OpenNMS Training for NCR

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Agenda

- Rough Schedule:
  - Day 1: OpenNMS Review
  - Day 2: Kafka/Minion
  - Day 3: Examples/Best Practices
- Hours: 10:00-18:00 UTC
  - Break every hour or two
  - Long break around 14:00

Unit 0: Introduction to OpenNMS

History

- OpenNMS was started in the Summer of 1999
- First Code Contributed to Sourceforge on 30 March 2000
- Maintained by Oculan until May, 2002.
- Maintained by the OpenNMS Group since September, 2004

OpenNMS is the world's first enterprise-grade network management application platform developed under the open source model.

• NetSaint	2000-01-10	1323
• OpenNMS	2000-03-30	4141
• Zabbix	2001-03-23	23494
• Nagios	2001-05-03	26589
• RRDTool	2003-01-13	71544
• Groundwork	2006-02-21	160654
• ZenOSS	2006-03-20	163126
• Hyperic	2006-07-17	172556

enterprise-grade

OpenNMS was designed from Day One to monitor tens if not hundreds of thousands of devices. Current work is focused on removing those constraints to allow for millions of devices and billions of metrics.

That scalability comes in a number of forms:

- Discreet devices (hundreds of thousands)
- Performance metrics (millions)
- Events per second (thousands)
- Remote monitors (thousands)

application platform

While OpenNMS works “out of the box”, it really starts to shine when you customize it. It is highly configurable and offers a myriad of ways to integrate with other systems.

- Full-featured ReST Interface for both configuration and queries, forms the basis for OpenNMS Compass
- Device and event information stored in a database
- Notification system can execute arbitrary commands
- Built-in integration includes
  - RANCID configuration management
  - DNS for provisioning
  - Trouble Ticketing API (RT, Jira, OTRS, Remedy, etc.)

open source

Fully 100% of the OpenNMS source code is available under an Open Source license (as defined by the Open Source Initiative).

The main application is published under the AGPLv3, with various subsystems such as Newts published under more permissive licenses such as the Apache License.

What is Network Management?

The term “network management” can be loosely defined as the maintenance and monitoring of computer networks to insure service availability. The formal definition is often referred to as FCAPS:

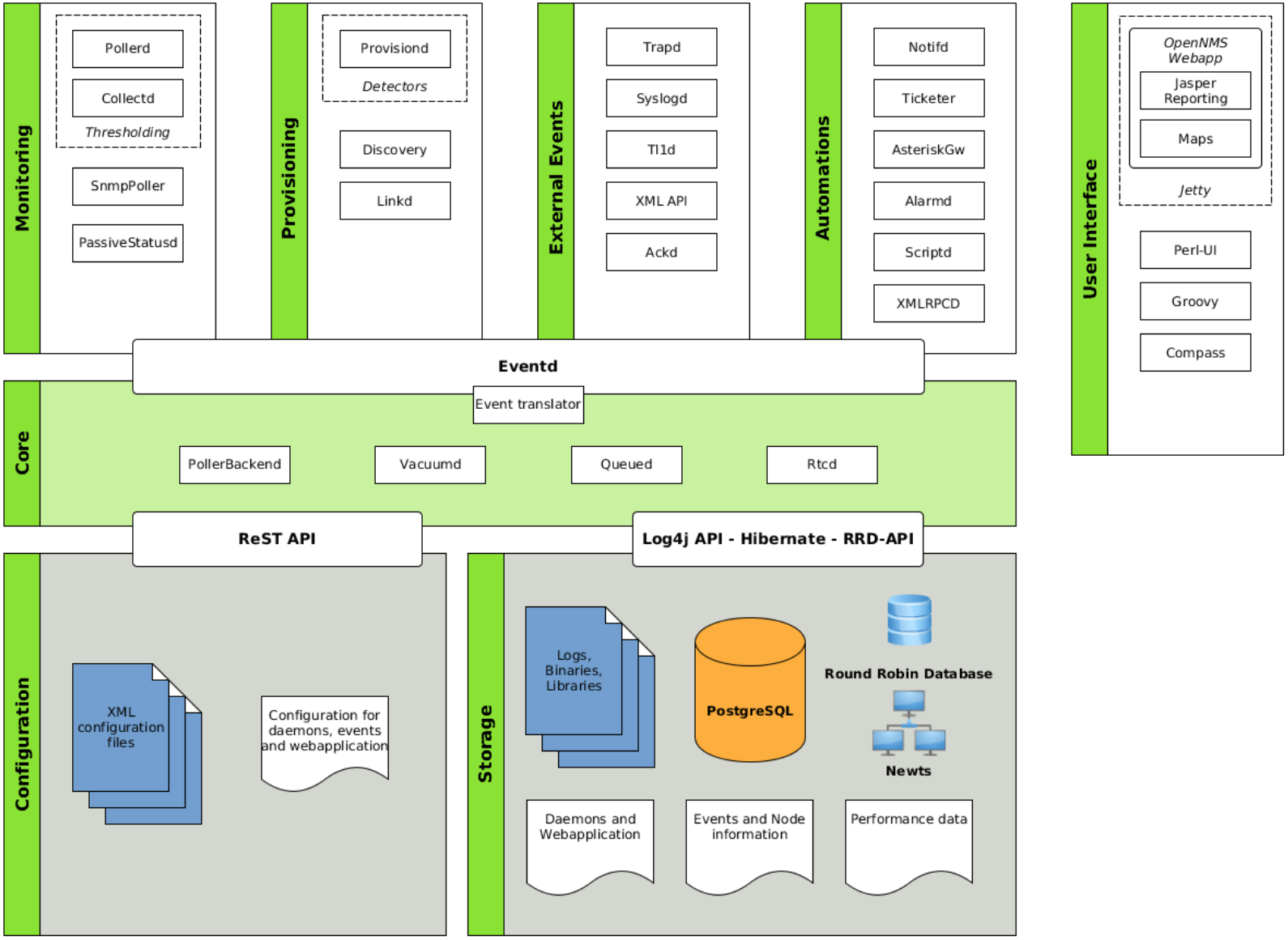
- Fault Management
- Configuration
- Accounting
- Performance Measurement
- Security

The Four Main Areas of OpenNMS

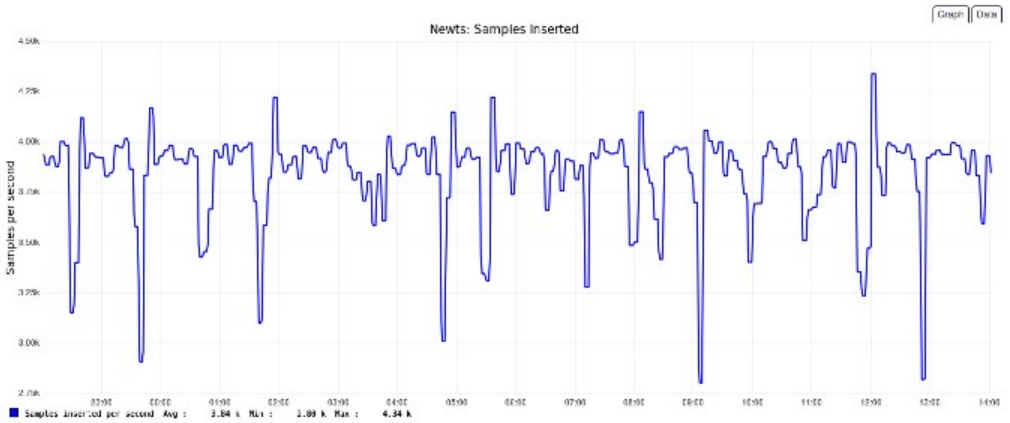
- Event and Notification Management: Generate, receive, enhance, reduce and correlate various network alerts and feed them to a robust notification system.
- Provisioning: Both Automated Discovery and Directed Discovery.
- Service Monitoring: Is a particular network service reachable and available?
- Performance Data Collection: Gather numeric data from across the network for display, trending and thresholding

OPENNMS VERSIONS

	MERIDIAN openNMS	HORIZON openNMS
Target:	Developed for Enterprises and Businesses looking for stable platforms with long term support	The OpenNMS proving grounds where innovation happens quickly to address the requirements for monitoring new technologies and IT ecosystems such as Docker, SDN/NFV, and virtual systems.
Key Words:	Stable, reliable and supported	Powerful, cutting edge with a rapid release cycle.
Development Model:	Open Source	Open Source
License:	AGPLv3 or optional Proprietary License	AGPLv3
Release Interval :	12 months, given release supported for three years.	3-4 months
Support:	Several options available, including access to the OpenNMS Connect forums	Community supported mailing lists and wiki, as well as with the OpenNMS ULTRA support product
Feature Selection:	Features chosen for level of stability, usefulness and quality of integration with existing code	Exploration of new technologies to test value to drive rapid advances in management technology

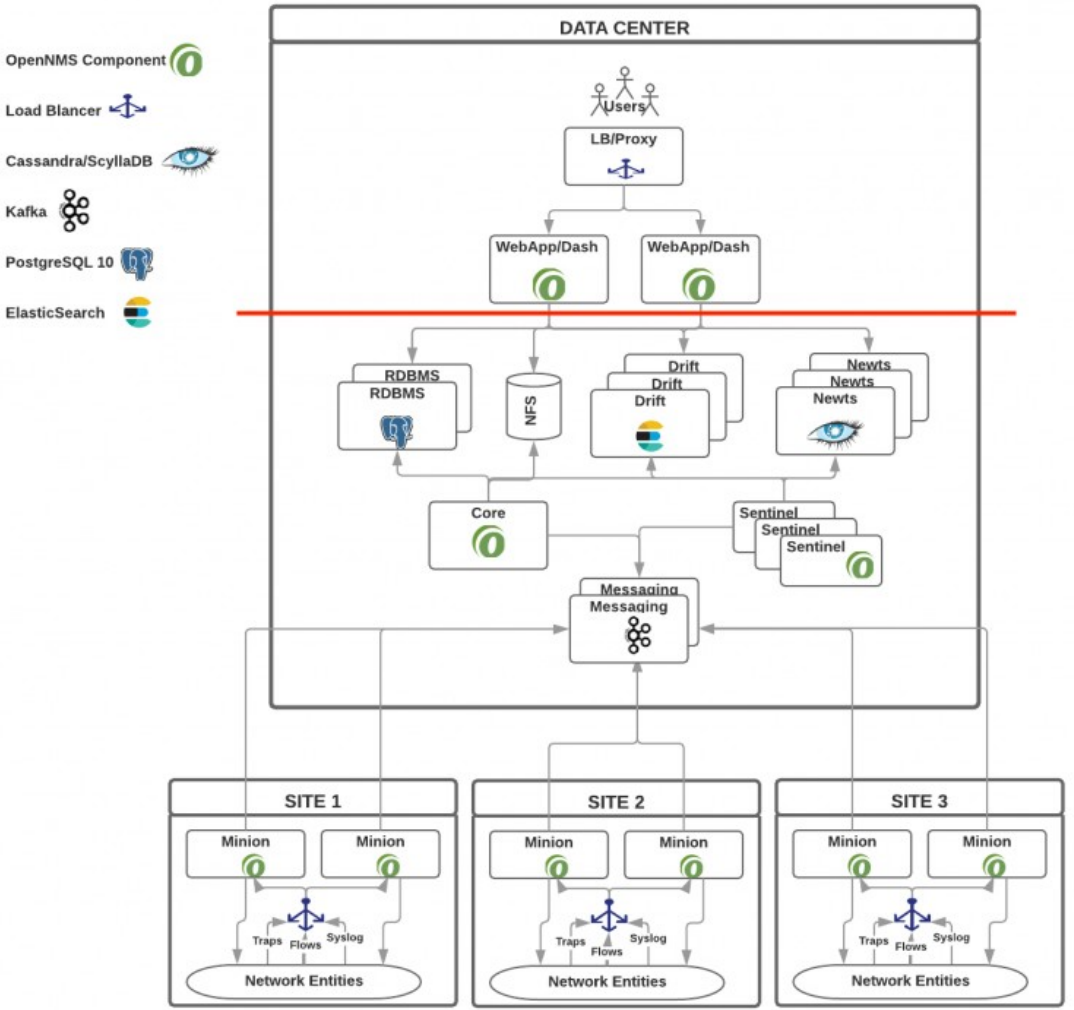

Monitoring
Pollerd
Collectd
Thresholding
SnmpPoller
PassiveStatusd
Provisioning
Provisiond
Detectors
Discovery
Linkd
External Events
Trapd
Syslogd
Tl1d
XML API
Ackd
Automations
Notifd
Ticketer
AsteriskGw
Alarmd
Scriptd
XMLRPCD
User Interface
OpenNMS Webapp
Jasper Reporting
Maps
Jetty
Perl-UI
Groovy
Compass
Eventd
Event translator
Core
PollerBackend
Vacuumd
Queued
Rtcd
ReST API
Log4j API - Hibernate - RRD-API
Configuration
XML configuration files
Configuration for daemons, events and webapplication
Storage
Logs, Binaries, Libraries
PostgreSQL
Round Robin Database
Newts
Daemons and Webapplication
Events and Node information
Performance data

Newts

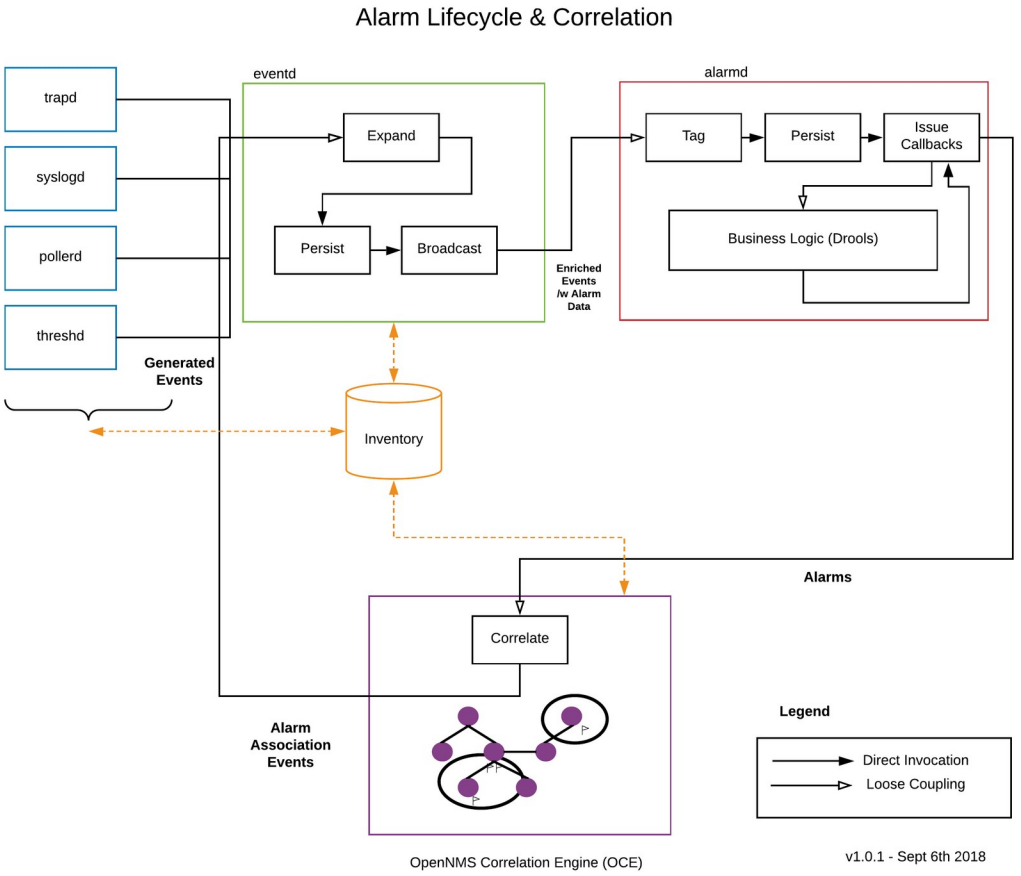



```
org.opennms.newts.stress.InsertDispatcher.samples
             count = 10512100
         mean rate = 51989.68 events/second
     1-minute rate = 51906.38 events/second
     5-minute rate = 38806.02 events/second
    15-minute rate = 31232.98 events/second
```

OPENNMS ARCHITECTURE DIAGRAM



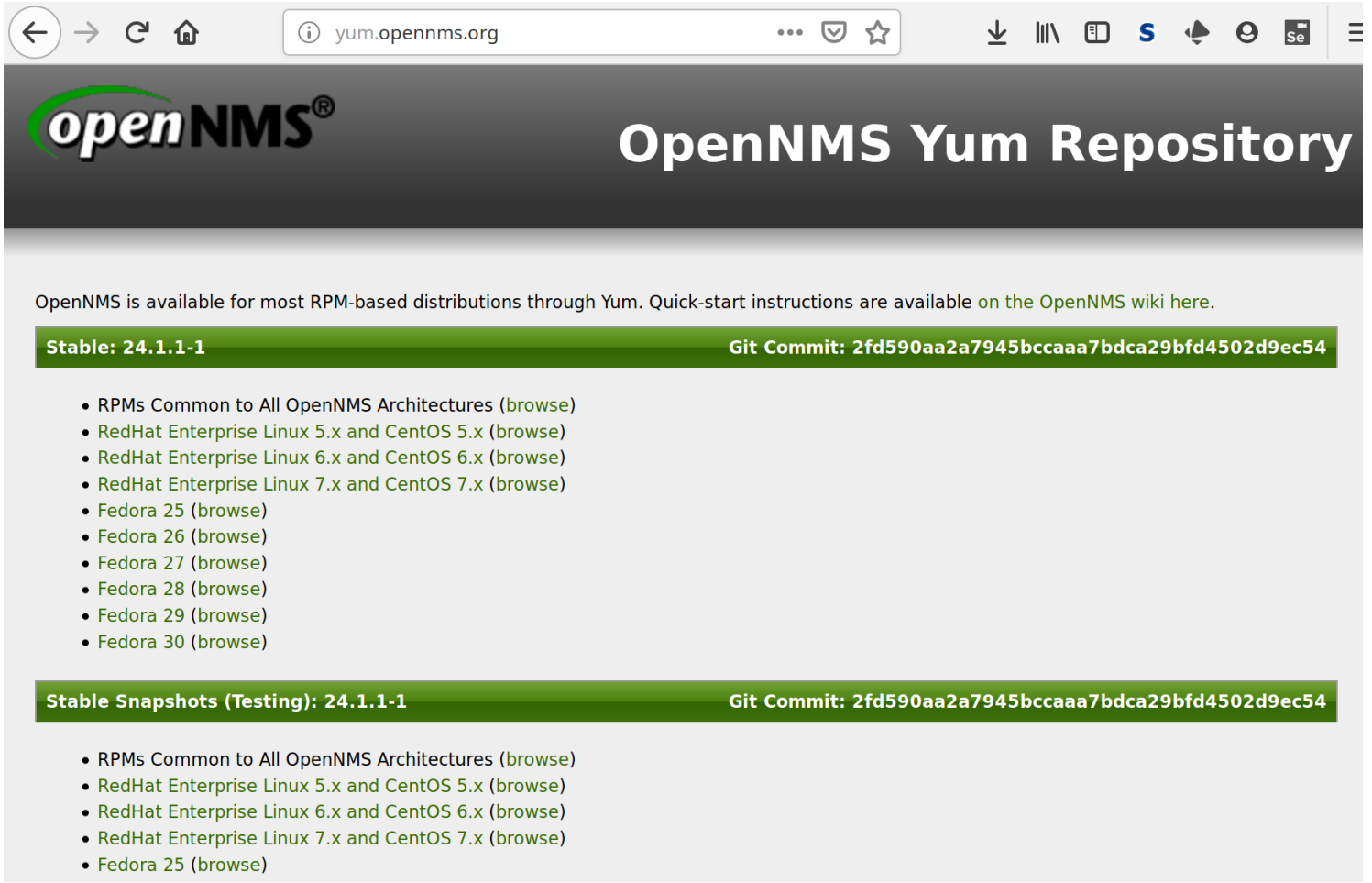
Architecture for Learning Enabled Correlation (ALEC)



Unit 1: Installation

Meridian vs. Horizon

- Both Require Java
- Both have some C++ code (jicmp, jrrd)
- Horizon – freely available downloads for apt (Debian/Ubuntu) and rpm (RHEL/CentOS)
- Meridian – password protected repository, rpm only (RHEL/CentOS)



http://yum.opennms.org/repofiles/opennms-repo-stable-rhel7.noarch.rpm

Installation Guide

Installation Guide

 OpenNMS 17.0.0, Last updated 2015-12-01 17:26:19 -05:00

1. Basic Installation of OpenNMS

The *OpenNMS* platform can be installed in several ways. This guide describes the installation of the platform on *RHEL*-, *Debian*- and *Microsoft Windows* based operation systems. Installable pre-compiled software packages are provided through *RPM* and *Debian* repository servers. Running *OpenNMS* requires the following components:

- Internet access to download and verify installation packages from public repository server
- Installed Oracle Java 8 environment
- PostgreSQL 9.1+ data base
- Set link to section which describes to install with RRDTool. Optional RRDtool to persist long term performance data

OpenJDK 8 can be used, but for production and critical environments *Oracle Java 8* is recommended.

`${OPENNMS_HOME}` is referred to the path *OpenNMS* is installed to. On *RHEL-based* systems it is `/opt/opennms` on *Debian-based* systems it is `/usr/share/opennms`. The environment in *Microsoft Windows* can refer to `C:\Program Files\opennms`

With the *opennms* meta package all dependencies needed for the components mentioned above are maintained. The following sections describe how to install *OpenNMS* on a single system. Dependencies for *Java* and the *PostgreSQL* data base are maintained with the *opennms* meta installation package.

https://docs.opennms.org/opennms/branches/develop/guide-install/guide-install.html

Install OpenNMS Repository

As root, run:

```
# rpm -Uvh http://yum.opennms.org/repofiles/opennms-repo-stable-rhel8.noarch.rpm

Retrieving http://yum.opennms.org/repofiles/opennms-repo-stable-rhel8.noarch.rpm
warning: /var/tmp/rpm-tmp.ogO2Lb: Header V3 DSA/SHA1 Signature, key ID 5b9efd43: NOKEY
Preparing...                          ################################# [100%]
Updating / installing...
   1:opennms-repo-stable-1.0-109      ################################# [100%]
```

Install OpenNMS

```
# yum install opennms

Dependencies Resolved

================================================================================
 Package                    Arch   Version              Repository          Size
================================================================================
Installing:
 opennms                    noarch 24.1.1-1             opennms-repo-stable-common 6.4 k
Installing for dependencies:
 copy-jdk-configs           noarch 3.3-10.el7_5         base                21 k
 dejavu-fonts-common        noarch 2.33-6.el7           base                64 k
 dejavu-sans-fonts          noarch 2.33-6.el7           base               1.4 M
 fontconfig                 x86_64 2.13.0-4.3.el7       base               254 k
 fontpackages-filesystem    noarch 1.44-8.el7           base               9.9 k
 giflib                     x86_64 4.1.6-9.el7          base                40 k
 java-11-openjdk            x86_64 1:11.0.3.7-0.el7_6   updates            194 k
 java-11-openjdk-devel      x86_64 1:11.0.3.7-0.el7_6   updates            3.3 M
 java-11-openjdk-headless   x86_64 1:11.0.3.7-0.el7_6   updates             38 M
 javapackages-tools         noarch 3.4.1-11.el7         base                73 k
 jicmp                      x86_64 2.0.3-1.el7.centos   opennms-repo-stable-rhel7 32 k
 jicmp6                     x86_64 2.0.2-1.el7.centos   opennms-repo-stable-rhel7 16 k
 libICE                     x86_64 1.0.9-9.el7          base                66 k
 libSM                      x86_64 1.2.2-2.el7          base                39 k
 libX11                     x86_64 1.6.5-2.el7          base               606 k
 libX11-common              noarch 1.6.5-2.el7          base               164 k
 libXau                     x86_64 1.0.8-2.1.el7        base                29 k
 libXext                    x86_64 1.3.3-3.el7          base                39 k
 libXi                      x86_64 1.7.9-1.el7          base                40 k
```

Install OpenNMS

```
 libXi                          x86_64 1.7.9-1.el7        base                          40 k
 libXrender                     x86_64 0.9.10-1.el7       base                          26 k
 libXtst                        x86_64 1.2.3-1.el7        base                          20 k
 libfontenc                     x86_64 1.1.3-3.el7        base                          31 k
 libjpeg-turbo                  x86_64 1.2.90-6.el7       base                         134 k
 libxcb                         x86_64 1.13-1.el7         base                         214 k
 libxslt                        x86_64 1.1.28-5.el7       base                         242 k
 lksctp-tools                   x86_64 1.0.17-2.el7       base                          88 k
 opennms-core                   noarch 24.1.1-1           opennms-repo-stable-common   474 M
 opennms-webapp-jetty           noarch 24.1.1-1           opennms-repo-stable-common    44 M
 postgresql                     x86_64 9.2.24-1.el7_5     base                         3.0 M
 postgresql-libs                x86_64 9.2.24-1.el7_5     base                         234 k
 postgresql-server              x86_64 9.2.24-1.el7_5     base                         3.8 M
 python-javapackages            noarch 3.4.1-11.el7       base                          31 k
 python-lxml                    x86_64 3.2.1-4.el7        base                         758 k
 ttmkfdir                       x86_64 3.0.9-42.el7       base                          48 k
 tzdata-java                    noarch 2019a-1.el7        updates                      187 k
 xorg-x11-font-utils            x86_64 1:7.5-21.el7       base                         104 k
 xorg-x11-fonts-Type1           noarch 7.5-9.el7          base                         521 k

Transaction Summary
================================================================================================
Install  1 Package (+37 Dependent packages)

Total download size: 572 M
Installed size: 924 M
Is this ok [y/d/N]:
```

Install rrdtool and jrrd2

```
# yum install rrdtool jrrd2

Dependencies Resolved
================================================================================
 Package                    Arch   Version                       Repository                 Size
================================================================================
Installing:
 jrrd2                      x86_64 1:2.0.3-4.el7.centos          opennms-repo-stable-rhel7   16 k
 rrdtool                    x86_64 1.6.0-0.3.opennms.el7.centos  opennms-repo-stable-rhel7  1.6 M
Installing for dependencies:
 cairo                      x86_64 1.15.12-3.el7                 base                       741 k
 dejavu-lgc-sans-fonts      noarch 2.33-6.el7                    base                       1.0 M
 dejavu-lgc-sans-mono-fonts noarch 2.33-6.el7                    base                       359 k
 dejavu-sans-mono-fonts     noarch 2.33-6.el7                    base                       433 k
 fribidi                    x86_64 1.0.2-1.el7                   base                        79 k
 graphite2                  x86_64 1.3.10-1.el7_3                base                       115 k
 harfbuzz                   x86_64 1.7.5-2.el7                   base                       267 k
 libXdamage                 x86_64 1.1.4-4.1.el7                 base                        20 k
 libXfixes                  x86_64 5.0.3-1.el7                   base                        18 k
 libXft                     x86_64 2.3.2-2.el7                   base                        58 k
 libXxf86vm                 x86_64 1.1.4-1.el7                   base                        18 k
 libglvnd                   x86_64 1:1.0.1-0.8.git5baa1e5.el7    base                        89 k
 libglvnd-egl               x86_64 1:1.0.1-0.8.git5baa1e5.el7    base                        44 k
 libglvnd-glx               x86_64 1:1.0.1-0.8.git5baa1e5.el7    base                       125 k
 libthai                    x86_64 0.1.14-9.el7                  base                       187 k
...
 rubygem-rdoc               noarch 4.0.0-35.el7_6                updates                    322 k
 rubygems                   noarch 2.0.14.1-35.el7               updates                    220 k


Transaction Summary
================================================================================
Install  1 Package (+62 Dependent packages)
Total download size: 21 M
Installed size: 71 M
Is this ok [y/d/N]:
```

OpenNMS File Locations

- `/opt/opennms/bin`: OpenNMS binary files
- `/opt/opennms/etc`: Configuration files
- `/opt/opennms/jetty-webapps`: Web server
- `/opt/opennms/lib`: Compiled libraries
- `/opt/opennms/share`: Reports and RRD data (symlink to /var/opennms)
- `/opt/opennms/logs`: Log Files (symlink to /var/log/opennms)

OpenNMS File Types

There are main two types of OpenNMS files:

- XML Files

  The eXtensible Markup Language creates files that are both Human and Machine readable.

- `.properties` Files

  Format of *`variable = value`* `<cr>`

Enable rrdtool

Edit the rrd-configuration.xml file:

```
# To switch to the JNI implementation uncomment the following lines.  Note
# that paths may differ from one platform to the next, and a few platforms
# use an extension other than ".so" on JNI shared objects; Mac OS X notably
# uses ".jnilib":
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
```

Setting Up PostgreSQL

First, as root, initialize the database:

```
# sudo postgresql-setup initdb
```

Next, edit /var/lib/pgsql/data/pg_hba.conf:

```
# TYPE  DATABASE        USER            ADDRESS                 METHOD
# "local" is for Unix domain socket connections only
local   all             all                                     trust
# IPv4 local connections:
host    all             all             127.0.0.1/32            trust
# IPv6 local connections:
host    all             all             ::1/128                 trust
```

Finally, start the database and enable it on startup:

```
# sudo systemctl start postgresql
# sudo systemctl enable postgresql
```

Tuning PostgreSQL

Database PostgreSQL [edit]

Shared Buffers [edit]

The default shared_buffers parameter in postgresql.conf is extremely conservative, and in most cases with modern servers, this can be significantly tweaked for a big performance boost, and drop in I/O wait time. This change will need to be in-line with kernel parameter changes to shmmax.

The PostgreSQL project wiki aggregates many good links in its Performance Optimization article. Among others linked from there, see Postgres Wiki tuning page and this PostgreSQL performance page for recommendations on this and other PostgreSQL settings.

If you want to put PostgreSQL on a different box then you want to change the SQL host look in opennms-datasources.xml. The PostgreSQL server will also need iplike installed and configured.

To clean up extra events out of the database try this Event_Configuration_How-To#The_Database

PostgreSQL 9.1 tuning [edit]

Summarized from these blog posts.

For a system that has been running for some time, a good start is to determine what resources are available. Linux systems have a nice SNMP "System Memory Stats" graph to review how system memory is used.

Next, db size can be found:

```
opennms=# select pg_size_pretty(pg_database_size('opennms')) as db_size;
 db_size
---------
 691 MB
(1 row)
```

https://wiki.opennms.org/wiki/Performance_tuning#Database_PostgreSQL_2

Setting Up OpenNMS

First, as root, set the Java version (writes to `/opt/opennms/etc/java.conf`):

```
# /opt/opennms/bin/runjava -s
runjava: Looking for an appropriate JRE...
runjava: Checking for an appropriate JRE in JAVA_HOME...
runjava: skipping... JAVA_HOME not set
runjava: Checking JRE in user's path: "/bin/java"...
runjava: found an appropriate JRE in user's path: "/bin/java"
runjava: value of "/bin/java" stored in configuration file
```

Next, run the installer (creates file `/opt/opennms/etc/configured`):

```
# /opt/opennms/bin/install -dis

================================================================================
OpenNMS Installer
================================================================================

Configures PostgreSQL tables, users, and other miscellaneous settings.
                                        . . .
Upgrade completed successfully!
```

Uses of `iplike`

- `iplike` is a stored procedure, installed separately
- It allows for quick IP Address comparisons:
  - Can use wildcards
  - Can use ranges
  - Can use combinations
- Examples:
  - 10.10.1.* (matches all in the 10.10.1.0 subnet)
  - 10.10.1.1-50 (matches the first 50 IP addresses)
  - 10.10.1,5,11-15.* (matches all in the 10.10.1.0, 10.10.5.0 and 10.10.11.0 through 10.10.15.0 networks)
- In psql, use it as `iplike(ipaddr,'pattern')`

Install `iplike` and Start OpenNMS

Finally, install the iplike stored procedure:

```
# yum -y install iplike
runjava: Looking for an appropriate JRE...
runjava: Checking for an appropriate JRE in JAVA_HOME...
runjava: skipping... JAVA_HOME not set
runjava: Checking JRE in user's path: "/bin/java"...
runjava: found an appropriate JRE in user's path: "/bin/java"
runjava: value of "/bin/java" stored in configuration file
```

Next, set up OpenNMS to start automatically on a reboot:

```
# sudo systemctl enable opennms
```

Then start OpenNMS:

```
# sudo systemctl start opennms
```

Open Firewall for port 8980

The OpenNMS web server listens on port 8980. To open that up on CentOS 7:

```
# firewall-cmd --zone=public --add-port=8980/tcp --permanent
success
# firewall-cmd --reload
success
```

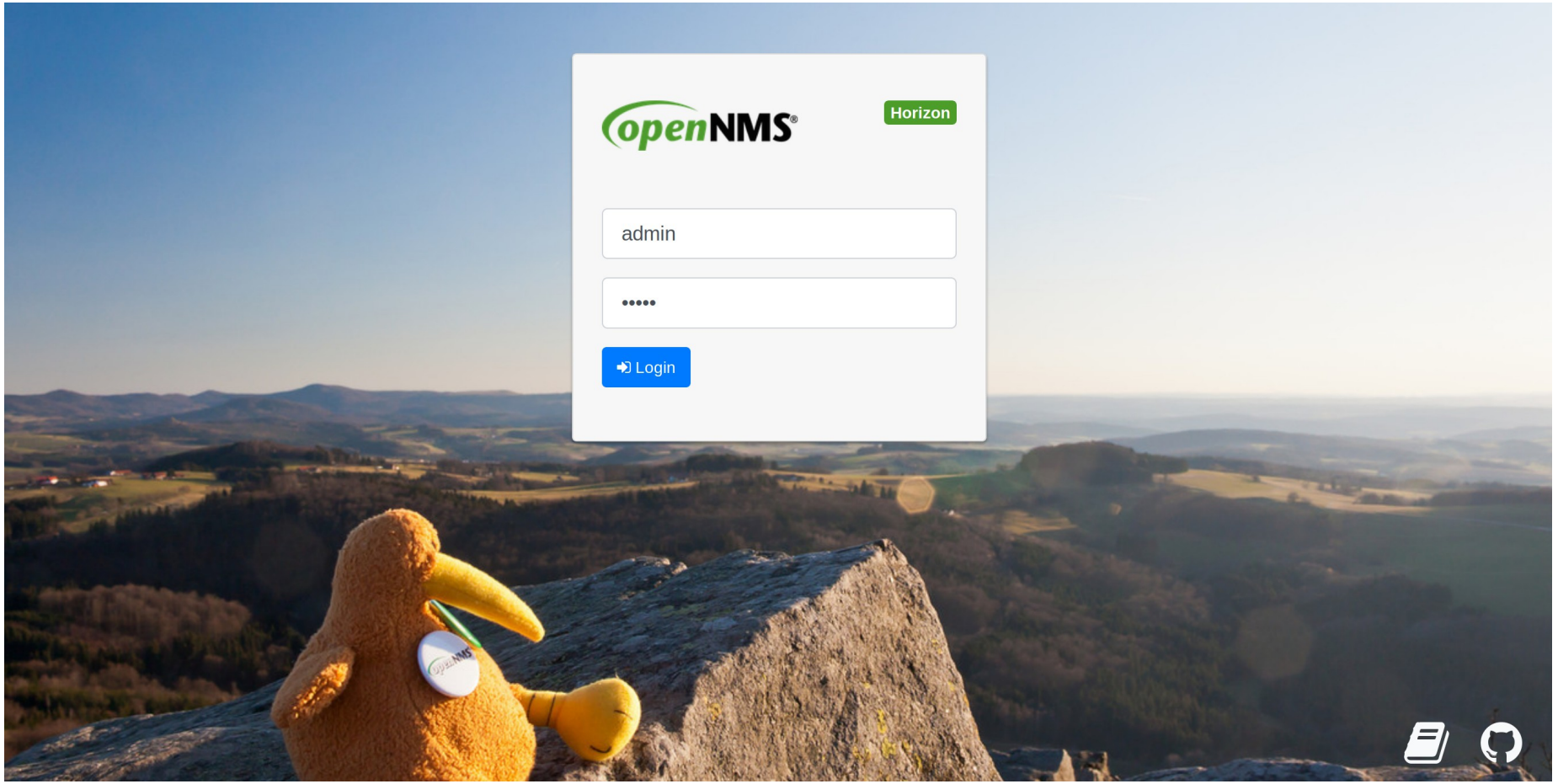
Then you should be able to access the web page at:

```
http://localhost:8980/opennms
```

.rpmnew files

You	OpenNMS	.rpmnew?
F	F	F
F	T	F
T	F	F
T	T	T

Unit 2: Getting Started



Help Improve OpenNMS

Help Improve OpenNMS

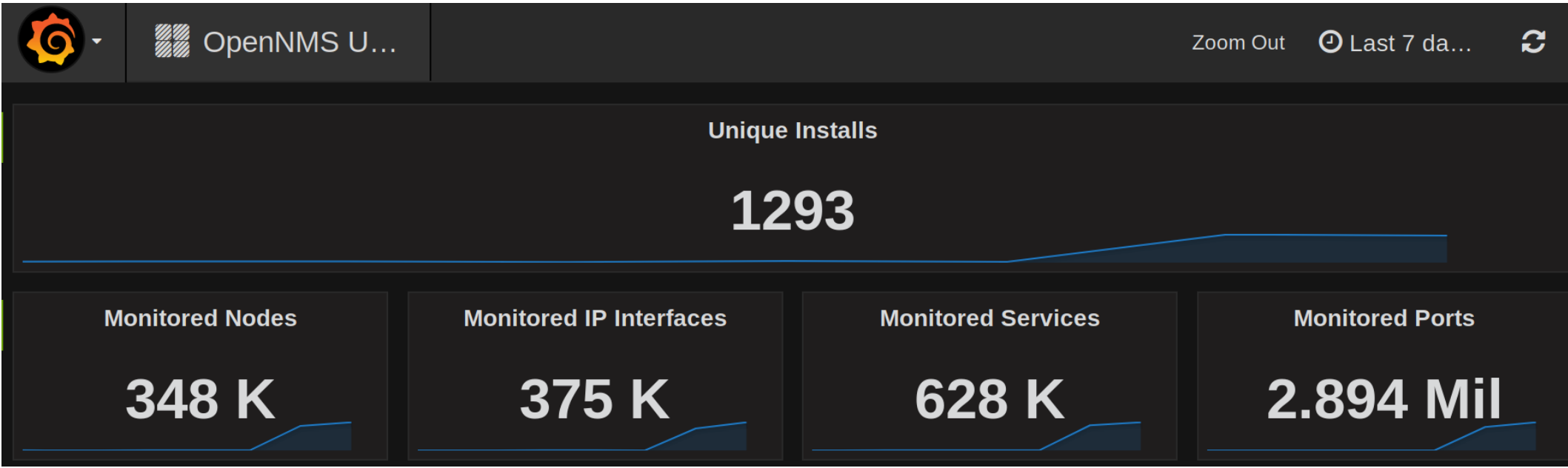
Please opt-in to send anonymous OpenNMS usage statistics to OpenNMS Statistics. This will help us improve your OpenNMS software, subject to our privacy policy. You can change this setting at any time from the Admin menu.

