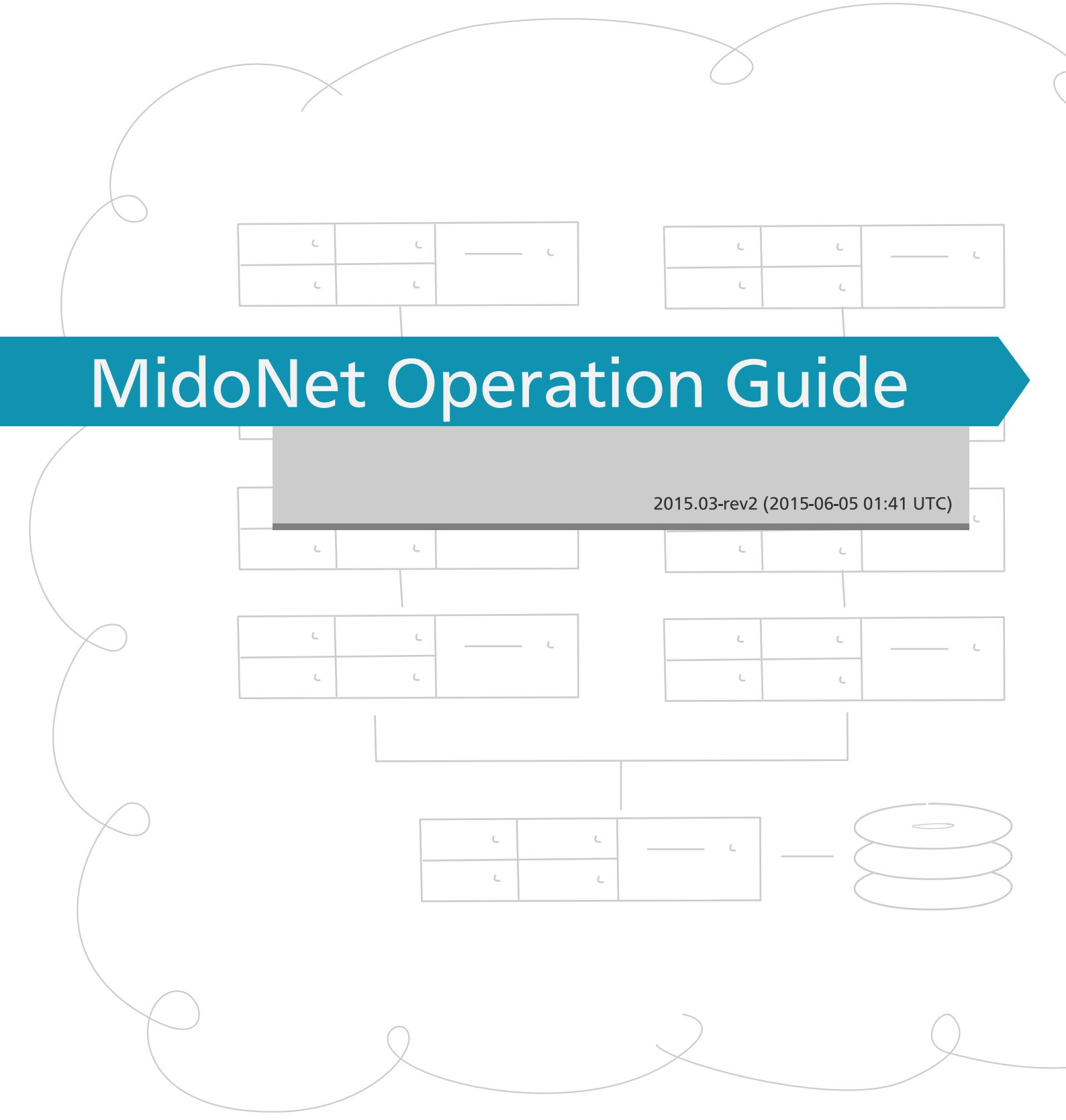


# MidoNet Operation Guide

2015.03-rev2 (2015-06-05 01:41 UTC)

midonet

docs.midonet.org

# MidoNet Operation Guide

2015.03-rev2 (2015-06-05 01:41 UTC)


MidoNet is a network virtualization software for Infrastructure-as-a-Service (IaaS) clouds.

It decouples your IaaS cloud from your network hardware, creating an intelligent software abstraction layer between your end hosts and your physical network.

This guide includes instructions on creating routers, bridges, and ports. It also describes rule chains and several MidoNet features, including L4 load balancing, resource protection, NAT configuration, handling IP packet fragments, and L2 address matching.

## Note

Please consult the MidoNet Mailing Lists or Chat if you need assistance.

# Table of Contents

# List of Figures

# List of Tables

# Preface

## Conventions

The MidoNet documentation uses several typesetting conventions.

## Notices

Notices take these forms:

### Note

A handy tip or reminder.

### Important

Something you must be aware of before proceeding.

### Warning

Critical information about the risk of data loss or security issues.

