd ⑩
    - ./overlay:/opt/opennms-overlay ⑪
  command: ['-s']
  ports:
    - "8980:8980/tcp"
    - "8101:8101/tcp"
    - "61616:61616/tcp"
  healthcheck:
    interval: 1m
    timeout: 5s
    retries: 3

① Volume definition to persist the PostgreSQL database permanently
Step 2: Start the service stack

```
cd opennms-horizon
docker-compose up -d
```

The startup and download can take a while; you can use the `docker-compose ps` command and wait until the health check for the `horizon` service is `up (healthy)`.

Step 3: Log in to the Web UI

After download and startup, verify that you can access the web user interface by going to `http://localhost:8980`. The default login is `admin` with password `admin`.

Please immediately change your admin account and set a strong password.

2.5.4. Configuration Reference

Startup Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-h</td>
<td>Display help with available arguments.</td>
</tr>
<tr>
<td>-f</td>
<td>Start the process in the foreground and use existing data and configuration.</td>
</tr>
<tr>
<td>-i</td>
<td>One-time command to initialize or update database and configuration files and do <strong>NOT</strong> start.</td>
</tr>
</tbody>
</table>
Command to initialize or update database and configuration files and start OpenNMS in the foreground.

One-time command to run the config-tester against the configuration.

### Environment Variables

**Table 4. Java options**

<table>
<thead>
<tr>
<th>Environment variable</th>
<th>Description</th>
<th>Required</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAVA_OPTS</td>
<td>Allows to add additional Java options</td>
<td>optional</td>
<td>-</td>
</tr>
</tbody>
</table>

**Table 5. PostgreSQL connection configuration in opennms-datasources.xml**

<table>
<thead>
<tr>
<th>Environment variable</th>
<th>Description</th>
<th>Required</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPENNMS_DBNAME</td>
<td>Database name used for OpenNMS Horizon</td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>OPENNMS_DBUSER</td>
<td>Username with access to the database</td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>OPENNMS_DBPASS</td>
<td>Password for user with access to the database</td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>POSTGRES_HOST</td>
<td>Host with the PostgreSQL server instance running</td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>POSTGRES_PORT</td>
<td>PostgreSQL server port</td>
<td>optional</td>
<td>5432</td>
</tr>
<tr>
<td>POSTGRES_USER</td>
<td>PostgreSQL super user to initialize database schema specified in OPENNMS_DBNAME</td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>POSTGRES_PASSWORD</td>
<td>PostgreSQL super user password</td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>OPENNMS_DATABASE_CONNECTION_POOLFACTORY</td>
<td>Database connection pool factory</td>
<td>optional</td>
<td>org.opennms.core.db.HikariCPConnectionFactory</td>
</tr>
<tr>
<td>OPENNMS_DATABASE_CONNECTION_IDLETIMEOUT</td>
<td>Database connection pool idle timeout</td>
<td>optional</td>
<td>600</td>
</tr>
<tr>
<td>OPENNMS_DATABASE_CONNECTION_LOGINTIMEOUT</td>
<td>Database connection pool login timeout</td>
<td>optional</td>
<td>3</td>
</tr>
<tr>
<td>Environment variable</td>
<td>Description</td>
<td>Required</td>
<td>Default value</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------------------------------------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>OPENNMS_DATABASE_CONNECTION_MINPOOL</td>
<td>Minimal connection pool size</td>
<td>optional</td>
<td>50</td>
</tr>
<tr>
<td>OPENNMS_DATABASE_CONNECTION_MAXPOOL</td>
<td>Maximum connection pool size</td>
<td>optional</td>
<td>50</td>
</tr>
<tr>
<td>OPENNMS_DATABASE_CONNECTION_MAXSIZE</td>
<td>Maximum connections</td>
<td>optional</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 6. Timeseries storage configuration in opennms.properties.d/_confd.timeseries.properties

<table>
<thead>
<tr>
<th>Environment variable</th>
<th>Description</th>
<th>Required</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPENNMS_TIMESERIES_STRATEGY</td>
<td>Used Timeseries storage strategy</td>
<td>optional</td>
<td>rrd</td>
</tr>
<tr>
<td>OPENNMS_RRD_STORE_BYFOREIGNSOURCE</td>
<td>Store timeseries data by foreign source</td>
<td>optional</td>
<td>true</td>
</tr>
<tr>
<td></td>
<td>instead of the database node id</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPENNMS_RRD_STRATEGYCLASS</td>
<td>Java RRD Strategy class</td>
<td>optional</td>
<td>org.opennms.netmgt.rrd.rrdtool.MultithreadedJniRrdStrategy</td>
</tr>
<tr>
<td>OPENNMS_RRD_INTERFACEJAR</td>
<td>Java RRD Interface library</td>
<td>optional</td>
<td>/usr/share/java/jrrd2.jar</td>
</tr>
<tr>
<td>OPENNMS_LIBRARY_JRRD2</td>
<td>JRRD2 libray path</td>
<td>optional</td>
<td>/usr/lib64/libjrrd2.so</td>
</tr>
</tbody>
</table>

Table 7. SNMP Trap receiver configuration in trapd-configuration.xml

<table>
<thead>
<tr>
<th>Environment variable</th>
<th>Description</th>
<th>Required</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPENNMS_TRAPD_ADDRESS</td>
<td>Listen interface for SNMP Trapd</td>
<td>optional</td>
<td>*</td>
</tr>
<tr>
<td>OPENNMS_TRAPD_PORT</td>
<td>Port to listen for SNMP Traps</td>
<td>optional</td>
<td>1162</td>
</tr>
<tr>
<td>OPENNMS_TRAPD_NEWSUSPECTONTRAP</td>
<td>Create new suspect event based Trap recepient for unknown devices</td>
<td>optional</td>
<td>false</td>
</tr>
<tr>
<td>OPENNMS_TRAPD_INCLUDERAWMESSAGE</td>
<td>Preserve raw messages in SNMP Traps</td>
<td>optional</td>
<td>false</td>
</tr>
<tr>
<td>OPENNMS_TRAPD_THREADS</td>
<td>Set maximum thread size to process SNMP Traps</td>
<td>optional</td>
<td>0</td>
</tr>
<tr>
<td>Environment variable</td>
<td>Description</td>
<td>Required</td>
<td>Default value</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------------------------------------------------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>OPENNMS_TRAPD_QUEUESIZE</td>
<td>Set maximum queue for SNMP Trap processing</td>
<td>optional</td>
<td>10000</td>
</tr>
<tr>
<td>OPENNMS_TRAPD_BATCHSIZE</td>
<td>Set batch size for SNMP Trap processing</td>
<td>optional</td>
<td>1000</td>
</tr>
<tr>
<td>OPENNMS_TRAPD_BATCHINTERVAL</td>
<td>Set batch processing interval in milliseconds</td>
<td>optional</td>
<td>500</td>
</tr>
</tbody>
</table>

Table 8. Karaf Shell configuration in org.apache.karaf.shell.cfg

<table>
<thead>
<tr>
<th>Environment variable</th>
<th>Description</th>
<th>Required</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPENNMS_karaf_SSH_HOST</td>
<td>Listen interface for Karaf shell</td>
<td>optional</td>
<td>0.0.0.0</td>
</tr>
<tr>
<td>OPENNMS_karaf_SSH_PORT</td>
<td>SSH Port for Karaf shell</td>
<td>optional</td>
<td>8101</td>
</tr>
</tbody>
</table>

Table 9. Cassandra and Newts configuration in opennms.properties.d/_confd.newts.properties