Show me what is being sent.

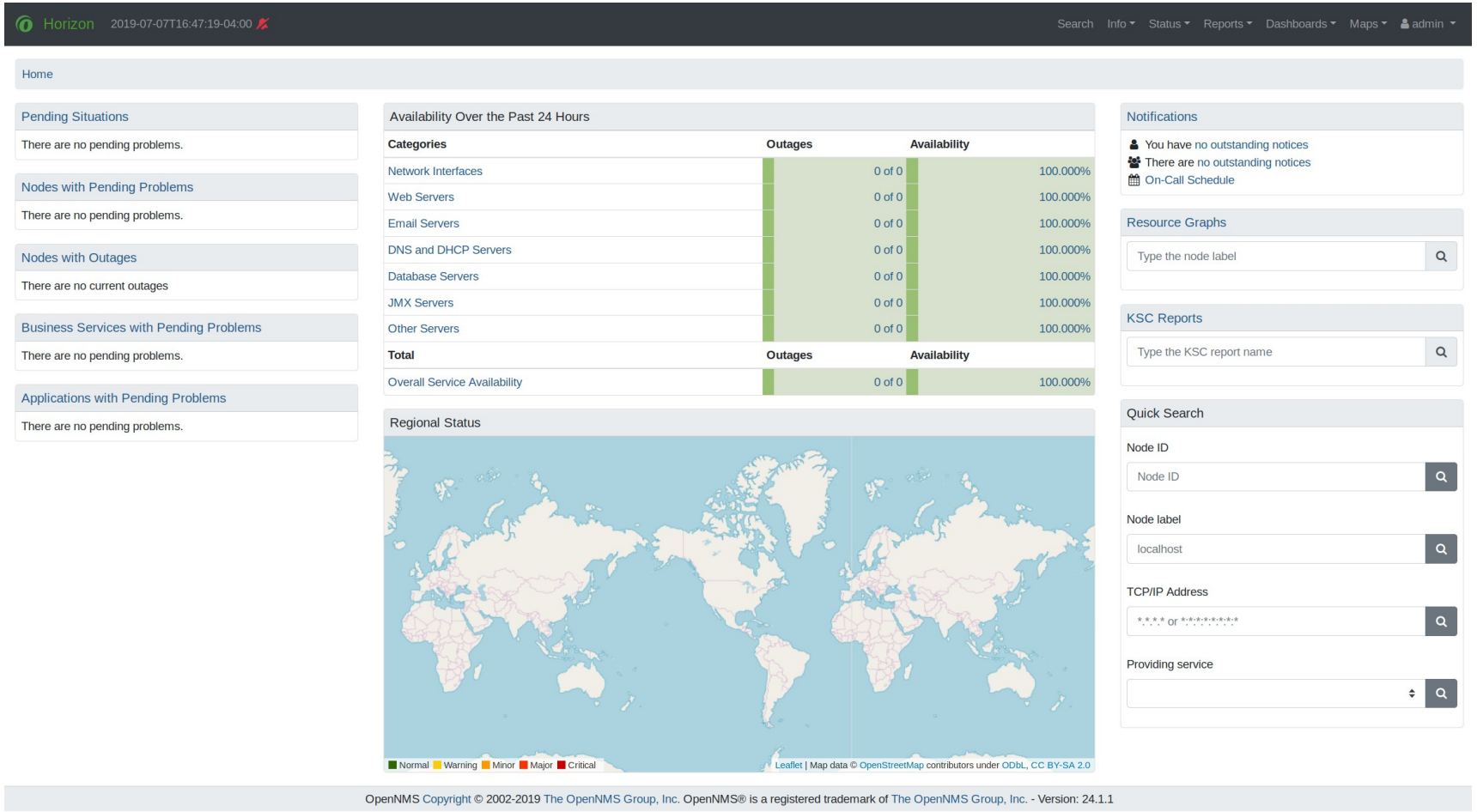

```
{
  "packageName": "opennms",
  "version": "24.1.1",
  "alarms": 0,
  "monitoredServices": 0,
  "ipInterfaces": 0,
  "snmpInterfaces": 0,
  "systemId": "bd8fc334-b62e-4d08-99ab-c9d168fb43b1",
  "nodes": 0,
  "events": 16,
  "nodesBySysOid": {},
  "osName": "Linux",
  "osArch": "amd64",
  "osVersion": "3.10.0-957.21.3.el7.x86_64"
}
```


Opt-in Opt-out

stats.opennms.org



The OpenNMS Home Page



Configuration Menu

Home / Admin

OpenNMS System

System Configuration
Configure Users, Groups and On-Call Roles

Provisioning

Manage Provisioning Requisitions
Import and Export Asset Information
Manage Surveillance Categories
Configure Discovery
Run Single Discovery Scan
Configure SNMP Community Names by IP Address
Manually Add an Interface
Delete Nodes
Configure Geocoder Service

Event Management

Manually Send an Event
Configure Notifications
Customize Event Configurations

Notification Status: ○ On ◉ Off Update

Configuration Menu (cont)

Flow Management

- Manage Flow Classification

Service Monitoring

- Configure Scheduled Outages
- Manage and Unmanage Interfaces and Services
- Manage Business Services

Performance Measurement

- Configure SNMP Collections and Data Collection Groups
- Configure SNMP Data Collection per Interface
- Configure Thresholds

Distributed Monitoring

- Manage Monitoring Locations
- Manage Applications
- Manage Remote Pollers
- Manage Minions

Additional Tools

- Instrumentation Log Reader
- Ops Board Configuration
- SNMP MIB Compiler
- Data Choices
- JMX Configuration Generator
- Surveillance Views Configuration

Exercise #2: Add an Admin User

- Login as “admin”
- Create a new user
- Add the user to the “admin” group
- Logout
- Login as the new user
- Note the status of the Configure OpenNMS menu item
- Logout
- Modify the user to add the Admin Role.
- Login as the new user
- Note the status of the Configure OpenNMS menu item

Add a User

Navigate to Configure Users, Groups and On-Call Roles → Configure Users

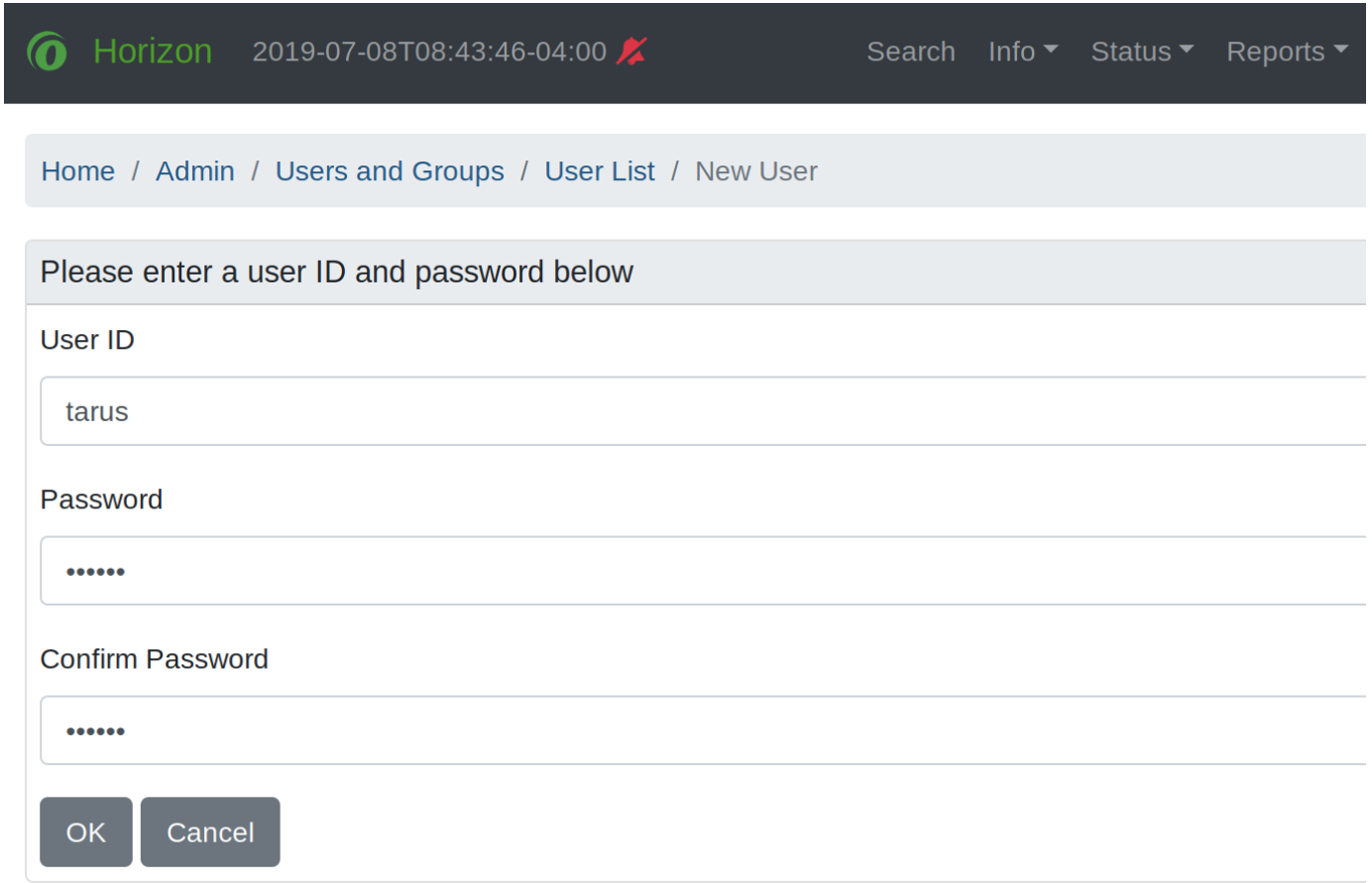
Home / Admin / Users and Groups / User List

Click on the *User ID* link to view detailed information about a user.

Add new user

Delete	Modify	Rename	User ID	Full Name	Email	Pager Email	XMPP Address
		Rename	admin	Administrator			
			Default administrator, do not delete				
		Rename	rtc	RTC			
			RTC user, do not delete				

Create Name and Password



Add Name and Details

User Information

Full Name: Tarus Balog

Comments: He talks a lot, eh?

Telephone PIN:

Security Roles

Available Roles

- ROLE_ADMIN
- ROLE_ASSET_EDITOR
- ROLE_DASHBOARD
- ROLE_DELEGATE
- ROLE_JMX
- ROLE_MINION
- ROLE_MOBILE
- ROLE_PROVISION
- ROLE_READONLY
- ROLE_REMOTING

Currently in User

- ROLE_USER

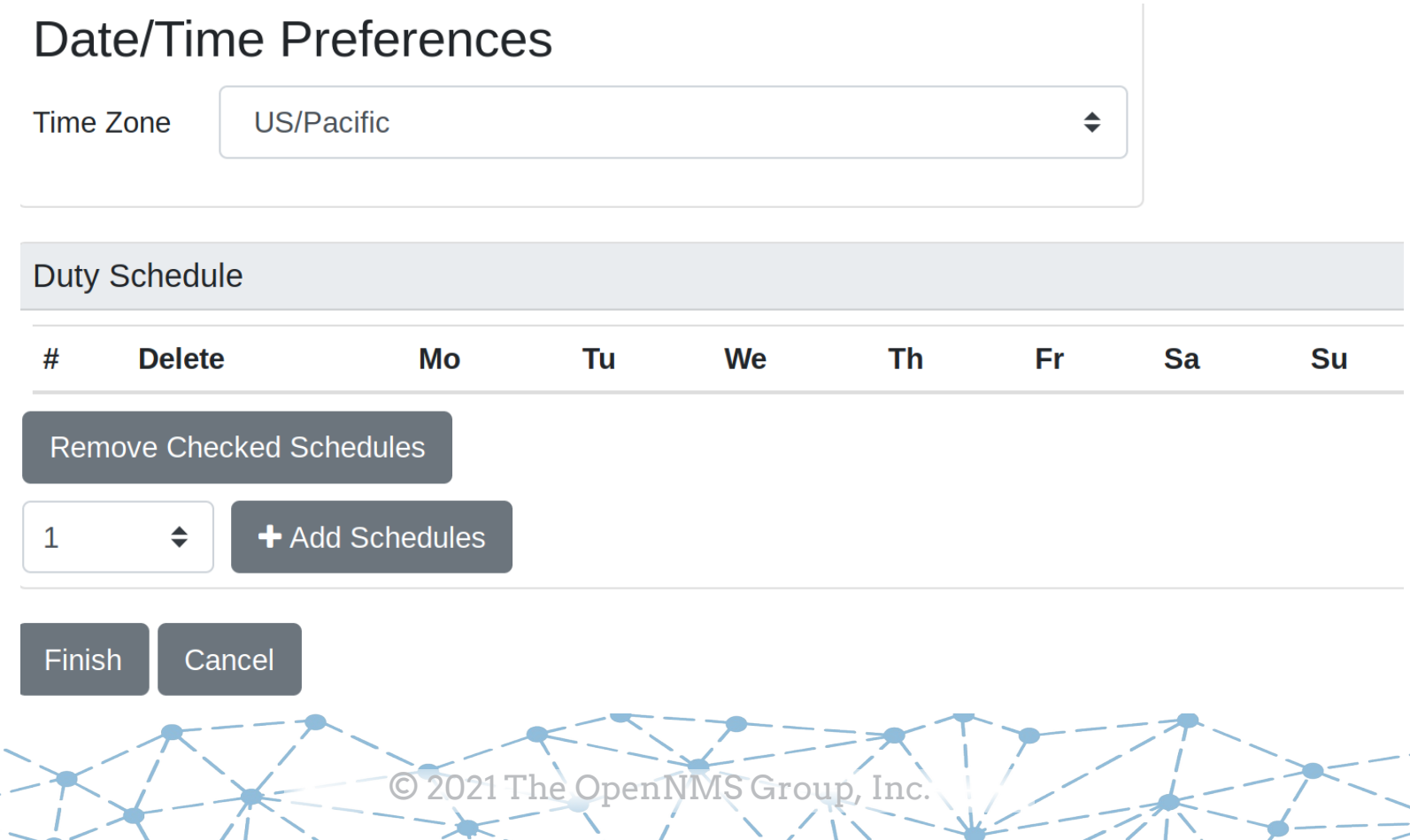
Add ›› | ‹‹ Remove

Notification Informaiton

Notification Information

Email	root@localhost
Pager Email	
XMPP Address	
Microblog Username	
Numeric Service	
Numeric PIN	
Text Service	
Text PIN	
Work Phone	
Mobile Phone	
Home Phone	

Click “Finish”



Add a User to a Group

Navigate to Configure Users, Groups and On-Call Roles → Configure Groups

Home / Admin / Users and Groups / Group List

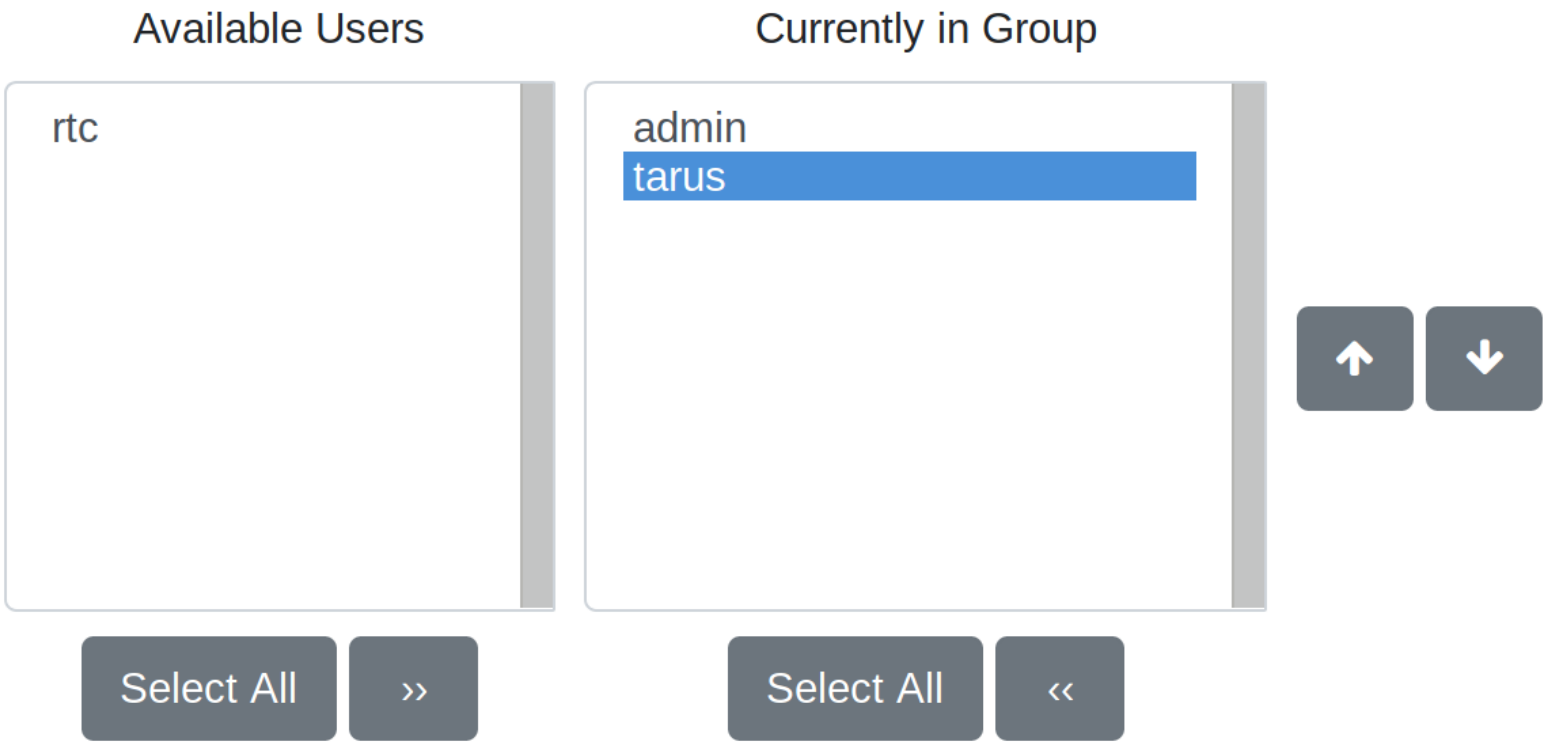
Click on the *Group Name* link to view detailed information about a group.

Add new group

Delete	Modify	Rename	Group Name	Comments
		Rename	Admin	The administrators
		Rename	Remoting Users	Users with access for submitting remote poller management data.

Add New User to Admin Group

Assign/Unassign Users



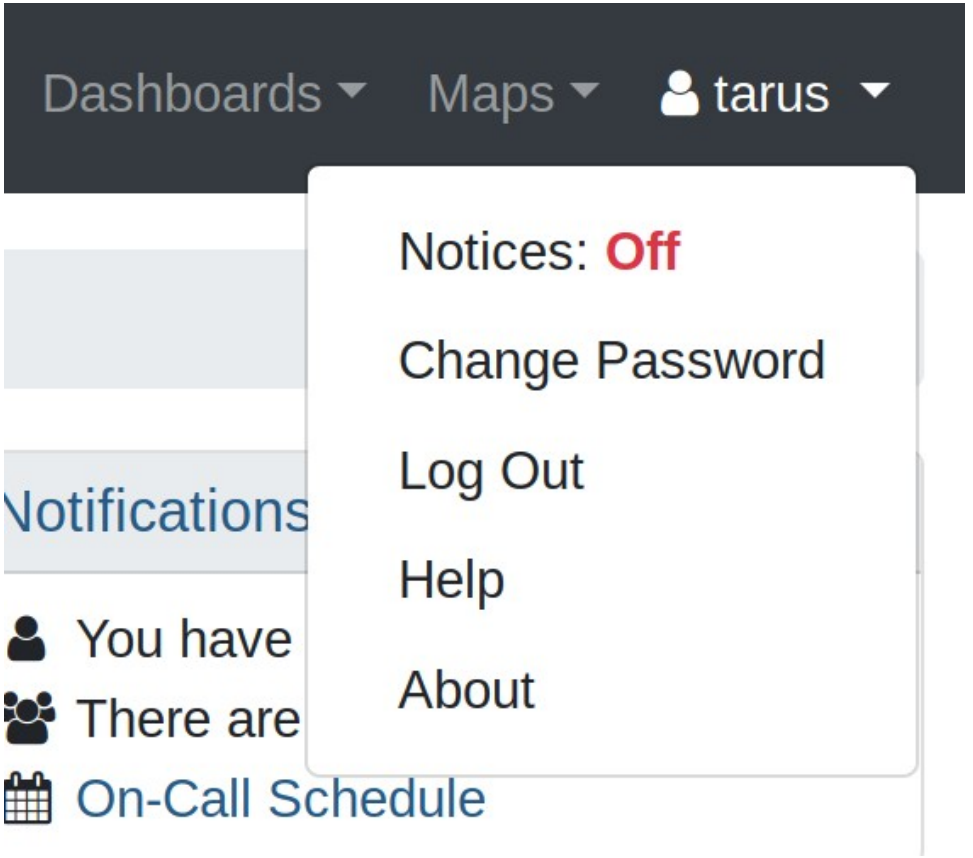
Group Categories (ACLs)

Assign/Unassign Categories

Available Categories	Currently in Group
Routers Switches Servers Production Test Development	

Select All ›› « Select All

Login with New User



Add ADMIN_ROLE to User

Full Name: Tarus Balog

Comments: He talks a lot, eh?

Telephone

PIN

Security Roles

Available Roles

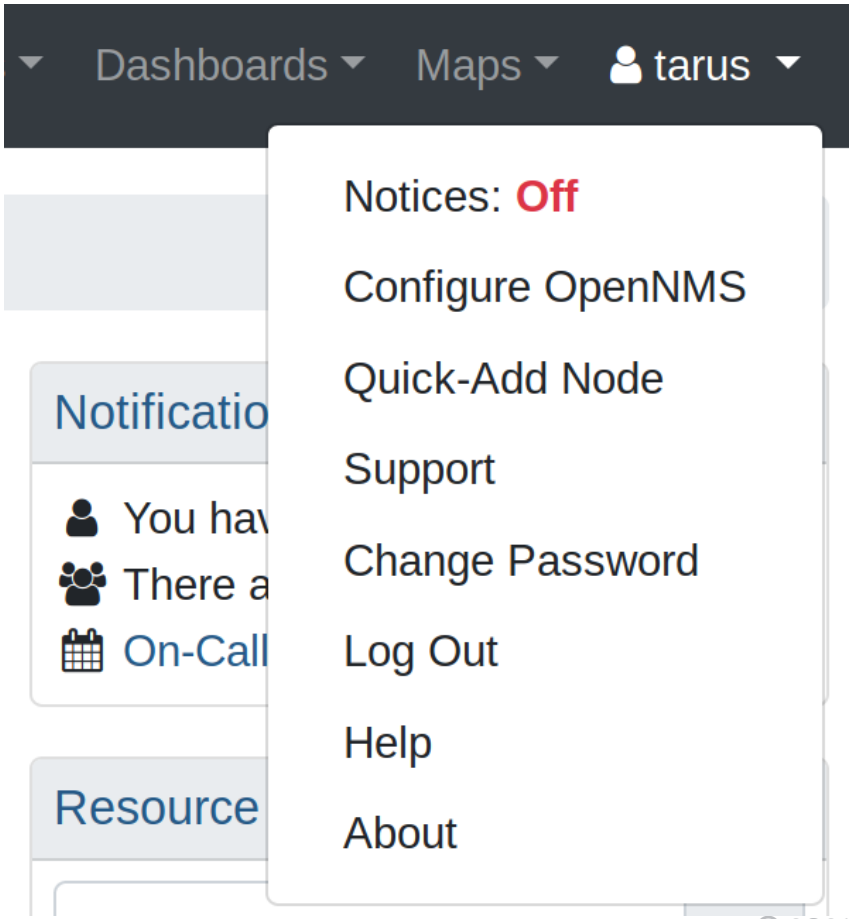
- ROLE_ASSET_EDITOR
- ROLE_DASHBOARD
- ROLE_DELEGATE
- ROLE_JMX
- ROLE_MINION
- ROLE_MOBILE
- ROLE_PROVISION
- ROLE_READONLY
- ROLE_REMOTING
- ROLE_REST

Currently in User

- ROLE_USER
- ROLE_ADMIN

Add ›› | ‹‹ Remove

Login and Note Admin Rights



Unit 3: Events

Events Are At the Heart of OpenNMS

- OpenNMS is event driven
- The key process is called “eventd”
- Listens on port 5817 for XML
- Daemon config: `eventd-configuration.xml`
- Events config: `eventconf.xml`
- Events identified by a “uei”: unique event identifier
- Use `send-event.pl` to send events

eventd-configuration.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<EventdConfiguration
    xmlns="http://xmlns.opennms.org/xsd/config/eventd"
    TCPAddress="127.0.0.1" TCPPort="5817"
    UDPAddress="127.0.0.1" UDPPort="5817"
    receivers="5"
    getNextEventID="SELECT nextval('eventsNxtId')"
    socketSoTimeoutRequired="yes"
    socketSoTimeoutPeriod="3000"/>
```

eventconf.xml

Event configuration is driven by this file, which has two main purposes:

- Global security settings
- Include files that list event definitions

Event Include Files

```
</events>
   <event-file>events/opennms.events.xml</event-file>
   <event-file>events/Translator.default.events.xml</event-file>
   <event-file>events/Rancid.events.xml</event-file>
   <event-file>events/3Com.events.xml</event-file>
   <event-file>events/AdaptecRaid.events.xml</event-file>
   <event-file>events/ADIC-v2.events.xml</event-file>
                          .  .  .
   <event-file>events/VMWare.vc.events.xml</event-file>
   <event-file>events/VMWare.vminfo.events.xml</event-file>
   <event-file>events/VMWare.obsolete.events.xml</event-file>
   <event-file>events/VMWare.events.xml</event-file>
   <event-file>events/Waverider.3000.events.xml</event-file>
   <event-file>events/Websense.events.xml</event-file>
   <event-file>events/Xerox-V2.events.xml</event-file>
   <event-file>events/Xerox.events.xml</event-file>
   <event-file>events/topology-status.events.xml</event-file>
   <event-file>events/ncs-component.events.xml</event-file>
   <event-file>events/asset-management.events.xml</event-file>
   <event-file>events/Standard.events.xml</event-file>
   <event-file>events/default.events.xml</event-file>
</events>
```

An Internal OpenNMS Event

```
<event>

    <uei>uei.opennms.org/internal/discovery/newSuspect</uei>
    <event-label>OpenNMS-defined internal event:
                 discovery newSuspect</event-label>

    <descr><p>Interface %interface% has been discovered and
is being queued for a services scan.</p>
    </descr>

    <logmsg dest="logndisplay">A new interface (%interface%)
            has been discovered and is being queued for a
            services scan.</logmsg>

      <severity>Warning</severity>
</event>
```

Event Substitutions

(https://wiki.opennms.org/wiki/Event_substitutions)

- uei
- source
- nodeid
- time
- shorttime (shorter format time stamp)
- host
- interface
- snmphost
- service
- snmp
- id
- idtext
- version
- specific
- generic
- community
- severity
- operinstruct
- mouseovertext
- parm[values-all]
- parm[names-all]
- parm[name-#] from release 1.6.3
- parm[all]
- parm[]
- parm[##]
- parm[#]

Log Message Destination

- `logndisplay` – both display the event in the user interface and log in the database.
- `logonly` – just log the event in the database.
- `donotpersist` – process the event but do not display or log it.
- `discardtraps` – just for SNMP traps, don't even process them.

Event Severities

Critical	This event means numerous devices on the network are affected by the event. Everyone who can should stop what they are doing and focus on fixing the problem.
Major	A device is completely down or in danger of going down. Attention needs to be paid to this problem immediately.
Minor	A part of a device (a service, and interface, a power supply, etc.) has stopped functioning. The device needs attention.
Warning	An event has occurred that may require action. This severity can also be used to indicate a condition that should be noted (logged) but does not require direct action.
Indeterminate	No Severity could be associated with this event.
Normal	Informational message. No action required.
Cleared	This event indicates that a prior error condition has been corrected and service is restored

Sending Events

- `$ /opt/opennms/bin/send-event.pl uei.foo`

ID	Severity	Time	Node	Interface	Service
17	**Indeterminate**	Dec 4, 2016 2:24:13 AM			
		uei.foo Edit notifications for event			
		An event with no matching configuration was received from interface .			

- `$ /opt/opennms/bin/send-event.pl -x 7 uei.foo`

ID	Severity	Time	Node	Interface	Service
18	**Critical**	Dec 4, 2016 2:30:31 AM			
		uei.foo Edit notifications for event			
		An event with no matching configuration was received from interface .			

Restart eventd For Changes

There several ways to let eventd know that ther configuration files have:

- Restart OpenNMS
- Send a specific event:

```
send-event.pl uei.opennms.org/internal/eventsConfigChange
```

- Send a generic event:

```
send-event.pl uei.opennms.org/internal/reloadDaemonConfig -p 'daemonName Eventd'
```

/opt/opennms/bin/opennms -v status

```
OpenNMS.Eventd          : running
OpenNMS.Trapd           : running
OpenNMS.Queued          : running
OpenNMS.Actiond         : running
OpenNMS.Notifd          : running
OpenNMS.Scriptd         : running
OpenNMS.Rtcd            : running
OpenNMS.Pollerd         : running
OpenNMS.PollerBackEnd   : running
OpenNMS.EnhancedLinkd   : running
OpenNMS.Ticketer        : running
OpenNMS.Collectd        : running
OpenNMS.Discovery       : running
OpenNMS.Vacuumd         : running
OpenNMS.EventTranslator: running
OpenNMS.PassiveStatusd  : running
OpenNMS.Statsd          : running
OpenNMS.Provisiond      : running
OpenNMS.Reportd         : running
OpenNMS.Alarmd          : running
OpenNMS.Ackd            : running
OpenNMS.JettyServer     : running
opennms is running
```

Exercise #3: Create an Event

- Send a `uei.opennms.org/class/happiness` event
- Note how it appears in the GUI
- Create a `Class.events.xml` file
- Add it to `eventconf.xml`
- Reload the event configuration
- Send the event again
- Note how it appears in the GUI

Send a “happiness” Event

```
$ send-event.pl uei.opennms.org/class/happiness
```

ID	Severity	Time	Node	Interface	Service
19	**Indeterminate**	Dec 4, 2016 3:11:21 AM			
		uei.opennms.org/class/happiness Edit notifications for event			
		An event with no matching configuration was received from interface .			

Get the `Class.events.xml` File

All event files should live in /opt/opennms/etc/events

- First, `cd /opt/opennms/etc/events`
- Then:

```
wget -N https://docs.opennms.com/~tarus/Class/Config/Exercise
%203/Class.events.xml
```

- Edit `/opt/opennms/etc/eventconf.xml`

```
 </global>
<event-file>events/Class.events.xml</event-file>
<event-file>events/opennms.events.xml</event-file>
<event-file>events/Translator.default.events.xml</event-file>
```

Class.events.xml

```
<events>
  <event>
    <uei>uei.opennms.org/class/happiness</uei>
    <event-label>OpenNMS defined event: The OpenNMS Class is so happy</event-label>
    <descr>
      &lt;p&gt;This event is sent when the OpenNMS Class is happy.&lt;/p&gt;
      &lt;ul&gt;
      &lt;li&gt;Dance, Everybody Dance!&lt;/li&gt;
      &lt;li&gt;Life is Good!&lt;/li&gt;
      &lt;li&gt;This is Fun!&lt;/li&gt;
      &lt;/ul&gt;
    </descr>
    <logmsg dest='logndisplay'>
      &lt;p&gt;OpenNMS Class is Happy! &lt;/p&gt;
    </logmsg>
    <severity>Normal</severity>
  </event>
</events>
```

Reload `eventd` and Send Event

```
$ send-event.pl
  uei.opennms.org/internal/reloadDaemonConfig -p 'daemonName Eventd'