## Command prompts

**$ prompt**

Any user, including the root user, can run commands that are prefixed with the $ prompt.

**# prompt**

The root user must run commands that are prefixed with the # prompt. You can also prefix these commands with the **sudo** command, if available, to run them.

# 1. Configuring uplinks

## Table of Contents



This section describes how to configure uplinks from a MidoNet-enabled cloud to an external network.

The basic steps for configuring uplinks are:

1. Connect a virtual port to an exterior port.
2. Set up a router. This includes configuring the routes for the traffic between networks.
3. Configure dynamic routing to allow for the exchange of routes between your local autonomous system (AS) and other autonomous systems. MidoNet supports BGP, which is an exterior routing protocol that allows MidoNet to advertize routes, such as the route to the network associated with floating IPs, and receive routes and reachability information from BGP peers.

## BGP Setup

You set up a BGP link to connect MidoNet with an external Autonomous System (AS). This creates an up-link to an external network.

Typically, you connect a MidoNet network to the Internet through two independent up-link routers. In the simple case of connecting MidoNet to the Internet via two BGP-enabled routers, it's best to create two ports on the virtual router and bind them to network interfaces in two different hosts (two Gateway Nodes). This will distribute load between both Gateway Nodes hosts, as well as eliminate a single point of failure. The two ports must be configured as a stateful port pair, for details, refer to the section called "Stateful port groups" [18].

### Note

One BGP session is associated with a virtual router port. MidoNet currently only supports one BGP session per port.

MidoNet uses quagga's bgpd to terminate BGP sessions on behalf of a virtual router. The routes that bgpd learns from its peers are added to the virtual router in MidoNet's topology. The quagga package is provided in the MidoNet release package repositories. Any system running Midolman should already have everything that it needs to set up the BGP. You have to keep in mind that bgpd processes run in the host where a particular virtual router port is bound.

### Important

Make sure you have the following information before setting up the BGP: Local and peer Autonomous System (AS) Numbers for the BGP session. The IP address of the BGP peer.

# Establishing a BGP session

This section walks you through the process of setting up a BGP session.

Make sure you have the following information before setting up the BGP:

- The tenant ID that owns the virtual router that will establish the BGP session. Typically this router is the "MidoNet Provider Router" and the tenant ID to use is "admin".
- Local and peer Autonomous System (AS) Numbers for the BGP session. In our example, we will use 64512 and 64513.
- The IP address of the BGP peer.
- A list of routes to advertise to the BGP peer.
- The UUID of the "MidoNet Provider Router".

Our sample virtual topology contains one router with one port.

1. Start the midonet-cli and find the provider router.

   To start the midonet-cli, at the system prompt, enter:

   ```
   $ midonet-cli
   ```

   At the midonet> prompt that appears, type the following commands:

   ```
   midonet> cleart
   midonet> router list
   router router0 name MidoNet Provider Router
   ```

   The cleart command removes the tenant that is loaded in CLI. Because the provider router does not have tenant ID set, you need to remove the tenant first.

2. Issue the following command to load the admin tenant:

   ```
   midonet> sett admin
   ```

   where *admin* is your admin tenant UUID in OpenStack, for example: 12345678-90123456-123456789012. You can obtain this identifier by calling OpenStack identity service (keystone):

   ```
   $ keystone tenant-list
   ```

3. Create a virtual port for the BGP session.

   You need to create the virtual port to be used for BGP communication with the remote router. To create a new virtual port, enter:

   ```
   midonet> router router0 add port address 10.12.12.1 net 10.12.12.0/24
   router0:port0
   ```

   To verify the created port, enter:

   ```
   midonet> router router0 list port
   port port0 device router0 state up mac 02:47:98:a1:e5:f8 address 10.12.
   12.1 net 10.12.12.0/24
   ```

4. To create a BGP session, start by listing the BGP links on the port:

```
midonet> router router0 port port0 list bgp
```

The output of this command should not return any BGP links. MidoNet only supports one BGP session per port.

Next, add a BGP session to the port:

```
midonet> router router0 port port0 add bgp local-AS 64512 peer-AS 64513
 peer 10.12.12.2
router0:port0:bgp0
midonet> router router0 port port0 list bgp
bgp bgp0 local-AS 64512 peer-AS 64513 peer 10.12.12.2
```

5. Advertise a route.

   At this point, you can advertise routes over the BGP session. In an OpenStack environment, you must advertise public floating IP ranges over BGP in order to provide external connectivity for hosted virtual machines.

```
midonet> router router0 port port0 bgp bgp0 add route net 192.168.12.0/
24
router0:port0:bgp0:ad-route0
midonet> router router0 port port0 bgp bgp0 list route
ad-route ad-route0 net 192.168.12.0/24
```

6. Bind the router's port to a physical network interface.

   If you just created the router port to connect to the BGP peer, the port might not be bound to any network interface. You need to bind the port to an active physical network interface to enable the port (and its BGP sessions).