<table>
<thead>
<tr>
<th>Environment variable</th>
<th>Description</th>
<th>Required</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPLICATION_FACTOR</td>
<td>Set Cassandra replication factor for the newts keyspace if Newts is used</td>
<td>optional</td>
<td>1</td>
</tr>
<tr>
<td>OPENNMS_CASSANDRA_HOSTNAMES</td>
<td>A comma separated list with Cassandra hosts for Newts</td>
<td>optional</td>
<td>localhost</td>
</tr>
<tr>
<td>OPENNMS_CASSANDRA_KEYSPACE</td>
<td>Name of the keyspace used by Newts</td>
<td>optional</td>
<td>newts</td>
</tr>
<tr>
<td>OPENNMS_CASSANDRA_PORT</td>
<td>Cassandra server port</td>
<td>optional</td>
<td>9042</td>
</tr>
<tr>
<td>OPENNMS_CASSANDRA_USERNAME</td>
<td>Username with access to Cassandra</td>
<td>optional</td>
<td>cassandra</td>
</tr>
<tr>
<td>OPENNMS_CASSANDRA_PASSWORD</td>
<td>Password for user with access to Cassandra</td>
<td>optional</td>
<td>cassandra</td>
</tr>
</tbody>
</table>

Directory Conventions

<table>
<thead>
<tr>
<th>Mountpoint</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/opt/opennms-overlay</td>
<td>Allows to overwrite files relative to /opt/opennms</td>
</tr>
<tr>
<td>/opennms-data</td>
<td>Directory with RRDTool/JRobin files and generated PDF reports sent to the file system</td>
</tr>
</tbody>
</table>
Chapter 3. Installing and Configuring a Minion

A Minion is an instance of the Karaf OSGi service that enables OpenNMS to monitor devices and services in locations that an OpenNMS instance cannot reach. Minions communicate with these remote devices while OpenNMS performs coordination and task delegation.

Minions can operate behind a firewall and/or network address translation (NAT) as long as they can communicate with OpenNMS via ActiveMQ, Apache Kafka, or gRPC.

This chapter describes how to install a Minion and configure an authenticated unencrypted communication between Minion and OpenNMS Horizon using ActiveMQ and REST.

3.1. Requirements

- Identical version numbers for OpenNMS Horizon instance and Minion package
- OpenNMS Horizon installed and communication to the REST (8980/tcp) and ActiveMQ (616161/tcp) endpoints is possible

For communication between OpenNMS Horizon and Kafka, see Setup using Apache Kafka. For gRPC, see Minion with gRPC strategy.

Packages are available as RPMs for RHEL-based systems and DEBs for Debian-based systems

If the instruction refers to \${MINION_HOME}, the path for Minion resolves to the following directory, depending on the operating system:

<table>
<thead>
<tr>
<th>RHEL</th>
<th>/opt/minion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debian</td>
<td>/usr/share/minion</td>
</tr>
</tbody>
</table>

3.2. Set Up OpenNMS Horizon to allow Minion communication

Communication between a Minion and OpenNMS Horizon uses the REST API and a messaging system, by default ActiveMQ. Before installing a Minion, you need to create an authenticated user with the ROLE_MINION security role for these communication channels.

For information on setting up communication between OpenNMS Horizon and Kafka, see Setup using Apache Kafka. For gRPC, see Minion with gRPC strategy.

This guide uses the user name minion with password minion as an example. Change your credentials accordingly.
Create a minion user in the OpenNMS Horizon web UI:

1. Log in to the web UI as an administrative user.
2. Click on the gears icon and choose Configure Users, Groups and On-Call Roles → Configure Users.
3. Add a new user with login name *minion* and password *minion* and click OK.
4. In the Security Roles area, assign the ROLE_MINION security role.
   a. Optional: fill in a comment for the Minion user’s location and purpose.
5. Click Finish.

The *minion* user should now be listed in the user List.

Configure ActiveMQ to allow communication on public network interface:

```
vi ${OPENNMS_HOME}/etc/opennms-activemq.xml
```

Remove comments for the transport connector listening on 0.0.0.0 and save

```
<transportConnector name="openwire" uri="tcp://0.0.0:61616?useJmx=false
&maximumConnections=1000&wireformat.maxFrameSize=104857600"/>
```

Restart OpenNMS Horizon

```
systemctl restart opennms
```

Verify that port 61616/tcp is listening on all interfaces

```
ss -lnpt sport = :61616
State   Recv-Q Send-Q Local Address:Port Peer Address:Port
LISTEN  0 128    *:61616    *:*        users:("java",pid=1,fd=706))
```

3.3. Installing on RHEL

Use the following commands to install the Minion package, start the Minion, test access to the Karaf shell, configure Minion to communicate with OpenNMS Horizon, and verify connectivity.

You must run all commands on the command line interface as the *root* user.

Make sure you have set up OpenNMS Horizon to allow communication with the Minion before completing the steps in this section.

For miscellaneous installation information including Minion directory structure, startup configuration, and an alternate way to configure credentials, see Information about Minion Packages and Configuration.
Step 1: Install the repository and Minion package

Connect with SSH to your remote RHEL system where you want to install a Minion.

Install the Yum repository

```
rpm --import https://yum.opennms.org/OPENNMS-GPG-KEY
```

RHEL 7:

```
rpm --import https://yum.opennms.org/OPENNMS-GPG-KEY
```

Install the Minion package

```
dnf -y install opennms-minion
```

RHEL 7:

```
yum -y install opennms-minion
```

Step 2: Start the Minion and test access to Karaf Shell

Configure systemd to start Minion on system boot

```
systemctl enable minion
```

Start up Minion

```
systemctl start minion
```
Test access to Karaf shell with user **admin** and password **admin** and configure the Minion

```
ssh -p 8201 admin@localhost

config:edit org.opennms.minion.controller
config:property-set location <span class="red">Office-Pittsboro</span>
config:property-set broker-url <span class="red">failover:tcp://opennms-fqdn:61616</span>
config:update
```

Include the **failover:** portion of the broker URL to allow the Minion to re-establish connectivity on failure. For a reference on the different URL formats, see ActiveMQ URI Protocols.

Configure the credentials to use when communicating with OpenNMS Horizon and exit Karaf shell

```
opennms:scv-set opennms.http <span class="red">minion username minion password</span>
opennms:scv-set opennms.broker <span class="red">minion username minion password</span>
<ctrl-d>
```

Another way to configure credentials is to use the `scvcli` utility in your Minion `bin` directory (see Alternate way to configure credentials).

Restart the Minion after updating the credentials

```
systemctl restart minion
```

The credentials are configured separately since they are encrypted on disk.

**Step 3: Verify Connectivity**

Connect to Karaf Shell of the Minion and verify connectivity

```
ssh -p 8201 admin@localhost
opennms:health-check
```

You should see the following message:

```
Connecting to OpenNMS ReST API [ Success ]
Verifying installed bundles [ Success ]
Connecting to JMS Broker [ Success ]
=> Everything is awesome
admin@minion()>
```
3.4. Installing on Debian

Use the following commands to install the Minion package, start the Minion, test access to the Karaf shell, configure Minion to communicate with OpenNMS Horizon, and verify connectivity.

You must run all commands on the command line interface as the root user.

Make sure you have set up OpenNMS Horizon to allow communication with the Minion before completing the steps in this section.

For miscellaneous installation information including Minion directory structure, startup configuration, and an alternate way to configure credentials, see Information about Minion Packages and Configuration.

Red text in commands indicates text that you must substitute for your own values (e.g., "Office Pittsboro" means substitute your own office name).

