# 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 27.0.0 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>
<thead>
<tr>
<th>Table 1. Operating Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RHEL</strong></td>
</tr>
<tr>
<td><strong>Debian</strong></td>
</tr>
<tr>
<td><strong>OpenJDK 11 Development Kit</strong></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>
<thead>
<tr>
<th>Table 2. Installation Requirements</th>
</tr>
</thead>
</table>
### Minimal Hardware

<table>
<thead>
<tr>
<th>Operating System</th>
<th>RHEL or Debian in a current version is recommended. Please be aware OpenNMS Horizon is developed and mostly operated on Linux systems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet</td>
<td>Access to {yum,debian}.opennms.org via https.</td>
</tr>
<tr>
<td>DNS Setup</td>
<td>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.</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Table 3. Directory Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHEL</td>
</tr>
<tr>
<td>Debian</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.

<table>
<thead>
<tr>
<th>Steps</th>
<th>Commands and instructions are specific to RHEL 8. We provide RHEL 7 alternatives where applicable.</th>
</tr>
</thead>
</table>

#### Step 1: Install OpenNMS Horizon

Add yum repository and import GPG key

**RHEL:**

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

**RHEL 7:**

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

```
dnf -y install opennms
```

RHEL 7:

```
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
```

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.

```
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
generic-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

```xml
<jdbc-data-source name="opennms"
    database-name="opennms"
    class-name="org.postgresql.Driver"
    url="jdbc:postgresql://localhost:5432/opennms"
    user-name="** YOUR-OPENNMS-USERNAME **"②
    password="** YOUR-OPENNMS-PASSWORD **" />③
</jdbc-data-source>

<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 **" />⑤
```

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

```
systemctl start opennms
```

Allow connection to the Web UI from your network

```
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 detectors, 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*

```bash
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**

```bash
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:

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

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

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](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](http://<ip-or-fqdn-of-your-server>:8980/opennms)
2. Login 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.

| ![Info Icon] | 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:
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

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

  horizon:
    image: opennms/horizon:27.0.0 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 ⑪
      - ./overlay:/opt/opennms-overlay ⑫
    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
Volume definition to persist the RRD files from OpenNMS Horizon permanently

Service name database for the PostgreSQL instance

Image reference for the vanilla PostgreSQL Docker image with a fixed version

Friendly container name

Environment variables to initialize a postgres user with a password

Assign volume to persist the PostgreSQL database

Create a health check for the PostgreSQL database

Image reference for the OpenNMS Horizon container image using the latest stable version

Set up a database connection using the postgres root user and initialize an opennms database with user and credentials

Assign the volume to persist the RRD files permanently

Mount the configuration files to make them accessible in a local directory

Publish ports for the web user interface, Karaf Shell and ActiveMQ

Create a health check against the login page from OpenNMS Horizon

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 NOT start.</td>
</tr>
</tbody>
</table>
- **Argument** | **Description**
---|---
-s | Command to initialize or update database and configuration files and start OpenNMS in the foreground.
-t | 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_CONNECTIONPOOLFACTORY</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 instead of the database node id</td>
<td>optional</td>
<td>true</td>
</tr>
<tr>
<td>OPENNMS_RRD_STRATEGYCLASS</td>
<td>Java RRD Strategy class</td>
<td>optional</td>
<td>org.opennms.netmgmt.rrd.rrdtool.MultithreadedJniRrdStrategy</td>
</tr>
<tr>
<td>OPENNMS_RRD_INTERFACEDIR</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 (61616/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>Operating System</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHEL</td>
<td>/opt/minion</td>
</tr>
<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:

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

Remove comments for the transport connector listening on 0.0.0.0 and save

```xml
<transportConnector name="openwire" uri="tcp://0.0.0.0:61616?useJmx=false
&amp;maximumConnections=1000&amp;wireformat.maxFrameSize=104857600"/>
```

Restart OpenNMS Horizon

```bash
systemctl restart opennms
```

Verify that port 61616/tcp is listening on all interfaces

```bash
ss -lnpt sport = :61616
```

<table>
<thead>
<tr>
<th>State</th>
<th>Recv-Q</th>
<th>Send-Q</th>
<th>Local Address:Port</th>
<th>Peer</th>
<th>Address:Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>LISTEN 0 128</td>
<td>*:61616</td>
<td><em>:</em></td>
<td>users:((&quot;java&quot;,pid=1,fd=706))</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

RHEL 7:

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

Install the Minion package

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

RHEL 7:

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

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

Configure systemd to start Minion on system boot

```bash
systemctl enable minion
```

Start up Minion

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

```bash
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

```bash
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

```bash
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

```bash
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*

```bash
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*

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

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

*Configure systemd to start Minion on system boot*