   To create that binding, you need to know the host and network interface. With that information, you can use the following commands to bind the port to the physical network interface and activate the BGP session.

**Note**

Make sure that no IP address is present on the interface you want to bind to a virtual port, and that the interface is UP.

   First, list the hosts:

```
midonet> host list
host host0 name ip-10-152-161-111 alive true
host host1 name ip-10-164-23-206 alive true
```

   After finding the host, you can list its network interfaces:

```
midonet> host host0 list interface
iface midonet host_id host0 mac 6a:07:42:e2:6c:88 mtu 1500 type Virtual
 endpoint DATAPATH
iface lo host_id host0 addresses [u'127.0.0.1', u'0:0:0:0:0:0:0:1'] mac
 00:00:00:00:00:00 mtu 16436 type Physical endpoint LOCALHOST
iface virbr0 host_id host0 addresses [u'192.168.122.1'] mac
 46:0b:df:a4:91:65 mtu 1500 type Virtual endpoint UNKNOWN
iface osvm-ef97-16fc host_id host0 addresses
 [u'fe80:0:0:0:7cf9:8ff:fe60:54ff'] mac 7e:f9:08:60:54:ff mtu 1500 type
 Virtual endpoint DATAPATH
iface osvm-38d0-266a host_id host0 addresses
 [u'fe80:0:0:0:2034:f5ff:fe89:1b89'] mac 22:34:f5:89:1b:89 mtu 1500 type
 Virtual endpoint DATAPATH
```

```
iface eth0 host_id host0 addresses [u'10.152.161.111',
 u'fe80:0:0:0:2000:aff:fe98:a16f'] mac 22:00:0a:98:a1:6f mtu 1500 type
 Physical endpoint PHYSICAL
iface eth1 host_id host0 mac 22:00:0a:7a:b3:4e mtu 1500 type Physical
 endpoint PHYSICAL
```

In this case, we will bind router0:port0 to interface eth1 on host0:

```
midonet> host host0 add binding port router0:port0 interface eth1
host host0 interface eth1 port router0:port0
```

At this point, the router port is activated in host0 and bgpd starts running.

### Note

The router0 and port0 aliases are auto-generated on demand in each midonet-cli session. Therefore, if you want to create the binding using those aliases (instead of UUIDs), midonet-cli must have "seen" those objects in the current session. To accomplish this, you can list them.

## BGP failover configuration on a BGP peer

The default BGP failover time is 2-3 minutes. However, you can reduce this time by changing some parameters on both ends of the BGP session.

You must make the change in mn-conf(1) on the MidoNet side, and the remote end BGP peer configuration.

The basic BGP timers are 'keepalive' and 'holdtime'. By default, keepalive timer is 60 seconds. The hold-down timer is, by convention, 3 times the keepalive interval, 180 seconds. You can go as low as 1 and 3 seconds for these values, but keep in mind that this may potentially result in the BGP session flapping.

Another important BGP timer that you can tweak is the BGP 'connect_retry' timer, also called the 'connect' timer. You can use this timer to set the amount of time between retries to establish a connection to configured peers which have gone down for some reason.

The example below shows how to reduce the default BGP values to 1, 1, and 3 seconds, for keep-alive, hold-time, and connect-retry, respectively, on the BGP peer's session end (e.g. Quagga or Cisco):

```
neighbor 192.0.2.1 timers 1 3
neighbor 192.0.2.1 timers connect 1
```

To match those settings you would have to set the following parameters on the MidoNet end of the BGP session:

```
# bgpd
bgp_connect_retry=1
bgp_holdtime=3
bgp_keepalive=1
```