**Step 1: Install the repository and Minion package**

Add apt repository in /etc/apt/sources.list.d/opennms.list and add GPG key

```
echo 'deb https://debian.opennms.org stable main
       deb-src https://debian.opennms.org stable main' >
/etc/apt/sources.list.d/opennms.list
wget -O - https://debian.opennms.org/OPENNMS-GPG-KEY | apt-key add -
apt update
```

Install the Minion package

```
apt -y install opennms-minion
```

**Step 2: Start the Minion and test access to Karaf Shell**

Configure systemd to start Minion on system boot

```
systemctl enable minion
```

Start up Minion

```
systemctl start minion
```
Test access to Karaf shell with user admin and password admin and configure the Minion

```
ssh -p 8201 admin@localhost
config:edit org.opennms.minion.controller
config:property-set location <span class="red">Office-Pittsboro</span>
config:property-set broker-url <span class="red">failover:tcp://opennms-fqdn:61616</span>
config:update
```

Include the failover: portion of the broker URL to allow the Minion to re-establish connectivity on failure. For a reference on the different URL formats, see ActiveMQ URI Protocols.

Configure the credentials to use when communicating with OpenNMS Horizon and exit Karaf shell

```
opennms:scv-set opennms.http <span class="red">minion username minion password</span>
opennms:scv-set opennms.broker <span class="red">minion username minion password</span>
<ctrl-d>
```

Another way to configure credentials is to use the scvcli utility in your Minion bin directory (see Alternate way to configure credentials).

Restart the Minion after updating the credentials

```
systemctl restart minion
```

The credentials are configured separately since they are encrypted on disk.

Step 3: Verify Connectivity

Connect to Karaf Shell of the Minion and verify connectivity

```
ssh -p 8201 admin@localhost
opennms:health-check
```

You should see the following message:

```
Connecting to OpenNMS ReST API  [ Success ]
Verifying installed bundles      [ Success ]
Connecting to JMS Broker         [ Success ]
=> Everything is awesome
admin@minion()>
```
3.5. Information about Minion Packages and Configuration

This section contains miscellaneous information about the Minion installation.

3.5.1. Directory structure

A successful installation means the Minion is installed in the following directory structure:

```
[root@localhost /opt/minion]# $ tree -L 1
.
  ├── bin
  │   ├── deploy
  │   └── etc
  │       └── lib
  │           └── repositories
  │               └── system
```

In Debian, symbolic links are set up pointing to /etc/minion and /var/log/minion to match Debian's expected filesystem layout.

3.5.2. Startup configuration

Edit /etc/sysconfig/minion file (RHEL) or the /etc/default/minion file (Debian) to change the Minion's startup configuration, if you want to override the defaults used at start up including:

- Location of the JDK
- Memory usage
- User to run as

3.5.3. Alternate way to configure credentials

You can also configure credentials by using the scvcli utility in your Minion bin directory:

```
cd /opt/minion
./bin/scvcli set opennms.http #minion user name minion password
./bin/scvcli set opennms.broker #minion user name minion password
```

3.6. Run with Docker

Modern infrastructure allows you to deploy and run workloads in containers. OpenNMS Horizon provides and publishes container images on DockerHub.
3.6.1. Objectives

- Run and configure a Minion in, and connect it to, the OpenNMS Horizon instance using environment variables
- Introduce a reference with all available configuration and mount conventions for more advanced setups

3.6.2. Before you begin

You must have at least the following components installed:

- Current stable Docker release installed, e.g., installed from Docker Documentation
- Current stable Docker Compose installed, e.g., installed from Docker Compose instructions You should have a basic knowledge of Docker, Docker Compose with networking, persisting files and mounting directories OpenNMS Horizon is configured to accept connections via ActiveMQ and a Minion user with ROLE_MINION The Minion can connect to OpenNMS Horizon with port 61616/TCP for ActiveMQ and REST on port 8980/TCP

3.6.3. Quickstart service stack

Step 1: Create service stack with a Minion

Create a project directory with mkdir opennms-minion and create a docker-compose.yml file in that directory with the following content:
---
version: '3'

services:
  minion:
    image: opennms/minion:27.0.3
    container_name: minion
    network_mode: host
    environment:
      - TZ=Europe/Berlin
      - MINION_ID=my-minion
      - MINION_LOCATION=my-location
      - OPENNMS_BROKER_URL=failover:tcp://horizon-instance:61616
      - OPENNMS_BROKER_USER=minion-user
      - OPENNMS_BROKER_PASS=minion-password
      - OPENNMS_HTTP_URL=http://horizon-instance:8980/opennms
      - OPENNMS_HTTP_USER=minion-user
      - OPENNMS_HTTP_PASS=minion-password
    command: ['-c']
    healthcheck:
      test: '/health.sh'
      interval: 15s
      timeout: 6s
      retries: 1

① Friendly container name

② If you process UDP data like SNMP traps, Syslogs or flows, network_mode: host ensures the UDP source addresses are not modified

③ Time zone for the Minion

④ A defined identifier for this Minion. If not set, a unique user identifier (UUID) will be generated

⑤ The name of the location of the Minion and the connection to the ActiveMQ broker running in OpenNMS Horizon

⑥ ActiveMQ broker endpoint from OpenNMS Horizon

⑦ Authentication for ActiveMQ broker

⑧ REST endpoint to connect to the OpenNMS Horizon instance

⑨ Authentication for the REST endpoint

⑩ Run our health check to indicate the Minion is ready. It uses the opennms:health-check internally running in Karaf.

In this example we haven’t set credentials to connect the Minion via REST and the ActiveMQ Message Broker. The Minion will fall back and uses the default admin/admin credentials for communication. Permissions for ActiveMQ and REST are assigned with the role ROLE_MINION on the OpenNMS Horizon instance.
If you process UDP data and you don’t use `network_mode: host`, the UDP source address from your packets will be modified from Docker. The source address is your Docker internal gateway instead of the source address of your device. Source addresses associate the Syslog or SNMP traps to the nodes in the OpenNMS database. You can use an isolated network and publish ports as usual if you don’t receive UDP-based monitoring data. If you don’t use `network_mode: host` you have to publish the listener ports manually.

**Step 2: Start the service stack and test the functionality**

```bash
cd opennms-minion
docker-compose up -d
```

**Step 3: Run Minion Health Check**

*Log in to the Minion Karaf Shell and run the health check*

```bash
ssh admin@localhost -p 8201

admin@minion> opennms:health-check
Verifying the health of the container

Connecting to OpenNMS ReST API   [ Success  ]
Verifying installed bundles      [ Success  ]
Connecting to JMS Broker         [ Success  ]

=> Everything is awesome
```

The default admin password for the Minion Karaf Shell is `admin`.

**Step 4: Verify status in the web UI**

- Log in as admin in the OpenNMS Horizon web interface
- Configure OpenNMS → Manage Minions. The Minion should be registered and the status should be up
- Verify that Minion is provisioned automatically by going to Info → Nodes and selecting the Minion. The services JMX-Minion, Minion-Heartbeat and Minion-RPC should be up and provisioned on the local loop-back interface

### 3.6.4. Startup Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-h</code></td>
<td>Display help with available arguments.</td>
</tr>
</tbody>
</table>
3.6.5. Environment Variables

Table 11. Generic Minion settings

<table>
<thead>
<tr>
<th>Environment variable</th>
<th>Description</th>
<th>Required</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINION_ID</td>
<td>Unique Minion identifier</td>
<td>optional</td>
<td>generated UUID</td>
</tr>
<tr>
<td>MINION_LOCATION</td>
<td>Name of the location the Minion is associated</td>
<td>required</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 12. Settings when ActiveMQ is used

<table>
<thead>
<tr>
<th>Environment variable</th>
<th>Description</th>
<th>Required</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPENNMS_HTTP_URL</td>
<td>Web user interface base URL for REST</td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>OPENNMS_HTTP_USER</td>
<td>User name for the Rest API</td>
<td>optional</td>
<td>admin</td>
</tr>
<tr>
<td>OPENNMS_HTTP_PASS</td>
<td>Password for the Rest API</td>
<td>optional</td>
<td>admin</td>
</tr>
<tr>
<td>OPENNMS_BROKER_URL</td>
<td>ActiveMQ broker URL</td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>OPENNMS_BROKER_USER</td>
<td>Username for ActiveMQ authentication</td>
<td>optional</td>
<td>admin</td>
</tr>
<tr>
<td>OPENNMS_BROKER_PASS</td>
<td>Password for ActiveMQ authentication</td>
<td>optional</td>
<td>admin</td>
</tr>
</tbody>
</table>

Apache Kafka Configuration

If you want to use Apache Kafka the environment variable names are converted with a prefix convention:

- Prefix KAFKA_RPC_ will be written to org.opennms.core.ipc.rpc.kafka.cfg
- Prefix KAFKA_SINK_ will be written to org.opennms.core.ipc.sink.kafka.cfg
- Everything behind will be converted to lower case and _ is replaced with .