$ send-event.pl uei.opennms.org/class/happiness
```

▼ ID	Severity	Time	Node	Interface	Service
25	**Normal** ⊞⊟	Dec 4, 2016 3:34:48 AM ◧◨			
		uei.opennms.org/class/happiness ⊞⊟ Edit notifications for event			
		OpenNMS Class is Happy!			
24	**Normal** ⊞⊟	Dec 4, 2016 3:34:46 AM ◧◨			
		uei.opennms.org/internal/reloadDaemonConfigSuccessful ⊞⊟ Edit notifications for event			
		The daemon: Eventd configuration changes have successfully been applied.			
23	**Normal** ⊞⊟	Dec 4, 2016 3:34:46 AM ◧◨			
		uei.opennms.org/internal/reloadDaemonConfig ⊞⊟ Edit notifications for event			
		The daemon: Eventd configuration files has changed.			

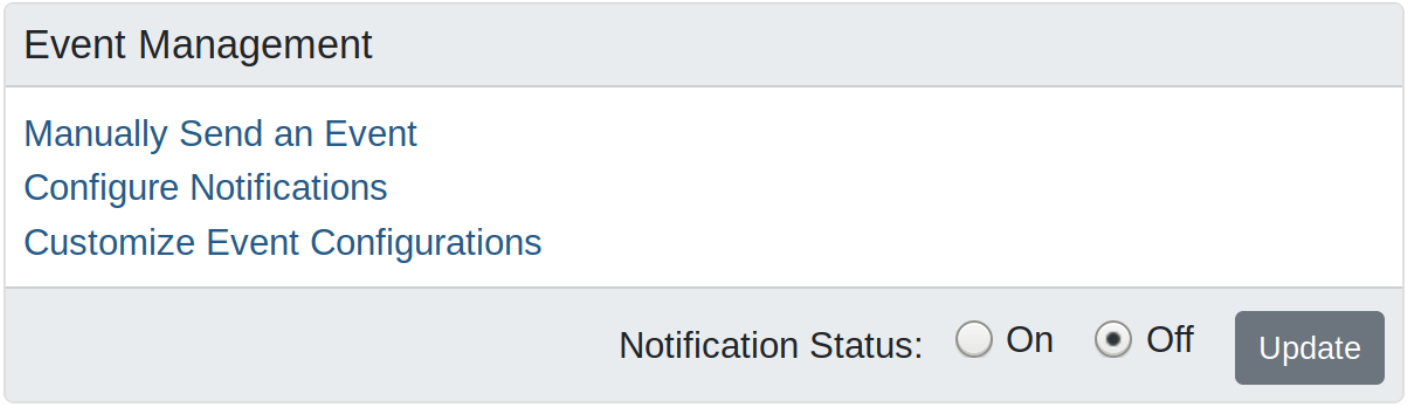
Unit 4: Notifications

Notices Tell People What's Happening

- Notices bring events to others attention
- Events can trigger notices
  - The event happens
  - A notice is triggered
  - It "walks a path"
- Those along the path get notified
- Escalations can insure notices get attention.
- Not a replacement for a Trouble Ticketing system.

Built-In Notifications

- A number of notices are built-in: nodeDown, interfaceDown, nodeLostService, nodeAdded, interfaceDeleted and thresholds.
- Notices are off by default, and should be turned off during restarts.
- Turn Notices On.

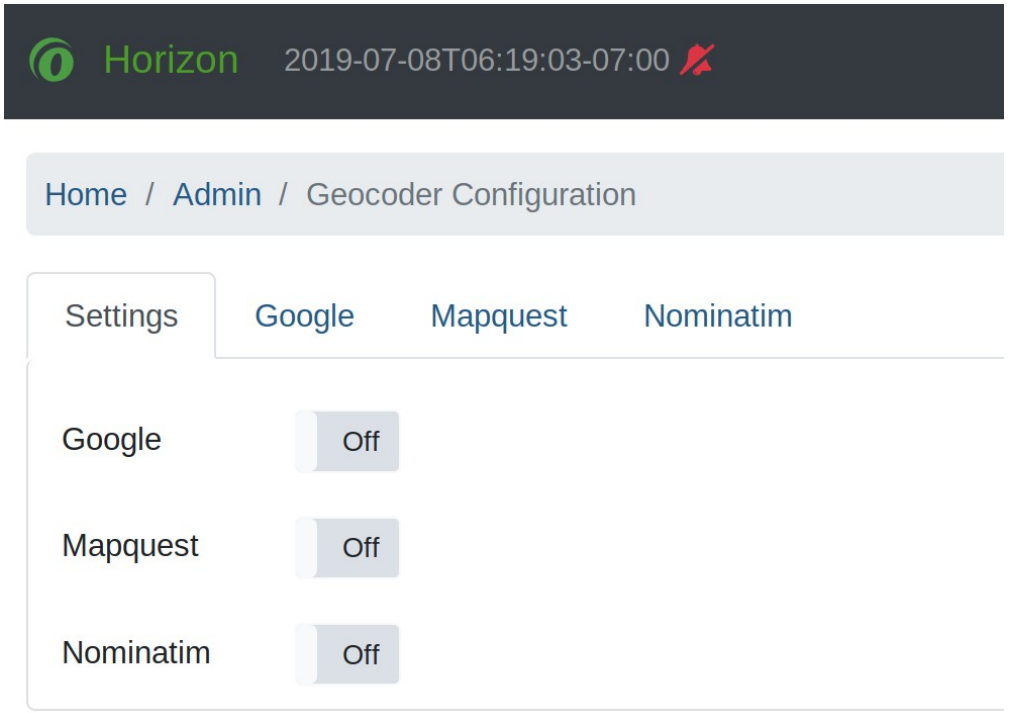


Time to Add a Node

- Provisioning, the act of adding Nodes, is a key part of OpenNMS
- There are two main methods:
  - Automated Discovery
  - Directed Discovery
- Directed Discovery is recommended, and can be augmented with a number of adapters and the ReST interface.

Add Geocoder Service

Navigate to Configure → Configure Geocoder Service



Configure Nominatim Service

Email

Please provide a valid email address

User Agent

OpenNMS-NominatimGeocoderService/2.0

Referer

Accept Usage Terms

Yes

Please accept the usage terms

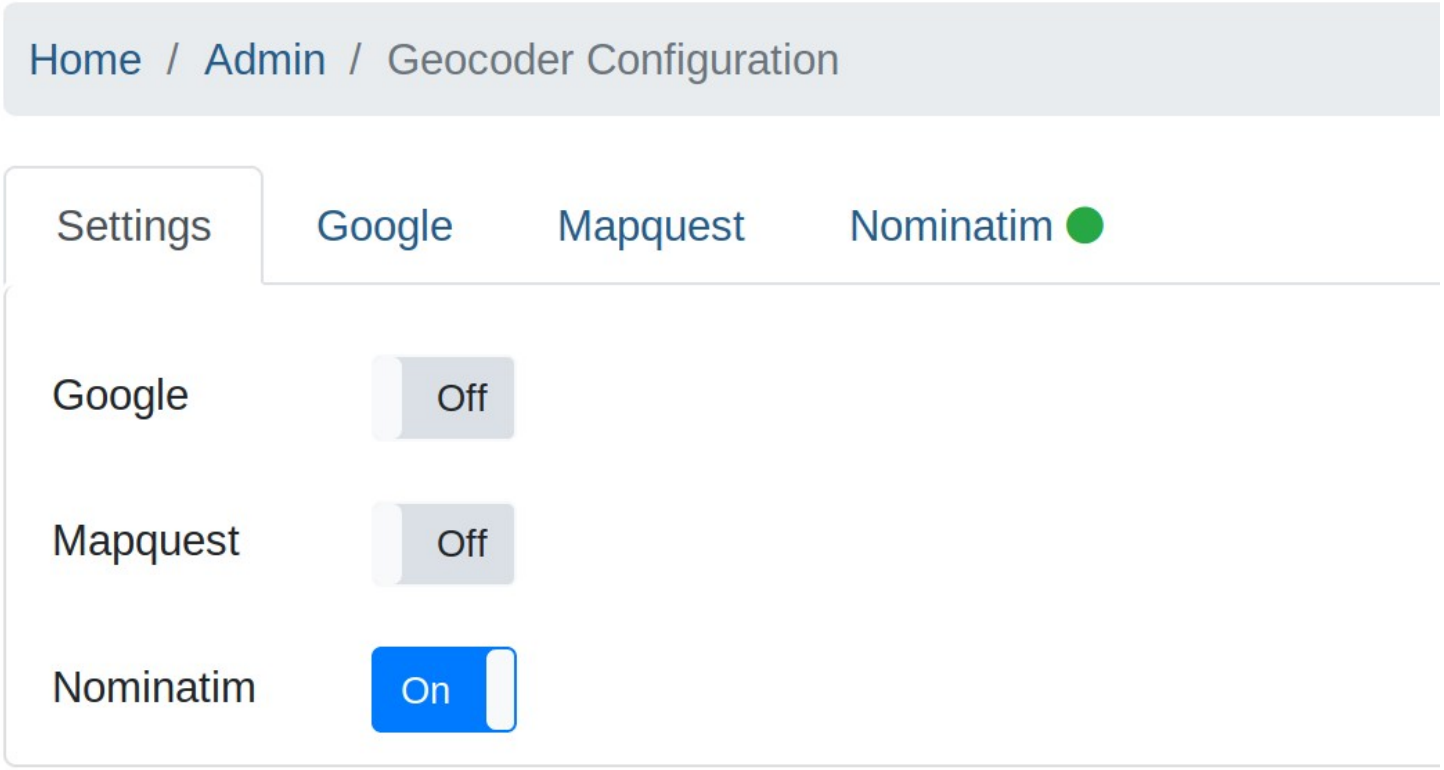
Use System Proxy

No

You have unsaved changes

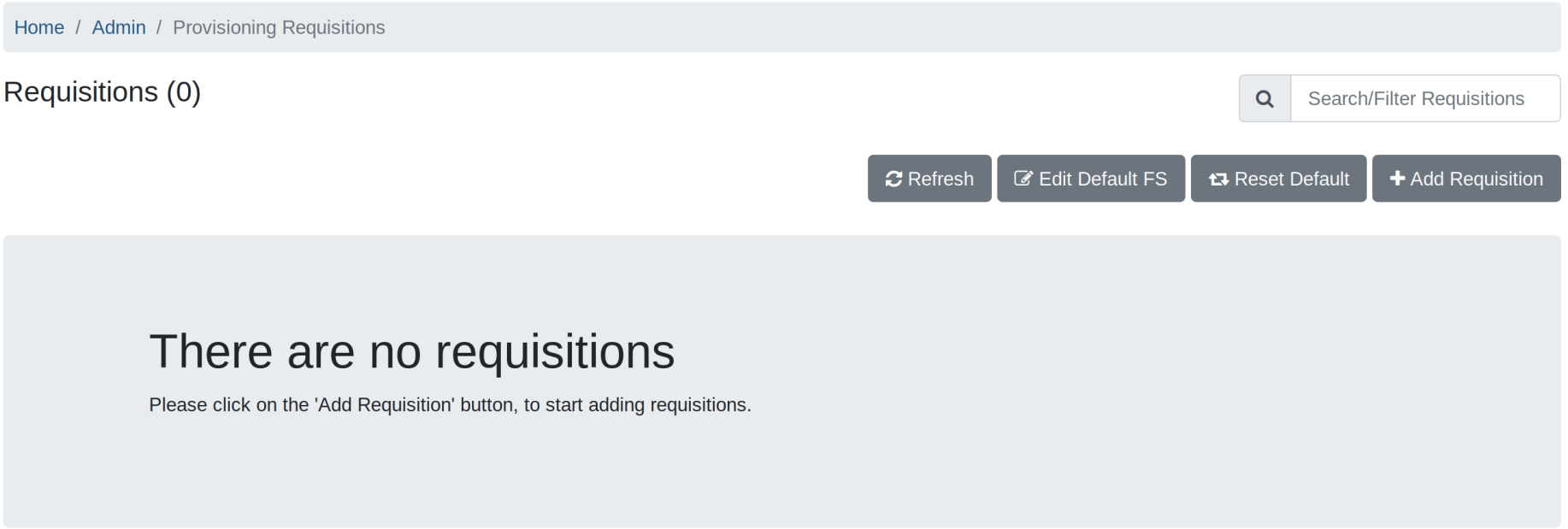
Save

Enable Nominatim Service



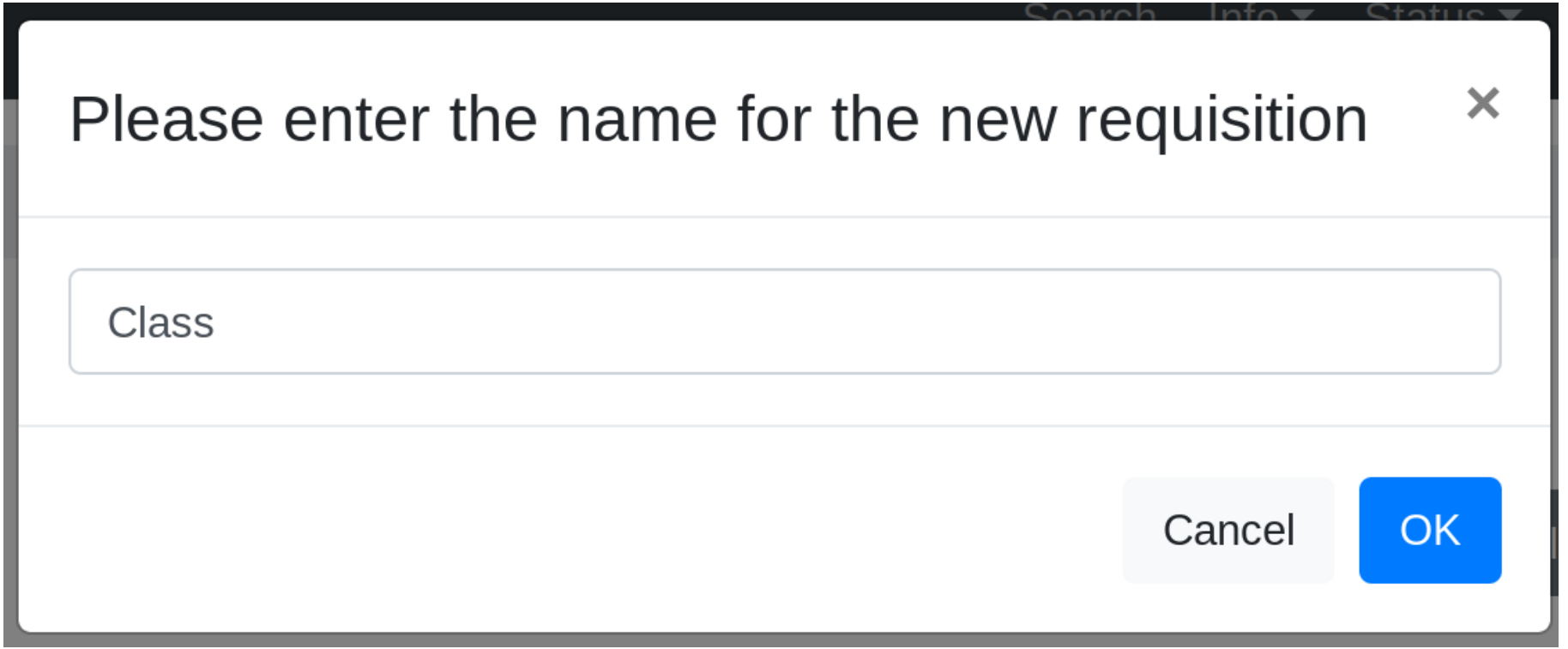
Create a Requisition

Navigate to Configure → Manage Provisioning Requisitions.



Add a Requisition

Add a new requisition called “Class”.



New Requisition Created

Home / Admin / Provisioning Requisitions

Requisitions (1)

Search/Filter Requisitions

Refresh | Quick Add Node | Edit Default FS | Reset Default | Add Requisition

Requisition Name	Last Update	Last Import	Nodes Defined	Nodes in Database	Actions
Class	2019-07-08T09:22:12-07:00	Never	0	0	

Key Attributes of a Requisition

- The name of the requisition
- The last time it was modified
- The last time it was imported
- Nodes in the requisition and nodes in the DB
- Actions:
  - Edit the requisition
  - Edit detectors and policies
  - Clone detectors and policies
  - Synchronize
  - Refresh
  - Delete Nodes
  - Delete the Requisition

Edit the Requistion

Home / Admin / Provisioning Requisitions / Class

Requisition Class (0 defined, 0 deployed)

Search/Filter Nodes

Refresh | Edit Definition | Synchronize | Add Node | Return

There are no nodes on the Class

Please click on the 'Add' button, to start adding nodes into this requisition.

Add a Node – Horizontal Layout

Node at Class

Use Vertical Layout | Return

Basic Information | Path Outage | Interfaces | Assets | Categories

Foreign ID

1562592501311 Auto-generate

Node Label

Node Label

Node Label is required.

Minion Location

Location [optional]

There are no locations available. (Set to Location "Default")

Building

Building [optional]

localhost Node – Vertical Layout

Node localhost at Class

Use Horizontal Layout | Save | Return

Basic Information

Foreign ID

1562592533627 [Auto-generate]

Node Label

localhost

Minion Location

Location [optional]

There are no locations available. (Set to Location "Default")

Building

Building [optional]

Path Outage

Parent Foreign Source

Parent Foreign Source (leave it blank to use the current requisition)

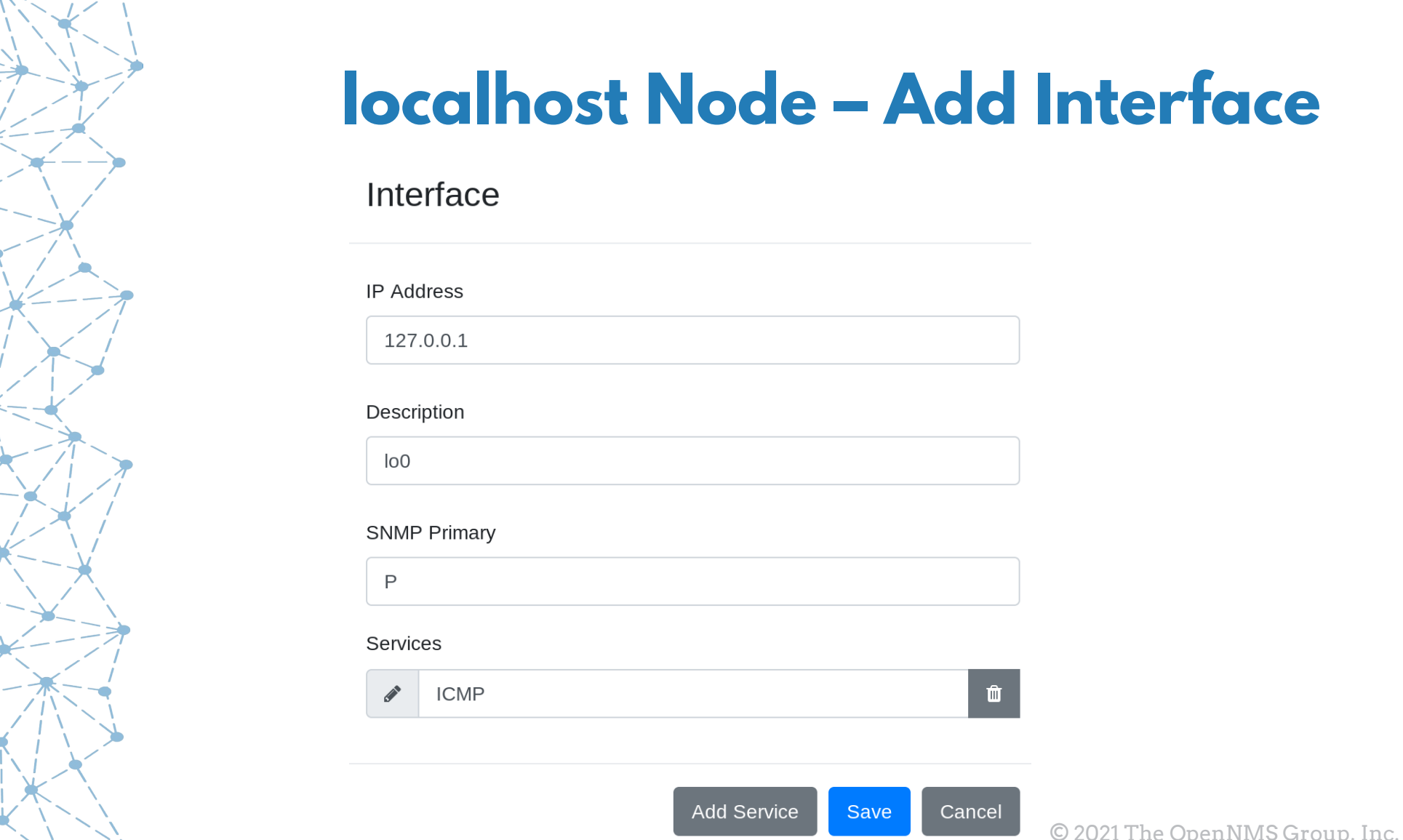
Parent Foreign ID

Parent Foreign ID (use either this or Parent Node Label)

Parent Node Label

Parent Node Label (use either this or Parent Foreign ID)

localhost Node – Add Interface



localhost Node – Add Assets

Assets

+ Add Asset

Name	Value	Actions
address1	13892 Victoria Street	
city	Fontana	
state	CA	
zip	92336	

Save and Synchronize

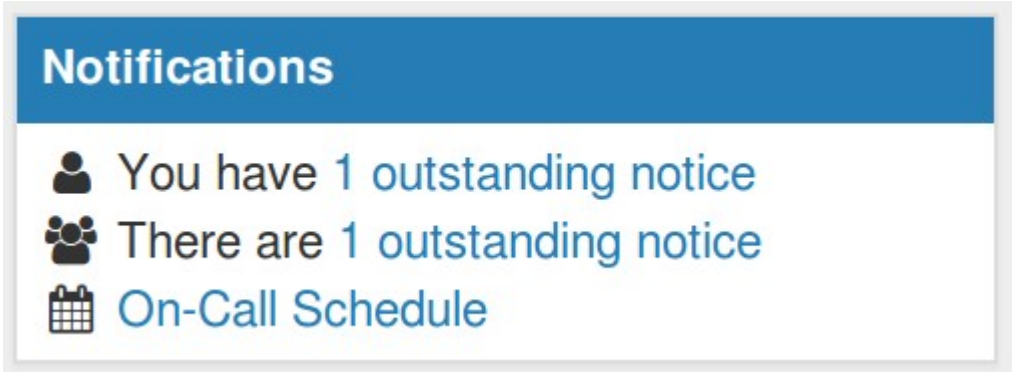
Click “Save” then “Return” and then “Synchronize”

Node Label	Foreign ID	Building	City	IP Addresses	# Assets	# Categories	Has Parent	Actions
localhost	1480863869842	N/A	N/A	127.0.0.1 (P)	0	0	No	

Then “Return” again

Requisition Name	Last Update	Last Import	Nodes Defined	Nodes in Database	Actions
Class	04-12-16 10:10:52	04-12-16 10:11:45	1	1	

Voila! A Notice



▼ ID	Event ID	Severity	Sent Time	Responder	Respond Time	Node	Interface	Service
☐ 1	48	Warning	Dec 5, 2016 12:30:20 AM			localhost ⊞ ⊟		
			OpenNMS has discovered a new node named localhost. Please be advised.					

35	**Normal**	Dec 5, 2016 12:11:58 AM	localhost		
		uei.opennms.org/internal/provisiond/nodeScanCompleted Edit notifications for event			
		The Node with Id: 1; ForeignSource: Class; ForeignId:1480863869842 has completed.			
34	**Warning**	Dec 5, 2016 12:11:51 AM	localhost	127.0.0.1	SMTP
		uei.opennms.org/nodes/nodeGainedService Edit notifications for event			
		The SMTP service has been discovered on interface 127.0.0.1.			
33	**Warning**	Dec 5, 2016 12:11:51 AM	localhost	127.0.0.1	SSH
		uei.opennms.org/nodes/nodeGainedService Edit notifications for event			
		The SSH service has been discovered on interface 127.0.0.1.			
32	**Warning**	Dec 5, 2016 12:11:50 AM	localhost	127.0.0.1	OpenNMS-JVM
		uei.opennms.org/nodes/nodeGainedService Edit notifications for event			
		The OpenNMS-JVM service has been discovered on interface 127.0.0.1.			
31	**Warning**	Dec 5, 2016 12:11:49 AM	localhost	127.0.0.1	ICMP
		uei.opennms.org/nodes/nodeGainedService Edit notifications for event			
		The ICMP service has been discovered on interface 127.0.0.1.			
30	**Warning**	Dec 5, 2016 12:11:49 AM	localhost		
		uei.opennms.org/nodes/nodeAdded Edit notifications for event			
		A new node (localhost) was discovered by OpenNMS.			
29	**Warning**	Dec 5, 2016 12:11:49 AM	localhost	127.0.0.1	
		uei.opennms.org/nodes/nodeGainedInterface Edit notifications for event			
		Interface 127.0.0.1 has been associated with Node #1.			
28	**Normal**	Dec 5, 2016 12:11:49 AM			
		uei.opennms.org/internal/importer/importSuccessful Edit notifications for event			
		This event indicates the model-importer process has completed successfully from resource: file:/opt/opennms/etc/imports/pending/Class.xml.1480864252078			
27	**Normal**	Dec 5, 2016 12:11:44 AM			
		uei.opennms.org/internal/importer/importStarted Edit notifications for event			
		This event indicates the model-importer process has started from resource: file [/opt/opennms/etc/imports/pending/Class.xml.1480864252078]			
26	**Normal**	Dec 5, 2016 12:11:44 AM			
		uei.opennms.org/internal/importer/reloadImport Edit notifications for event			
		A request had been made to run the model-import process with the parms: url="file:/opt/opennms/etc/imports/pending/Class.xml.1480864252078" importRescanExisting="true".			

So, What Just Happened?

- Provisioning a node created a “nodeAdded” event
- Since notices were on globally, it was checked against the notification configuration
- There was a nodeAdded event notice, and it was on, so it was triggered.
- The event passed the filter, so it was sent
- It followed the Destination Path defined in the notice, with the configuration of the notice.

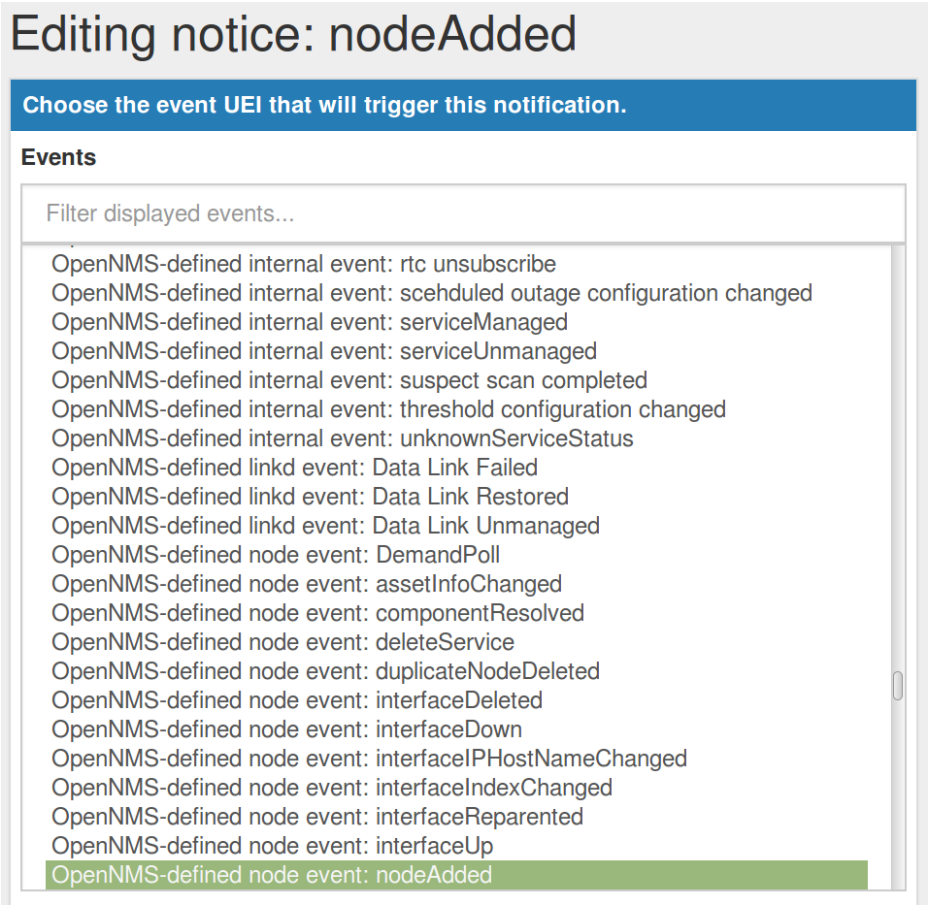
Let's Look at the Notice

Navigate to Configure → Configure Notifications → Configure Event Notifications

Event Notifications

Actions			Notification	Event	UEI
Edit	Delete	Off On	High Threshold	OpenNMS-defined threshold event: highThresholdExceeded	uei.opennms.org/threshold/highThresholdExceeded
Edit	Delete	Off On	High Threshold Rearmed	OpenNMS-defined threshold event: highThresholdRearmed	uei.opennms.org/threshold/highThresholdRearmed
Edit	Delete	Off On	Low Threshold	OpenNMS-defined threshold event: lowThresholdExceeded	uei.opennms.org/threshold/lowThresholdExceeded
Edit	Delete	Off On	Low Threshold Rearmed	OpenNMS-defined threshold event: lowThresholdRearmed	uei.opennms.org/threshold/lowThresholdRearmed
Edit	Delete	Off On	interfaceDeleted	OpenNMS-defined node event: interfaceDeleted	uei.opennms.org/nodes/interfaceDeleted
Edit	Delete	Off On	interfaceDown	OpenNMS-defined node event: interfaceDown	uei.opennms.org/nodes/interfaceDown
Edit	Delete	Off On	nodeAdded	OpenNMS-defined node event: nodeAdded	uei.opennms.org/nodes/nodeAdded
Edit	Delete	Off On	nodeDown	OpenNMS-defined node event: nodeDown	uei.opennms.org/nodes/nodeDown
Edit	Delete	Off On	nodeLostService	OpenNMS-defined node event: nodeLostService	uei.opennms.org/nodes/nodeLostService

nodeAdded Event Trigger



Apply Filters (if any)

Current Rule:

IPADDR != '0.0.0.0'

Select each service you would like to filter on in conjunction with the TCP/IP address in the previous column. For example highlighting both HTTP and FTP will match TCP/IP addresses that support HTTP **OR** FTP.

Services:

ICMP
OpenNMS-JVM
SSH
SMTP

Select each service you would like to do a NOT filter on in conjunction with the TCP/IP address. Highlighting multiple items ANDs them--for example, highlighting HTTP and FTP will match events (NOT on HTTP) AND (NOT on FTP).

"NOT" Services:

ICMP
OpenNMS-JVM
SSH
SMTP

Define the Notice

Editing notice: nodeAdded

Choose the destination path and enter the information to send via the notification

Name:	nodeAdded	
Description:		
Parameter:	**Name:**	**Value:**
Choose A Path:	Email-Admin	
Text Message:	OpenNMS has discovered a new node named %parm[nodelabel]%. Please be advised.	
Short Message:	111-%noticeid%	
Email Subject:	Notice #%noticeid%: %parm[nodelabel]% discovered.	

Special Values:

Can be used in both the text message and email subject:

%noticeid% = Notification ID number	%time% = Time sent	%severity% = Event severity
%nodelabel% = May be IP address or empty	%interface% = IP address, may be empty	%service% = Service name, may be empty
%eventid% = Event ID, may be empty	%parm[a_parm_name]% = Value of a named event parameter	%parm[#N]% = Value of the event parameter at index N
%ifalias% = SNMP ifAlias of affected interface	%interfaceresolve% = Reverse DNS name of interface IP address	%operinstruct% = Operator instructions from event definition

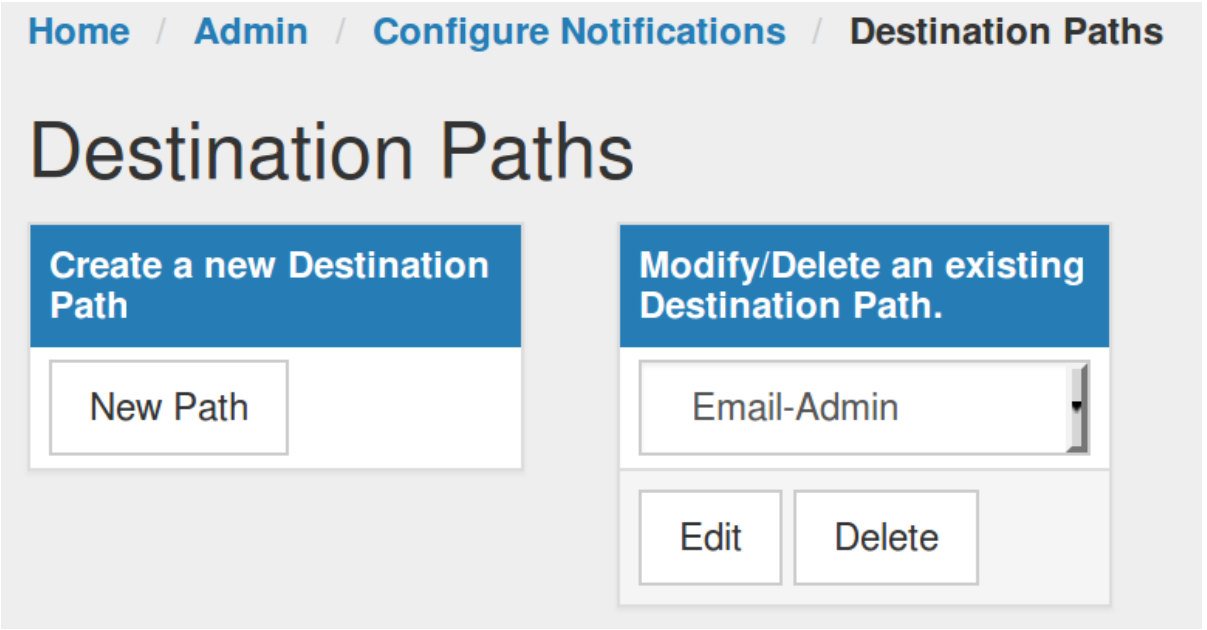
A Word About the Database

Access the database with: `psql -U opennms opennms`

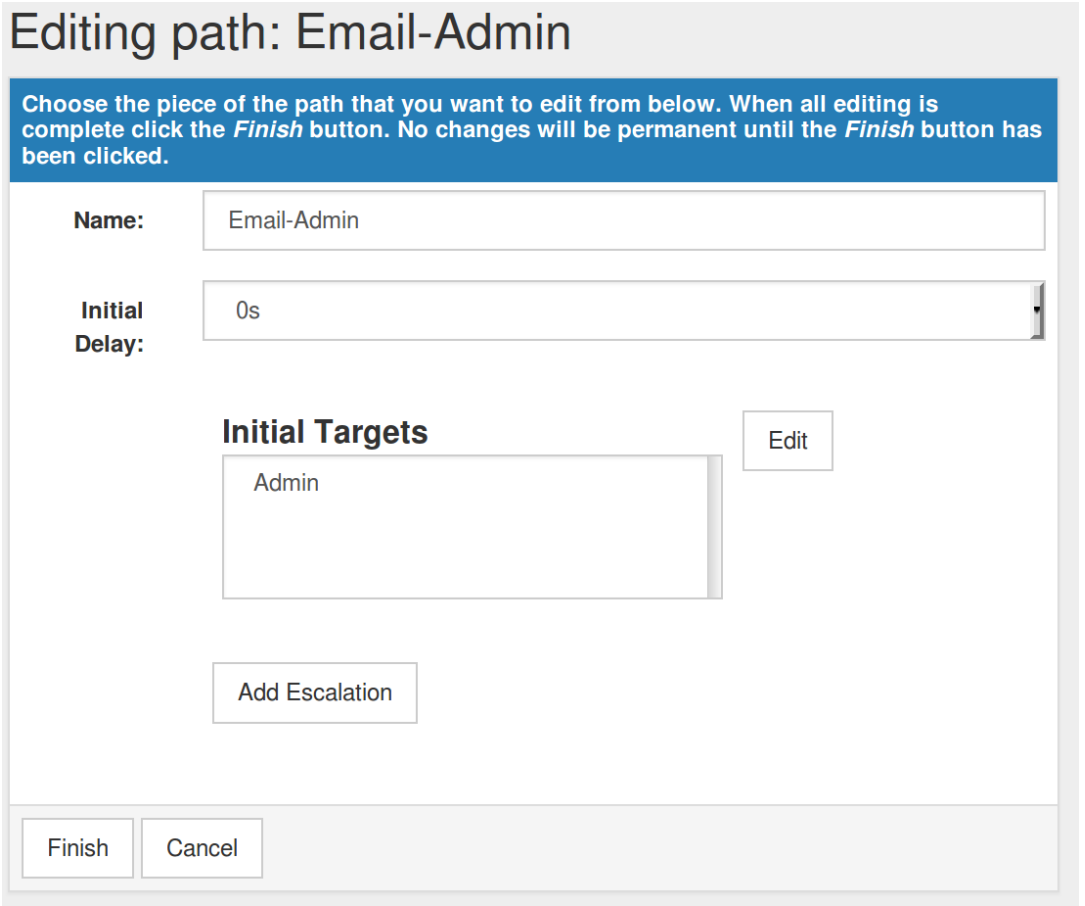
```
opennms=# \x
Expanded display is on.
opennms=# select * from events where eventid=30;
-[ RECORD 1 ]----------------------------------------------------------------
eventid                 | 30
eventuei                | uei.opennms.org/nodes/nodeAdded
nodeid                  | 1
eventtime               | 2016-12-05 00:11:49.853+09
eventhost               |
eventsource             | Provisiond
ipaddr                  |
eventsnmphost           |
serviceid               |
eventsnmp               |
eventparms              | nodelabel=localhost(string,text);nodelabelsource=U(string,text)
eventcreatetime         | 2016-12-05 00:11:49.95+09
eventdescr              | <p>A new node (localhost) was discovered by
                        |       OpenNMS.</p>
eventloggroup           |
eventlogmsg             | A new node (localhost) was discovered by OpenNMS.
eventseverity           | 4
```

Destination Paths

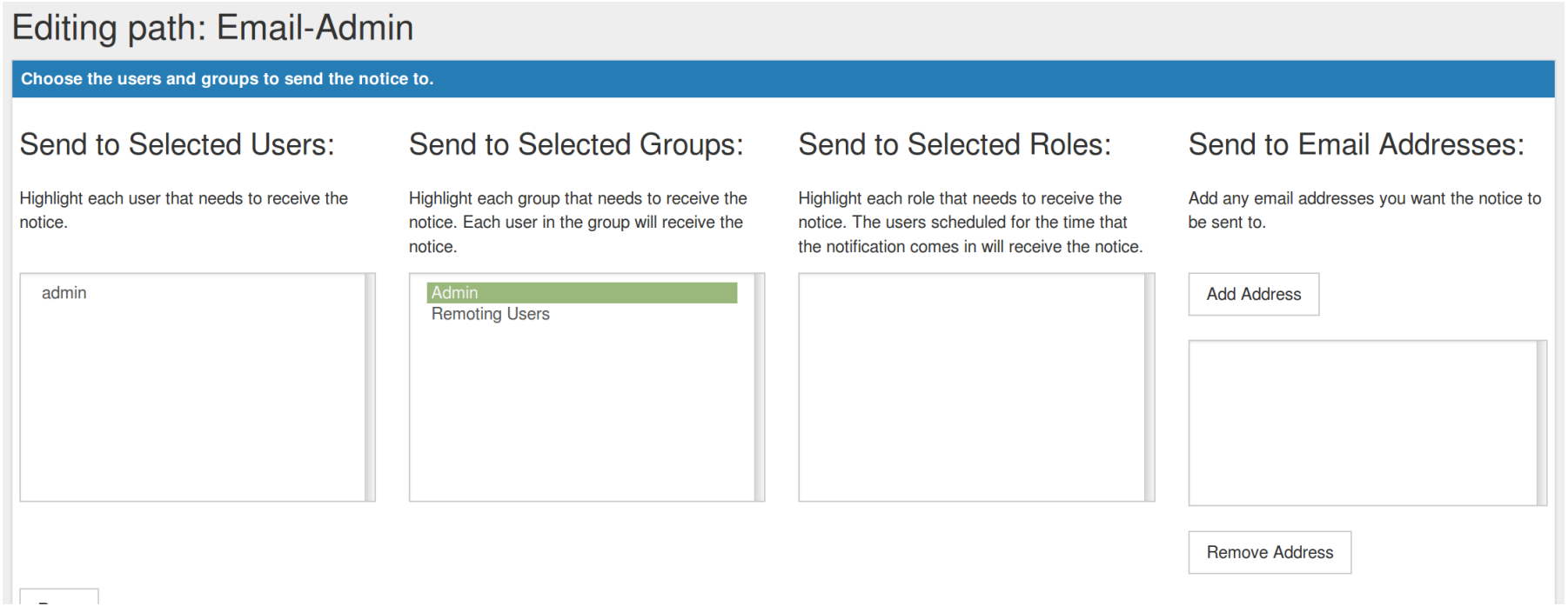
Navigate to Configure → Configure Notifications → Configure Destination Paths



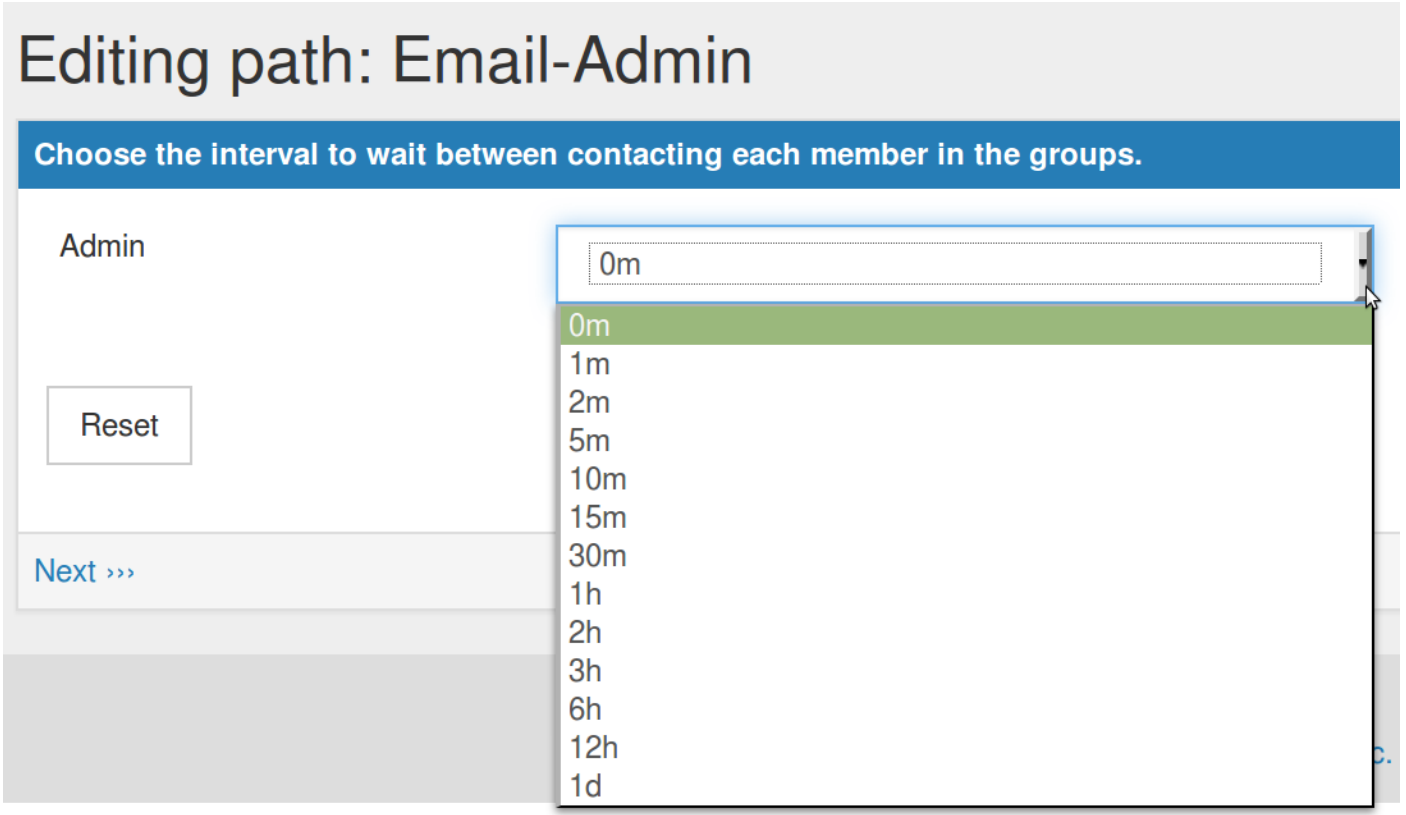
Edit Email-Admin



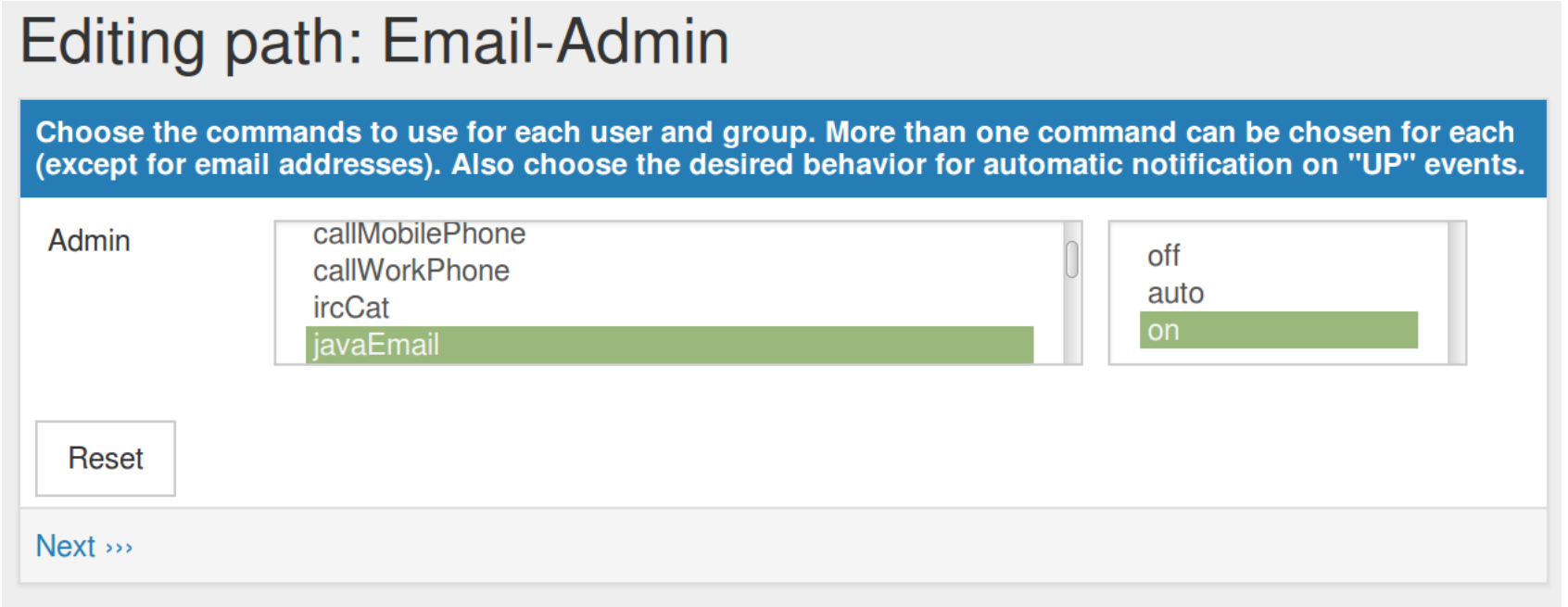
Path Targets



Group Delay



Action to Take



javamail-configuration.properties