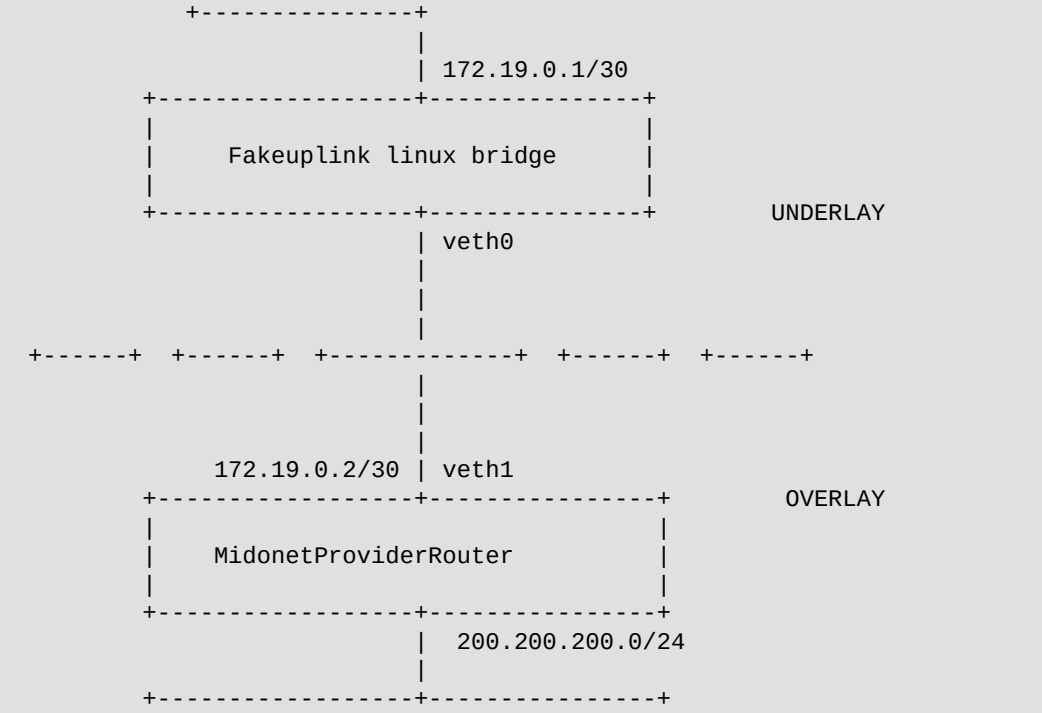
# Static Setup

If you are not connecting through a BGP link, or you just want to use static routing follow this section.

This creates a static up-link to connect VMs to the external network.

1. Create fake uplink

   We are going to create the following topology to allow the VMs reach external networks:




2. Create a veth pair

```
# ip link add type veth
# ip link set dev veth0 up
# ip link set dev veth1 up
```

3. Create a bridge, set an IP address and attach veth0

```
# brctl addbr uplinkbridge
# brctl addif uplinkbridge veth0
# ip addr add 172.19.0.1/30 dev uplinkbridge
# ip link set dev uplinkbridge up
```

4. Enable IP forwarding

```
# sysctl -w net.ipv4.ip_forward=1
```

5. Route packets to 'external' network to the bridge

```
# ip route add 200.200.200.0/24 via 172.19.0.2
```

6. Create a port on the MidoNet Provider Router and bind it to the veth:

```
$ midonet-cli
midonet> router list
router router0 name MidoNet Provider Router state up
midonet> router router0 add port address 172.19.0.2 net 172.19.0.0/30
router0:port0
midonet> router router0 add route src 0.0.0.0/0 dst 0.0.0.0/0 type
 normal port router router0 port port0 gw 172.19.0.1
midonet> host list
host host0 name controller alive true
midonet> host host0 add binding port router router0 port port0 interface
 veth1
```

```
host host0 interface veth1 port router0:port
```

7. Add masquerading to your external interface so connections coming from the overlay with addresses that belong to the "fake" external network are NATed. Also make sure these packets can be forwarded:

```
# iptables -t nat -I POSTROUTING -o eth0 -s 200.200.200.0/24 -j
 MASQUERADE
# iptables -I FORWARD -s 200.200.200.0/24 -j ACCEPT
```

Now we can reach VMs from the underlay host using their floating IPs, and VMs can reach external networks as well (as long as the host has external connectivity).

# 2. Authentication and authorization

## Table of Contents



The MidoNet Application Programming Interface (API) provides its authentication and authorization services by integrating with external identity services.

It does not provide an API to create or delete tenants, but it does have an API to tag resources and filter queries with tenant IDs. Tenants are managed completely by the external identity service, and where appropriate, the string representations of tenant IDs are sent in the requests to the MidoNet API. This design makes possible a federated identity service model where one identity service provides authentication and authorization to all the services in the cloud environment, including the MidoNet API.

Although the MidoNet API does not provide its own identity service, it does provide simple authentication (for validating the user) and authorization (for checking the access level of the user) functionality. For authentication, it simply takes the token included in the HTTP header and forwards it to the external identity service. To generate a new token, it also provides an API to log in to the external identity service with username/password credentials. (See the MidoNet REST API document for more information on the token.) For authorization, the MidoNet API provides a very simple Role-Based Access Control (RBAC) mechanism explained in the next section.

See the MidoNet REST API document for information on implementing authentication and authorization using MidoNet's API. Go to http://docs.openstack.org/ and follow the links to Documentation and API for information about the OpenStack API.

# Available authentication services in MidoNet

There are two auth modes in MidoNet API: KeystoneAuthService and MockAuthService.

This section describes the Keystone authentication service, mock authentication, and how to select the desired service using the web.xml file.

## Keystone-specific configurations

In order to use the OpenStack Keystone authentication service with MidoNet, you must configure settings in your web.xml file.

This is how you specify Keystone for the authentication service. The name of the configuration element is: keystone-service_protocol and the allowed values are: http, https. http allows you to access Keystone using plain text HTTP. However, if you specify https, the connection between the MidoNet API server and the Keystone authentication server will be encrypted, which is recommended. The example below shows the name and value key pair encoded in XML used to configure encrypted communication using Keystone.