As an example:

```
environment:
  - KAFKA_RPC_BOOTSTRAP_SERVERS=192.168.1.1,192.168.1.2
```
This will create the file `org.opennms.core.ipc.rpc.kafka.cfg` with the content:

```
bootstrap.servers=192.168.1.1,192.168.1.2
```

### 3.6.6. Directory Conventions

<table>
<thead>
<tr>
<th>Mountpoint</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>/opt/minion-etc-overlay</code></td>
<td>Allows to overwrite files relative to <code>/opt/minion/etc</code></td>
</tr>
<tr>
<td><code>/keystore</code></td>
<td>Directory with credentials for encrypted keystore file</td>
</tr>
</tbody>
</table>
Chapter 4. Sentinel

This section describes how to install the Sentinel to scale individual components of OpenNMS Horizon.

At the moment only flows can be distributed using Sentinel. In the future more components will follow.

4.1. Before you begin

Setting up a OpenNMS Horizon with Sentinel requires:

- Instance of OpenNMS Horizon needs to be exact same version as Sentinel packages
- Packages are available as RPMs for RHEL-based systems and DEBs for Debian-based systems
- OpenNMS Horizon needs to be installed and communication to the REST (8980/tcp) and ActiveMQ (616161/tcp) endpoints is possible
- At least one Minion needs to be installed and successful communicate with the OpenNMS Horizon

Depending on the installed operating system, the path for Sentinel is different. If the instruction refers to \$\{SENTINEL_HOME\}, the path is resolved to the following directories:

<table>
<thead>
<tr>
<th>RHEL</th>
<th>/opt/sentinel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debian</td>
<td>/usr/share/sentinel</td>
</tr>
</tbody>
</table>

4.2. Installing on RHEL

Commands and instructions are specific to RHEL 8. We provide RHEL 7 alternatives where applicable.

1. Setup OpenNMS Horizon to allow Sentinel communication
2. Installation of the opennms-sentinel meta package which handles all dependencies
3. Starting Sentinel and access the Karaf console over SSH
4. Configure Sentinel to communicate with OpenNMS Horizon
5. Verify the connectivity between Sentinel and OpenNMS Horizon

All commands on the command line interface need to be executed with root permissions.

Step 1: Setup OpenNMS Horizon to allow Sentinel communication

This step is exactly the same as for Minion. Even the role name ROLE_MINION can be used, as there does not exist a dedicated role ROLE_SENTINEL yet.
Therefore, please refer to section Setup OpenNMS Horizon to allow Minion communication.

---

Even if we have to configure the communication to the OpenNMS Horizon exactly the same as for Minion no ReST requests are made and may be removed at a later state.

---

**Step 2: Install the repository and Sentinel package**

Connect with SSH to your remote RHEL system where the Sentinel should be installed.

**Install the Yum repository**

```
rpm --import https://yum.opennms.org/OPENNMS-GPG-KEY
```

**RHEL 7:**

```
rpm --import https://yum.opennms.org/OPENNMS-GPG-KEY
```

**Install the Sentinel package**

```
dnf -y install opennms-sentinel
```

**RHEL 7:**

```
yum -y install opennms-sentinel
```

With the successful installed packages the Sentinel is installed in the following directory structure:

```
[root@localhost /opt/sentinel]# $ tree -L 1
.
|-- bin
|-- COPYING
|-- data
|-- deploy
|-- etc
|-- lib
 `-- system
```

The Sentinel's startup configuration can be changed by editing the `/etc/sysconfig/sentinel` file. It allows to override the defaults used at startup including:

- Location of the JDK
- Memory usage
- User to run as
Step 3: Starting the Sentinel and test access to Karaf Shell

Configure systemd to start Sentinel on system boot

```bash
systemctl enable sentinel
```

Startup Sentinel

```bash
systemctl start sentinel
```

Test access to Karaf shell with user admin and password admin and exit with <ctrl-d>

```bash
ssh -p 8301 admin@localhost
```

Step 4: Configure Sentinel to communicate with OpenNMS Horizon

Login to the Karaf Shell on the system where your Sentinel is installed with SSH

```bash
ssh -p 8301 admin@localhost
```

Configure the Sentinel's location and endpoint URLs for communication with OpenNMS Horizon

```
[root@localhost /root]# $ ssh -p 8201 admin@localhost
... 
admin@sentinel()> config:edit org.opennms.sentinel.controller
admin@sentinel()> config:property-set location Office-Pittsboro
admin@sentinel()> config:property-set http-url http://opennms-fqdn:8980/opennms
admin@sentinel()> config:property-set broker-url failover:tcp://opennms-fqdn:61616
admin@sentinel()> config:update
```

Include the `failover:` portion of the broker URL to allow the Sentinel to re-establish connectivity on failure. For a reference on the different URL formats, see ActiveMQ URI Protocols.

Even if the id, location and http-url must be set the same ways as for Minion, this may change in future versions of Sentinel.

Configure the credentials to use when communicating with OpenNMS Horizon

```
admin@sentinel()> opennms:scv-set opennms.http minion minion
admin@sentinel()> opennms:scv-set opennms.broker-url failover:tcp://opennms-fqdn:61616
admin@sentinel()> opennms:scv-set opennms.broker-url failover:tcp://opennms-fqdn:61616
```

Username and password is explicitly set to `minion` as it is assumed that they share the same credentials and roles.
Another way to configure credentials is to use the `scvcli` utility in your Sentinel bin directory.

Example of configuring credentials with the command line utility `scvcli`

```
[root@localhost /root]# $ cd /opt/sentinel
[root@localhost /opt/sentinel]# $ ./bin/scvcli set opennms.http minion minion
[root@localhost /opt/sentinel]# $ ./bin/scvcli set opennms.broker minion minion
```

Restart the Sentinel after updating the credentials

```
[root@localhost /root]# $ systemctl restart sentinel
```

The credentials are configured separately since they are encrypted on disk.

**Step 5: Verifying Connectivity**

Connect to Karaf Shell of the Sentinel

```
ssh -p 8301 admin@localhost
```

Verify connectivity with the OpenNMS Horizon

```
admin@sentinel()> feature:install sentinel-core
admin@sentinel> opennms:health-check
Verifying the health of the container

Verifying installed bundles      [ Success  ]
Connecting to OpenNMS ReST API   [ Success  ]

=> Everything is awesome
admin@sentinel()>
```

The `opennms:health-check` command is a newer and more flexible version of the original `minion:ping` command. Therefore on Sentinel there is no equivalent such as `sentinel:ping`.

**4.3. Installing on Debian**

1. Setup OpenNMS Horizon to allow Sentinel communication
2. Installation of the `opennms-sentinel` meta package which handles all dependencies
3. Starting Sentinel and access the Karaf console over SSH
4. Configure Sentinel to communicate with OpenNMS Horizon
5. Verify the connectivity between Sentinel and OpenNMS Horizon
All commands on the command line interface need to be executed with root permissions.