```
# This property defines system sender account.
#
# The default setting is root@[127.0.0.1]
#org.opennms.core.utils.fromAddress=root@[127.0.0.1]


#
# These properties define the SMTP Host.
#
#org.opennms.core.utils.mailHost=127.0.0.1
#org.opennms.core.utils.mailer=smtpsend
#org.opennms.core.utils.transport=smtp
#org.opennms.core.utils.debug=true
#org.opennms.core.utils.smtpport=25
#org.opennms.core.utils.smtpssl.enable=false
#org.opennms.core.utils.quitwait=true
#
# This property controls the use of the JMTA
# if it is true, mailHost will be ignored
org.opennms.core.utils.useJMTA=false
#
# These properties define the Mail authentication.
#
#org.opennms.core.utils.authenticate=false
#org.opennms.core.utils.authenticateUser=opennms
#org.opennms.core.utils.authenticatePassword=opennms
#org.opennms.core.utils.starttls.enable=false


#
# These properties configure message content
#
#org.opennms.core.utils.messageContentType=text/plain
#org.opennms.core.utils.charset=us-ascii
```

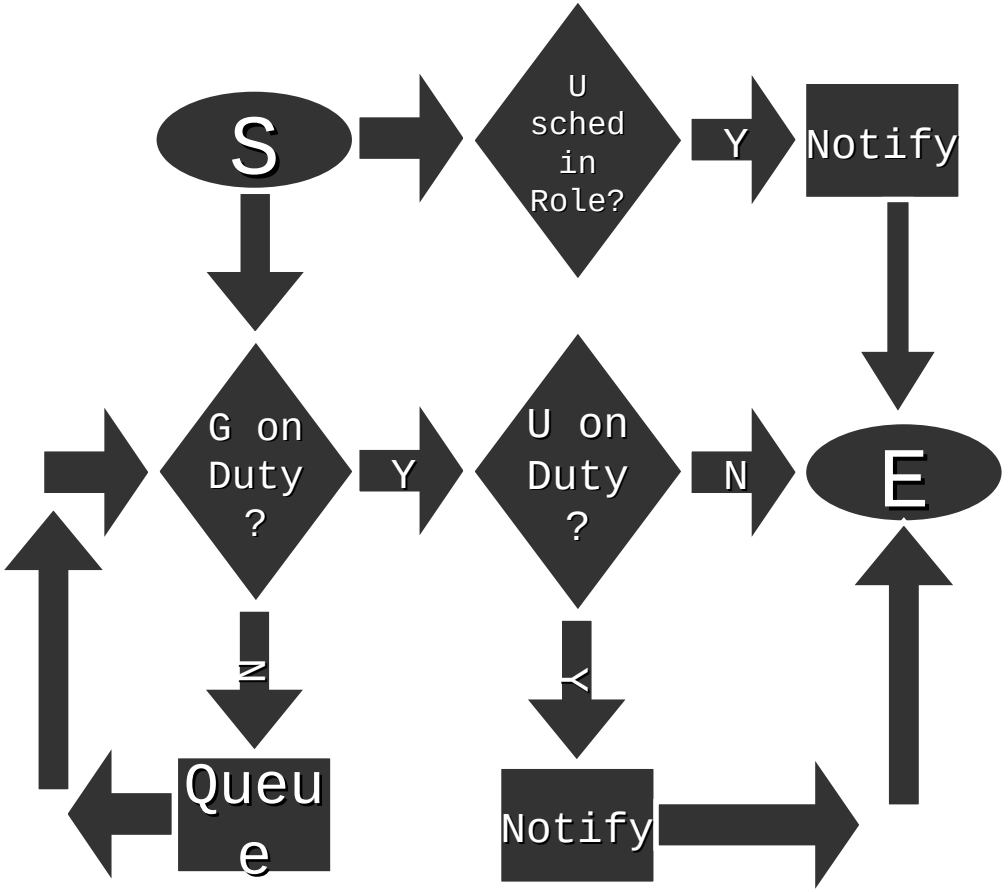
An Example Using GMail

```
org.opennms.core.utils.transport=smtps
org.opennms.core.utils.mailHost=smtp.gmail.com
org.opennms.core.utils.smtpport=465
org.opennms.core.utils.smtpssl.enable=true
org.opennms.core.utils.authenticate=true
org.opennms.core.utils.authenticateUser=myuser@gmail.com
org.opennms.core.utils.authenticatePassword=xxxxxxxx
org.opennms.core.utils.starttls.enable=true
org.opennms.core.utils.messageContentType=text/html
org.opennms.core.utils.charset=UTF-8
```

Duty Schedules

- Users can have duty schedules
  - No notices when not on duty
  - Multiple schedules can exist
- Groups can have duty schedules
  - Outstanding notices sent when back on duty
  - Overridden by users
- On-Call roles always get notices

Duty Schedule Flowchart



Path Outages

- Path Outages can suppress notices for “downstream” nodes
- When a nodeDown event is received, the “parent” is pinged for availability. If that fails, the notice based on that nodeDown event is not sent.
- A default “parent” can be set in `opennms-server.xml`

```
<local-server server-name="nms1"
    defaultCriticalPathIp="192.168.0.1"
    defaultCriticalPathService="ICMP"
    defaultCriticalPathTimeout="1000"
    defaultCriticalPathRetries="1"
    verify-server="false">
</local-server>
```

Exercise #4-1: Create an New Notice

- Create a new “unhappiness” event
- Create a new On-Call role
- Create a new Destination Path
- Send to On-Call
- Send to Group
- Send to User
- Create a notice on the new event
- Generate the event and test

Get the new `Class.events.xml` File

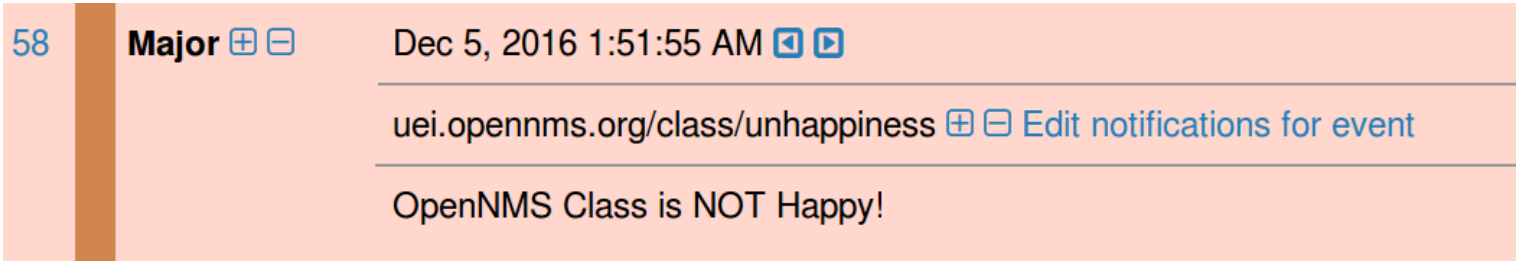
- First, `cd /opt/opennms/etc/events`
- Then:

```
wget -N http://10.42.0.1/Class/Config/Exercise%204/Class.events.xml
```

```
<event>
    <uei>uei.opennms.org/class/unhappiness</uei>
    <event-label>OpenNMS defined event: The OpenNMS Class is not happy</event-label>
    <descr>
      &lt;p&gt;This event is sent when the OpenNMS Class is unhappy.&lt;/p&gt;
      &lt;ul&gt;
      &lt;li&gt;I can't get no&lt;/li&gt;
      &lt;li&gt;I can't get no&lt;/li&gt;
      &lt;li&gt;I can't get no&lt;/li&gt;
      &lt;li&gt;Satisfaction&lt;/li&gt;
      &lt;/ul&gt;
    </descr>
    <logmsg dest='logndisplay'>
      &lt;p&gt;OpenNMS Class is NOT Happy! &lt;/p&gt;
    </logmsg>
    <severity>Major</severity>
  </event>
```

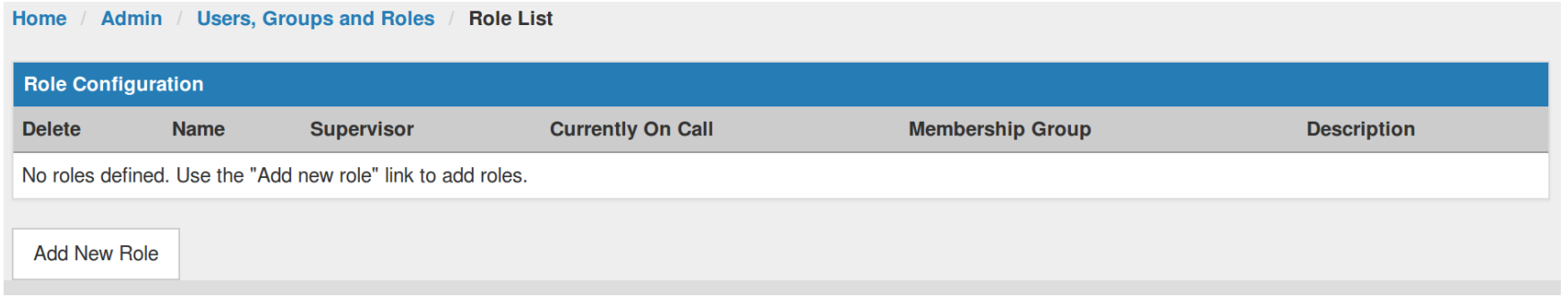
Reload `eventd` and Send Event

```
$ send-event.pl
  uei.opennms.org/internal/reloadDaemonConfig -p 'daemonName Eventd'

$ send-event.pl uei.opennms.org/class/unhappiness
```

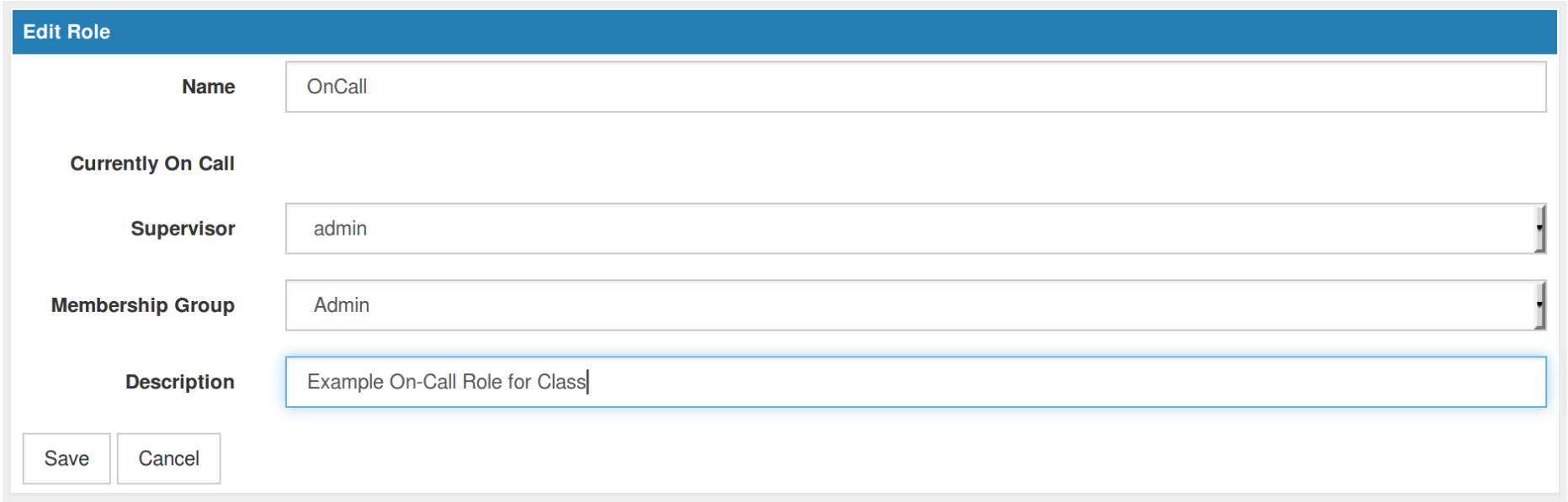


On-Call Roles

Navigate to Configure → Configure Users, Groups and On-Call Roles → Configure Roles



Add New Role



On Call Role Calendar

View Role			
Name	OnCall	**Currently On Call**	admin
Supervisor	admin	**Membership Group**	Admin
Description	Example On-Call Role for Class		

Value Details

Done

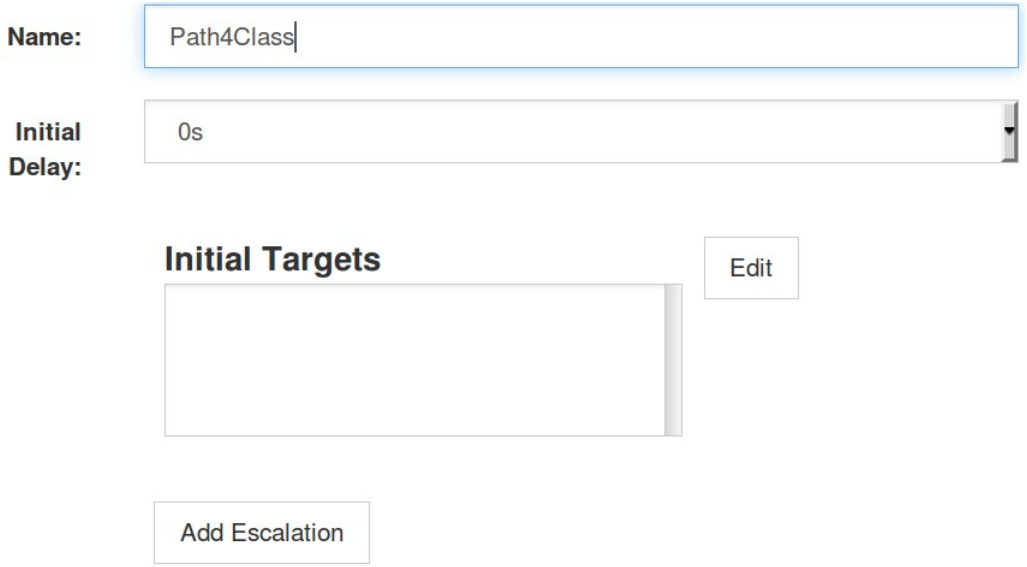
Role Schedule

‹‹‹ December 2016 ›››

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1 00:00: unscheduled	**2** 00:00: unscheduled	**3** 00:00: unscheduled
4 00:00: unscheduled	**5** 00:00: unscheduled 09:00: tarus	**6** 00:00: tarus	**7** 00:00: tarus	**8** 00:00: tarus	**9** 00:00: tarus 15:00: unscheduled	**10** 00:00: unscheduled
11 00:00: unscheduled	**12** 00:00: unscheduled	**13** 00:00: unscheduled	**14** 00:00: unscheduled	**15** 00:00: unscheduled	**16** 00:00: unscheduled	**17** 00:00: unscheduled
18 00:00: unscheduled	**19** 00:00: unscheduled	**20** 00:00: unscheduled	**21** 00:00: unscheduled	**22** 00:00: unscheduled	**23** 00:00: unscheduled	**24** 00:00: unscheduled
25 00:00: unscheduled	**26** 00:00: unscheduled	**27** 00:00: unscheduled	**28** 00:00: unscheduled	**29** 00:00: unscheduled	**30** 00:00: unscheduled	**31** 00:00: unscheduled

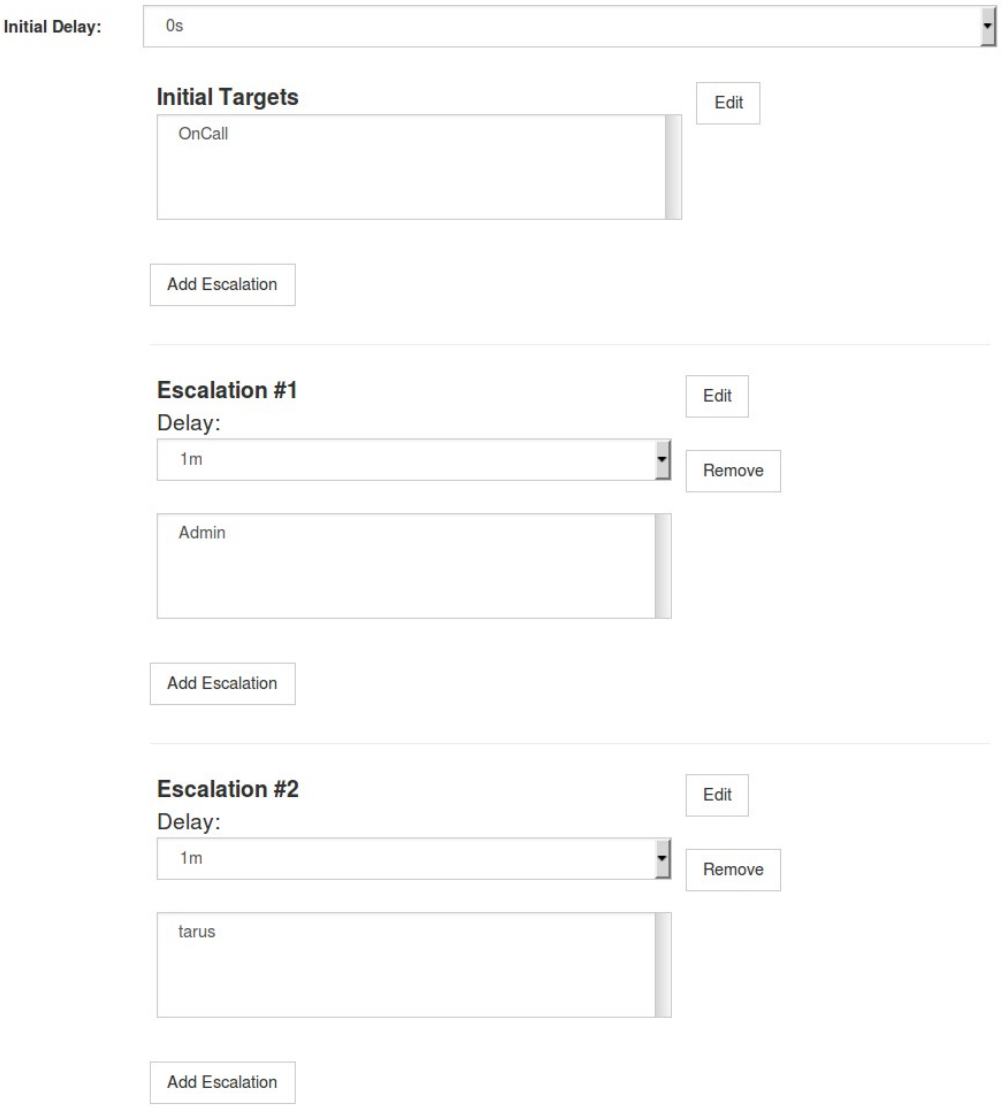
Create a New Path: Path4Class

- Navigate to Configure → Configure Notification → Configure Destination Paths
- Add New Path



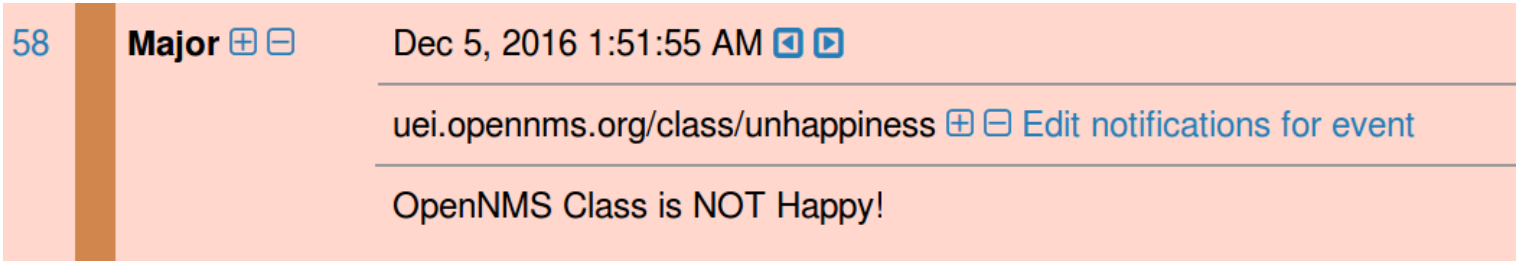
Escalations

- Escalations insure notices get seen
- Once a notice is acknowledged, escalations stop
- The initial delay provides for “auto-acknowledged” notices to be cleared



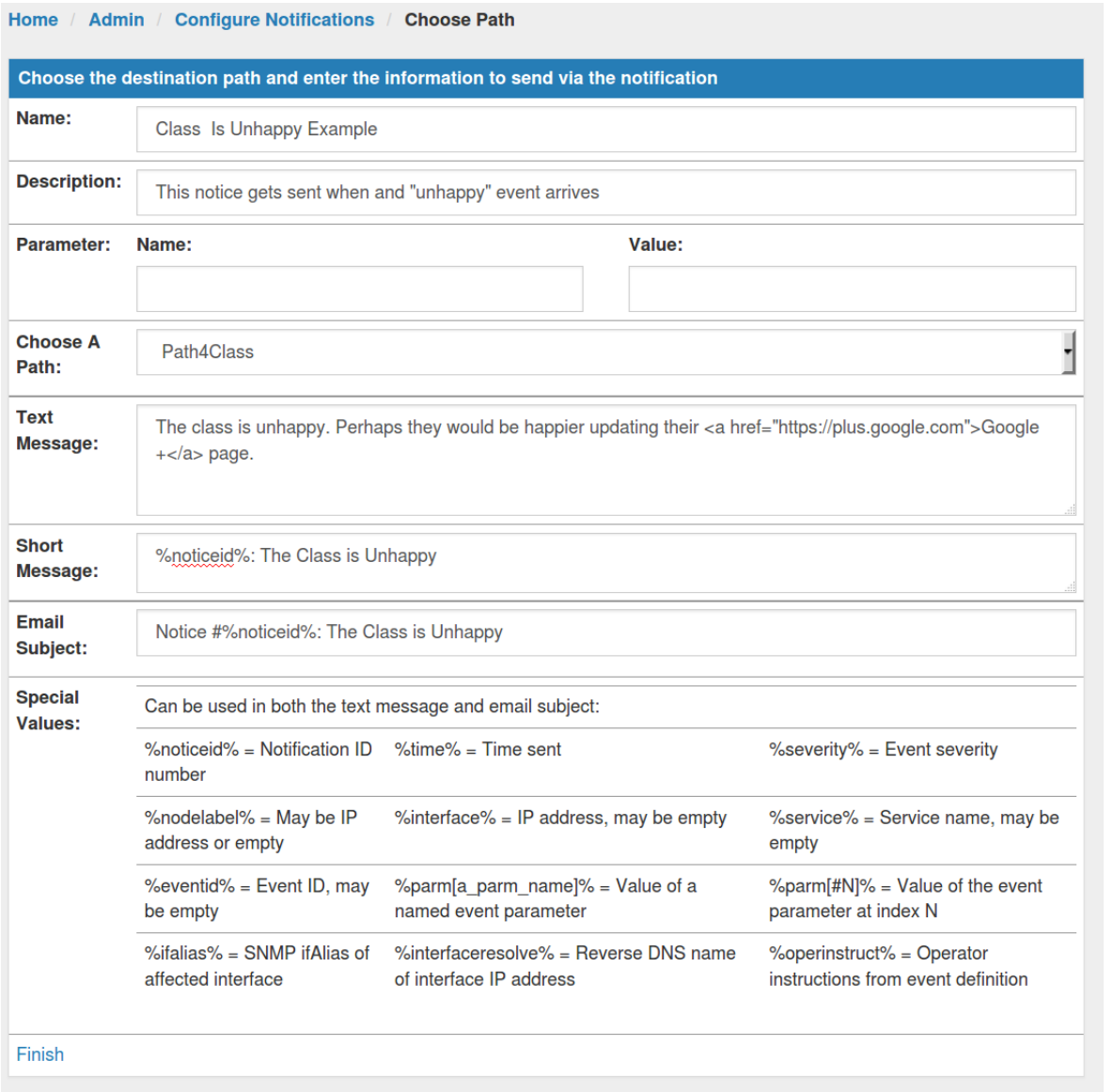
Create a New Notice

- Go back and find the new event
- Select “Edit notifications for event”
- “Skip results validation” on the next screen



New Notice

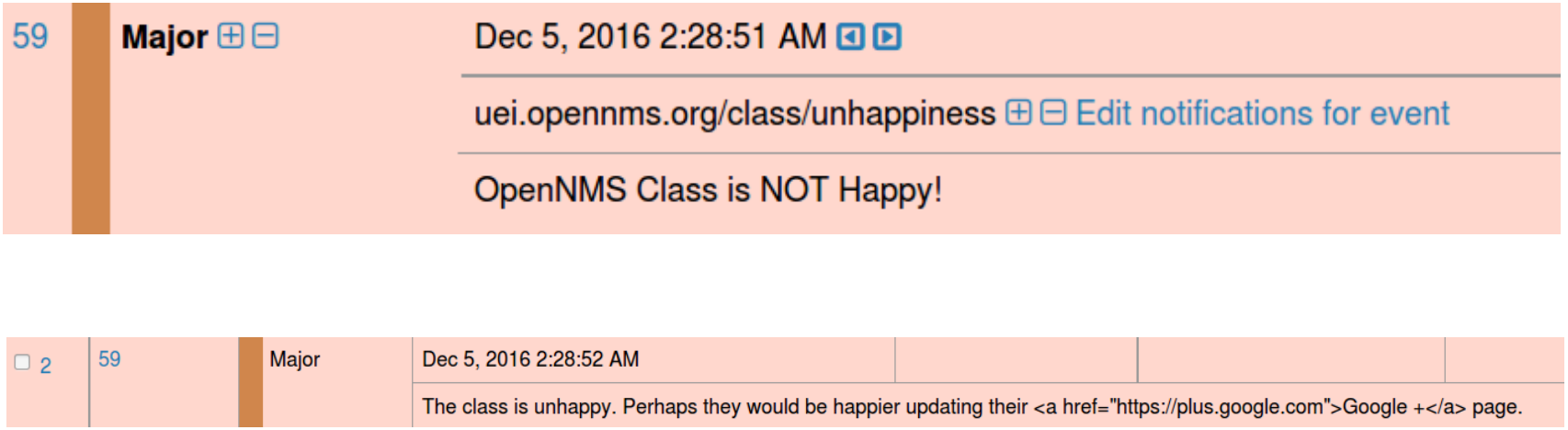
- ***Name:*** A unique name for the notice
- ***Description:*** describe the notice
- ***Parameter:*** an optional parameter match
- ***Path:*** required destination path
- ***Text Message:*** information included with the notice
- ***Short Message:*** information designed for SMS
- ***Email Subject:*** subject line of e-mail



Send the Event

Send the event and watch what happens:

```
send-event.pl uei.opennms.org/class/unhappiness
```



View Notice and Escalations

Notice 2 from Event 59					
Notification Time	Dec 5, 2016 2:28:52 AM	**Time Replied**		**Responder**	
Node		**Interface**		**Service**	

Numeric Message

2: The Class is Unhappy

Text Message

```
The class is unhappy. Perhaps they would be happier updating their Google + page.
```

Users Notified

Sent To	Sent At	Media	Contact Info
admin	Dec 5, 2016 2:28:53 AM	javaEmail	
tarus	Dec 5, 2016 2:29:53 AM	javaEmail	
admin	Dec 5, 2016 2:29:53 AM	javaEmail	
tarus	Dec 5, 2016 2:30:53 AM	javaEmail	

Exercise #4-2: Notification Commands

- Create a syslog command
- Add it to the Destination Path
- Create an auto-acknowledge entry
- Send the event
- Verify the log is created
- Auto-acknowledge the event before it escalates to the Group

notificationCommands.xml - Java

```
<command binary="false">
  <name>javaEmail</name>
  <execute>org.opennms.netmgt.notifd.JavaMailNotificationStrategy</execute>
  <comment>class for sending email notifications</comment>
  <contact-type>email</contact-type>
  <argument streamed="false">
      <switch>-subject</switch>
  </argument>
  <argument streamed="false">
      <switch>-email</switch>
  </argument>
  <argument streamed="false">
      <switch>-tm</switch>
  </argument>
</command>
```

notificationCommands.xml - binary

```
<command binary="true">
    <name>syslog</name>
    <execute>/usr/bin/logger</execute>
    <comment>syslog to local0.warning</comment>
    <argument streamed="false">
       <substitution>-p</substitution>
    </argument>
    <argument streamed="false">
       <substitution>local0.warning</substitution>
    </argument>
    <argument streamed="false">
       <substitution>-t</substitution>
    </argument>
    <argument streamed="false">
       <substitution>opennms</substitution>
    </argument>
    <argument streamed="true">
       <switch>-nm</switch>
    </argument>
</command>
```

notifd-configuration.xml

Notifd-configuration.xml controls several things:

- The status of notifications being on or off
- Events that will automatically acknowledge a notice