### Table 2.1. Keystone Service Protocols

| Parameter Name | Value | Description |
|---|---|---|
| | keystone-service_protocol | keystone-service_protocol |
| http | Use plain HTTP to communicate with the Keystone server. | |

Edit the `/usr/share/midonet-api/WEB-INF/web.xml` file to contain the desired service protocol:

```
<context-param>
    <param-name>keystone-service_protocol</param-name>
    <param-value>https</param-value>
</context-param>
```

## About mock authentication

Mock authentication mocks an authentication system by mapping fake tokens to any roles in the `web.xml` configuration file. If a token mapped to the admin role is used in the API request, authentication and authorization are effectively disabled.

### Warning

This mode is used for testing purposes but should not be used in production.

# Roles in MidoNet

The MidoNet API implements an RBAC mechanism to perform authorization.

Defined in the AuthRole class, the roles in MidoNet are:

- Admin: The root administrator of the system. Users with this role are allowed to do all operations.
- TenantAdmin: Users with this role have write and read access to their own resources.
- TenantUser: Users with this role only have read access to their own resources.

### Note

Keep in mind that the RBAC policies defined in the external identity services are not applied to MidoNet RBAC. For example, the type of access you receive in Keystone does not directly map to the exact same access in MidoNet. The MidoNet API strictly follows the policies for the three roles described above.

## Creating admin roles for MidoNet

The authorization service relies on the entries specified in the web.xml file to determine the role mapping. web.xml is the configuration file for the MidoNet API and is located in:

```
/usr/share/midonet-api/WEB-INF/web.xml
```

The configuration elements you configure in the web.xml file consist of a name and value pair. When you add a name and value pair, you need to encode them in XML.

You can use the authorization service to convert the roles in an external service (like OpenStack Keystone) to those in MidoNet. The example below shows how to create separate admin roles (auth-admin-role, auth-tenant-admin, and auth-tenant_user_role) for MidoNet.

**Table 2.2. Admin Roles**

| Name | Value | Description |
|---|---|---|
| auth-admin_role | [name] | Specifies the name for the admin role in MidoNet. |
| auth-tenant_admin_role | [name] | Specifies the name for the tenant admin role in MidoNet. |
| auth-tenant_user_role | [name] | Specifies the name for the tenant user role in MidoNet. |

```
...
<context-param>
    <param-name>auth-admin_role</param-name>
    <param-value>mido_admin</param-value> </context-param>
<context-param>
    <param-name>auth-tenant_admin_role</param-name>
    <param-value>mido_tenant_admin</param-value> </context-param>
<context-param>
    <param-name>auth-tenant_user_role</param-name>
    <param-value>mido_tenant_user</param-value>
</context-param>
...
```

In the above example, mido_admin, mido_tenant_admin, and mido_tenant_user roles stored in the external service are translated to admin, tenant_admin, and tenant_user in Midonet, respectively.

# Using the Keystone authentication service

This section explains how to use the Keystone authentication service with MidoNet.

## Enabling Keystone authentication

In order to use the OpenStack Keystone authentication service with MidoNet, you must configure a number of settings in your web.xml file.

### auth-auth_provider

Lists the fully qualified path of the Java class that provides the authentication service.

```
<context-param>
  <param-name>auth-auth_provider</param-name>
  <param-value>
    org.midonet.api.auth.keystone.v2_0.KeystoneService
  </param-value>
</context-param>
```

### keystone-service_protocol

Identifies the protocol used for the Keystone service.

```
<context-param>
  <param-name>keystone-service_protocol</param-name>
  <param-value>http</param-value>
```

```
</context-param>
```

### keystone-service_host

Identifies the host of the Keystone service.

```
<context-param>
  <param-name>keystone-service_host</param-name>
  <param-value>192.168.100.104</param-value>
</context-param>
```

### keystone-service_port

Identifies the port number of the Keystone service.

```
<context-param>
  <param-name>keystone-service_port</param-name>
  <param-value>35357</param-value>
</context-param>
```

### keystone-admin_token

Identifies the token of the admin user in Keystone that the API uses to make requests to Keystone.

```
<context-param>
  <param-name>keystone-admin_token</param-name>
  <param-value>secret_token_XYZ</param-value>
</context-param>
```

### auth-admin_role

Identifies the name of the admin role in MidoNet. The admin has read and write access to all the resources. We recommend re-using the OpenStack "admin" role. Optionally you can create a separate admin role for MidoNet.

```
<context-param>
  <param-name>auth-admin_role</param-name>
  <param-value>admin</param-value>
</context-param>
```

### keystone-tenant_name

Specifies the name of the tenant that is used when logging into Keystone. The log-in authentication to Keystone requires the username, password, and tenant name of the user. By specifying the tenant name here, you can avoid the need for applications to supply the tenant name when logging into Keystone through the MidoNet API.

```
<context-param>
  <param-name>keystone-tenant_name</param-name>
  <param-value>admin</param-value>
</context-param>
```

## Disabling Keystone authentication

MidoNet lets you disable authentication by using a mock authentication service.