**Step 1: Setup OpenNMS Horizon to allow Sentinel communication**

This step is exactly the same as for Minion. Even the role name ROLE_MINION can be used, as there does not exist a dedicated role ROLE_SENTINEL yet.

Therefore, please refer to section Setup OpenNMS Horizon to allow Minion communication.

---

**Step 2: Install the repository and Sentinel package**

*Add apt repository in /etc/apt/sources.list.d/opennms.list and add GPG key*

```
echo 'deb https://debian.opennms.org stable main 
   deb-src https://debian.opennms.org branches/features-sentinel main' >
/etc/apt/sources.list.d/opennms.list
wget -O - https://debian.opennms.org/OPENNMS-GPG-KEY | apt-key add -
apt update
```

*Install the Sentinel package*

```
apt -y install opennms-sentinel
```

The Sentinel packages setup the following directory structure:

```
[root@localhost /usr/share/sentinel]# $ tree -L 1
.
|-- bin
`-- COPYING
| `-- data
    `-- debian
    `-- deploy
    `-- etc
    `-- lib
    `-- system
```

Additionally, symbolic links are set up pointing to /etc/sentinel and /var/log/sentinel to match Debian's expected filesystem layout.

The Minion's startup configuration can be changed by editing the /etc/default/sentinel file. It allows to override the defaults used at startup including:

- Location of the JDK
• Memory usage
• User to run as

**Step 3: Starting the Sentinel and test access to Karaf Shell**

*Configure systemd to start Sentinel on system boot*

```
systemctl enable sentinel
```

*Startup Sentinel*

```
systemctl start sentinel
```

*Test access to Karaf shell with user admin and password admin and exit with <ctrl-d>*

```
ssh -p 8301 admin@localhost
```

**Step 4: Configure Sentinel to communicate with OpenNMS Horizon**

*Login to the Karaf Shell on the system where your Sentinel is installed with SSH*

```
ssh -p 8301 admin@localhost
```

*Configure the Sentinel's location and endpoint URLs for communication with OpenNMS Horizon*

```bash
[root@localhost /root]# $ ssh -p 8201 admin@localhost
...
admin@sentinel()> config:edit org.opennms.sentinel.controller
admin@sentinel()> config:property-set location Office-Pittsboro
admin@sentinel()> config:property-set http-url http://opennms-fqdn:8980/opennms
admin@sentinel()> config:property-set broker-url failover:tcp://opennms-fqdn:61616
admin@sentinel()> config:update
```

*Include the failover: portion of the broker URL to allow the Sentinel to re-establish connectivity on failure. For a reference on the different URL formats, see [ActiveMQ](https://activemq.apache.org/) URI Protocols.*

*Even if the id, location and http-url must be set the same ways as for Minion, this may change in future versions of Sentinel.*

*Configure the credentials to use when communicating with OpenNMS Horizon*

```bash
admin@sentinel()> opennms:scv-set opennms.http minion minion
admin@sentinel()> opennms:scv-set opennms.broker-url failover:tcp://opennms-fqdn:61616
admin@sentinel()> config:update
```
Username and password is explicitly set to **minion** as it is assumed that they share the same credentials and roles.

![Note]
Another way to configure credentials is to use the **scvcli** utility in your **Sentinel bin** directory.

**Example of configuring credentials with the command line utility scvcli**

```
[root@localhost /root]# $ cd /opt/sentinel
[root@localhost /usr/share/sentinel]# $ ./bin/scvcli set opennms.http minion minion
[root@localhost /usr/share/sentinel]# $ ./bin/scvcli set opennms.broker minion minion
```

**Restart the Sentinel after updating the credentials**

```
[root@localhost /root]# $ systemctl restart sentinel
```

![Note]
The credentials are configured separately since they are encrypted on disk.

**Step 5: Verifying Connectivity**

**Connect to Karaf Shell of the Sentinel**

```
ssh -p 8301 admin@localhost
```

**Verify connectivity with the OpenNMS Horizon**

```
admin@sentinel()> feature:install sentinel-core
admin@sentinel> opennms:health-check
Verifying the health of the container

Verifying installed bundles [ Success ]
Connecting to OpenNMS ReST API [ Success ]

=> Everything is awesome
admin@sentinel>
```

![Note]
The **opennms:health-check** command is a newer and more flexible version of the original **minion:ping** command. Therefore on **Sentinel** there is no equivalent such as **sentinel:ping**.
Chapter 5. Minion with custom messaging system

Minions and OpenNMS Horizon communicate via a messaging system. By default, an embedded ActiveMQ broker is used. OpenNMS Horizon is designed to work with different messaging systems and based on the system requirements or workload, an alternative to ActiveMQ can be used. In general, the communication between OpenNMS Horizon and Minion is provided by two patterns:

- **Remote Producer Calls (RPCs)** are used to issue specific tasks (such as a request to poll or perform data collection) from an OpenNMS Horizon instance to a Minion in a remote location.
  - These calls are normally self-contained and include all of the meta-data and information required for them to be performed.
- The **Sink** pattern is used to send unsolicited messages (i.e. Syslog, SNMP Traps or Flows) received from a Minion to an OpenNMS Horizon instance

High level components used for communication between OpenNMS Horizon and Minions

This section describes how you can setup OpenNMS Horizon to use other supported messaging systems for the communication with Minions.

5.1. Setup using Apache Kafka

This section describes how to use Apache Kafka as a messaging system between OpenNMS Horizon and Minions in a remote location.

5.1.1. Objectives

- Configure OpenNMS Horizon to forward RPC to a Minion
- Configure Minion to forward messages over the Sink component to an OpenNMS Horizon instance
- Disable the embedded Active MQ message broker on the Minion.
- Verify the functionality on the Minion using the opennms:health-check command and ensure the Minion is registered and monitored in the OpenNMS Horizon web interface
5.1.2. Before you begin

The following requirements should be satisfied before you can start with this tutorial:

- At least a minimal Kafka system up and running If you want to start in a lab, the Apache Kafka Quickstart guide is a good starting point
- An instance running with OpenNMS Horizon and at least one deployed Minion
- Communication between OpenNMS Horizon, Minion and Apache Kafka is possible on TCP port 9092

Network topology used for the following configuration example

![Network topology diagram](image)

The example is used to describe how the components need to be configured. IP addresses and hostnames need to be adjusted accordingly.

You can add more than one Kafka server to the configuration. The driver will attempt to connect to the first entry. If that is successful the whole broker topology will be discovered and will be known by the client. The other entries are only used if the connection to the first entry fails.

5.1.3. Configure OpenNMS Horizon

Step 1: Set Kafka as RPC strategy and add Kafka server

```
cat <<EOF >${OPENNMS_HOME}/etc/opennms.properties.d/kafka.properties
org.opennms.core.ipc.rpc.strategy=kafka
org.opennms.core.ipc.rpc.kafka.bootstrap.servers=kafka-1:9092,kafka-2:9092,kafka-3:9092
EOF
```
Step 2: Set Kafka as Sink strategy and add Kafka server

```
cat <<EOF >>${OPENNMS_HOME}/etc/opennms.properties.d/kafka.properties
# Ensure that messages are not consumed from Kafka until the system has fully
initialized
org.opennms.core.ipc.sink.initialSleepTime=60000
org.opennms.core.ipc.sink.strategy=kafka
org.opennms.core.ipc.sink.kafka.bootstrap.servers=kafka-1:9092,kafka-2:9092,kafka-3:9092
EOF
```

Step 3: Restart OpenNMS Horizon

```
systemctl restart opennms
```

5.1.4. Configure Minion

Step 1: Disable ActiveMQ for RPC and Sink

Disable ActiveMQ on Minion startup

```
cat <<EOF >${MINION_HOME}/etc/featuresBoot.d/disable-activemq.boot
!minion-jms
!opennms-core-ipc-rpc-jms
!opennms-core-ipc-sink-camel
EOF
```