```
    <auto-acknowledge resolution-prefix="Cleared: "
        uei="uei.opennms.org/nodes/nodeRegainedService"
acknowledge="uei.opennms.org/nodes/nodeLostService">
        <match>nodeid</match>
        <match>interfaceid</match>
        <match>serviceid</match>
    </auto-acknowledge>
```

Auto-acknowledge unhappiness Notice

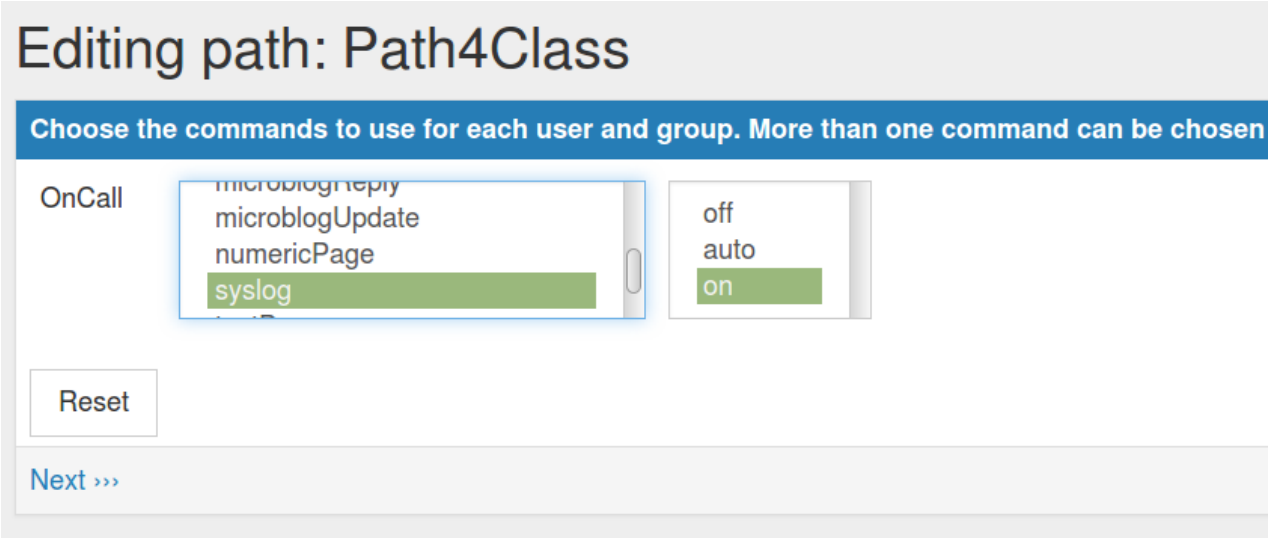
```
    <auto-acknowledge resolution-prefix="Cleared: "
        uei="uei.opennms.org/class/happiness"
acknowledge="uei.opennms.org/class/unhappiness">
        <match>nodeid</match>
    </auto-acknowledge>
```

Implement New Command

- Add “syslog” command to notification commands
- Restart OpenNMS
  `systemctl restart opennms`
- Edit “Class” destination path
- Add “syslog” in addition to “javaEmail” to first target
- Generate the unhappiness event again (with -n 1)
- Generate the happiness event (with -n 1)
- Note that the syslog gets generated
- Note the escalation stops

Implement New Command

- Navigate to Configure → Configure Notification → Configure Destination Paths
- Edit “Path4Class” and the first Target “OnCall”



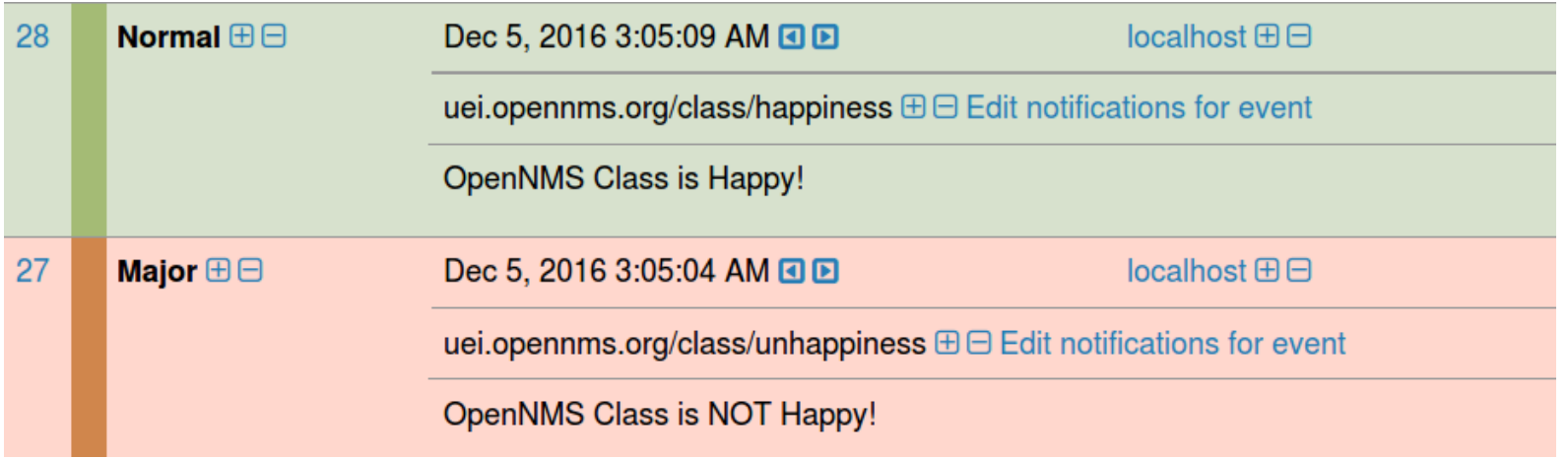
Send the Event

Send the “unhappy” event (with the node 1 option):

```
send-event.pl -n 1 uei.opennms.org/class/unhappiness
```

then send the “happy” event (with the node 1 option):

```
send-event.pl -n 1 uei.opennms.org/class/happiness
```



Note the Escalation

Notice 3 from Event 29					
Notification Time	Dec 5, 2016 3:07:25 AM	**Time Replied**	Dec 5, 2016 3:07:50 AM	**Responder**	auto-acknowledged
Node	localhost	**Interface**		**Service**	
Current outages for localhost					

Numeric Message
3: The Class is Unhappy

Text Message
The class is unhappy. Perhaps they would be happier updating their Google + page.

Users Notified			
Sent To	**Sent At**	**Media**	**Contact Info**
admin	Dec 5, 2016 3:07:42 AM	javaEmail	
admin	Dec 5, 2016 3:07:42 AM	syslog	

Verify Syslog

```
# tail /var/log/messages

Dec  5 03:03:20 localhost systemd: Starting OpenNMS Meridian server...
Dec  5 03:03:24 localhost opennms: Starting OpenNMS Meridian: (not waiting for
startup) [  OK  ]
Dec  5 03:03:24 localhost systemd: Started OpenNMS Meridian server.
Dec  5 03:07:42 localhost opennms: 3: The Class is Unhappy
Dec  5 03:08:02 localhost opennms: Cleared: 3: The Class is Unhappy
```

Unit 5: Alarms

Alarms Implement Workflow

- Extremely powerful system for
  - Reducing the number of duplicate events
  - Performing automated actions to manage and control alarms
  - Performing general database activities
- Modeled on systems costing hundreds of thousands of dollars

Event Reduction

Send a uei.foo event three times

29	**Indeterminate**	2019-07-09T06:26:37-07:00	Default	00000000-0000-0000-0000-000000000000
	uei.foo Edit notifications for event			
	An event with no matching configuration was received from interface .			
28	**Indeterminate**	2019-07-09T06:26:36-07:00	Default	00000000-0000-0000-0000-000000000000
	uei.foo Edit notifications for event			
	An event with no matching configuration was received from interface .			
27	**Indeterminate**	2019-07-09T06:26:35-07:00	Default	00000000-0000-0000-0000-000000000000
	uei.foo Edit notifications for event			
	An event with no matching configuration was received from interface .			

It gets reduced to one alarm with a count of 3

Results 1-1 of 1

Ack	▼ ID	Situation	Severity	Node	Count	Last	Log Msg
☐	2	☐	**Indeterminate**		3	2019-07-09T06:26:37-07:00	An event with no matching configuration was received from interface .

Event Reduction

Ack	ID	Severity	Node	Interface	Service	Count	Last Event Time	First Event Time
☐	11283	Warning [+] [-]	PDU-G01L [+] [-]	10.123.7.18 [+] [-]		9720	12/17/06 6:29:55 AM [<] [>]	10/20/06 1:33:36 AM [<] [>]
		Ackd:	Ackd Time:			UEI: uei.opennms.org/generic/traps/SNMP_Authen_Failure [+] [-]		
		Incorrect Community Name (authenticationFailure Trap) enterprise:.1.3.6.1.4.1.318 (.1.3.6.1.4.1.318) args(1):.1.3.6.1.4.1.318.2.3.3.0=""						
☐	4762	Minor [+] [-]	tasrvad01.bos3 [+] [-]	10.24.1.10 [+] [-]	SNMP [+] [-]	2866	12/17/06 11:21:23 AM [<] [>]	9/5/06 6:26:23 PM [<] [>]
		Ackd:	Ackd Time:			UEI: uei.opennms.org/nodes/dataCollectionFailed [+] [-]		
		SNMP data collection on interface 10.24.1.10 failed.						
☐	5379	Normal [+] [-]	tasrvad01.bos3 [+] [-]	10.24.1.10 [+] [-]	SNMP [+] [-]	2852	12/17/06 11:11:17 AM [<] [>]	9/6/06 5:54:57 PM [<] [>]
		Ackd:	Ackd Time:			UEI: uei.opennms.org/nodes/dataCollectionSucceeded [+] [-]		
		SNMP data collection on interface 10.24.1.10 prevously failed and has been restored.						
☐	4744	Minor [+] [-]	tasrvsr01c02.bos3 [+] [-]	10.24.1.14 [+] [-]	SNMP [+] [-]	1441	12/15/06 11:28:08 PM [<] [>]	9/5/06 6:26:18 PM [<] [>]
		Ackd:	Ackd Time:			UEI: uei.opennms.org/nodes/dataCollectionFailed [+] [-]		
		SNMP data collection on interface 10.24.1.14 failed.						
☐	4825	Normal [+] [-]	tasrvsr01c02.bos3 [+] [-]	10.24.1.14 [+] [-]	SNMP [+] [-]	1429	12/15/06 11:43:18 PM [<] [>]	9/5/06 6:36:39 PM [<] [>]
		Ackd:	Ackd Time:			UEI: uei.opennms.org/nodes/dataCollectionSucceeded [+] [-]		
		SNMP data collection on interface 10.24.1.14 prevously failed and has been restored.						

Create an Alarm from an Event

```
<event>
   <uei>uei.opennms.org/default/event</uei>
   <event-label>OpenNMS-defined default event: event</event-label>
   <descr>&lt;p>An event with no matching configuration was received
                from interface %interface%. This event included the
                following parameters:
                %parm[all]%&lt;/p></descr>
   <logmsg dest="logndisplay">An event with no matching configuration
was received from interface %interface%.</logmsg>
   <severity>Indeterminate</severity>
   <alarm-data reduction-key="%uei%:%dpname%:%nodeid%:%interface%"
alarm-type="3"/>
   </event>
```

<alarm-data> Elements

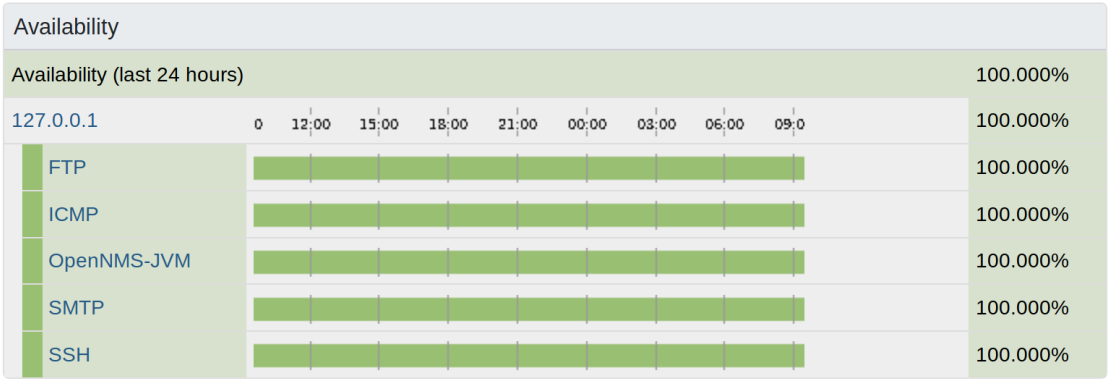
- reduction-key: a string that uniquely identifies the event. Can use the same %variables% as events and notices.
- alarm-type: an optional value used in automations.
  1) Problem
  2)Resolution
  3)Unknown
- clear-key: an optional value to match an up alarm with the reduction-key of a down alarm.

Business Rules

- Rules allow actions to be done to the database, mainly focused on the alarms table.
- For example, the "`cosmicClear`" rule matches "up"alarms with "down" alarms and clears the down alarm.
- As a demonstration, let's add the FTP service to our `localhost` node and see what happens.

Install an FTP Server

- Run
  ```
  yum install vsftpd
  ```
- Start the web server
  ```
  systemctl start vsftpd
  ```
- Rescan “localhost”



Recent Events

34	2019-07-09T06:32:50-07:00	Warning	The FTP service has been discovered on interface 127.0.0.1.
33	2019-07-09T06:32:46-07:00	Warning	A services scan has been forced on this node.

Correlation Demonstration

- Navigate to Status → Alarms → Alarm Summary
- Run

```
systemctl stop vsftpd
```

Results 1-1 of 1

Ack	ID	Situation	Severity	Node	Count	Last	Log Msg
☐	4	☐	**Minor** ⊞⊟	localhost ⊞⊟	1	2019-07-09T06:37:51-07:00 ◧◨	FTP outage identified on interface 127.0.0.1.

Resolve the Alarm

- Run

```
systemctl start vsftpd
```

- Refresh until the alarm is cleared

Results 1-1 of 1

Ack	ID	Situation	Severity	Node	Count	Last	Log Msg
☐	4	☐	**Cleared**	localhost	1	2019-07-09T06:41:24-07:00	The FTP outage on interface 127.0.0.1 has been cleared. Service is restored.

So, How'd That Work?

Rules are configured in the `alarmd/drools-rules.d/alarmd.drl` file

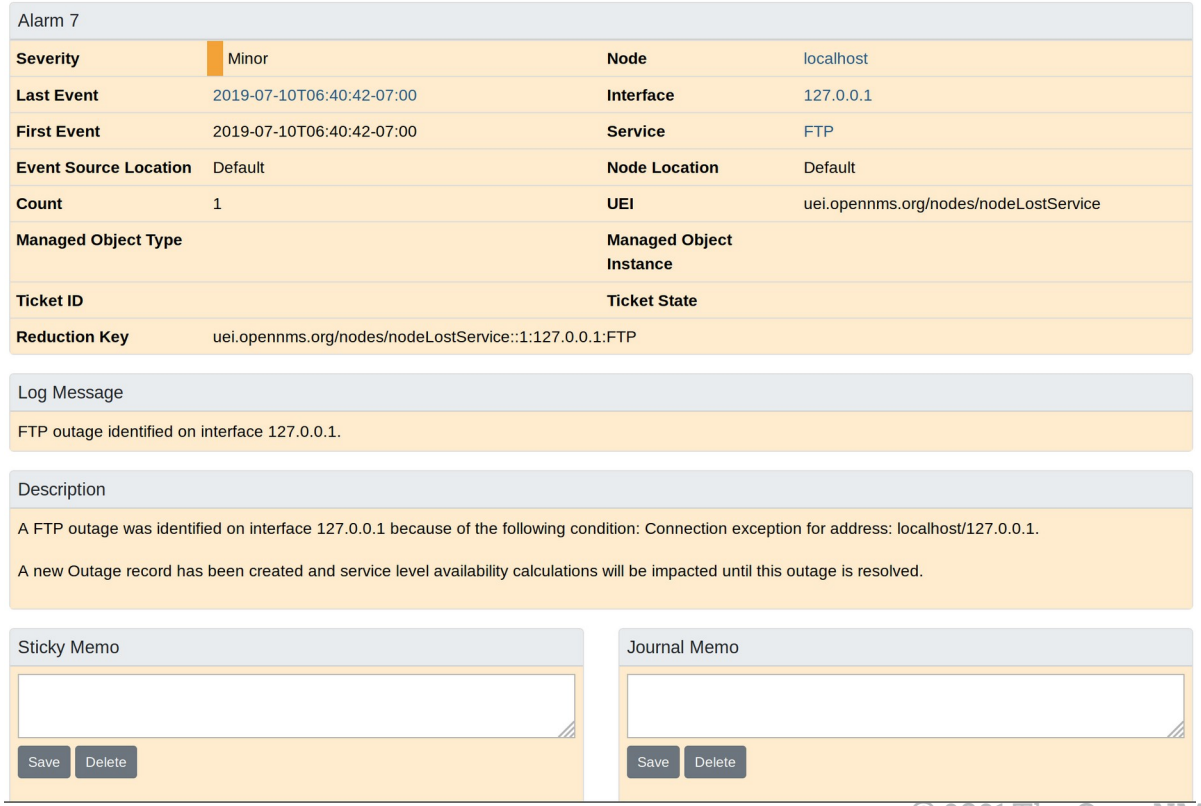
```
rule "cosmicClear"
  salience 100
  when
    $clear : OnmsAlarm(alarmType == OnmsAlarm.RESOLUTION_TYPE)
    $trigger : OnmsAlarm(alarmType == OnmsAlarm.PROBLEM_TYPE,
               severity.isGreaterThanOrEqual(OnmsSeverity.NORMAL),
               reductionKey == $clear.clearKey, lastEventTime <=
                               $clear.lastEventTime)
  then
    alarmService.clearAlarm($trigger, $clear.getLastEventTime());
end
```

Automations

```
<automation name="cosmicClear" interval="30000" active="true"
            trigger-name="selectAlarmsToClear"
            action-name="clearAlarms"
            action-event="sendAlarmClearedEvent" />


 <!-- Find all alarms that can be cleared -->
 <trigger name="selectAlarmsToClear" operator="&gt;=" row-count="1" >
   <statement>
     SELECT *, now() AS _ts FROM alarms as problems
     WHERE alarmType=1 AND severity &gt; 2 AND reductionKey IN
           (SELECT clearKey FROM alarms WHERE alarmType=2 AND lastEventTime &gt;
                  problems.lastEventTime)
   </statement>
 </trigger>


 <action name="clearAlarms" >
   <statement>
     UPDATE alarms
        SET severity=2, firstautomationtime = COALESCE(firstautomationtime, ${_ts}),
                                                    lastautomationtime = ${_ts}
      WHERE alarmId=${alarmId}
   </statement>
 </action>
```

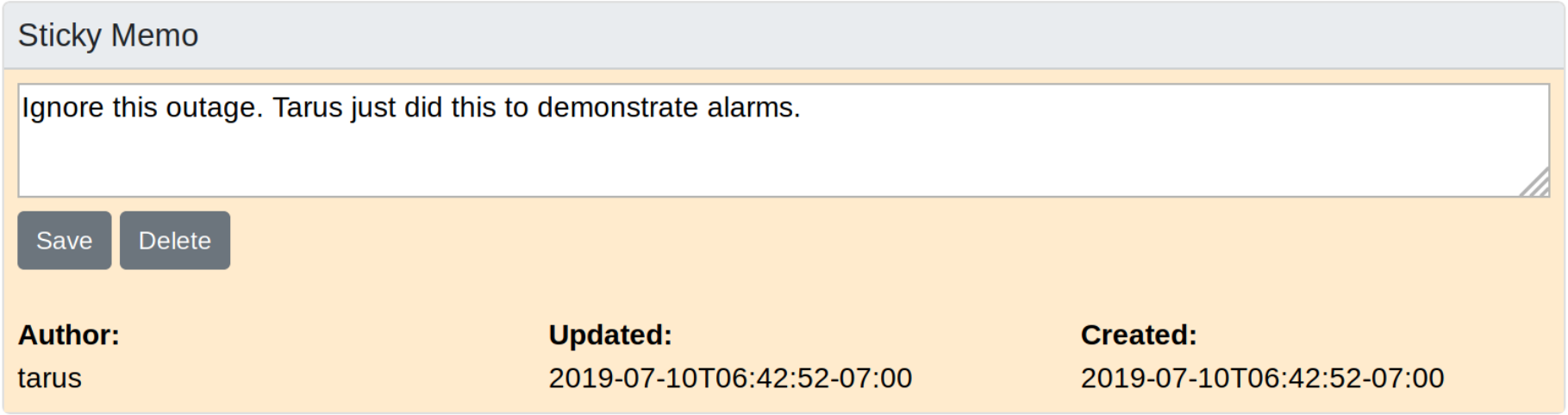
Adding Notes to Alarms

You can add notes to alarms: Sticky and Journal



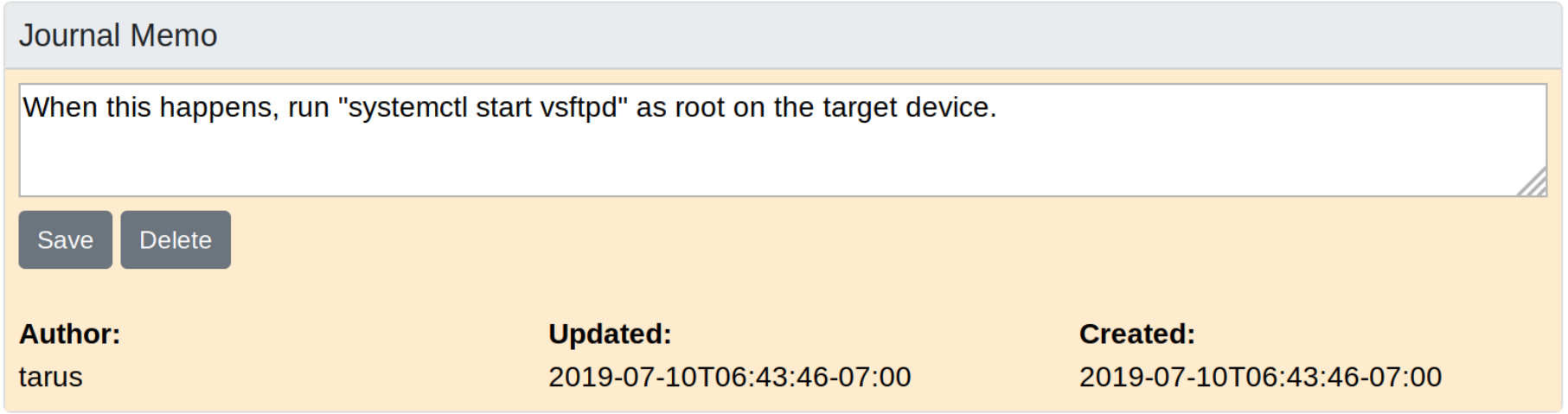
Sticky Notes

Sticky notes are like Post-Its™ - tied to a particular alarm



Journal Notes

Journal notes are tied to all alarms with a particular reduction-key



Exercise #5: Make New Alarms

- Edit the `Class.events.xml` file
- Add alarm data to the "`unhappiness`" event and set it as Type 1.
- Add alarm data to the "`happiness`" event and set it to Type 2 and have it resolve the "`unhappiness`" event
- Reload the event configuration
- Test

Get the new `Class.events.xml` file and Reload

```
# wget -N https://docs.opennms.com/~tarus/Class/Config/Exercise%205/Class.events.xml

--2016-12-05 04:02:45--
https://docs.opennms.com/~tarus/Class/Config/Exercise%205/Class.events.xml
Resolving www.opennms.org (www.opennms.org)... 104.131.77.90,
2604:a880:800:10::1b1a:7001
Connecting to www.opennms.org (www.opennms.org)|104.131.77.90|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1438 (1.4K) [application/xml]
Saving to: ‘Class.events.xml’

100%[=============================================>] 1,438       --.-K/s   in 0s

2016-12-05 04:02:45 (84.0 MB/s) - ‘Class.events.xml’ saved [1438/1438]

# send-event.pl  uei.opennms.org/internal/reloadDaemonConfig -p 'daemonName Eventd'
```

unhappiness Event with Alarm Data

```
<event>
  <uei>uei.opennms.org/class/unhappiness</uei>
  <event-label>OpenNMS defined event: The OpenNMS Class is not happy</event-label>
  <descr>
    &lt;p&gt;This event is sent when the OpenNMS Class is unhappy.&lt;/p&gt;
    &lt;ul&gt;
    &lt;li&gt;I can't get no&lt;/li&gt;
    &lt;li&gt;I can't get no&lt;/li&gt;
    &lt;li&gt;I can't get no&lt;/li&gt;
    &lt;li&gt;Satisfaction&lt;/li&gt;
    &lt;/ul&gt;
  </descr>
  <logmsg dest='logndisplay'>
    &lt;p&gt;OpenNMS Class is NOT Happy! &lt;/p&gt;
  </logmsg>
  <severity>Major</severity>
  <alarm-data reduction-key="%uei%"
              alarm-type="1"
              auto-clean="false"/>
</event>
```

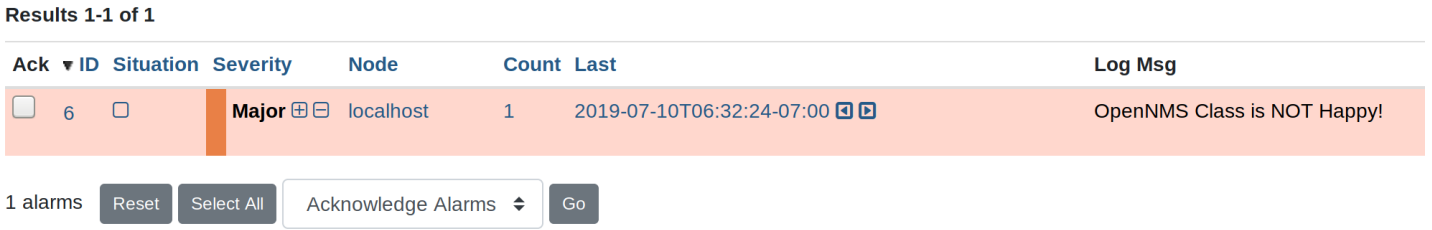
happiness Event with Alarm Data

```
<event>
  <uei>uei.opennms.org/class/happiness</uei>
  <event-label>OpenNMS defined event: The OpenNMS Class is so happy</event-label>
  <descr>
    &lt;p&gt;This event is sent when the OpenNMS Class is happy.&lt;/p&gt;
    &lt;ul&gt;
    &lt;li&gt;Dance, Everybody Dance!&lt;/li&gt;
    &lt;li&gt;Life is Good!&lt;/li&gt;
    &lt;li&gt;This is Fun!&lt;/li&gt;
    &lt;/ul&gt;
  </descr>
  <logmsg dest='logndisplay'>
    &lt;p&gt;OpenNMS Class is Happy! &lt;/p&gt;
  </logmsg>
  <severity>Normal</severity>
  <alarm-data reduction-key="%uei%"
              alarm-type="2"
              clear-key="uei.opennms.org/class/unhappiness"
              auto-clean="false"/>
</event>
```

Test the Automation

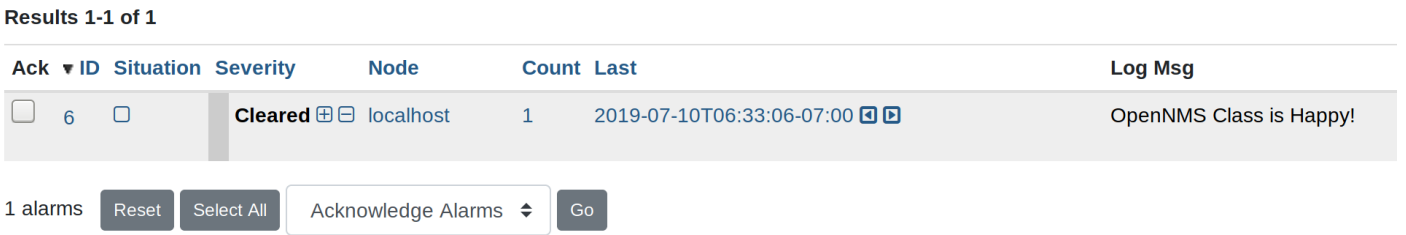
Send the “down” event and watch what happens:

```
send-event.pl uei.opennms.org/class/unhappiness
```



Then send the “up” event and watch what happens:

```
send-event.pl uei.opennms.org/class/happiness
```



Unit 6: Simple Network Management Protocol (SNMP)

Simple Network Management Protocol

- In OpenNMS, SNMP is a service and more
- The Simple Network Management Protocol (SNMP) is used to gather performance data
- It can also me used to monitor the status of a service.
- The Net-SNMP Agent can be extended to add a lot of useful features

Management Information Base (MIB)

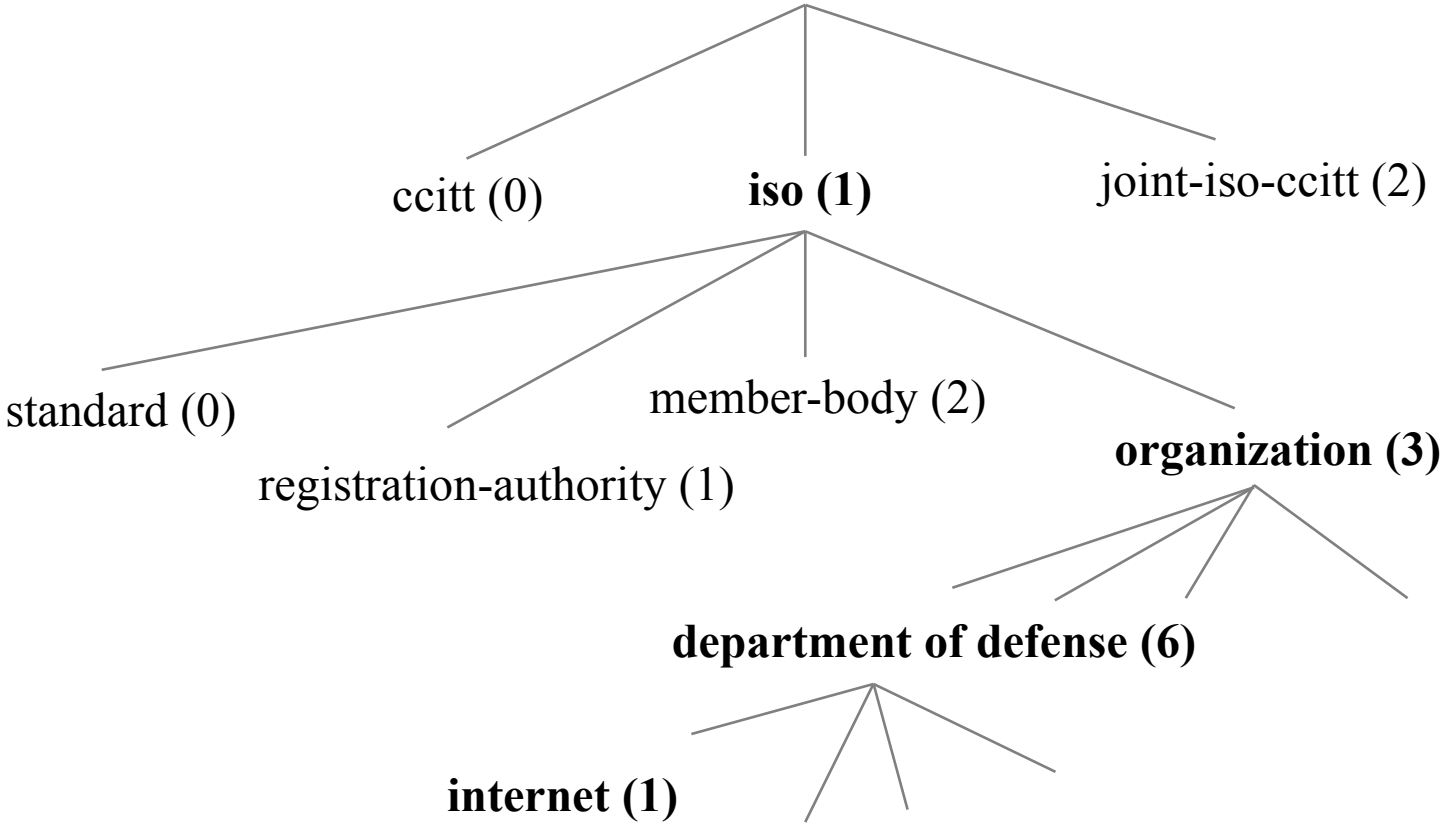
- Data Structure Written in Abstract Syntax Notation (ASN.1)
- Internet Network Management Framework, RFC 1052 (April 1989)
  - Structure of Management Information (SMI), RFC 1065
  - Management Information Bases, RFC 1066
  - Simple Network Management Protocol, RFC 1067

(All August 1988)

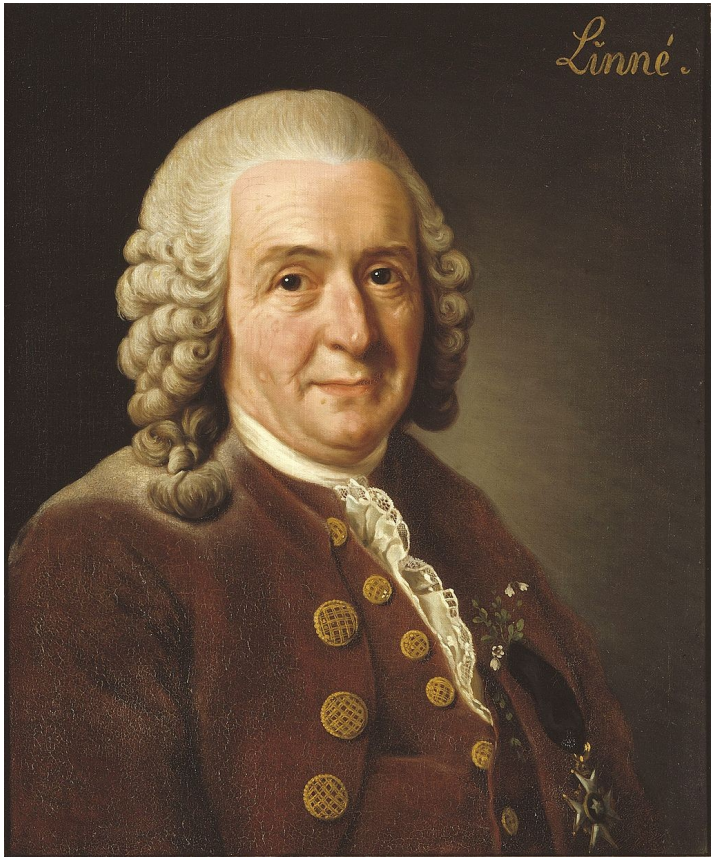
Types of Data Objects

- Integer
- String
- Counter
- Gauge
- TimeTicks (hundredths of a second)

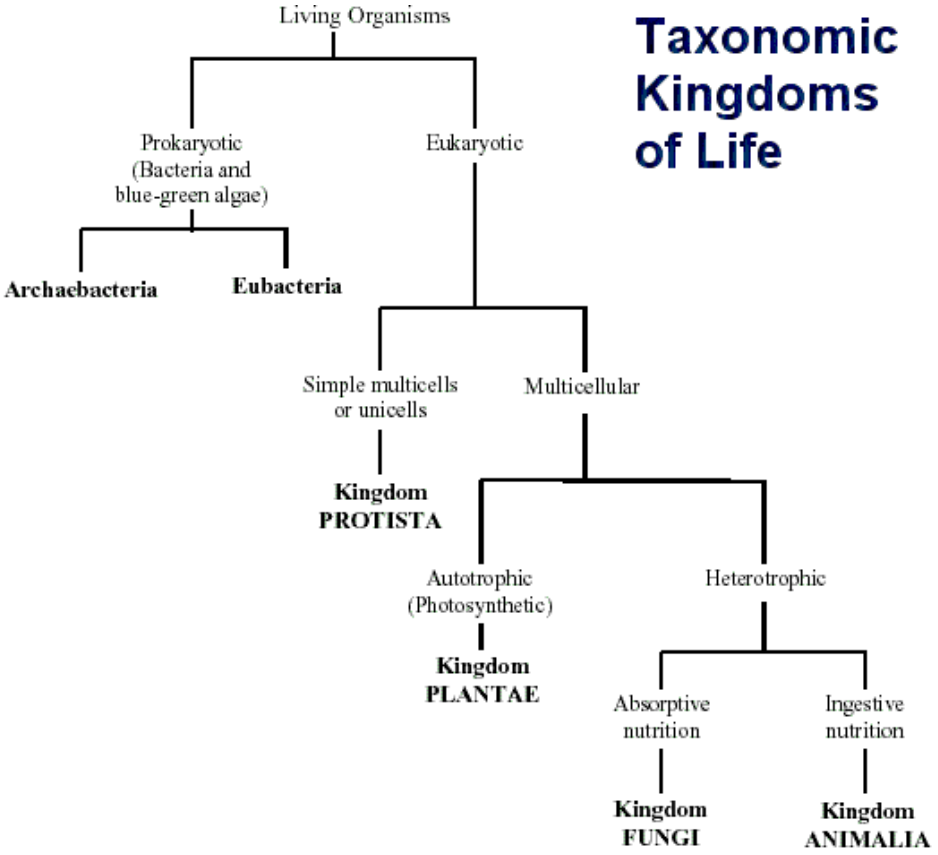
OID Tree Structure



Carl Linnaeus

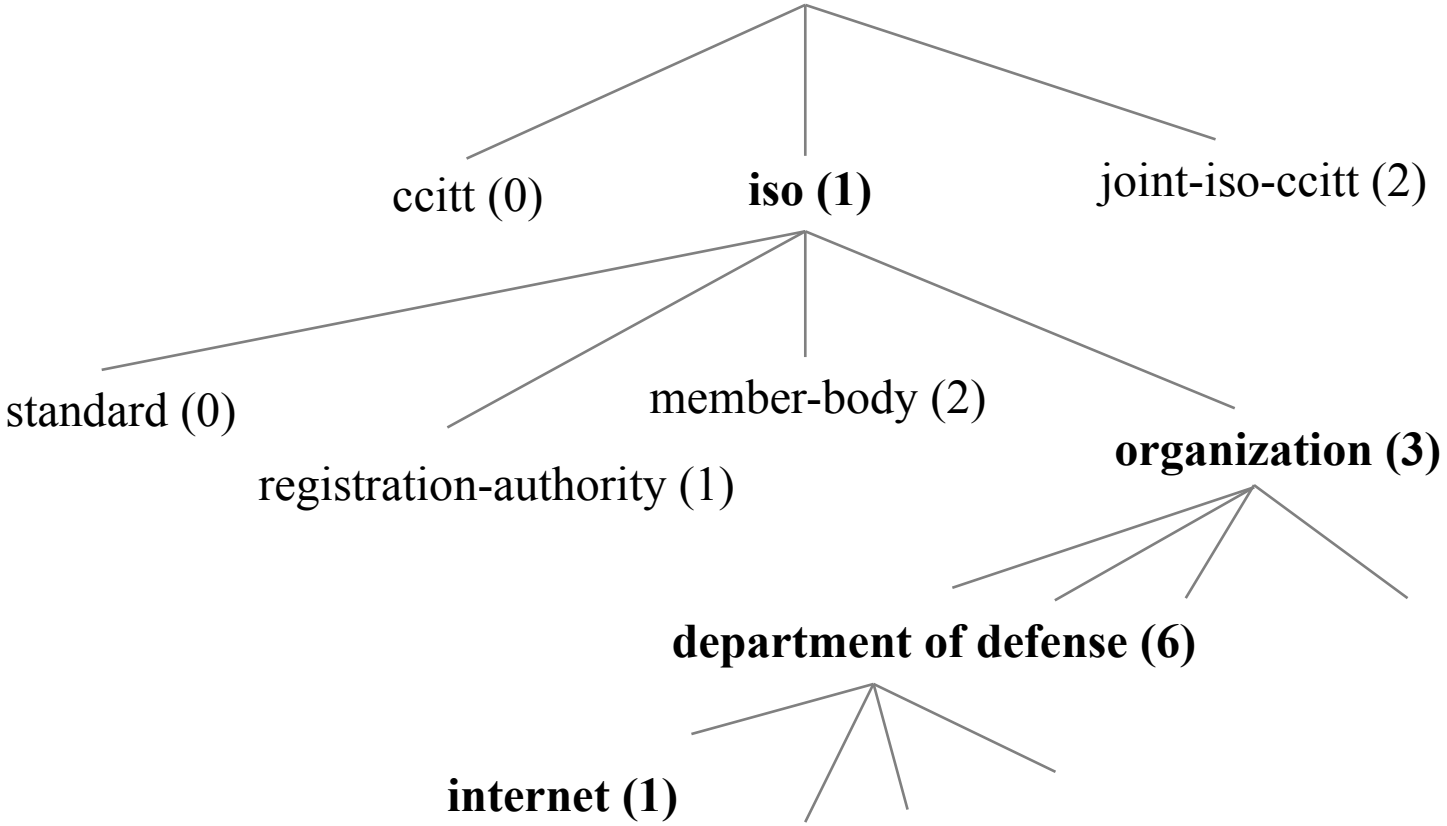


Tree of Life

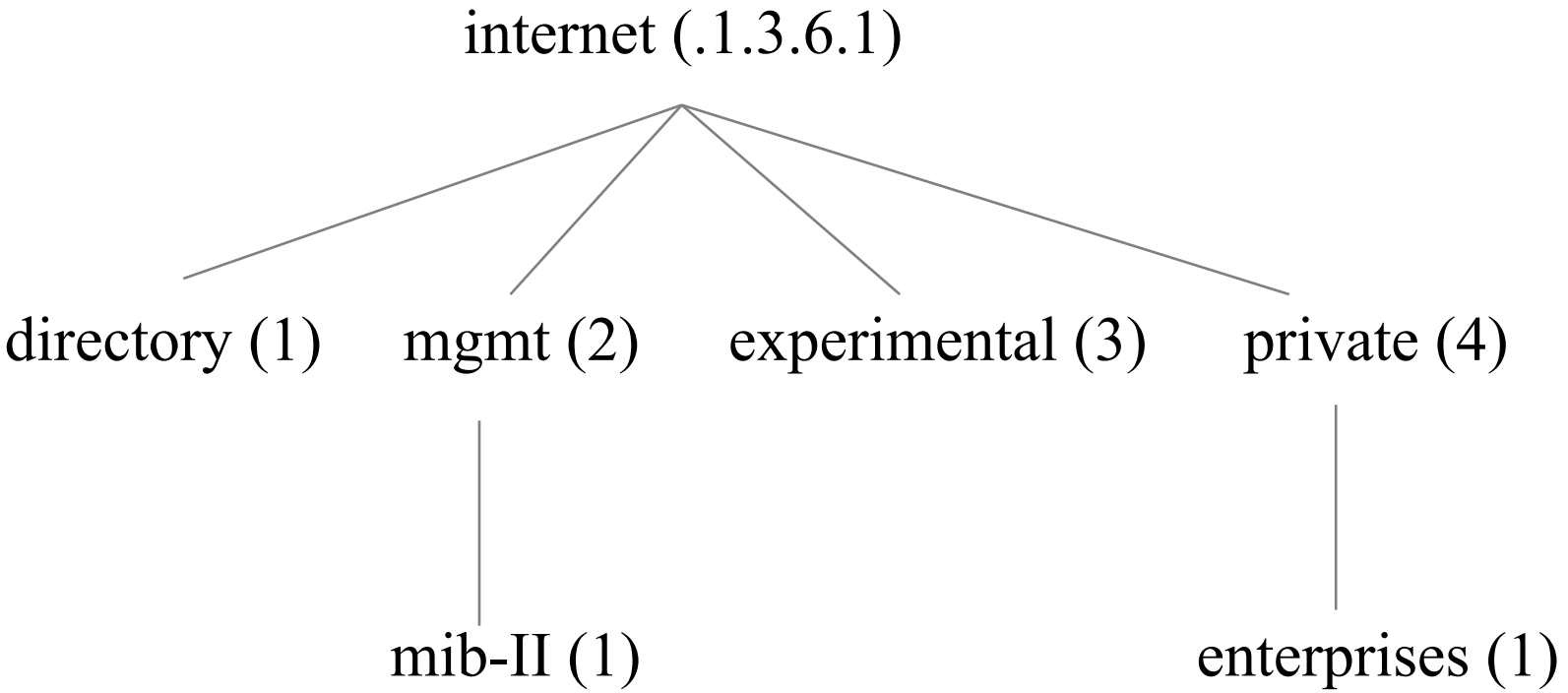


Taxonomic Kingdoms of Life

Types of Data Objects



Internet OID Subtree



MIB-II

- See Handout
- Scaler: ends in “0”

  sysDescr - `.1.3.6.1.2.1.1.1.0`
- Tabular: ends in a non-zero series of numbers

  ifDescr - `.1.3.6.1.2.1.2.2.1.2.3`

  Description of the 3rd interface (third entry in the ifTable, second object, which is the interface description)

ASN.1 Example