Using this service has the effect that no outside authentication service is used. Instead, MidoNet will simply return tokens based on what is set in the web.xml file.

To use the mock authentication service, you must configure the following settings in your web.xml file.

## auth-auth_provider

Lists the fully qualified path of the Java class that provides the authentication service.

```
<context-param>
  <param-name>auth-auth_provider</param-name>
  <param-value>
    org.midonet.api.auth.MockAuthService
  </param-value>
</context-param>
```

## mock_auth-admin_token

Identifies the fake token used to emulate admin role access. This is only applicable if you specify mock authentication (MockAuth) as the authentication service.

```
<context-param>
  <param-name>mock_auth-admin_token</param-name>
  <param-value>secret_token_XYZ</param-value>
</context-param>
```

## mock_auth-tenant_admin_token

Identifies the fake token used to emulate tenant admin role access. This is only applicable if you specify mock authentication (MockAuth) as the authentication service.

```
<context-param>
  <param-name>mock_auth-tenant_admin_token</param-name>
  <param-value>secret_token_XYZ</param-value>
</context-param>
```

## mock_auth-tenant_user_token

Identifies the fake token used to emulate tenant user role access. This is only applicable if you specify mock authentication (MockAuth) as the authentication service.

```
<context-param>
  <param-name>mock_auth-tenant_user_token</param-name>
  <param-value>secret_token_XYZ</param-value>
</context-param>
```

# 3. Admitting resources to MidoNet

## Table of Contents



When started, the MidoNet Agent (midolman) automatically connects to the ZooKeeper database and registers itself as an available host. You need to admit that host into a tunnel zone so the host can communicate within the tunnel zone to other hosts.

You can think of this as registering the host. When you admit a host, you select the physical interface the host will use for communication with other hosts. This interface must be connected to the underlay network. After you select the interface, you bind it to the tunnel zone. This allows the host to establish tunnels with all the other hosts in the tunnel zone via the selected interface.

# What are tunnel zones?

A tunnel zone is an isolation zone for hosts.

Physical hosts in the same tunnel zone, communicate directly with one another, without a need to use a tunnel. MidoNet supports two types of tunnel zones for separating physical hosts in the underlay, GRE (default) and VXLAN.

A third type of a tunnel zone, VTEP, is used for connecting MidoNet hosts to a hardware VTEP. Whereas, a MidoNet host may only belong to one tunnel zone, type GRE or VXLAN, it may belong to two different tunnel zones if one of them is of GRE/VXLAN type and the other one of VTEP type. In fact, this configuration is required to successfully connect a MidoNet host to a hardware VTEP. For more information, see "VXLAN configuration" section in the "MidoNet Operation Guide".

## Creating tunnel zones

This section describes how to create tunnel zones.

1. Enter the `create tunnel-zone name tz-name type tz-type` command to create a new tunnel zone, where *tz-type* is tunnel zone type, gre, vxlan, or vtep. For example:

   ```
   midonet> create tunnel-zone name new-tz type gre
   tzone0
   ```

   Where: new-tz = the name you want to assign to the tunnel zone; the output shows the alias ("tzone0") assigned to the tunnel zone

2. Enter the `list tunnel-zone` command to list and confirm the tunnel zone. For example:

   ```
   midonet> list tunnel-zone
   tzone tzone0 name new-tz type gre
   tzone tzone1 name gre type gre
   ```

## Deleting tunnel zones

Use this procedure to delete a tunnel zone.

1. Enter the `list tunnel-zone` command to list the tunnel zones. For example:

```
midonet> list tunnel-zone
tzone tzone0 name new-tz type gre
tzone tzone1 name gre type gre
```

2. Enter the `delete tunnel-zone tz-alias` command to delete the desired tunnel zone. For example:

```
midonet> delete tunnel-zone tzone0
```

   Specify the dynamically assigned number of the alias for the tunnel zone to delete; in the above example, the assigned number is 0 (tzone0).

3. (Optional) Enter the command to list the tunnel zones to confirm the deletion:

```
midonet> list tunnel-zone
tzone tzone1 name gre type gre
```

## Viewing tunnel zone information

Use this procedure to view tunnel zone information.

```
midonet> tunnel-zone tzone0 list member
zone tzone0 host host0 address 192.168.0.3
zone tzone0 host host1 address 192.168.0.5
zone tzone0 host host2 address 192.168.0.4
zone tzone0 host host3 address 192.168.0.6
```

The above output shows the:

- Aliases for the hosts in the tunnel zone (host0, host1, and so on)
- IP addresses assigned to the hosts

# Working with hosts

This section shows how to view host information and admit new hosts to a tunnel zone.

## Viewing host information

Use this procedure to view information about hosts.