Step 2: Enable Kafka for RPC and Sink

```
cat <<EOF >${MINION_HOME}/etc/featuresBoot.d/kafka.boot
opennms-core-ipc-rpc-kafka
opennms-core-ipc-sink-kafka
EOF
```

Step 3: Configure Kafka server

Add Kafka server for RPC communication

```
cat <<EOF >${MINION_HOME}/etc/org.opennms.core.ipc.rpc.kafka.cfg
bootstrap.servers=kafka-1:9092,kafka-2:9092,kafka-3:9092
acks=1
EOF
```
Add Kafka server for Sink communication

```bash
cat <<EOF >${MINION_HOME}/etc/org.opennms.core.ipc.sink.kafka.cfg
bootstrap.servers=kafka-1:9092,kafka-2:9092,kafka-3:9092
acks=1
EOF
```

Step 4: Restart Minion to apply changes

```
systemctl restart minion
```

Step 5: Verify Kafka configuration and connectivity

Login to Karaf Shell

```
ssh admin@localhost -p 8201
```

Test if Kafka RPC and Sink feature is started

```
feature:list | grep opennms-core-ipc-rpc-kafka
opennms-core-ipc-rpc-kafka | 25.0.0 | x | Started
```

```
feature:list | grep opennms-core-ipc-sink-kafka
opennms-core-ipc-sink-kafka | 25.0.0 | x | Started
```

Test connectivity to Kafka

```
opennms:health-check
Verifying the health of the container
    Connecting to OpenNMS ReST API [ Success ]
    Verifying installed bundles [ Success ]
    Connecting to Kafka from RPC [ Success ]
    Connecting to Kafka from Sink [ Success ]

=> Everything is awesome
```

Step 6. Verify Minion functionality

Ensure the Minion is registered in the OpenNMS Horizon web interface

1. Login as Administrator
2. Configure OpenNMS
3. Manage Minions
4. Minion should be registered and should be shown as "Up"
5. Click on the name of the Minion and go to the node detail page
6. Verify if the services on the loopback interface JMX-Minion, Minion-Heartbeat, Minion-RPC are monitored and "Up"

5.1.5. Tuning Apache Kafka

The configuration is shipped with sane defaults, but depending on the size and network topology it can be required to tune the Apache Kafka environment to meet certain needs. Apache Kafka options can be set directly in the org.opennms.core.ipc.rpc.kafka.cfg and org.opennms.core.ipc.sink.kafka.cfg file.

Alternatively: Kafka producer/consumer options can be set by defining additional system properties prefixed with org.opennms.core.ipc.rpc.kafka and org.opennms.core.ipc.sink.kafka.

You can find available configuration parameters for Kafka here:

- **ProducerConfigs** for RPC communication
- **New ConsumerConfigs** for Sink communication

**Multiple OpenNMS Horizon instances**

Topics will be automatically created and are prefixed by default with OpenNMS. If you want to use an Apache Kafka cluster with multiple OpenNMS Horizon instances, the topic prefix can be customized by setting org.opennms.core.ipc.rpc.kafka.group.id and org.opennms.core.ipc.sink.kafka.group.id to a string value which identifies your instance.

**Tips for Kafka**

<table>
<thead>
<tr>
<th></th>
<th>For Kafka RPC, the number of partitions should always be greater than the number of minions at a location. When there are multiple locations, partitions &gt;= max number of minions at a location.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>By default, Kafka RPC supports buffers greater than &gt;1MB by splitting large buffer into chunks of 900KB(912600). Max buffer size (900KB, by default) can be configured by setting org.opennms.core.ipc.rpc.kafka.max.buffer.size (in bytes).</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Default time to live (time at which request will expire) is 20000 msec (20sec). It can be changed by configuring system property org.opennms.core.ipc.rpc.kafka.ttl in msec.</th>
</tr>
</thead>
</table>

5.1.6. Using Single Topic for Kafka RPC

By default OpenNMS creates a request and response topic for each module at every location. When dealing with too many locations, these numerous topics can overbuden Kafka. A single topic structure creates one request topic for each location and one response topic for all modules, regardless of location. Note that all Minions at any location must be running the same features in order to make use of single topic.

Single topic must be configured on both Minion and OpenNMS.
Configure single topic on Minion

```
echo 'single-topic=true' >> "${MINION_HOME}/etc/org.opennms.core.ipc.rpc.kafka.cfg"
```

On OpenNMS, enable single topic by setting the `org.opennms.core.ipc.rpc.kafka.single-topic` system property to true.

## 5.2. Minion with gRPC Strategy

Minions and OpenNMS Horizon can communicate via gRPC for both RPC and Sink patterns. While using gRPC strategy Minion runs a gRPC client that connects to OpenNMS Horizon gRPC server on a custom port.

RPC pattern on GRPC strategy uses bidirectional streaming to send requests from OpenNMS Horizon and get responses back from Minion. Sink pattern on GRPC strategy uses unidirectional streaming to send sink messages from Minion to OpenNMS Horizon.

This section describes how you can set up OpenNMS Horizon to use gRPC for communication with Minions.

### 5.2.1. Configure OpenNMS Horizon

**Step 1: Set GRPC as IPC strategy.**

```
cat <<EOF >${OPENNMS_HOME}/etc/opennms.properties.d/grpc.properties
org.opennms.core.ipc.strategy=osgi
EOF
```

**Step 2: Add GRPC Server feature.**

```
cat <<EOF >${OPENNMS_HOME}/etc/featuresBoot.d/grpc.boot
opennms-core-ipc-grpc-server
EOF
```

**Step 3: Enable and configure TLS on gRPC server.**

Enable TLS and configure TLS certificates and private keys.

```
cat <<EOF >${OPENNMS_HOME}/etc/org.opennms.core.ipc.grpc.server.cfg
  tls.enabled=true
  server.cert.filepath=/custom-path/server.crt
  server.private.key.filepath=/custom-path/server.pem
  client.cert.filepath=/custom-path/client.crt
EOF
```
Step 4: Configure max. message size if default of 10MB is not sufficient.

(needs to be configured on both server and client)

Configure max. message size

```
cat <<EOF >${OPENNMS_HOME}/etc/org.opennms.core.ipc.grpc.server.cfg
max.message.size=10485760
EOF
```

Step 5: Restart OpenNMS Horizon.

```
systemctl restart opennms
```

5.2.2. Configure Minion

Step 1: Disable ActiveMQ for RPC and Sink.

Disable ActiveMQ on Minion startup

```
cat <<EOF >${MINION_HOME}/etc/featuresBoot.d/disable-activemq.boot
!minion-jms
!opennms-core-ipc-rpc-jms
!opennms-core-ipc-sink-camel
EOF
```

Step 2: Enable GRPC for RPC and Sink.

```
cat <<EOF >${MINION_HOME}/etc/featuresBoot.d/grpc.boot
opennms-core-ipc-grpc-client
EOF
```

Step 3: Configure gRPC server information.