```
sysDescr OBJECT-TYPE
    SYNTAX      DisplayString (SIZE(0..255))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "A textual description of the entity.  This value should
            include the full name and version identification of the
            system's hardware type, software operating-system, and
            networking software."
    ::= { system 1 }
```

Private Enterprise MIBs

- Under the private.enterprises OID subtree .1.3.6.1.4.1
- Numbers assigned by the Internet Assigned Numbers Authority (IANA)
- Common numbers:
  - IBM (2)
  - Cisco (9)
  - HP (11)
  - OpenNMS (5813)
- For more info, see https://www.iana.org/assignments/enterprise-numbers/enterprise-numbers

Private Enterprise MIBs

IBM RS/6000:	.1.3.6.1.4.1.2.3.1.2.1.1.2
HP 9000/800	.1.3.6.1.4.1.11.2.3.2.3
HP 9000/700	.1.3.6.1.4.1.11.2.3.2.5
Microsoft Windows	.1.3.6.1.4.1.311.1.1.3.1
Bay Networks 28K Switch	.1.3.6.1.4.1.45.3.15.1
Wellfleet Router	.1.3.6.1.4.1.18.1.1
Net-SNMP on Linux:	.1.3.6.1.4.1.8072.3.2.10

SNMPv1: Five Commands

- GetRequest
- GetResponse
- GetNext Request
- SetRequest
- Trap

SNMPv1: Problems

- Security
  - Community names:
    - Public (read only)
    - Private (write only)
    - Other
  - Device based security
- UDP is connectionless
- Limited to 32-bit Counters

SNMPv2

- 400 pages in RFCs 1441-1452 (April 1993)

  Jeffery Case, Keith McCloghrie, Marshall Rose, Steve Waldbusser
- Results:
  - consensus documents RFCs 1902-1908 (January 1996)
  - SNMPv2C (community based) RFC 1901 (January 1996)
- SNMP version 3 RFC 2570 (April 1999)

SNMPv2: Results

- New data types:
  - BITS
  - Integer32
  - Counter32
  - Gauge32
  - Counter64
- New commands:
  - GetBulkRequest (large amounts of data)
  - InformRequest (manager to manager)

SNMPv3: Results

- SNMP v3 is SNMPv2c with security
- Can encrypt:
  - Authentication
  - Payload
  - Both
  - Neither

net-snmp

- Powerful open-source SNMP agent
- Usually configured in `/etc/snmp/snmpd.conf`
- Must edit for permissions
- OpenNMS requires mapping from `ipAddrTable` to `ifTable`.
- Install with
  `yum install net-snmp net-snmp-utils`

snmpd.conf

```
####
# First, map the community name "public" into a "security name"

#       sec.name  source          community
com2sec notConfigUser  default       public
com2sec onmsUser       default       YrUsonoZ

####
# Second, map the security name into a group name:

#       groupName      securityModel securityName
group   notConfigGroup v1            notConfigUser
group   notConfigGroup v2c           notConfigUser
group   onmsGroup      v1            onmsUser
group   onmsGroup      v2c           onmsUser
```

snmpd.conf (cont)

```
####
# Third, create a view for us to let the group have rights to:

# Make at least  snmpwalk -v 1 localhost -c public system fast again.
#       name           incl/excl     subtree         mask(optional)
view    systemview    included   .1.3.6.1.2.1.1
view    systemview    included   .1.3.6.1.2.1.25.1.1
view    allview       included   .1

####
# Finally, grant the group read-only access to the systemview view.

#       group          context sec.model sec.level prefix read   write  notif
access  notConfigGroup ""      any       noauth    exact  systemview none none
access  onmsGroup      ""      any       noauth    exact  allview    none none
```

snmpd.conf (cont)

```
# It is also possible to set the sysContact and sysLocation  # system variables
through the snmpd.conf file:

syslocation Classroom, Raytheon, 22110 Pacific Blvd., Sterling,
            Virgina, 20166, United States, North America, Earth
syscontact  Tarus Balog <tarus@opennms.com>
```

At the bottom of the file, add:

```
# Destination for traps
trapsink 127.0.0.1

# Disks
disk /
disk /boot
disk /vagrant
```

Then run, as root, `systemctl restart snmpd`

Exercise #6: Configure net-snmp

- Edit the snmpd.conf file to allow for access to anything below .1
- Restart the SNMP daemon.
- Test access via community string
- Update community string in OpenNMS
- Rescan the localhost node

Test Community Strings

Run an snmpwalk with “public”:

```
snmpwalk -v2c -c public localhost .1
```

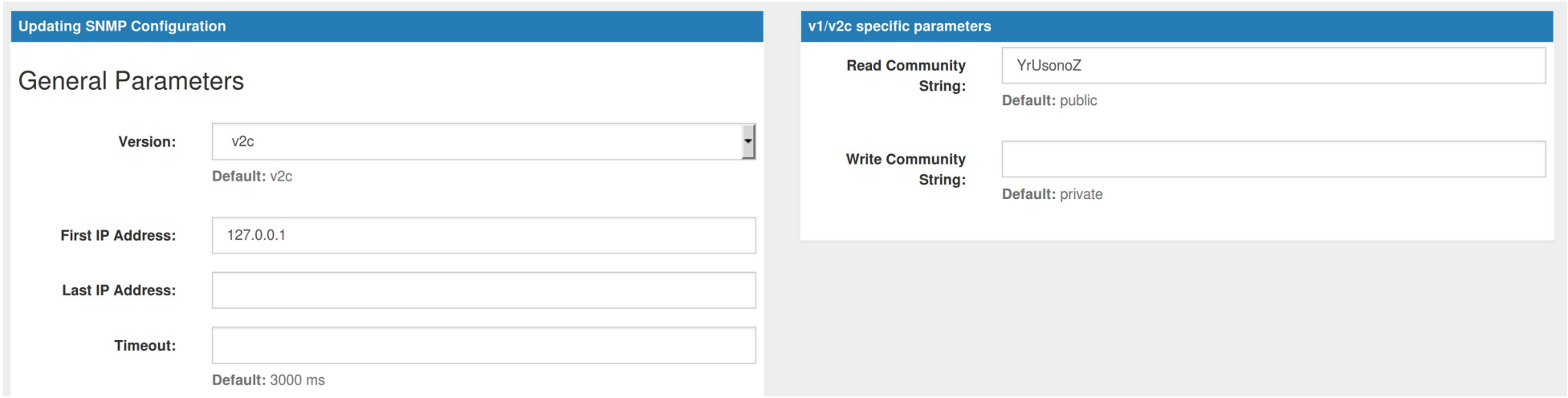
and look at the output.

Repeat the snmpwalk with “YrUsonoZ”:

```
snmpwalk -v2c -c YrUsonoZ localhost .1
```

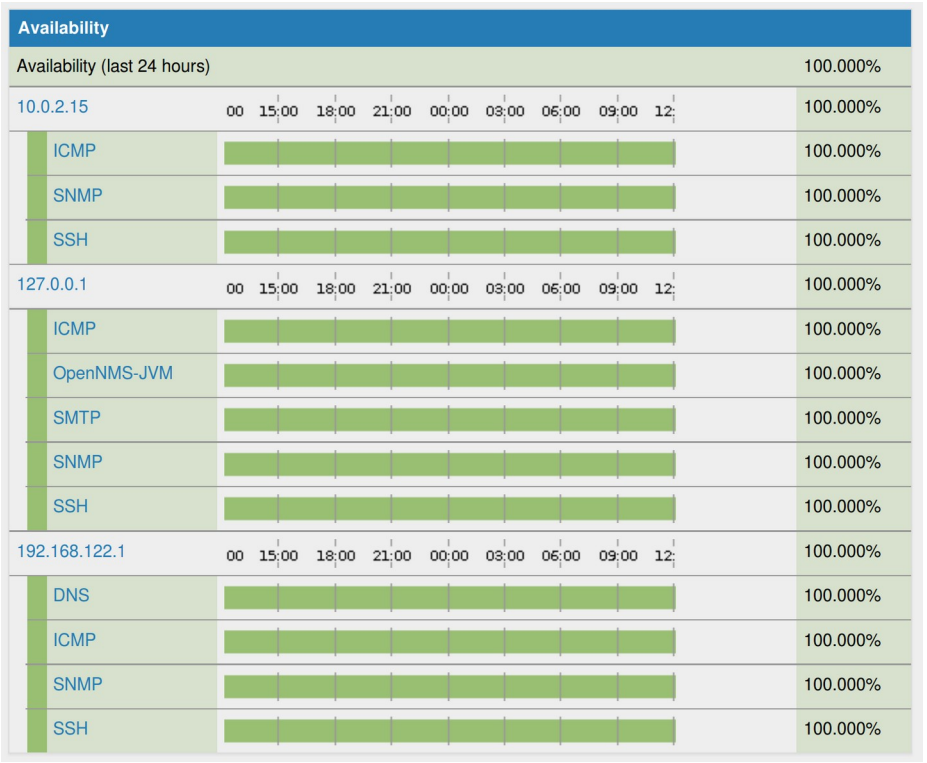
Set the Community String

Navigate to Configure → Configure SNMP Community Names by IP Address



Discover SNMP on localhost

Rescan the localhost node, note SNMP data and interfaces



snmp-config.xml

```
<snmp-config
   xmlns="http://xmlns.opennms.org/xsd/config/snmp"
   version="v2c"
   read-community="public"
   timeout="1800" retry="1">
   <definition read-community="YrUsonoZ">
      <specific>127.0.0.1</specific>
   </definition>
</snmp-config>
```

Unit 7: SNMP Traps

SNMP Traps

- OpenNMS Can Receive SNMP Traps
- Traps Must be Mapped to UEIs
- Events can be edited to use masks to make this happen

Many Traps are Pre-defined

Recent Events			
90	12/6/16 12:14:07	Normal	Agent Up with Possible Changes (coldStart Trap) enterprise:.1.3.6.1.4.1.8072.3.2.10 (.1.3.6.1.4.1.8072.3.2.10) args(0):
89	12/6/16 12:14:06	Warning	nsNotifyShutdown trap received

Send Traps With `snmptrap`

```
snmptrap -v 1 -c public 127.0.0.1 \
    .1.3.6.1.4.1.99999.2 localhost 6 1 ' ' \
    .1.3.6.1.4.1.99999.3.1 s 'They be bored'
```

Event 91			
Severity	Normal	**Node**	localhost
Time	Dec 6, 2016 12:17:29 PM	**Interface**	127.0.0.1
Service			
UEI	uei.opennms.org/generic/traps/EnterpriseDefault		

Log Message

Received unformatted enterprise event (enterprise:.1.3.6.1.4.1.99999.2 generic:6 specific:1). 1 args: .1.3.6.1.4.1.99999.3.1="They be bored"

Description

This is the default event format used when an enterprise specific event (trap) is received for which no format has been configured (i.e. no event definition exists).

The total number of arguments received with the trap: 1.

They were:

.1.3.6.1.4.1.99999.3.1="They be bored"

Here is a "mask" element definition that matches this event, for use in event configuration files:

```
<mask>
  <maskelement>
    <mename>id</mename>
    <mevalue>.1.3.6.1.4.1.99999.2</mevalue>
  </maskelement>
  <maskelement>
    <mename>generic</mename>
    <mevalue>6</mevalue>
  </maskelement>
  <maskelement>
    <mename>specific</mename>
    <mevalue>1</mevalue>
  </maskelement>
</mask>
```

Formatting SNMP Traps

- OpenNMS will provide the mask needed to match a trap
- The MIB Compiler tool can be used to import trap definitions
- Use the SystemOID to help deduce the device that sent the trap

Update `Class.events.xml`

- `cd /opt/opennms/etc/events`
- Run

```
wget -N
https://docs.opennms.com/~tarus/Class/Config/Exercise%207/Class.events.xml
```

- Reload Eventd

```
send-event.pl uei.opennms.org/internal/reloadDaemonConfig -p 'daemonName Eventd'
```

Class.events.xml: Add a "Down" Trap

```
<event>
  <mask>
    <maskelement>
      <mename>id</mename>
      <mevalue>.1.3.6.1.4.1.99999.2</mevalue>
    </maskelement>
    <maskelement>
      <mename>generic</mename>
      <mevalue>6</mevalue>
    </maskelement>
    <maskelement>
      <mename>specific</mename>
      <mevalue>1</mevalue>
    </maskelement>
  </mask>
  <uei>uei.opennms.org/class/moody</uei>
  <event-label>OpenNMS defined event: The OpenNMS Class is moody</event-label>
  <descr>
    &lt;p&gt;This event is sent when the OpenNMS Class is moody.&lt;/p&gt;
  </descr>
  <logmsg dest='logndisplay'>
    &lt;p&gt;OpenNMS Class is moody: %parm[#1]%&lt;/p&gt;
  </logmsg>
  <severity>Warning</severity>
</event>
```

Class.events.xml: Add an "Up" Trap

```
<event>
  <mask>
    <maskelement>
      <mename>id</mename>
      <mevalue>.1.3.6.1.4.1.99999.2</mevalue>
    </maskelement>
    <maskelement>
      <mename>generic</mename>
      <mevalue>6</mevalue>
    </maskelement>
    <maskelement>
      <mename>specific</mename>
      <mevalue>2</mevalue>
    </maskelement>
  </mask>
  <uei>uei.opennms.org/class/joyful</uei>
  <event-label>OpenNMS defined event: The OpenNMS Class is joyful</event-label>
  <descr>
    &lt;p&gt;This event is sent when the OpenNMS Class is joyful.&lt;/p&gt;
  </descr>
  <logmsg dest='logndisplay'>
    &lt;p&gt;OpenNMS Class is joyful: %parm[#1]%&lt;/p&gt;
  </logmsg>
  <severity>Normal</severity>
</event>
```

Formatted Events

ID	Severity	Time	Node	Interface	Service
97	**Normal** ⊞⊟	Dec 6, 2016 12:46:16 PM ◀▶	localhost ⊞⊟	127.0.0.1 ⊞⊟	
		uei.opennms.org/class/joyful ⊞⊟ Edit notifications for event			
		OpenNMS Class is joyful: They have Pizza!			
96	**Warning** ⊞⊟	Dec 6, 2016 12:46:14 PM ◀▶	localhost ⊞⊟	127.0.0.1 ⊞⊟	
		uei.opennms.org/class/moody ⊞⊟ Edit notifications for event			
		OpenNMS Class is moody: They be bored			

Other Event Sources

- Using send-event.pl or other methods to talk directly to port 5817
- Convert SNMP traps to events via trapd
- Convert Syslogs to events via syslogd
- Convert TL/1 messages via tl1d

Exercise #7: Define Trap Events

- Generate the “moody” trap
- Generate the “joyful” trap
- Note that both are unformatted
- Update Class.events.xml
- Repeat both traps
- Note that they are formatted
- Have fun!

Trap Commands

Moody:

```
snmptrap -v 1 -c public 127.0.0.1 \
.1.3.6.1.4.1.99999.2 localhost 6 1 ' ' \
.1.3.6.1.4.1.99999.3.1 s 'They be bored'
```

Joyful:

```
snmptrap -v 1 -c public 127.0.0.1 \
.1.3.6.1.4.1.99999.2 localhost 6 2 ' ' \
.1.3.6.1.4.1.99999.3.1 s 'They have Pizza!'
```

Unit 8: Service Assurance

Monitoring a Service

- Now that SNMP is configured, create a new service
- Use “extend” to create a “Class-Monitor” service.
- Test the service from the command line
- Add the service to the localhost node
- Update the poller configuration
- Test the service

net-snmp extend

- The “extend” directive can be used to expose the output of a command via SNMP.
- Create a script called `/tmp/classmonitor.sh`

```
#!/bin/bash
echo ok
```

- `chmod +x /tmp/classmonitor.sh`
- `/tmp/classmonitor.sh`

```
ok
```

Update `/etc/snmp/snmpd.conf`

- Edit `/etc/snmp/snmpd.conf`
- Add at the bottom

```
extend classmonitor /tmp/classmonitor.sh
```

- Restart `snmpd`

```
systemctl restart snmpd
```

snmpwalk Output

```
# snmpwalk -v2c -c YrUsonoZ localhost .1.3.6.1.4.1.8072.1.3.2
NET-SNMP-EXTEND-MIB::nsExtendNumEntries.0 = INTEGER: 1
NET-SNMP-EXTEND-MIB::nsExtendCommand."classmonitor" = STRING: /tmp/class-monitor.sh
NET-SNMP-EXTEND-MIB::nsExtendArgs."classmonitor" = STRING:
NET-SNMP-EXTEND-MIB::nsExtendInput."classmonitor" = STRING:
NET-SNMP-EXTEND-MIB::nsExtendCacheTime."classmonitor" = INTEGER: 5
NET-SNMP-EXTEND-MIB::nsExtendExecType."classmonitor" = INTEGER: exec(1)
NET-SNMP-EXTEND-MIB::nsExtendRunType."classmonitor" = INTEGER: run-on-read(1)
NET-SNMP-EXTEND-MIB::nsExtendStorage."classmonitor" = INTEGER: permanent(4)
NET-SNMP-EXTEND-MIB::nsExtendStatus."classmonitor" = INTEGER: active(1)
NET-SNMP-EXTEND-MIB::nsExtendOutput1Line."classmonitor" = STRING: ok
NET-SNMP-EXTEND-MIB::nsExtendOutputFull."classmonitor" = STRING: ok
NET-SNMP-EXTEND-MIB::nsExtendOutNumLines."classmonitor" = INTEGER: 1
NET-SNMP-EXTEND-MIB::nsExtendResult."classmonitor" = INTEGER: 0
NET-SNMP-EXTEND-MIB::nsExtendOutLine."classmonitor".1 = STRING: ok
```

snmpwalk -On Output

```
# snmpwalk -v2c -c YrUsonoZ -On localhost .1.3.6.1.4.1.8072.1.3.2
.1.3.6.1.4.1.8072.1.3.2.1.0 = INTEGER: 1
.1.3.6.1.4.1.8072.1.3.2.2.1.2.12.99.108.97.115.115.109.111.110.105.116.111.114 = STRING: /tmp/class-
monitor.sh
.1.3.6.1.4.1.8072.1.3.2.2.1.3.12.99.108.97.115.115.109.111.110.105.116.111.114 = STRING:
.1.3.6.1.4.1.8072.1.3.2.2.1.4.12.99.108.97.115.115.109.111.110.105.116.111.114 = STRING:
.1.3.6.1.4.1.8072.1.3.2.2.1.5.12.99.108.97.115.115.109.111.110.105.116.111.114 = INTEGER: 5
.1.3.6.1.4.1.8072.1.3.2.2.1.6.12.99.108.97.115.115.109.111.110.105.116.111.114 = INTEGER: exec(1)
.1.3.6.1.4.1.8072.1.3.2.2.1.7.12.99.108.97.115.115.109.111.110.105.116.111.114 = INTEGER: run-on-read(1)
.1.3.6.1.4.1.8072.1.3.2.2.1.20.12.99.108.97.115.115.109.111.110.105.116.111.114 = INTEGER: permanent(4)
.1.3.6.1.4.1.8072.1.3.2.2.1.21.12.99.108.97.115.115.109.111.110.105.116.111.114 = INTEGER: active(1)
.1.3.6.1.4.1.8072.1.3.2.3.1.1.12.99.108.97.115.115.109.111.110.105.116.111.114 = STRING: ok
.1.3.6.1.4.1.8072.1.3.2.3.1.2.12.99.108.97.115.115.109.111.110.105.116.111.114 = STRING: ok
.1.3.6.1.4.1.8072.1.3.2.3.1.3.12.99.108.97.115.115.109.111.110.105.116.111.114 = INTEGER: 1
.1.3.6.1.4.1.8072.1.3.2.3.1.4.12.99.108.97.115.115.109.111.110.105.116.111.114 = INTEGER: 0
.1.3.6.1.4.1.8072.1.3.2.4.1.2.12.99.108.97.115.115.109.111.110.105.116.111.114.1 = STRING: ok
```

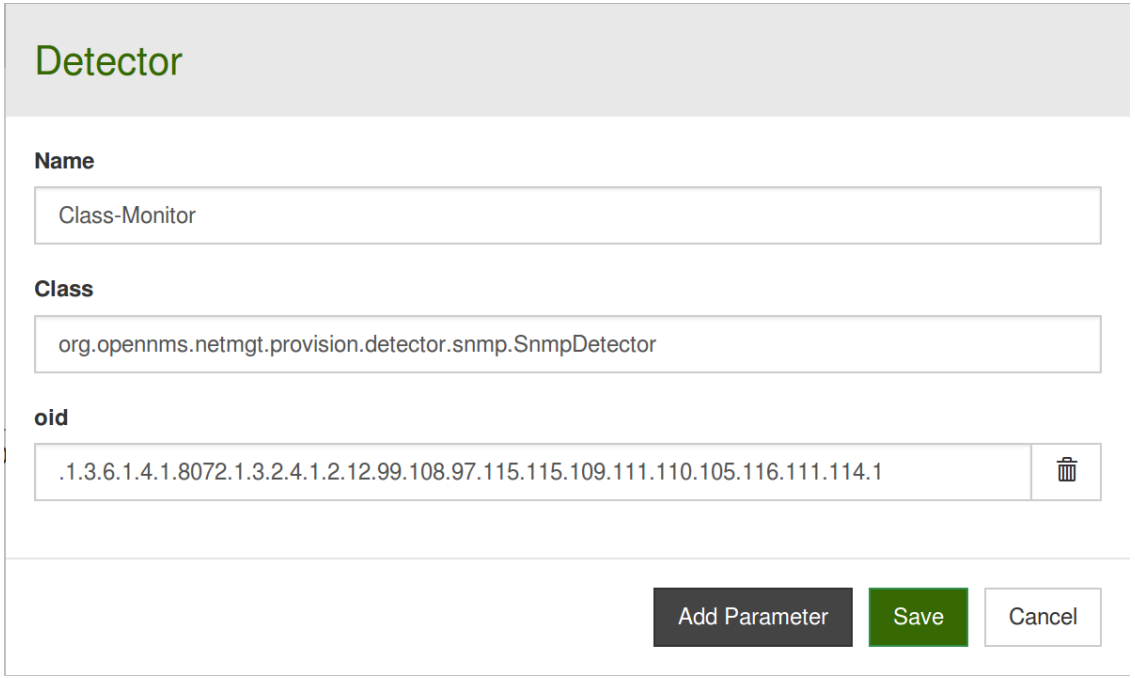
```
99.108.97.115.115.109.111.110.105.116.111.114 = classmonitor
```

Exercise #8: Service Monitoring

- Create the SNMP-based `Class-Monitor` service detector
- Add it to the `localhost` node
- Note monitoring status
- Insure that a polling package exists and that monitoring is occurring
- Cause an outage
- Restore the outage

Edit Default Foreign Source

Navigate to Configure → Manage Provisioning Requisitions → Edit Default FS

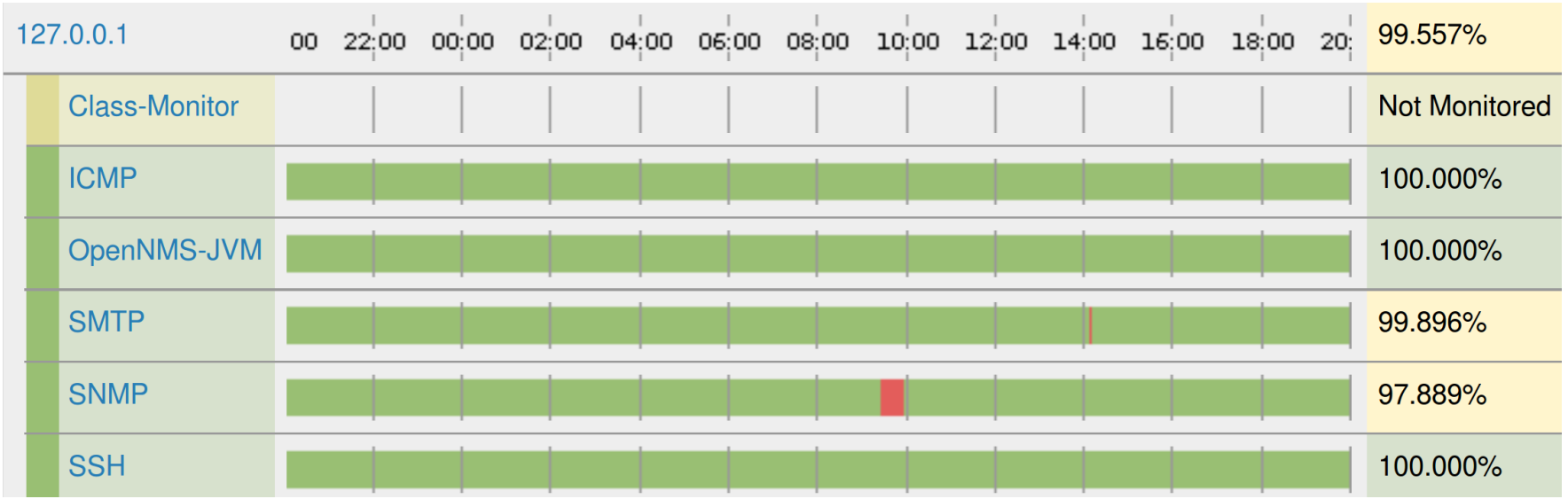


Add `Class-Monitor` Service

- Add the new SNMP Detector with oid match
- Save the detector
- Save changes to the Default FS
- Rescan `localhost`

Recent Events			
232	12/6/16 19:58:07	Normal	The Node with Id: 1; ForeignSource: Class; ForeignId:1480972555732 has completed.
231	12/6/16 19:58:07	Warning	SNMP information on 127.0.0.1 is being refreshed for data collection purposes.
230	12/6/16 19:58:00	Warning	The Class-Monitor service has been discovered on interface 127.0.0.1.
229	12/6/16 19:57:59	Warning	A services scan has been forced on this node.
228	12/6/16 19:56:27	Normal	The Node with Id: 1; ForeignSource: Class; ForeignId:1480972555732 has completed.

Not Monitored



Update `poller-configuration.xml`

- `cd /opt/opennms/etc`
- Run

```
wget -N http://10.42.0.1/Class/Config/Exercise%208/poller-configuration.xml
```

- Restart OpenNMS

```
systemctl restart opennms
```

- Edit the classmonitor.sh file and change “ok” to something else.

Create a Poller Package

```
<package name="Package for Class">
  <filter>IPADDR != '0.0.0.0'</filter>
  <include-range begin="1.1.1.1" end="254.254.254.254" />
  <include-range begin="::1" end="ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff" />
  <rrd step="30">
    <rra>RRA:AVERAGE:0.5:1:20160</rra>
    <rra>RRA:AVERAGE:0.5:120:1488</rra>
    <rra>RRA:AVERAGE:0.5:2880:366</rra>
    <rra>RRA:MAX:0.5:2880:366</rra>
    <rra>RRA:MIN:0.5:2880:366</rra>
  </rrd>
  <service name="Class-Monitor" interval="30000" user-defined="true" status="on">
    <parameter key="oid"
               value=".1.3.6.1.4.1.8072.1.3.2.4.1.2.12.99.108.97.115.115.109.111.110.105.116.111.114.1" />
    <parameter key="operator" value="=" />
    <parameter key="operand" value="ok" />
  </service>
  <downtime interval="30000" begin="0" end="300000" /><!-- 30s, 0, 5m -->
  <downtime interval="300000" begin="300000" end="43200000" /><!-- 5m, 5m, 12h -->
  <downtime interval="600000" begin="43200000" end="432000000" /><!-- 10m, 12h, 5d -->
  <downtime begin="432000000" delete="true" /><!-- anything after 5 days delete -->
</package>
<monitor service="Class-Monitor" class-name="org.opennms.netmgt.poller.monitors.SnmpMonitor" />
```

Downtime Model

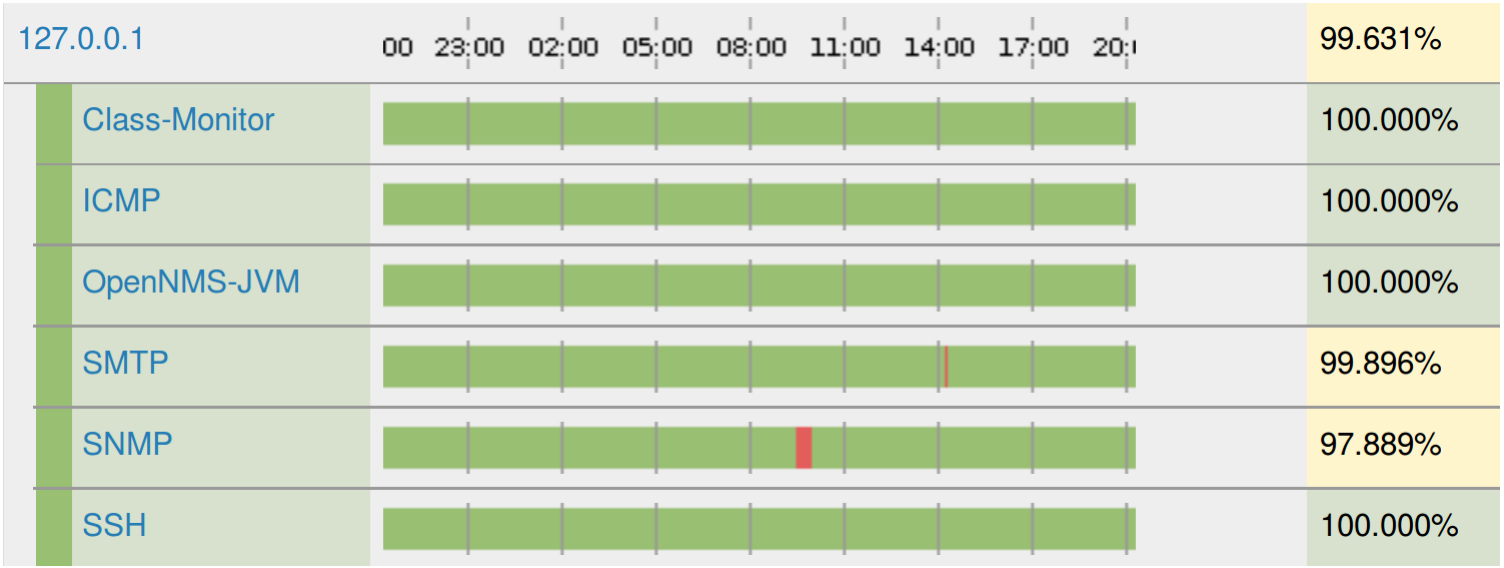
The OpenNMS downtime model is unique:

```
 <downtime interval="30000" begin="0" end="300000" />
                              <!-- 30s, 0, 5m -->
 <downtime interval="300000" begin="300000" end="43200000" />
                              <!-- 5m, 5m, 12h -->
<downtime interval="600000" begin="43200000" end="432000000" />
                              <!-- 10m, 12h, 5d -->
<downtime begin="432000000" delete="true" />
                              <!-- anything after 5 days delete -->
```

Remember to remove the “end” when removing delete

Reload the Pollerd Configuration