- To list the hosts enter the command:

```
midonet> list host
host host0 name controller alive true
host host2 name compute1 alive true
host host3 name compute3 alive false
host host1 name compute2 alive false
```

- To list the interfaces on a certain host enter the command:

```
midonet> host host0 list interface
iface midonet host_id host0 status 0 addresses [] mac 12:6e:b7:d0:4f:f1
 mtu 1500 type Virtual endpoint DATAPATH
```

```
iface lo host_id host0 status 3 addresses [u'127.0.0.1',
 u'0:0:0:0:0:0:0:1'] mac 00:00:00:00:00:00 mtu 65536 type Virtual
 endpoint LOCALHOST
iface tapbf954474-ef host_id host0 status 3 addresses
 [u'fe80:0:0:0:dc40:9aff:feef:7b5e'] mac de:40:9a:ef:7b:5e mtu 1500 type
 Virtual endpoint DATAPATH
iface eth0 host_id host0 status 3 addresses [u'192.168.0.3',
 u'fe80:0:0:0:f816:3eff:febe:590'] mac fa:16:3e:be:05:90 mtu 8842 type
 Physical endpoint PHYSICAL
```

- To show the port binding for a certain host enter the command:

```
midonet> host host0 list binding
host host0 interface tapbf954474-ef port bridge0:port0
```

The above output shows that device tap tapbf954474-ef on host0 is currently connected to port0 on bridge0.

# Admitting a host

You need to add new hosts to a tunnel zone. Use this procedure to admit a host into a tunnel zone.

1. To view a list of all tunnel zones, enter the `list tunnel-zone` command. For example:

```
midonet> list tunnel-zone
tzone tzone0 name gre type gre
```

2. To view the list of all hosts, enter the `list host` command. For example:

```
midonet> list host
host host0 name compute-1 alive true
host host1 name compute-2 alive true
```

3. To list all interfaces on a host, enter the `host hostX list interface` command (where: X is the dynamically assigned number for the desired host alias).

```
midonet> host host0 list interface
iface lo host_id host0 status 3 addresses [u'127.0.0.1',
 u'0:0:0:0:0:0:0:1'] mac 00:00:00:00:00:00 mtu 65536 type Virtual
 endpoint LOCALHOST
iface midonet host_id host0 status 0 addresses [] mac 8e:4d:60:c1:70:d7
 mtu 1500 type Virtual endpoint DATAPATH
iface eth1 host_id host0 status 3 addresses
 [u'fe80:0:0:0:250:56ff:fe93:7c35'] mac 00:50:56:93:7c:35 mtu 1500 type
 Physical endpoint PHYSICAL
iface eth0 host_id host0 status 3 addresses [u'10.1.2.200',
 u'fe80:0:0:0:250:56ff:fe93:c9a4'] mac 00:50:56:93:c9:a4 mtu 1500 type
 Physical endpoint PHYSICAL
```

Note the IP address of the interface that will be used for tunnel creation.

4. Enter the `tunnel-zone tzone add member host host` command to add a new member (host) to a tunnel zone. For example:

```
midonet> tunnel-zone tzone0 add member host host0
address host zone
```

5. Enter the `tunnel-zone tzone add member host host address ip-address` command to specify the IP address of the new member. For example:

```
midonet> tunnel-zone tzone0 add member host host0 address 10.1.2.200
```

In the above command example:

- tzone0 = the tunnel zone you want to add the member (host) to
- host0 = the alias of the host you want to add
- 10.1.2.200 = the IP address of the host you want to add

## Removing a host from a tunnel zone

Use this procedure to remove a host from a tunnel zone.

1. Enter the `list tunnel-zone` command to list the tunnel zone. For example:

```
midonet> list tunnel-zone
tzone tzone0 name default_tz type gre
```

2. Enter the `tunnel-zone tunnel-zone list member` command to list the tunnel zone members (hosts). For example:

```
midonet> tunnel-zone tzone0 list member
zone tzone0 host host0 address 172.19.0.2
```

3. Enter the `tunnel-zone tunnel-zone member host host show` command to show information about a specific host. For example:

```
midonet> tunnel-zone tzone0 member host host0 show
tunnel-zone-host zone tzone0 host host0 address 172.19.0.2
```

4. Enter the `tunnel-zone tunnel-zone member host host delete` command to delete the desired host (identified by the host's alias). For example:

```
midonet> tunnel-zone tzone0 member host host0 delete
```

5. (Optional) You can add the host back to the tunnel zone, using the `tunnel-zone tunnel-zone member add host host address ip-address` command as shown below:

```
midonet> tunnel-zone tzone0 member add host host0 address 172.19.0.2
zone tzone0 host host0 address 172.19.0.2
```

## Removing a host

Use this procedure to remove inactive hosts.

1. Enter the command to list the hosts:

```
midonet> list host
host host0 name precise64 alive true
```

2. Enter the command to delete the desired host (identified by its alias):

```
midonet> host host0 delete
```

# 4. Device abstractions

## Table of Contents



The major resources in MidoNet's virtual network model are routers, bridges, ports, load balancers, VTEPs, chains, and rules.