Add gRPC server for RPC/Sink communication.

```
cat <<EOF >${MINION_HOME}/etc/org.opennms.core.ipc.grpc.client.cfg
host=localhost
port=8990
EOF
```

Step 4: Enable and configure TLS on gRPC client.
Enable TLS and configure TLS certificates and private keys.

```bash
cat <<EOF >${MINION_HOME}/etc/org.opennms.core.ipc.grpc.client.cfg
tls.enabled=true
trust.cert.filepath=/custom-path/ca.crt
client.cert.filepath=/custom-path/client.crt
client.private.key.filepath=/custom-path/client.pem
EOF
```

**Step 5: Configure max. message size if default of 10MB is not sufficient.**

(needs to be configured on both server and client)

Configure max. message size

```bash
cat <<EOF >${MINION_HOME}/etc/org.opennms.core.ipc.grpc.client.cfg
max.message.size=10485760
EOF
```

**Step 6: Restart Minion to apply changes.**

`systemctl restart minion`

**Step 7: Verify GRPC configuration and connectivity.**

**Login to Karaf shell**

```bash
ssh admin@localhost -p 8201
```

**Test if gRPC client can connect to OpenNMS Horizon gRPC server**

```bash
feature:list | grep opennms-core-ipc-grpc-client
opennms-core-ipc-grpc-client | 27.0.3 | x | Started
```

**Test connectivity to Kafka**

```bash
opennms-health:check
Verifying the health of the container

Connecting to OpenNMS ReST API [ Success ]
Verifying installed bundles [ Success ]
Connecting to gRPC IPC Server [ Success ]

=> Everything is awesome
```
Step 8. Verify Minion functionality.

Ensure the Minion is registered in the OpenNMS Horizon web interface

1. Login as Administrator
2. Configure OpenNMS
3. Manage Minions
4. Minion should be registered and should be shown as "Up"
5. Click on the name of the Minion and go to the node detail page
6. Verify if the services on the loopback interface JMX-Minion, Minion-Heartbeat, Minion-RPC are monitored and "Up"
Chapter 6. Install other versions than stable

Installation packages are available for different releases of OpenNMS Horizon or Minion. You will need to choose which release you would like to run and then configure your package repository to point to that release. Configuring a package repository will enable you to install and update the software by using standard Linux software update tools like yum and apt.

The following package repositories are available:

Table 14. OpenNMS package repositories

<table>
<thead>
<tr>
<th>Release</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>stable</td>
<td>Latest stable release. This version is recommended for all users.</td>
</tr>
<tr>
<td>testing</td>
<td>Release candidate for the next stable release.</td>
</tr>
<tr>
<td>snapshot</td>
<td>Latest successful development build, the &quot;nightly&quot; build.</td>
</tr>
<tr>
<td>branches/${BRANCH-NAME}</td>
<td>Install from a specific branch name for testing a specific feature that is under development. Available branches can be found in <a href="https://yum.opennms.org/branches/">https://yum.opennms.org/branches/</a> or <a href="https://debian.opennms.org/dists/branches/">https://debian.opennms.org/dists/branches/</a>.</td>
</tr>
</tbody>
</table>

To install a different release the repository files have to be installed and manually modified.

In Debian systems modify the repository file in /etc/apt/sources.list.d/opennms.list.

```
deb https://debian.opennms.org snapshot main
deb-src https://debian.opennms.org snapshot main
EOF
wget -O - https://debian.opennms.org/OPENNMS-GPG-KEY | apt-key add -
apt update
```

① Change from stable to snapshot

On RHEL systems you can install a snapshot repository with:

```
yum -y install https://yum.opennms.org/repofiles/opennms-repo-snapshot-rhel7.noarch.rpm
```

For branches use repofiles/opennms-repo-branches-$\{branch-name\}$-rhel7.noarch.rpm.

The installation procedure is the same as with the stable version.
Chapter 7. Setup Minion with a config file

Beside manually configuring a Minion instance via the Karaf CLI it is possible to modify and deploy its configuration file through configuration management tools. The configuration file is located in `${MINION_HOME}/etc/org.opennms.minion.controller.cfg`. All configurations set in Karaf CLI will be persisted in this configuration file which can also be populated through configuration management tools.

### Configuration file for Minion

```plaintext
id = 00000000-0000-0000-0000-deadbeef0001
location = MINION
broker-url = tcp://myopennms.example.org:61616
http-url = http://myopennms.example.org:8980/opennms
```

The Minion needs to be restarted when this configuration file is changed.

💡 In case the credentials needs to be set through the CLI with configuration management tools or scripts, the `${MINION_HOME}/bin/client` command can be used which allows to execute Karaf commands through the Linux shell.
Chapter 8. Running in non-root environments

This section provides information running OpenNMS Horizon and Minions processes in non-root environments. Running with a system user have restricted possibilities. This section describes how to configure your Linux system related to:

- sending ICMP packages as an unprivileged user
- receiving Syslog on ports < 1023, e.g. 514/udp
- receiving SNMP Trap on ports < 1023, e.g. 162/udp

8.1. Send ICMP as non-root

By default, Linux does not allow regular users to perform ping operations from arbitrary programs (including Java). To enable the Minion or OpenNMS Horizon to ping properly, you must set a sysctl option.

Enable User Ping (Running System)

```
# run this command as root to allow ping by any user (does not survive reboots)
sysctl net.ipv4.ping_group_range='0 429496729'
```

If you wish to restrict the range further, use the GID for the user the Minion or OpenNMS Horizon will run as, rather than 429496729.

To enable this permanently, create a file in /etc/sysctl.d/ to set the range:

```
/etc/sysctl.d/99-zzz-non-root-icmp.conf
```

```
# we start this filename with "99-zzz-" to make sure it's last, after anything else that might have set it
net.ipv4.ping_group_range=0 429496729
```

8.2. Trap reception as non-root

If you wish your Minion or OpenNMS Horizon to listen to SNMP Traps, you will need to configure your firewall to port forward from the privileged trap port (162) to the Minion's default trap listener on port 1162.
8.3. Syslog reception as non-root

If you wish your Minion or OpenNMS Horizon to listen to syslog messages, you will need to configure your firewall to port forward from the privileged Syslog port (514) to the Minion’s default syslog listener on port 1514.
Chapter 9. Use R for statistical computing

R is a free software environment for statistical computing and graphics. OpenNMS Horizon can leverage the power of R for forecasting and advanced calculations on collected time series data.

OpenNMS Horizon interfaces with R via stdin and stdout, and for this reason, R must be installed on the same host as OpenNMS Horizon. Note that installing R is optional, and not required by any of the core components.

9.1. Install R on RHEL

Commands and instructions are specific to RHEL 8. For RHEL 7, replace dnf with yum.

Ensure the dnf (yum on RHEL 7) plugin config-manager is installed

```
dnf -y install dnf-plugins-core
```

Enable the PowerTools repository for R dependencies

```
dnf config-manager --set-enabled PowerTools
```

Install the epel-release repository with R packages

```
dnf -y install epel-release
```

Install R-core package

```
dnf -y install R-core
```

9.2. Install R on Debian

Install R

```
apt -y install r-recommended
```
Chapter 10. Using a different Time Series Storage

*OpenNMS Horizon* stores performance data in a time series storage which is by default *JRobin*. For different scenarios it is useful to switch to a different time series storage. The following implementations are supported:

Table 15. Supported Time Series Databases

<table>
<thead>
<tr>
<th>Time Series Database</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JRobin</strong></td>
<td><em>JRobin</em> is a clone of <em>RRDTool</em> written in <em>Java</em>, it does not fully cover the latest feature set of <em>RRDTool</em> and is the default when you install <em>OpenNMS Horizon</em>. Data is stored on the local file system of the OpenNMS Horizon node. Depending on I/O capabilities it works good for small to medium sized installations.</td>
</tr>
<tr>
<td><strong>RRDTool</strong></td>
<td><em>RRDTool</em> is active maintained and the de-facto standard dealing with time series data. Data is stored on the local file system of the OpenNMS Horizon node. Depending on I/O capabilities it works good for small to medium sized installations.</td>
</tr>
<tr>
<td><strong>Newts</strong></td>
<td><em>Newts</em> is a database schema for <em>Cassandra</em>. The time series is stored on a dedicated <em>Cassandra</em> cluster which gives growth flexibility and allows to persist time series data in a large scale.</td>
</tr>
</tbody>
</table>

This section describes how to configure *OpenNMS Horizon* to use *RRDTool* and *Newts*.