```
# systemctl restart opennms
[# send-event.pl  uei.opennms.org/internal/reloadDaemonConfig -p 'daemonName Pollerd']
```



Test the New Monitor

Edit `/tmp/classmonitor.sh` and change "ok"

Recent Events

255 12/6/16 20:35:51 | Minor | Class-Monitor outage identified on interface 127.0.0.1 with reason code: Observed value 'notok' does not meet criteria '= ok'.

Results 1-1 of 1

Ack	ID	Severity	Node	Count	Last Event Time	Log Msg
☐	32		localhost ⊞⊟	1	Dec 6, 2016 8:35:51 PM ◧◨	Class-Monitor outage identified on interface 127.0.0.1 with reason code: Observed value 'notok' does not meet criteria '= ok'.

ID	Event ID	Severity	Sent Time	Responder	Respond Time	Node	Interface	Service
☐ 13	255	Minor	Dec 6, 2016 8:35:51 PM			localhost ⊞⊟	127.0.0.1 ⊞	Class-Monitor ⊞
			The Class-Monitor service poll on interface localhost (127.0.0.1) on node localhost failed at Tuesday, December 6, 2016 8:35:51 PM EST.					

Scheduled Outages

- Scheduled Outages are “poll” outages: OpenNMS stops polling
- Can be made daily, weekly, day of the month or for a specific date range.

				Affects...				
Name	**Type**	**Nodes/Interfaces**	**Times**	**Notifications**	**Polling**	**Thresholds**	**Data collection**	
thereckoning.opennms.org	specific	Node: thereckoning.opennms.org	22-Nov-2016 00:00:00 - 31-Dec-2016 23:59:59	✓	✓	✓	✓	Edit Delete
Vitelity No Notifications	specific	Node: outbound.vitelity.net	06-Dec-2016 00:00:00 - 31-Dec-2017 23:59:59	✓	✗	✗	✗	Edit Delete

Node: **outbound.vitelity.net** 70 Vitelity 1361221938266

View Events View Alarms View Outages Asset Info Hardware Info Availability Site Status

This node is currently affected by the following scheduled outages: Vitelity No Notifications

Unit 9: Page Sequence Monitor

Page Sequence Monitor (PSM)

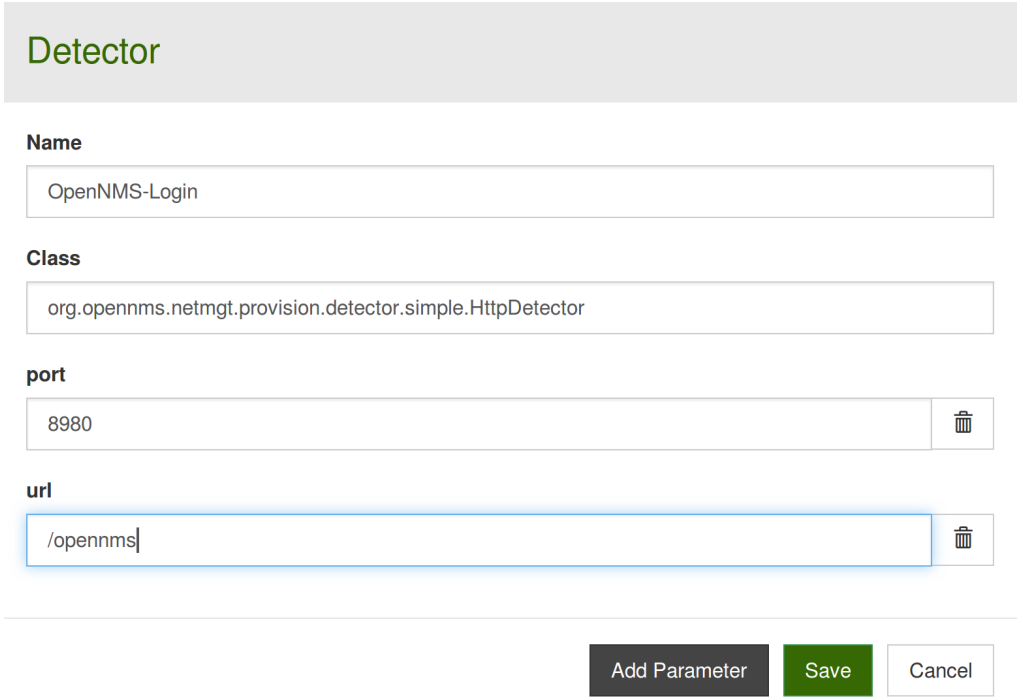
- OpenNMS has a range of monitors, from the simple: ICMP and TCP, to the complex, the PSM and Selenium.
- The Page Sequence Monitor allows for in-depth monitoring of websites and applications.
- You modify the default monitor with a “page-sequence” parameter which lists a series of pages that the monitor should access

Exercise #9: OpenNMS PSM

- Create the PSM-based `OpenNMS-Login` service detector
- Add it to the `localhost` node
- Note monitoring status
- Add a monitor to the existing Class polling package and insure monitoring is occurring
- Cause an outage
- Restore the outage

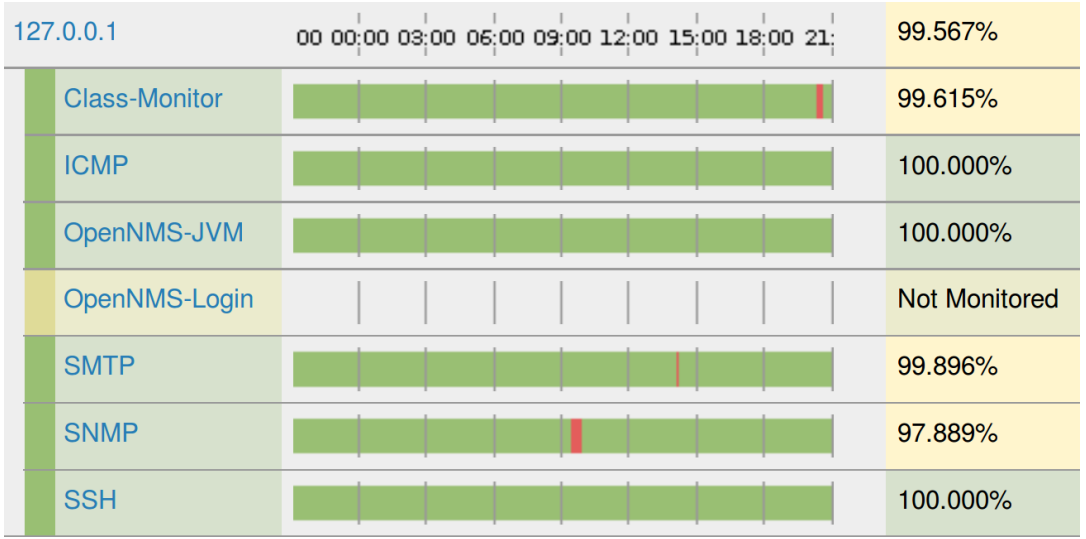
Edit Default Foreign Source

Navigate to Configure → Manage Provisioning Requisitions → Edit Default FS



Add `OpenNMS-Login` Service

- Add the new PSM Detector with port and url
- Save the detector
- Save changes to the Default FS
- Rescan `localhost`



Create a Monitor Service

```
<service name="OpenNMS-Login" interval="30000" user-defined="true" status="on">
  <parameter key="retry" value="1"/>
  <parameter key="timeout" value="5000"/>
  <parameter key="rrd-repository" value="/usr/share/opennms/share/rrd/response"/>
  <parameter key="ds-name" value="opennmslogin"/>
  <parameter key="page-sequence">
    <page-sequence>
      <page path="/opennms/index.jsp" port="8980" successMatch="Password" virtual-host="${nodelabel}" />
      <page path="/opennms/j_spring_security_check"  port="8980" method="POST" virtual-host="${nodelabel}" >
        <parameter key="j_username" value="admin"/>
        <parameter key="j_password" value="admin"/>
      </page>
      <page path="/opennms/index.jsp" port="8980" successMatch="Log Out" virtual-host="${nodelabel}" />
      <page path="/opennms/event/index" port="8980"
            successMatch="Event Queries" virtual-host="${nodelabel}" />
      <page path="/opennms/j_spring_security_logout" port="8980"
            successMatch="input_j_username" virtual-host="${nodelabel}" />
    </page-sequence>
  </parameter>
</service>

<monitor service="OpenNMS-Login" class-name="org.opennms.netmgt.poller.monitors.PageSequenceMonitor"/>
```

Update `poller-configuration.xml`

- `cd /opt/opennms/etc`
- Run

```
wget -N http://10.42.0.1/Class/Config/Exercise%209/poller-configuration.xml
```

- Restart OpenNMS

```
systemctl restart opennms
```

- Edit the classmonitor.sh file and change “ok” to something else.

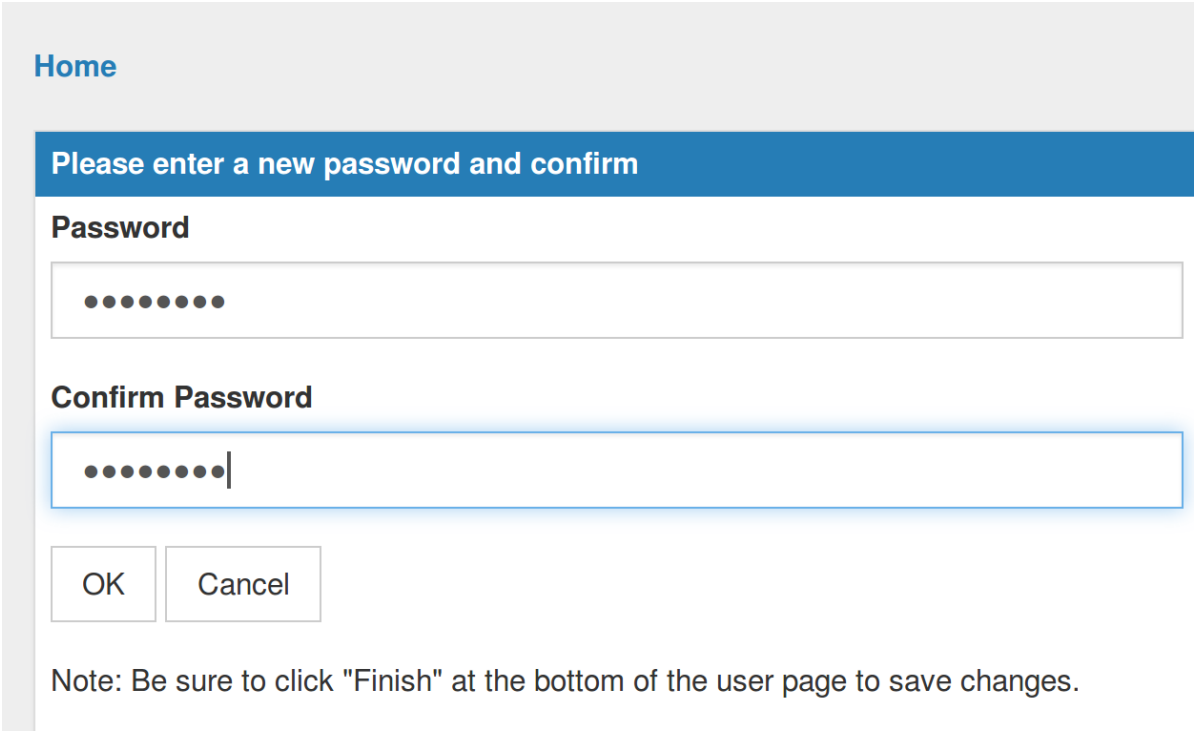
Might Fail on Restart

```
# systemctl restart opennms
```

Recent Events			
284	12/6/16 21:11:41	Normal	The OpenNMS-Login outage on interface 192.168.122.1 has been cleared. Service is restored.
283	12/6/16 21:11:37	Normal	The OpenNMS-Login outage on interface 127.0.0.1 has been cleared. Service is restored.
282	12/6/16 21:11:31	Normal	The OpenNMS-Login outage on interface 10.0.2.15 has been cleared. Service is restored.
265	12/6/16 21:10:57	Minor	OpenNMS-Login outage identified on interface 192.168.122.1 with reason code: Connection refused.
264	12/6/16 21:10:56	Minor	OpenNMS-Login outage identified on interface 127.0.0.1 with reason code: Connection refused.

Test the New Monitor

Change the “admin” password from “admin”



Note Event, Alarm and Notice

287	12/6/16 21:14:43		Minor	OpenNMS-Login outage identified on interface 127.0.0.1 with reason code: Failed to find 'Log Out' in page content at http://127.0.0.1:8980/opennms/index.jsp.

☐	35	localhost ⊞ ⊟	2	Dec 6, 2016 9:14:43 PM ◀ ▶	OpenNMS-Login outage identified on interface 127.0.0.1 with reason code: Failed to find 'Log Out' in page content at http://127.0.0.1:8980/opennms/index.jsp.

☐ 18	287	Minor	Dec 6, 2016 9:14:43 PM			localhost ⊞ ⊟	127.0.0.1 ⊞	OpenNMS-Login ⊞
	The OpenNMS-Login service poll on interface localhost (127.0.0.1) on node localhost failed at Tuesday, December 6, 2016 9:14:43 PM EST.							

Unit 10: Passive Status Keeper (PSK)

Passive Status Keeper (PSK)

- The Passive Status Keeper (PSK) lets you monitor “passive” services
- Status is kept in a table in memory that stores the status of the service:
  `Node – Interface – Service - Status`
- The poller then checks that table for changes and then treats it like an “active” service
- Status is changed via events

Event Translator is Key

- The Event Translator takes one event and converts it to another.
- The event can be changed entirely or just enriched.
- The UEI *must* change to avoid loops.
- For the PSK, events are turned into Passive Service Status events.

Enriched `linkDown` Event

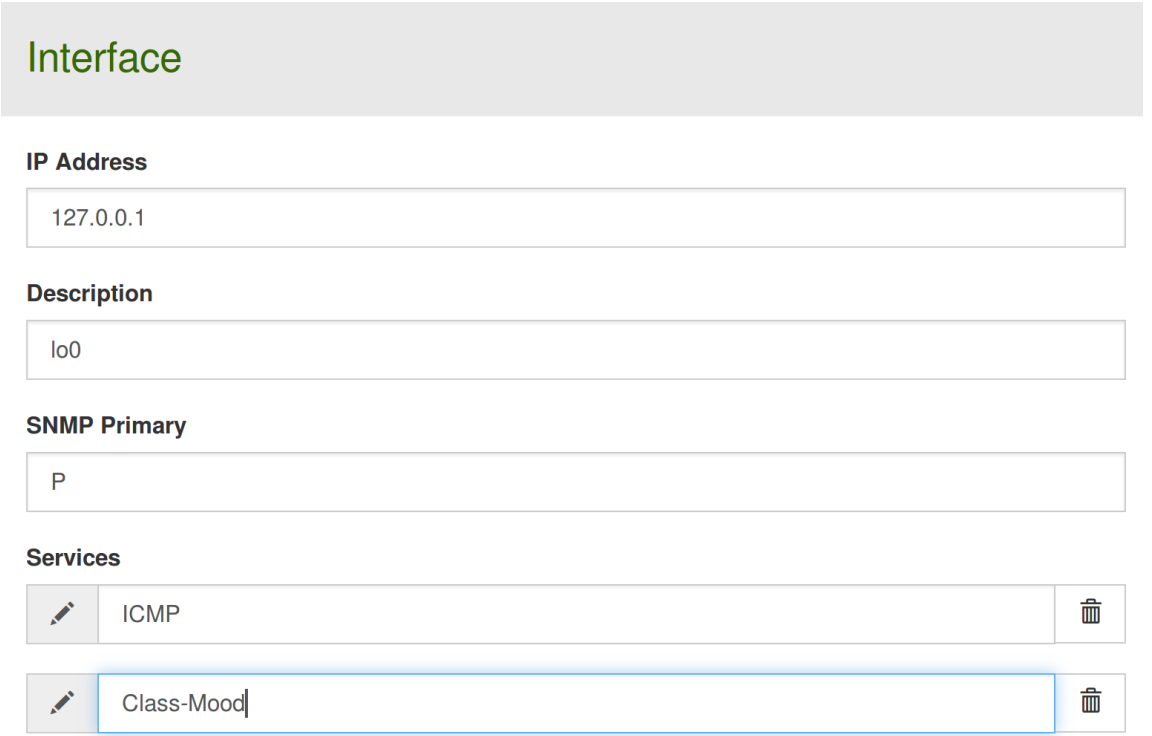
```
<translation>
  <event-translation-spec uei="uei.opennms.org/generic/traps/SNMP_Link_Down">
    <mappings>
      <mapping>
        <assignment name="uei" type="field" >
          <value type="constant" result="uei.opennms.org/translator/traps/SNMP_Link_Down" />
        </assignment>
        <assignment name="ifDescr" type="parameter">
         <value type="sql" result="SELECT snmp.snmpIfDescr
                                   FROM snmpInterface snmp WHERE snmp.nodeid = ?::integer
                                   AND snmp.snmpifindex = ?::integer" >
           <value type="field" name="nodeid" matches=".*" result="${0}" />
           <value type="parameter" name="~^\.1\.3\.6\.1\.2\.1\.2\.2\.1\.1\.([0-9]*)$" matches=".*" result="${0}" />
         </value>
        </assignment>
        <assignment name="ifName" type="parameter">
         <value type="sql" result="SELECT snmp.snmpIfName
                                   FROM snmpInterface snmp WHERE snmp.nodeid = ?::integer
                                   AND snmp.snmpifindex = ?::integer" >
           <value type="field" name="nodeid" matches=".*" result="${0}" />
           <value type="parameter" name="~^\.1\.3\.6\.1\.2\.1\.2\.2\.1\.1\.([0-9]*)$" matches=".*" result="${0}" />
         </value>
        </assignment>
```

Exercise #10: Add `Class-Mood` PSK

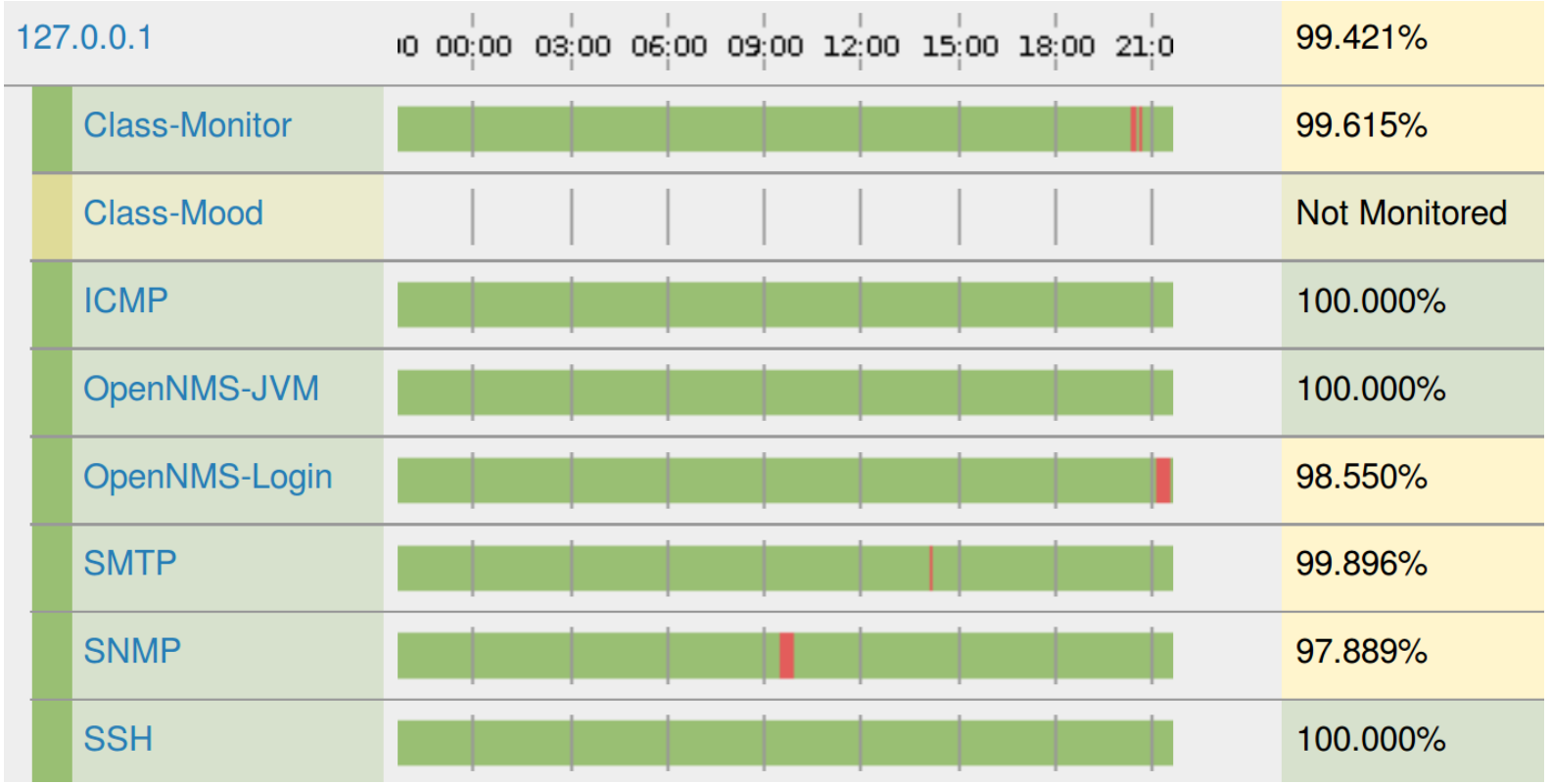
- "Ad hoc" add Class-Mood to 127.0.0.1
- Synchronize the requisition
- Note monitoring status
- Add a monitor to the existing Class polling package
- Update the Event Translator
- Restart OpenNMS
- Cause an outage
- Restore the outage

Add the `Class-Mood` Service

- Navigate to Configure → Manage Provisioning Requisitions
- Edit the Class Requisition
- Edit the `localhost` node
- Edit the 127.0.0.1 interface
- Save, Return and Synchronize



The `Class-Mood` Service is Added



Create a Monitor Service

It's one line, no parameters:

```
<service name="Class-Mood" interval="30000" user-defined="true" status="on" />
```

Remember to add the "monitor" to the bottom:

```
<monitor service="Mood" class-name="org.opennms.netmgt.poller.monitors.PassiveServiceMonitor" />
```

Create the “down” Status Event

```
<event-translation-spec uei="uei.opennms.org/class/moody">
  <mappings>
    <mapping>
      <!-- Create a parameter -->
      <assignment type="parameter" name="passiveNodeLabel">
        <value type="constant" result="localhost" />
      </assignment>
      <!-- Create a parameter -->
      <assignment type="parameter" name="passiveIpAddr">
        <value type="constant" result="127.0.0.1" />
      </assignment>
      <!-- Create a parameter -->
      <assignment type="parameter" name="passiveServiceName">
        <value type="constant" result="Class-Mood" />
      </assignment>
      <!-- Create a parameter -->
      <assignment type="parameter" name="passiveStatus" >
        <value type="constant" result="Down" />
      </assignment>
      <!-- Set the Reason -->
      <assignment type="parameter" name="passiveReasonCode" >
          <value type="parameter" name="~^\.1\.3\.6\.1\.4\.1\.99999\.3\.1$" matches=".*" result="${0}" />
      </assignment>
      <!-- Change the UEI to be a passive status event-->
      <assignment type="field" name="uei">
        <value type="constant" result="uei.opennms.org/services/passiveServiceStatus" />
      </assignment>
    </mapping>
  </mappings>
</event-translation-spec>
```

Create the “up” Status Event

```
<event-translation-spec uei="uei.opennms.org/class/joyful">
  <mappings>
    <mapping>
      <!-- Create a parameter -->
      <assignment type="parameter" name="passiveNodeLabel">
        <value type="constant" result="localhost" />
      </assignment>
      <!-- Create a parameter -->
      <assignment type="parameter" name="passiveIpAddr">
        <value type="constant" result="127.0.0.1" />
      </assignment>
      <!-- Create a parameter -->
      <assignment type="parameter" name="passiveServiceName">
        <value type="constant" result="Class-Mood" />
      </assignment>
      <!-- Create a parameter -->
      <assignment type="parameter" name="passiveStatus" >
        <value type="constant" result="Up" />
      </assignment>
      <!-- Change the UEI to be a passive status event-->
      <assignment type="field" name="uei">
        <value type="constant" result="uei.opennms.org/services/passiveServiceStatus" />
      </assignment>
    </mapping>
  </mappings>
</event-translation-spec>
```

Update Configuration Files

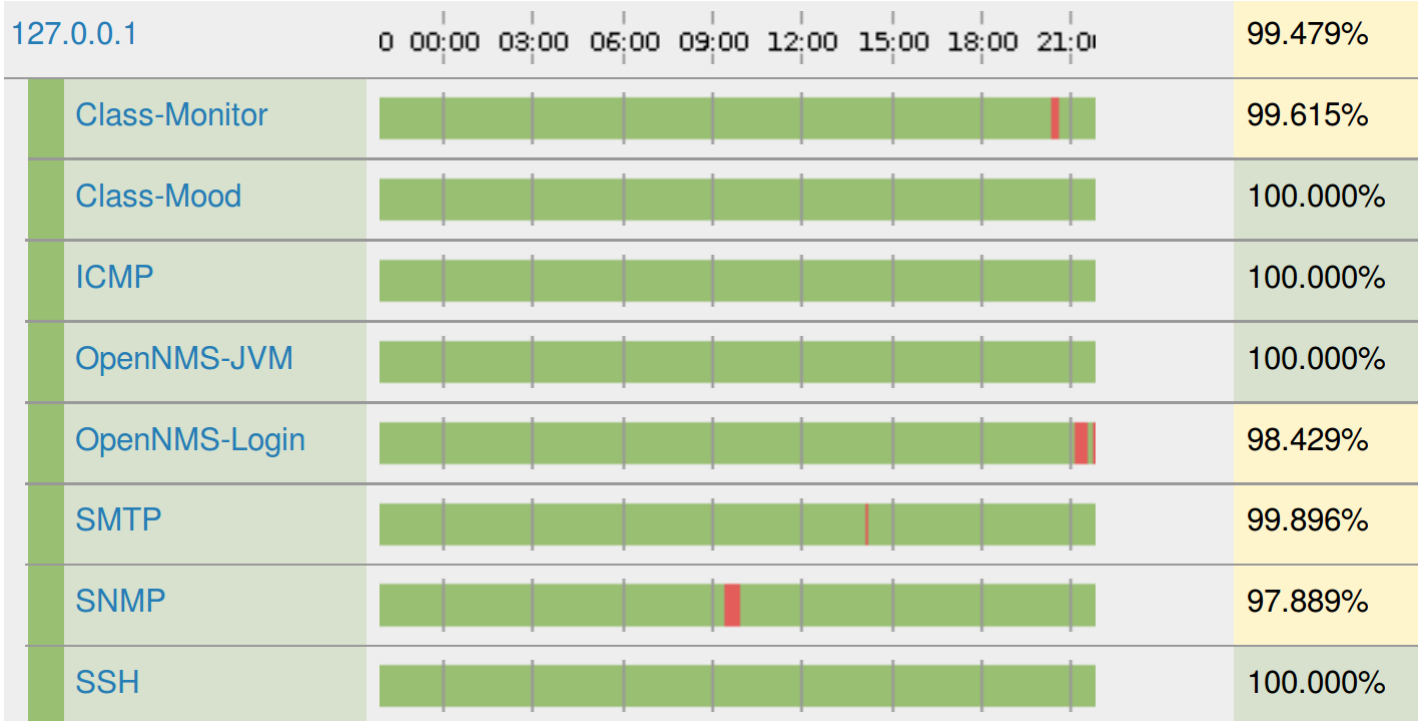
- `cd /opt/opennms/etc`

- Run

```
wget -N http://10.42.0.1/Class/Config/Exercise%2010/poller-configuration.xml
wget -N http://10.42.0.1/Class/Config/Exercise%2010/translator-configuration.xml
```

Restart and See the Service

```
# systemctl restart opennms
```



Create an Outage

```
# snmptrap -v 1 -c public 127.0.0.1 .1.3.6.1.4.1.99999.2 \
  localhost 6 1 ' ' .1.3.6.1.4.1.99999.3.1 s 'They be bored'
```

Recent Events

389	12/6/16 22:00:06		Minor	Class-Mood outage identified on interface 127.0.0.1 with reason code: They be bored.
388	12/6/16 21:59:51		Normal	Status information for service Class-Mood has been updated.
387	12/6/16 21:59:51		Warning	OpenNMS Class is moody: They be bored

☐	59	localhost ⊞ ⊟	1	Dec 6, 2016 10:00:06 PM ◧ ◨	Class-Mood outage identified on interface 127.0.0.1 with reason code: They be bored.

☐ 27	389		Minor	Dec 6, 2016 10:00:06 PM			localhost ⊞ ⊟	127.0.0.1 ⊞	Class-Mood ⊞
				The Class-Mood service poll on interface localhost (127.0.0.1) on node localhost failed at Tuesday, December 6, 2016 10:00:06 PM EST.					

Resolve the Outage

```
# snmptrap -v 1 -c public 127.0.0.1 .1.3.6.1.4.1.99999.2 \
  localhost 6 2 ' ' .1.3.6.1.4.1.99999.3.1 s 'They have Pizza!'
```

392	12/6/16 22:04:07	Normal	The Class-Mood outage on interface 127.0.0.1 has been cleared. Service is restored.
391	12/6/16 22:03:49	Normal	Status information for service Class-Mood has been updated.
390	12/6/16 22:03:49	Normal	OpenNMS Class is joyful: They have Pizza!

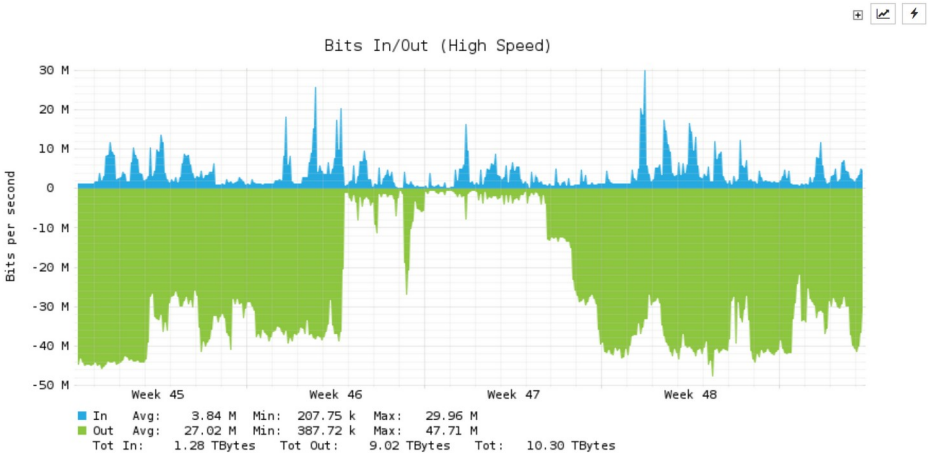
☐	60	localhost ⊞⊟	1	Dec 6, 2016 10:04:07 PM ◧◨	The Class-Mood outage on interface 127.0.0.1 has been cleared. Service is restored.
☐	59	localhost ⊞⊟	1	Dec 6, 2016 10:00:06 PM ◧◨	Class-Mood outage identified on interface 127.0.0.1 with reason code: They be bored.

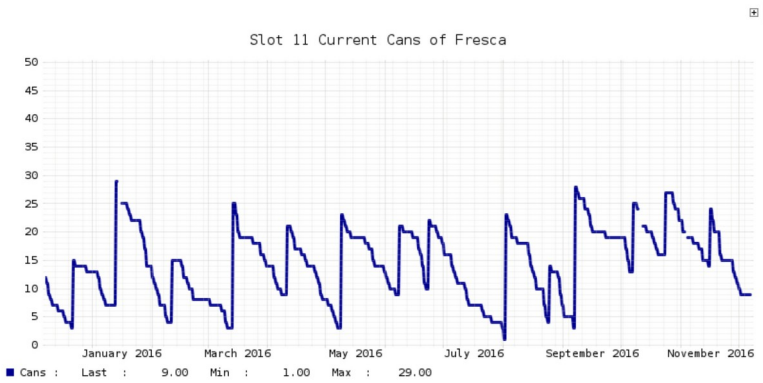
Unit 11: Performance Data Collection

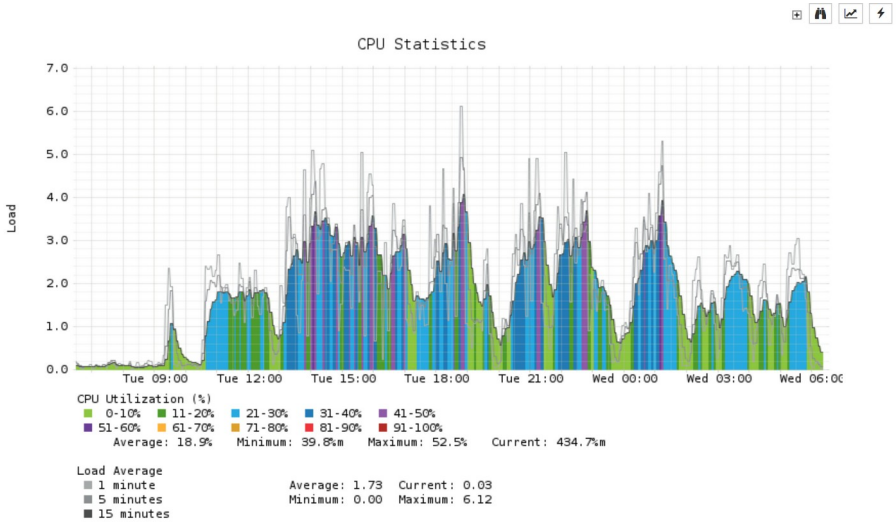
Performance Data Collection

- Uses RRDTool, Jrobin or Newts to store time series data
- Support for
  - SNMP (v1, v2c, v3)
  - JMX
  - HTTP/XML
  - NSClient
  - WMI
  - SQL
- Automated configuration

Performance Reports

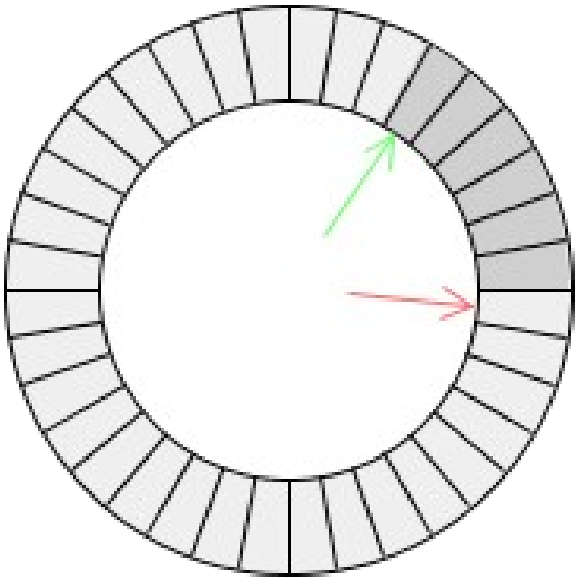






Round Robin Database

- Compact way to store time series data
- Maximum file size when database is created



RRD Database Structure

The RRD configuration consists of:

- step size: how “wide” is the “bucket” in seconds
- Round Robin Arrays (RRA) in the format:

  RRA:cf:xff:steps:rows

  - cf is the consolidation function which is one of AVERAGE, MIN, MAX or LAST
  - xff or x-files factor is the percentage of valid samples required for a consolidation
  - steps: how many steps in the RRA
  - rows: how many rows in the RRA

RRD Configuration

```
<rrd step="300">
  <rra>RRA:AVERAGE:0.5:1:2016</rra>
     <rra>RRA:AVERAGE:0.5:12:1488</rra>
     <rra>RRA:AVERAGE:0.5:288:366</rra>
     <rra>RRA:MAX:0.5:288:366</rra>
     <rra>RRA:MIN:0.5:288:366</rra>
  </rrd>
```

- step size of 300 seconds or five minutes
- Store the average value of one step 2016 times (12 samples/hour x 24 hours/day x 7 days = 2016 samples)
- Store the average value of 12 steps (1 hour) 1488 times (1 sample/hour x 24 hours/day x 62 days = 1488)
- Store the average, max and min values of 288 steps (1 day) for 366 days

rrdtool dump

step = 1

```
<!-- 2016-12-07 06:00:00 EST / 1481108400 --> <row><v>3.2933333333e+00</v></row>
<!-- 2016-12-07 06:05:00 EST / 1481108700 --> <row><v>9.8733333333e+00</v></row>
<!-- 2016-12-07 06:10:00 EST / 1481109000 --> <row><v>3.3410000000e+01</v></row>
<!-- 2016-12-07 06:15:00 EST / 1481109300 --> <row><v>0.0000000000e+00</v></row>
<!-- 2016-12-07 06:20:00 EST / 1481109600 --> <row><v>0.0000000000e+00</v></row>
```

step = 12

```
<!-- 2016-12-07 03:00:00 EST / 1481097600 --> <row><v>2.4194444444e+00</v></row>
<!-- 2016-12-07 04:00:00 EST / 1481101200 --> <row><v>2.0008333333e+00</v></row>
<!-- 2016-12-07 05:00:00 EST / 1481104800 --> <row><v>5.6833333333e-01</v></row>
<!-- 2016-12-07 06:00:00 EST / 1481108400 --> <row><v>4.5850000000e+00</v></row>
```

step = 288

```
<!-- 2016-12-04 19:00:00 EST / 1480896000 --> <row><v>NaN</v></row>
<!-- 2016-12-05 19:00:00 EST / 1480982400 --> <row><v>NaN</v></row>
<!-- 2016-12-06 19:00:00 EST / 1481068800 --> <row><v>0.0000000000e+00</v></row>
```

RRD File Locations

- The .rrd files are stored in /opt/opennms/share/rrd which is a symlink to /var/opennms/rrd.
- Response time values are stored under response by IP address
- All other data is stored in snmp by nodeid (although you can configure it for foreign source:foreign ID)
  - Node level data is stored in the top directory
  - Interface data is stored by ifDescr+MAC address
  - Generic resource data is stored by resource name then index value

Response Time Data

```
$ pwd
/opt/opennms/share/rrd/response
$ ls
104.131.123.4                           2001:0470:e2f1:0000:d8a9:cf84:705f:16e0
104.131.77.90                           2001:0470:e2f1:0000:d9ed:0b49:68a3:4ec6
104.236.133.125                         2001:0470:e2f1:0000:e557:2893:2726:aca0
104.236.160.233                         2001:0470:e2f1:0000:e871:d4eb:900d:2202
104.236.216.233                         2001:0470:e2f1:0000:ea9a:8fff:fe63:ea19
104.236.230.125                         2001:0470:e2f1:0000:edde:9635:ed2d:9255
104.236.59.203                          2001:0470:e2f1:0000:f1d6:8b52:2366:af2e
107.170.58.43                           2001:0470:e2f1:0000:f464:d018:2de9:b997
108.169.150.242                         2001:0470:e2f1:0000:f580:f4df:ab88:e9d3
108.169.150.243                         2001:0470:e2f1:0000:fcc4:bdae:f309:ae61