```bash
systemctl enable minion
```

*Start up Minion*

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

\begin{verbatim}
ssh -p 8201 admin@localhost

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

\begin{verbatim}
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>
\end{verbatim}

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

\begin{verbatim}
systemctl restart minion
\end{verbatim}

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

\begin{verbatim}
ssh -p 8201 admin@localhost
opennms:health-check
\end{verbatim}

You should see the following message:

\begin{verbatim}
Connecting to OpenNMS ReST API [ Success ]
Verifying installed bundles [ Success ]
Connecting to JMS Broker [ Success ]
=> Everything is awesome
admin@minion()>
\end{verbatim}
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:27.0.0
    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>-h</td>
<td>Display help with available arguments.</td>
</tr>
</tbody>
</table>
-c Start Minion and use environment credentials to register *Minion* on *OpenNMS Horizon*.

-s One-time command to initialize an encrypted keystore file with credentials in /keystore/scv.jce.

-f Initialize and start *Minion* in foreground.

### 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 <em>Minion</em> identifier</td>
<td>optional</td>
<td>generated UUID</td>
</tr>
<tr>
<td>MINION_LOCATION</td>
<td>Name of the location the <em>Minion</em> 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 <em>URL</em> for <em>REST</em></td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>OPENNMS_HTTP_USER</td>
<td>User name for the <em>ReST API</em></td>
<td>optional</td>
<td>admin</td>
</tr>
<tr>
<td>OPENNMS_HTTP_PASS</td>
<td>Password for the <em>ReST API</em></td>
<td>optional</td>
<td>admin</td>
</tr>
<tr>
<td>OPENNMS_BROKER_URL</td>
<td><em>ActiveMQ</em> broker <em>URL</em></td>
<td>required</td>
<td>-</td>
</tr>
<tr>
<td>OPENNMS_BROKER_USER</td>
<td>Username for <em>ActiveMQ</em> authentication</td>
<td>optional</td>
<td>admin</td>
</tr>
<tr>
<td>OPENNMS_BROKER_PASS</td>
<td>Password for <em>ActiveMQ</em> 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:

```bash
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>/opt/minion/etc-overlay</td>
<td>Allows to overwrite files relative to <code>/opt/minion/etc</code></td>
</tr>
<tr>
<td>/keystore</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**

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

**RHEL 7:**

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

**Install the Sentinel package**

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

**RHEL 7:**

```bash
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

```
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

```
[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 minion minion
```

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
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

```
[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 minion minion
```
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 `scvcl` utility in your Sentinel `bin` directory.

**Example of configuring credentials with the command line utility `scvcl`**

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

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

```
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:

- **Producer Configs** for RPC communication
- **New Consumer Configs** 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>
<tbody>
<tr>
<td></td>
<td>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 <code>org.opennms.core.ipc.rpc.kafka.max.buffer.size</code> (in bytes).</td>
</tr>
<tr>
<td></td>
<td>Default time to live (time at which request will expire) is 20000 msec (20sec). It can be changed by configuring system property <code>org.opennms.core.ipc.rpc.kafka.ttl</code> in msec.</td>
</tr>
</tbody>
</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

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

Step 5: Restart OpenNMS Horizon.

```bash
systemctl restart opennms
```

5.2.2. Configure Minion

Step 1: Disable ActiveMQ for RPC and Sink.

Disable ActiveMQ on Minion startup

```bash
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.

```bash
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.

```bash
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.**

```bash
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*

```
feature:list | grep opennms-core-ipc-grpc-client
opennms-core-ipc-grpc-client | 27.0.0 | 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 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>
<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`.

```bash
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:

```bash
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_

```ini
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 need 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.

Forward 514 to 1514 with Firewalld

```bash
# enable masquerade to allow port-forwards
firewall-cmd --add-masquerade

# forward port 514 TCP and UDP to port 1514 on localhost
firewall-cmd --add-forward-port=port=514:proto=udp:toport=1514:toaddr=127.0.0.1
firewall-cmd --add-forward-port=port=514:proto=tcp:toport=1514:toaddr=127.0.0.1
```
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>
<thead>
<tr>
<th>Table 15. Supported Time Series Databases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JRobin</strong></td>
</tr>
<tr>
<td><strong>RRDTool</strong></td>
</tr>
<tr>
<td><strong>Newts</strong></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.*.
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

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

Step 2: Configure OpenNMS Horizon to use RRDTool

```
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

```
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**

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

**Step 3: Verify if the keyspace was properly initialized**

Connect to a Cassandra node with a CQL shell

```bash
cd ${CASSANDRA_HOME}/bin
./cqlsh
use newts;
describe table terms;
describe table samples;
```

**Step 4: Apply changes and verify your configuration**
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.