The way how data is stored in the different time series databases makes it extremely hard to migrate from one technology to another. Data loss can’t be prevented when you switch from one to another.

10.1. RRDtool

In most *Open Source* applications, *RRDtool* is often used and is the de-facto open standard for *Time Series Data*. The basic installation of *OpenNMS Horizon* comes with *JRobin* but it is simple to switch the system to use *RRDTool* to persist *Time Series Data*. This section describes how to install *RRDtool*, the *jrrd2 OpenNMS Java Interface* and how to configure *OpenNMS Horizon* to use it.

10.1.1. Install RRDTool on RHEL

Following this guide does not cover data migration from *JRobin* to *RRDTool*.

To install *jrrd2* enable the OpenNMS YUM repository ensure the repositories are enabled. You can enable them with `dnf config-manager --enable opennms-repo-stable-*`. 

51
Step 1: Install RRDTool and the jrrd2 interface

Installation on RHEL

dnf -y install rrdtool jrrd2

Step 2: Configure OpenNMS Horizon to use RRDTool

cat << EOF | sudo tee /opt/opennms/etc/opennms.properties.d/timeseries.properties
org.opennms.rrd.strategyClass=org.opennms.netmgt.rrd.rrdtool.MultithreadedJniRrdStrategy
org.opennms.rrd.interfaceJar=/usr/share/java/jrrd2.jar
opennms.library.jrrd2=/usr/lib64/libjrrd2.so
org.opennms.web.graphs.engine=rrdtool # optional, unset if you want to keep Backshift as default
EOF

The visualization with the graph engine is optional. You can still use the default graphing engine backshift by not setting the org.opennms.web.graphs.engine property and use the system default.

Step 3: Restart OpenNMS Horizon and verify setup

find /opt/opennms/share/rrd -iname "*.rrd"

With the first data collection, RRDTool files with extension .rrd will be created. The JRobin files with extension .jrb are not used anymore and are not deleted automatically.

10.1.2. Reference

The following configuration files have references to the RRDTool binary and may be changed if you have a customized RRDTool setup.

Table 16. References to the RRDtool binary

<table>
<thead>
<tr>
<th>Configuration file</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>opennms.properties</td>
<td>rrd.binary=/usr/bin/rrdtool</td>
</tr>
<tr>
<td>response-adhoc-graph.properties</td>
<td>command.prefix=/usr/bin/rrdtool</td>
</tr>
<tr>
<td>response-graph.properties</td>
<td>command.prefix=/usr/bin/rrdtool</td>
</tr>
<tr>
<td></td>
<td>info.command=/usr/bin/rrdtool</td>
</tr>
<tr>
<td>snmp-adhoc-graph.properties</td>
<td>command.prefix=/usr/bin/rrdtool</td>
</tr>
<tr>
<td>snmp-graph.properties</td>
<td>command.prefix=/usr/bin/rrdtool</td>
</tr>
<tr>
<td></td>
<td>command=/usr/bin/rrdtool info</td>
</tr>
</tbody>
</table>
10.1.3. Install RRDTool on Debian

Following this guide does not cover data migration from JRobin to RRDTool.

A more current version of RRDTool is in the OpenNMS YUM repository. The provided versions can be shown with `apt show rrdtool`. This guide uses the RRDTool provided in the OpenNMS repository. When using the Debian/Ubuntu provided RRDTool package verify the path to the `rrdtool` binary file.

Step 1: Install RRDTool and the jrrd2 interface

*Installation on RHEL*

```bash
apt -y install rrdtool jrrd2
```

Step 2: Configure OpenNMS Horizon to use RRDTool

```bash
cat << EOF | sudo tee
/usr/share/opennms/etc/opennms.properties.d/timeseries.properties
org.opennms.rrd.strategyClass=org.opennms.netmgt.rrd.rrdtool.MultithreadedJniRrdStrategy
org.opennms.rrd.interfaceJar=/usr/share/java/jrrd2.jar
opennms.library.jrrd2=/usr/lib/jni/libjrrd2.so
org.opennms.web.graphs.engine=rrdtool # optional, unset if you want to keep Backshift as default
EOF
```

The visualization with the graph engine is optional. You can still use the default graphing engine backshift by not setting the `org.opennms.web.graphs.engine` property and use the system default.

Step 3: Restart OpenNMS Horizon and verify setup

```bash
find /usr/share/opennms/share/rrd -iname "*.rrd"
```

With the first data collection, RRDTool files with extension .rrd will be created. The JRobin files with extension .jrb are not used anymore and are not deleted automatically.

10.1.4. Reference

The following configuration files have references to the RRDTool binary and may be changed if you have a customized RRDTool setup.

*Table 17. References to the RRDtool binary*
### 10.2. Newts for Time Series data

Newts is a time-series data schema for Apache Cassandra. It enables horizontally scale capabilities for your time series storage and is an alternative to JRobin and RRDtool.

The Cassandra cluster design, setup, sizing, tuning and operation is out of scope for this section. To install and set up a Cassandra cluster please follow the Cassandra installation instructions. For further information see Cassandra Getting Started Guide.

To avoid unwanted updates disable the Cassandra repository on DNF/YUM based distributions or use `apt-mark hold cassandra` on APT based distributions.

For simplicity we use the `${OPENNMS_HOME}/bin/newts init` command which initializes a Newts keyspace for you and the defaults are not optimal tuned for a production-ready environment. If you want to build a production environment please consult Sizing Cassandra for Newts and planning Anti-patterns in Cassandra articles.

### 10.2.1. Objectives

- Configure OpenNMS Horizon to use an existing Cassandra cluster
- Initializing the Newts keyspace using `newts init` with STCS without production-ready tuning
- Verify time series data is stored and can be accessed

### 10.2.2. Before you begin

- A running instance of OpenNMS Horizon running on Linux
- Working data collection and response time metrics from Collectd and Pollerd
- Cassandra cluster with access to the Cassandra client port TCP/9042

It is currently not supported to initialize the Newts keyspace from Microsoft Windows Server operating system. Microsoft Windows based Cassandra server can be part of the cluster, but keyspace initialization is only possible using a Linux operating system.
10.2.3. Configure OpenNMS Horizon to use Newts

Step 1: Configure Cassandra endpoints, keyspace and time series strategy

```bash
cat << EOF | sudo tee /opt/opennms/etc/opennms.properties.d/timeseries.properties
# Configure storage strategy
org.opennms.rrd.storeByForeignSource=true
org.opennms.timeseries.strategy=newts

# Configure Newts time series storage connection
org.opennms.newts.config.hostname={cassandra-ip1,cassandra-ip2}
org.opennms.newts.config.keyspace=newts
org.opennms.newts.config.port=9042

# One year in seconds
org.opennms.newts.config.ttl=31540000

# Seven days in seconds
org.opennms.newts.config.resource_shard=604800
EOF
```

1. Associate time series data by the foreign ID instead of the database generated Node-ID
2. Set time-series strategy to use newts
3. Host or IP addresses of the Cassandra cluster nodes can be a comma-separated list
4. Name of the keyspace which is initialized and used
5. Port to connect to Cassandra

Step 2: Initialize the Newts schema in Cassandra

```
${OPENNMS_HOME}/bin/newts init
```

Step 3: Verify if the keyspace was properly initialized

Connect to a Cassandra node with a CQL shell

```
cd ${CASSANDRA_HOME}/bin
./cqlsh

use newts;
describe table terms;
describe table samples;
```

Step 4: Apply changes and verify your configuration
systemctl restart opennms

Go to the Node detail page from a SNMP managed device and verify if you response time graphs for ICMP and Node-level Performance data.