$ ls 104.131.123.4
ds.properties  http.rrd    https.rrd  icmp.rrd   smtp.rrd  ssh.rrd
http.meta      https.meta  icmp.meta  smtp.meta  ssh.meta
```

Other Performance Data

```
$ pwd
/opt/opennms/share/rrd/snmp

$ ls
1    107  117  13   141  148  16   193  21  30  38  45  53  62  8   9
10   108  12   131  142  149  17   194  23  31  39  47  54  63  82  92
100  109  120  132  143  15   186  195  25  32  4   48  55  66  84  95
101  111  122  135  144  150  187  196  26  34  40  49  59  67  85  97
103  114  123  139  145  151  19   197  27  35  42  5   6   7   86  98
105  115  126  14   146  153  190  198  28  36  43  51  60  73  87  99
106  116  127  140  147  154  191  2    29  37  44  52  61  74  89
```

Node-level Data

```
$ pwd
/opt/opennms/share/rrd/snmp/66
$ ls *rrd
icmpInAddrMaskReps.rrd   icmpOutEchoReps.rrd      juniperCpuFpc0.rrd
icmpInAddrMasks.rrd      icmpOutEchos.rrd         juniperCpuRe.rrd
icmpInDestUnreachs.rrd   icmpOutErrors.rrd        juniperTempFpc0.rrd
icmpInEchoReps.rrd       icmpOutMsgs.rrd          juniperTempRe.rrd
icmpInEchos.rrd          icmpOutParmProbs.rrd     tcpActiveOpens.rrd
icmpInErrors.rrd         icmpOutRedirects.rrd     tcpAttemptFails.rrd
icmpInMsgs.rrd           icmpOutSrcQuenchs.rrd    tcpCurrEstab.rrd
icmpInParmProbs.rrd      icmpOutTimeExcds.rrd     tcpEstabResets.rrd
icmpInRedirects.rrd      icmpOutTimestamps.rrd    tcpInErrors.rrd
icmpInSrcQuenchs.rrd     icmpOutTimestmpReps.rrd  tcpInSegs.rrd
icmpInTimeExcds.rrd      junFwddBufferUtiliz.rrd  tcpOutRsts.rrd
icmpInTimestampReps.rrd  junFwddCpuMKernel.rrd    tcpOutSegs.rrd
icmpInTimestamps.rrd     junFwddCpuRtThread.rrd   tcpPassiveOpens.rrd
icmpOutAddrMaskReps.rrd  junFwddHeapUtiliz.rrd    tcpRetransSegs.rrd
icmpOutAddrMasks.rrd     junFwddUptime.rrd
icmpOutDestUnreachs.rrd  juniperBufferFpc0.rrd
```

Interfaces and Generic Resources

```
$ pwd
/opt/opennms/share/rrd/snmp/66
$ find . -type d
./ge_0_0_0-a8d0e5a0a480                ./ge_0_0_0_0-a8d0e5a0a480
./ge_0_0_1-a8d0e5a0a481                ./ge_0_0_11-a8d0e5a0a48b
./ge_0_0_13-a8d0e5a0a48d               ./ge_0_0_15-a8d0e5a0a48f
./ge_0_0_1_0-a8d0e5a0a481              ./ge_0_0_2-a8d0e5a0a482
./ge_0_0_2_0-a8d0e5a0a482              ./ge_0_0_3-a8d0e5a0a483
./ge_0_0_8-a8d0e5a0a488                ./ge_0_0_8_0-a8d0e5a0a488
./ge_0_0_9-a8d0e5a0a489
./jnxJsSPUMonitoringObjectsTable       ./jnxJsSPUMonitoringObjectsTable/single
./jnxOperatingTable                    ./jnxOperatingTable/RoutingEngine
./lo0_16385                            ./sp_0_0_0_16383
./vlan_0-a8d0e5a0a490                  ./vlan_1-a8d0e5a0a490
./vlan_2-a8d0e5a0a490
```

Interface Data

```
$ pwd
/opt/opennms/share/rrd/snmp/66/vlan_0-a8d0e5a0a490
$ ls *rrd
ifHCInBroadcastPkts.rrd  ifHCOutOctets.rrd     ifInUcastpkts.rrd
ifHCInMulticastPkts.rrd  ifHCOutUcastPkts.rrd  ifOutDiscards.rrd
ifHCInOctets.rrd         ifInDiscards.rrd      ifOutErrors.rrd
ifHCInUcastPkts.rrd      ifInErrors.rrd        ifOutNUcastPkts.rrd
ifHCOutBroadcastPkt.rrd  ifInNUcastpkts.rrd    ifOutOctets.rrd
ifHCOutMulticastPkt.rrd  ifInOctets.rrd        ifOutUcastPkts.rrd

$ pwd
/opt/opennms/share/rrd/snmp/66/vlan_1-a8d0e5a0a490
$ ls *rrd
ifHCInBroadcastPkts.rrd  ifHCOutOctets.rrd     ifInUcastpkts.rrd
ifHCInMulticastPkts.rrd  ifHCOutUcastPkts.rrd  ifOutDiscards.rrd
ifHCInOctets.rrd         ifInDiscards.rrd      ifOutErrors.rrd
ifHCInUcastPkts.rrd      ifInErrors.rrd        ifOutNUcastPkts.rrd
ifHCOutBroadcastPkt.rrd  ifInNUcastpkts.rrd    ifOutOctets.rrd
ifHCOutMulticastPkt.rrd  ifInOctets.rrd        ifOutUcastPkts.rrd
```

Generic Resource Data

```
$ pwd
/opt/opennms/share/rrd/snmp/97/dskIndex

$ ls
boot  home  _root_fs
$ cd _root_fs/
ns-dskAvailHigh.rrd    ns-dskPercent.rrd    ns-dskUsedHigh.rrd
ns-dskAvailLow.rrd     ns-dskTotalHigh.rrd  ns-dskUsedLow.rrd
ns-dskAvail.rrd        ns-dskTotalLow.rrd   ns-dskUsed.rrd
ns-dskPercentNode.rrd  ns-dskTotal.rrd

$ cd ../boot
ns-dskAvailHigh.rrd    ns-dskPercent.rrd    ns-dskUsedHigh.rrd
ns-dskAvailLow.rrd     ns-dskTotalHigh.rrd  ns-dskUsedLow.rrd
ns-dskAvail.rrd        ns-dskTotalLow.rrd   ns-dskUsed.rrd
ns-dskPercentNode.rrd  ns-dskTotal.rrd

$ cd ../home
ns-dskAvailHigh.rrd    ns-dskPercent.rrd    ns-dskUsedHigh.rrd
ns-dskAvailLow.rrd     ns-dskTotalHigh.rrd  ns-dskUsedLow.rrd
ns-dskAvail.rrd        ns-dskTotalLow.rrd   ns-dskUsed.rrd
ns-dskPercentNode.rrd  ns-dskTotal.rrd
```

Newts

- Newts data storage is totally different
- Newts stores “as polled” data in an Apache Cassandra cluster

`org.opennms.newts.config.ttl`	`31540000`	Number of seconds after which samples will automatically be deleted. Defaults to one year.
`org.opennms.newts.config.resource_shard`	`604800`	Duration in seconds for which samples will be stored at the same key. Defaults to 7 days in seconds.
`org.opennms.newts.query.minimum_step`	`300000`	Minimum step size in milliseconds. Used to prevent large queries.
`org.opennms.newts.query.interval_divider`	`2`	If no interval is specified in the query, the step will be divided into this many intervals when aggregating values.
`org.opennms.newts.query.heartbeat`	`450000`	Duration in milliseconds. Used when no heartbeat is specified. Should generally be 1.5x your largest collection interval.
`org.opennms.newts.query.parallelism`	Number of cores	Maximum number of threads that can be used to compute aggregates. Defaults to the number of available cores.

SNMP Data Collection

- All Performance Data Collection is controlled by `collectd`
- Data collection for each protocol is managed by a specific `datacollection-config.xml` file:
  - SNMP: `datacollection-config.xml`
  - HTTP: `http-datacollection-config.xml`
  - JMX: `jmx-datacollection-config.xml`
- Where possible, individual configuration files are stored in a specific sub-directory to ease management

collectd-configuration.xml

```
<package name="example1" remote="false">
   <filter>IPADDR != '0.0.0.0'</filter>
   <include-range begin="1.1.1.1" end="254.254.254.254"/>
   <include-range begin="::1" end="ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff"/>
   <service name="SNMP" interval="300000" user-defined="false" status="on">
      <parameter key="collection" value="default"/>
      <parameter key="thresholding-enabled" value="true"/>
   </service>
   <service name="WMI" interval="300000" user-defined="false" status="off">
      <parameter key="collection" value="default"/>
      <parameter key="thresholding-enabled" value="true"/>
   </service>
   <service name="WS-Man" interval="300000" user-defined="false" status="on">
      <parameter key="collection" value="default"/>
      <parameter key="thresholding-enabled" value="true"/>
   </service>
</package>


<collector service="SNMP" class-name="org.opennms.netmgt.collectd.SnmpCollector"/>
<collector service="WMI" class-name="org.opennms.netmgt.collectd.WmiCollector"/>
<collector service="WS-Man" class-name="org.opennms.netmgt.collectd.WsManCollector"/>
```

datacollection-config.xml

```
<datacollection-config xmlns="http://xmlns.opennms.org/xsd/config/datacollection"
rrdRepository="/opt/opennms/share/rrd/snmp/">
   <snmp-collection name="default" snmpStorageFlag="select">
      <rrd step="300">
         <rra>RRA:AVERAGE:0.5:1:2016</rra>
         <rra>RRA:AVERAGE:0.5:12:1488</rra>
         <rra>RRA:AVERAGE:0.5:288:366</rra>
         <rra>RRA:MAX:0.5:288:366</rra>
         <rra>RRA:MIN:0.5:288:366</rra>
      </rrd>
      <include-collection dataCollectionGroup="MIB2"/>
      <include-collection dataCollectionGroup="3Com"/>
      <include-collection dataCollectionGroup="Acme Packet"/>
      <include-collection dataCollectionGroup="AKCP sensorProbe"/>
      <include-collection dataCollectionGroup="Alvarion"/>
      <include-collection dataCollectionGroup="APC"/>
      <include-collection dataCollectionGroup="Ascend"/>
      <include-collection dataCollectionGroup="Asterisk"/>
      <include-collection dataCollectionGroup="Bluecat"/>
      <include-collection dataCollectionGroup="Bluecoat"/>
      <include-collection dataCollectionGroup="Bridgewave"/>
      <include-collection dataCollectionGroup="Brocade"/>
```

SNMP Data Collection Group Files

Data Collection Group Files are stored in the "datacollection" subdirectory, and do three main things:

- Systems (SystemOIDs) are associated with specific groups of OIDs to collect
- Groups are defined that list the OIDs to collect and how to store them
- Generic resources determine how data in tables are collected and stored

The MIB2 Group: Systems

```
<systemDef name="Enterprise">
   <sysoidMask>.1.3.6.1.4.1.</sysoidMask>
   <collect>
      <includeGroup>mib2-interfaces</includeGroup>
      <includeGroup>mib2-tcp</includeGroup>
      <includeGroup>mib2-powerethernet</includeGroup>
   </collect>
</systemDef>
```

The MIB2 Group: TCP Group

```
<group name="mib2-tcp" ifType="ignore">
   <mibObj oid=".1.3.6.1.2.1.6.5"  instance="0" alias="tcpActiveOpens" type="Counter32"/>
   <mibObj oid=".1.3.6.1.2.1.6.6"  instance="0" alias="tcpPassiveOpens" type="Counter32"/>
   <mibObj oid=".1.3.6.1.2.1.6.7"  instance="0" alias="tcpAttemptFails" type="Counter32"/>
   <mibObj oid=".1.3.6.1.2.1.6.8"  instance="0" alias="tcpEstabResets" type="Counter32"/>
   <mibObj oid=".1.3.6.1.2.1.6.9"  instance="0" alias="tcpCurrEstab" type="Gauge32"/>
   <mibObj oid=".1.3.6.1.2.1.6.10" instance="0" alias="tcpInSegs" type="Counter32"/>
   <mibObj oid=".1.3.6.1.2.1.6.11" instance="0" alias="tcpOutSegs" type="Counter32"/>
   <mibObj oid=".1.3.6.1.2.1.6.12" instance="0" alias="tcpRetransSegs" type="Counter32"/>
   <mibObj oid=".1.3.6.1.2.1.6.14" instance="0" alias="tcpInErrors" type="Counter32"/>
   <mibObj oid=".1.3.6.1.2.1.6.15" instance="0" alias="tcpOutRsts" type="Counter32"/>
</group>
```

The MIB2 Group: interfaces Group

```
<group name="mib2-interfaces" ifType="all">
   <mibObj oid=".1.3.6.1.2.1.2.2.1.2"  instance="ifIndex" alias="ifDescr" type="string"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.5"  instance="ifIndex" alias="ifSpeed" type="string"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.10" instance="ifIndex" alias="ifInOctets" type="counter"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.11" instance="ifIndex" alias="ifInUcastpkts" type="counter"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.12" instance="ifIndex" alias="ifInNUcastpkts" type="counter"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.13" instance="ifIndex" alias="ifInDiscards" type="counter"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.14" instance="ifIndex" alias="ifInErrors" type="counter"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.16" instance="ifIndex" alias="ifOutOctets" type="counter"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.17" instance="ifIndex" alias="ifOutUcastPkts" type="counter"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.18" instance="ifIndex" alias="ifOutNUcastPkts" type="counter"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.19" instance="ifIndex" alias="ifOutDiscards" type="counter"/>
   <mibObj oid=".1.3.6.1.2.1.2.2.1.20" instance="ifIndex" alias="ifOutErrors" type="counter"/>
</group>
```

The MIB2 Group: X-interfaces Group

```
<group name="mib2-X-interfaces" ifType="all">
   <mibObj oid=".1.3.6.1.2.1.31.1.1.1.1"  instance="ifIndex" alias="ifName" type="string"/>
   <mibObj oid=".1.3.6.1.2.1.31.1.1.1.15" instance="ifIndex" alias="ifHighSpeed" type="string"/>
   <mibObj oid=".1.3.6.1.2.1.31.1.1.1.6"  instance="ifIndex" alias="ifHCInOctets" type="Counter64"/>
   <mibObj oid=".1.3.6.1.2.1.31.1.1.1.10" instance="ifIndex" alias="ifHCOutOctets" type="Counter64"/>
</group>
```

The MIB2 Group: Non-Unique HR Storage

```
<group name="mib2-host-resources-storage-non-unique" ifType="all">
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.2" instance="hrStorageNonUnique" alias="hrStorageType"
           type="string"/>
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.3" instance="hrStorageNonUnique" alias="hrStorageDescr"
           type="string"/>
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.4" instance="hrStorageNonUnique" alias="hrStorageAllocUnits"
           type="gauge"/>
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.5" instance="hrStorageNonUnique" alias="hrStorageSize"
           type="gauge"/>
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.6" instance="hrStorageNonUnique" alias="hrStorageUsed"
           type="gauge"/>
</group>

<resourceType name="hrStorageNonUnique"
              label="Storage (SNMP MIB-2 Host Resources, non-unique descriptions)"
              resourceLabel="${hrStorageDescr} (index ${index})">
   <persistenceSelectorStrategy class="org.opennms.netmgt.collection.support.PersistAllSelectorStrategy"/>
   <storageStrategy class="org.opennms.netmgt.collection.support.IndexStorageStrategy"/>
</resourceType>
```

The MIB2 Group: HR Storage

```
<group name="mib2-host-resources-storage" ifType="all">
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.2" instance="hrStorageIndex" alias="hrStorageType" type="string"/>
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.3" instance="hrStorageIndex" alias="hrStorageDescr" type="string"/>
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.4" instance="hrStorageIndex" alias="hrStorageAllocUnits"
           type="gauge"/>
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.5" instance="hrStorageIndex" alias="hrStorageSize" type="gauge"/>
   <mibObj oid=".1.3.6.1.2.1.25.2.3.1.6" instance="hrStorageIndex" alias="hrStorageUsed" type="gauge"/>
</group>

<resourceType name="hrStorageIndex" label="Storage (SNMP MIB-2 Host Resources)"
              resourceLabel="${hrStorageDescr}">
   <persistenceSelectorStrategy class="org.opennms.netmgt.collection.support.PersistAllSelectorStrategy"/>
   <storageStrategy class="org.opennms.netmgt.dao.support.SiblingColumnStorageStrategy">
      <parameter key="sibling-column-name" value="hrStorageDescr"/>
      <parameter key="replace-first" value="s/^-$/_root_fs/"/>
      <parameter key="replace-all" value="s/^-//"/>
      <parameter key="replace-all" value="s/\s//"/>
      <parameter key="replace-all" value="s/:\\.*//"/>
   </storageStrategy>
</resourceType>
```

The MIB2 Group: Coffee MIB

```
<group name="mib2-coffee-rfc2325" ifType="ignore">
   <mibObj oid=".1.3.6.1.2.1.10.132.2"    instance="0" alias="coffeePotCapacity" type="integer"/>
   <mibObj oid=".1.3.6.1.2.1.10.132.4.1.2" instance="0" alias="coffeePotLevel" type="integer"/>
   <mibObj oid=".1.3.6.1.2.1.10.132.4.1.6" instance="0" alias="coffeePotTemp" type="integer"/>
</group>
```

Exercise #11-1: Add New SNMP Group

- Create a new script that returns a number
- Use `extend` in net-snmp to expose it via SNMP
- Create a new data collection group
  - Add a new OID group
  - Add a new System definition
- Add the group to the data collection config
- Verify that data is being collected

classcollect.sh

- Create a script called /tmp/classcollect.sh

```
#!/bin/bash
echo $RANDOM
```

- chmod +x /tmp/classcollect.sh
- /tmp/classcollect.sh

```
     306
```

Update `/etc/snmp/snmpd.conf`

- Edit `/etc/snmp/snmpd.conf`
- Add at the bottom

```
extend classcollect /tmp/classcollect.sh
```

- Restart snmpd

```
systemctl restart snmpd
```

View the New extend Output

```
# snmpwalk -v1 -c YrUsonoZ localhost .1.3.6.1.4.1.8072.1.3.2

NET-SNMP-EXTEND-MIB::nsExtendNumEntries.0 = INTEGER: 1
NET-SNMP-EXTEND-MIB::nsExtendCommand."classcollect" = STRING: /tmp/classcollect.sh
NET-SNMP-EXTEND-MIB::nsExtendArgs."classcollect" = STRING:
NET-SNMP-EXTEND-MIB::nsExtendInput."classcollect" = STRING:
NET-SNMP-EXTEND-MIB::nsExtendCacheTime."classcollect" = INTEGER: 5
NET-SNMP-EXTEND-MIB::nsExtendExecType."classcollect" = INTEGER: exec(1)
NET-SNMP-EXTEND-MIB::nsExtendRunType."classcollect" = INTEGER: run-on-read(1)
NET-SNMP-EXTEND-MIB::nsExtendStorage."classcollect" = INTEGER: permanent(4)
NET-SNMP-EXTEND-MIB::nsExtendStatus."classcollect" = INTEGER: active(1)
NET-SNMP-EXTEND-MIB::nsExtendOutput1Line."classcollect" = STRING: 22023
NET-SNMP-EXTEND-MIB::nsExtendOutputFull."classcollect" = STRING: 22023
NET-SNMP-EXTEND-MIB::nsExtendOutNumLines."classcollect" = INTEGER: 1
NET-SNMP-EXTEND-MIB::nsExtendResult."classcollect" = INTEGER: 0
NET-SNMP-EXTEND-MIB::nsExtendOutLine."classcollect".1 = STRING: 22023
```

Use the `-On` Option for Numeric OIDs

```
# snmpwalk -v1 -c YrUsonoZ -On localhost .1.3.6.1.4.1.8072.1.3.2

.1.3.6.1.4.1.8072.1.3.2.1.0 = INTEGER: 1
.1.3.6.1.4.1.8072.1.3.2.2.1.2.12.99.108.97.115.115.99.111.108.108.101.99.116 = STRING:
                                                                              /tmp/classcollect.sh
.1.3.6.1.4.1.8072.1.3.2.2.1.3.12.99.108.97.115.115.99.111.108.108.101.99.116 = STRING:
.1.3.6.1.4.1.8072.1.3.2.2.1.4.12.99.108.97.115.115.99.111.108.108.101.99.116 = STRING:
.1.3.6.1.4.1.8072.1.3.2.2.1.5.12.99.108.97.115.115.99.111.108.108.101.99.116 = INTEGER: 5
.1.3.6.1.4.1.8072.1.3.2.2.1.6.12.99.108.97.115.115.99.111.108.108.101.99.116 = INTEGER: exec(1)
.1.3.6.1.4.1.8072.1.3.2.2.1.7.12.99.108.97.115.115.99.111.108.108.101.99.116 = INTEGER: run-on-read(1)
.1.3.6.1.4.1.8072.1.3.2.2.1.20.12.99.108.97.115.115.99.111.108.108.101.99.116 = INTEGER: permanent(4)
.1.3.6.1.4.1.8072.1.3.2.2.1.21.12.99.108.97.115.115.99.111.108.108.101.99.116 = INTEGER: active(1)
.1.3.6.1.4.1.8072.1.3.2.3.1.1.12.99.108.97.115.115.99.111.108.108.101.99.116 = STRING: 28335
.1.3.6.1.4.1.8072.1.3.2.3.1.2.12.99.108.97.115.115.99.111.108.108.101.99.116 = STRING: 28335
.1.3.6.1.4.1.8072.1.3.2.3.1.3.12.99.108.97.115.115.99.111.108.108.101.99.116 = INTEGER: 1
.1.3.6.1.4.1.8072.1.3.2.3.1.4.12.99.108.97.115.115.99.111.108.108.101.99.116 = INTEGER: 0
.1.3.6.1.4.1.8072.1.3.2.4.1.2.12.99.108.97.115.115.99.111.108.108.101.99.116.1 = STRING: 28335
```

```
99.108.97.115.115.99.111.108.108.101.99.116 = classcollect
```

Create a Data Collection Group File

- `cd /opt/opennms/etc/datacollection`
- `wget -N http://10.42.0.1/Class/Config/Exercise%2011/classgroupfile.xml`
- `cd /opt/opennms/etc`

  Edit `datacollection-config.xml` and add "Group4Class" to the default schema

```
        <include-collection dataCollectionGroup="VMware3"/>
        <include-collection dataCollectionGroup="VMware4"/>
        <include-collection dataCollectionGroup="VMware5"/>
        <include-collection dataCollectionGroup="VMware-Cim"/>
        <include-collection dataCollectionGroup="Group4Class"/>
    </snmp-collection>
```

classgroupfile.xml

```
# cat /opt/opennms/etc/datacollection/classgroupfile.xml

<datacollection-group
   xmlns="http://xmlns.opennms.org/xsd/config/datacollection"
   name="Group4Class">

   <group name="class-oids" ifType="ignore">
      <mibObj
       oid=".1.3.6.1.4.1.8072.1.3.2.4.1.2.12.99.108.97.115.115.99.111.108.108.101.99.116"
       instance="1" alias="classRandom" type="integer"/>
   </group>

   <systemDef name="Class Net-SNMP System">
      <sysoidMask>.1.3.6.1.4.1.8072.</sysoidMask>
      <collect>
         <includeGroup>class-oids</includeGroup>
      </collect>
   </systemDef>

</datacollection-group>
```

datacollection-config.xml

```
<datacollection-config xmlns="http://xmlns.opennms.org/xsd/config/datacollection"
   rrdRepository="/opt/opennms/share/rrd/snmp/">
   <snmp-collection name="default" snmpStorageFlag="select">
      <rrd step="300">
         <rra>RRA:AVERAGE:0.5:1:2016</rra>
         <rra>RRA:AVERAGE:0.5:12:1488</rra>
         <rra>RRA:AVERAGE:0.5:288:366</rra>
         <rra>RRA:MAX:0.5:288:366</rra>
         <rra>RRA:MIN:0.5:288:366</rra>
      </rrd>
      <include-collection dataCollectionGroup="MIB2"/>
      <include-collection dataCollectionGroup="3Com"/>
      <include-collection dataCollectionGroup="Acme Packet"/>
                              .  .  .
      <include-collection dataCollectionGroup="VMware4"/>
      <include-collection dataCollectionGroup="VMware5"/>
      <include-collection dataCollectionGroup="VMware-Cim"/>
      <include-collection dataCollectionGroup="Group4Class"/>
   </snmp-collection>
```

Verify Data is Being Collected

```
# ls -l /opt/opennms/share/rrd/snmp/1

-rw-rw-r-- 1 root root   145 Dec  8 07:01 classRandom.meta
-rw-rw-r-- 1 root root 38232 Dec  8 07:21 classRandom.rrd
-rw-rw-r-- 1 root root    90 Dec  5 22:03 CpuRawIdle.meta
-rw-rw-r-- 1 root root 38232 Dec  8 07:21 CpuRawIdle.rrd
-rw-rw-r-- 1 root root    95 Dec  5 22:03 CpuRawInterrupt.meta
-rw-rw-r-- 1 root root 38232 Dec  8 07:21 CpuRawInterrupt.rrd
-rw-rw-r-- 1 root root    92 Dec  5 22:03 CpuRawKernel.meta
-rw-rw-r-- 1 root root 38232 Dec  8 07:21 CpuRawKernel.rrd
-rw-rw-r-- 1 root root    90 Dec  5 22:03 CpuRawNice.meta
-rw-rw-r-- 1 root root 38232 Dec  8 07:21 CpuRawNice.rrd
-rw-rw-r-- 1 root root   102 Dec  5 22:03 CpuRawSoftIRQ.meta
-rw-rw-r-- 1 root root 38232 Dec  8 07:21 CpuRawSoftIRQ.rrd
-rw-rw-r-- 1 root root    92 Dec  5 22:03 CpuRawSystem.meta
-rw-rw-r-- 1 root root 38232 Dec  8 07:21 CpuRawSystem.rrd
```

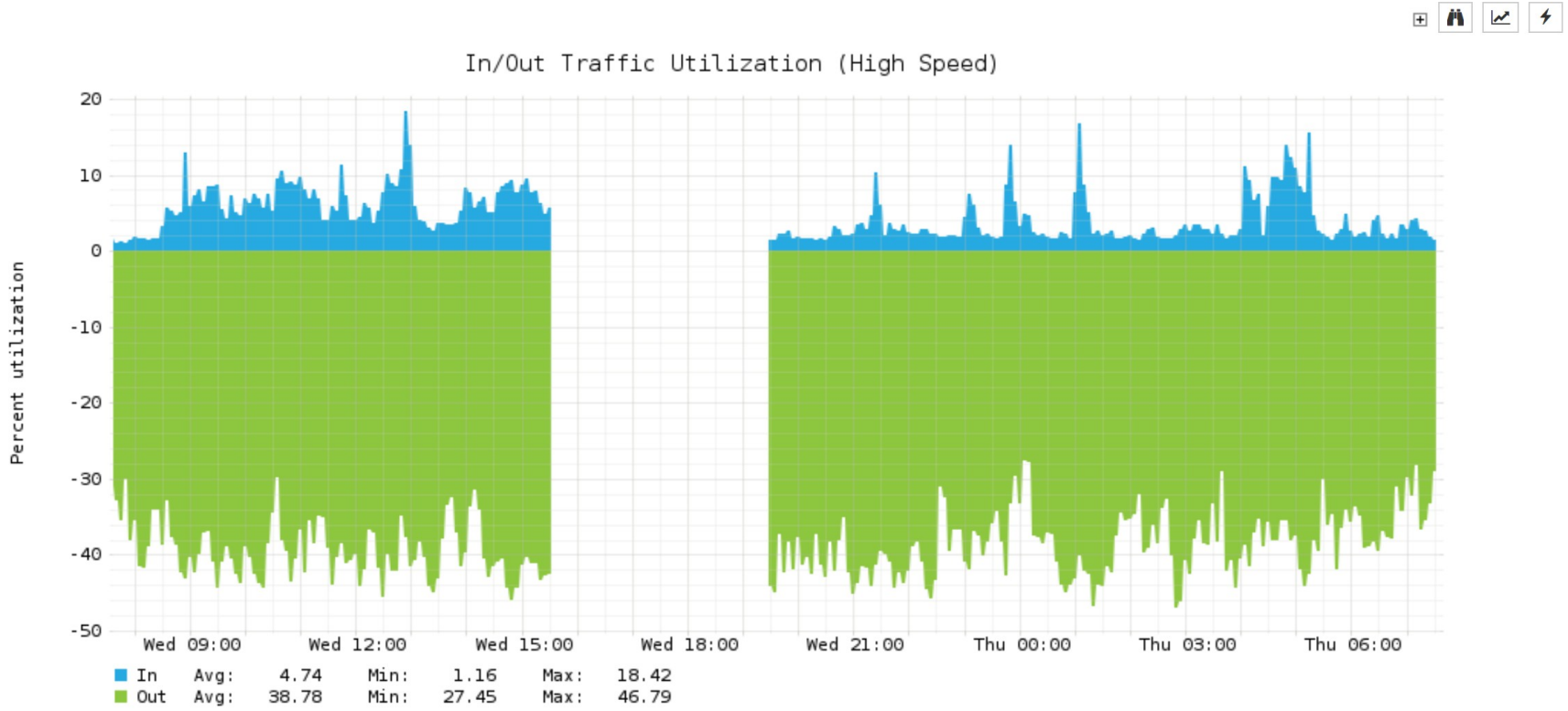
rrdtool dump

```
# rrdtool dump /opt/opennms/share/rrd/snmp/1/classRandom.rrd

    <ds>
        <name> classRandom </name>
        <type> GAUGE </type>
        <minimal_heartbeat>600</minimal_heartbeat>
        <min>NaN</min>
        <max>NaN</max>

        <!-- PDP Status -->
        <last_ds>29679</last_ds>
        <value>8.3694780000e+06</value>
        <unknown_sec> 0 </unknown_sec>
    </ds>

<!-- 2016-12-08 07:45:00 EST / 1481201100 --> <row><v>NaN</v></row>
<!-- 2016-12-08 07:50:00 EST / 1481201400 --> <row><v>NaN</v></row>
<!-- 2016-12-08 07:55:00 EST / 1481201700 --> <row><v>1.5284120000e+04</v></row>
<!-- 2016-12-08 08:00:00 EST / 1481202000 --> <row><v>1.8387720000e+04</v></row>
```

Graphing Performance Values

- RRDtool contains a syntax for creating graphs
- Graphs can display a single variable or a large number of variables
- Reverse Polish Notation can be used to perform mathematical operations on raw RRA data
- With some creativity, detailed and complex graphs can be created
- Graph definitions are stored in: `/opt/opennms/etc/snmp-graph.properties.d`

Bandwith Utilization Graph



/opt/opennms/etc/snmp-graph.properties.d/ mib2-graph.properties

```
reports=mib2.HCbits, \
mib2.bits, \
mib2.HCpercentdiscards, \
mib2.percentdiscards, \
mib2.HCpercenterrors, \
mib2.percenterrors, \
mib2.discards, \
mib2.errors, \
mib2.packets, \
mib2.tcpopen, \
mib2.tcpcurrent, \
mib2.tcperrs, \
mib2.tcpsegs, \
mib2.udpdgrams, \
mib2.udpnoports, \
mib2.udperrors, \
mib2.powerethernet, \
mib2.traffic-inout, \
mib2.HCtraffic-inout, \
```

mib2.HCtraffic-inout

```
report.mib2.HCtraffic-inout.name=InOut Traffic (High Speed)
report.mib2.HCtraffic-inout.suppress=mib2.traffic-inout
report.mib2.HCtraffic-inout.columns=ifHCInOctets,ifHCOutOctets
report.mib2.HCtraffic-inout.type=interfaceSnmp
report.mib2.HCtraffic-inout.propertiesValues=ifHighSpeed
report.mib2.HCtraffic-inout.command=--title="In/Out Traffic Utilization (High Speed)" \
 --vertical-label="Percent utilization" \
 DEF:octIn={rrd1}:ifHCInOctets:AVERAGE \
 DEF:octOut={rrd2}:ifHCOutOctets:AVERAGE \
 CDEF:percentIn=octIn,8,*,1000000,/,{ifHighSpeed},/,100,* \
 CDEF:percentOut=octOut,8,*,1000000,/,{ifHighSpeed},/,100,* \
 CDEF:percentOutNeg=0,percentOut,- \
 COMMENT:"      " \
 AREA:percentIn#27AAE1:"In " \
 GPRINT:percentIn:AVERAGE:"Avg\\: %7.2lf %s" \
 GPRINT:percentIn:MIN:"Min\\: %7.2lf %s" \
 GPRINT:percentIn:MAX:"Max\\: %7.2lf %s\\n" \
 COMMENT:"      " \
 AREA:percentOutNeg#8DC63F:"Out" \
 GPRINT:percentOut:AVERAGE:"Avg\\: %7.2lf %s" \
 GPRINT:percentOut:MIN:"Min\\: %7.2lf %s" \
 GPRINT:percentOut:MAX:"Max\\: %7.2lf %s\\n"
```

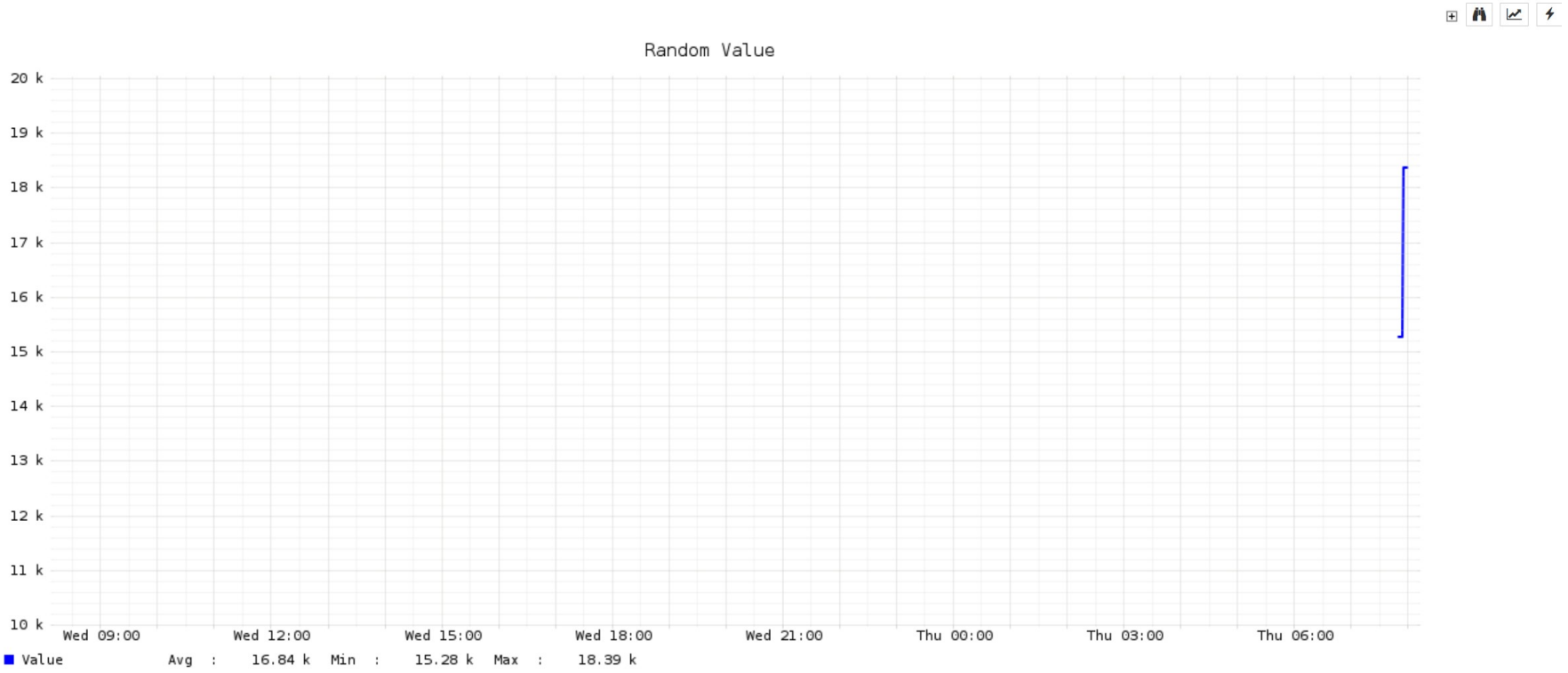
Exercise #11-2: Create a Graph

- Create a new graph properties file

  Place it in `/opt/opennms/etc/snmp-graph.properties.d`

```
# cat class-graph.properties

reports=class.collect


report.class.collect.name=Random Collection Example
report.class.collect.columns=classRandom
report.class.collect.type=nodeSnmp
report.class.collect.command=--title="Random Value" \
 DEF:value={rrd1}:classRandom:AVERAGE \
 LINE2:value#0000ff:"Value          " \
 GPRINT:value:AVERAGE:"Avg  \\: %8.2lf %s" \
 GPRINT:value:MIN:"Min  \\: %8.2lf %s" \
 GPRINT:value:MAX:"Max  \\: %8.2lf %s\\n"
```

Random Graph



Near Realtime Grapher