Routers, bridges, and ports are devices that comprise a virtual network topology and chains and rules are policies applied to the network elements.

MidoNet lets you create routers and bridges.

## Creating a router

You can create routers to provide L3 connectivity on a virtual network.

To create a router:

1. Enter the following command to list the routers on the current tenant:

```
midonet> list router
midonet>
```

   The above example shows no routers on the current tenant.

2. Enter the command to create a new router and assign it a name:

```
midonet> router create name test-router
router1
```

   The above command example shows how to create a new router named "test-router". The output shows the alias "router1" assigned to the new router.

## Adding a port to a router

You need to add a port to a router to connect the router to a bridge (network) or another router.

### Note

When using the MidoNet CLI, if necessary, use the sett command or some other means to access the desired tenant.

1. Enter the command to add a port to the desired router and specify the desired IP address and network for the port:

```
midonet> router router1 add port address 10.100.1.1 net 10.0.0.0/24
```

```
router1:port0
```

The above output shows the alias ("port0") assigned to the new port.

2. Enter the command to list port information for the router:

```
midonet> router router1 list port
port port0 device router1 state up mac 02:a6:81:08:ab:5d address 10.100.
1.1 net 10.0.0.0/24
```

The above output shows the:

- Alias assigned to the port ("port0")
- Device the port is attached to (router1)
- Port's state (up)
- Port's MAC address
- Port's IP and network addresses

# Adding a bridge

Use this procedure to create a bridge.

Enter the following command to create a bridge and assign it a name:

```
midonet> bridge create name test-bridge
bridge1
```

The above output shows the alias ("bridge1") assigned to the new bridge.

# Adding a port to a bridge

Use this procedure to add a port to a bridge.

1. Enter the command to list the bridges on the current tenant:

```
midonet> bridge list
bridge bridge1 name test-bridge state up
```

2. Enter the command to add a port to the desired bridge:

```
midonet> bridge bridge1 add port
bridge1:port0
```

The above output shows the alias ("port0") assigned to the new port.

# Binding an exterior port to a host

In order to connect a MidoNet-enabled cloud to an external network, you need to bind an exterior port to a host, such as a network interface card (NIC) with an ID of eth0, for example.

1. Enter the command to list the hosts:

```
midonet> list host
host host0 name compute-1 alive true
host host1 name compute-2 alive true
```

2. Enter the command to list the bridges on the current tenant:

```
midonet> list bridge
bridge bridge0 name External state up
bridge bridge1 name Management state up
bridge bridge2 name Internal state up
```

3. Enter the command to list the ports on the desired bridge:

```
midonet> bridge bridge0 list port
port port0 device bridge0 state up
port port1 device bridge0 state up
port port2 device bridge0 state up
```

4. Enter the command to list the interfaces on a certain host:

```
midonet> host host0 list interface
iface lo host_id host0 status 3 addresses [u'127.0.0.1',
 u'0:0:0:0:0:0:0:1'] mac 00:00:00:00:00:00 mtu 65536 type Virtual
 endpoint LOCALHOST
iface midonet host_id host0 status 0 addresses [] mac 8e:4d:60:c1:70:d7
 mtu 1500 type Virtual endpoint DATAPATH
iface eth1 host_id host0 status 3 addresses
 [u'fe80:0:0:0:250:56ff:fe93:7c35'] mac 00:50:56:93:7c:35 mtu 1500 type
 Physical endpoint PHYSICAL
iface eth0 host_id host0 status 3 addresses [u'10.1.2.200',
 u'fe80:0:0:0:250:56ff:fe93:c9a4'] mac 00:50:56:93:c9:a4 mtu 1500 type
 Physical endpoint PHYSICAL
```

5. Enter the command to bind a certain host to virtual port:

```
midonet> host host0 add binding
host interface port
```

6. Enter the command to bind a virtual port on the bridge with a physical interface on the host:

```
midonet> host host0 add binding port bridge0:port0 interface eth1
host host0 interface eth1 port bridge0:port0
```

# Stateful port groups

MidoNet features stateful port groups, which are groups of virtual ports (typically two) that are logically associated, usually to perform load balancing or for link redundancy.

For such ports MidoNet keeps state local to the two endpoints of a connection. In most cases, connections that traverse MidoNet do so between a single pair of ports. Typical cases include a router with two uplink BGP ports, or an L2GW with two ports connected to a physical L2 network. In both cases, the pair of ports becomes a set of ports because packets may return through different paths. Those port pairs will share state.

You configure stateful port groups in the MidoNet CLI, using the port-group command.

## Creating stateful port groups

Follow the steps of this procedure to create a stateful group of ports, using the MidoNet CLI.

Before you launch the MidoNet CLI you need to find out the OpenStack UUID of the tenant on which you want to create your port group. To this end, you can use keystone. Issue the following commands in the terminal on the MidoNet host:

```
[root@rhos5-allinone-jenkins ~]# source keystonerc_admin
[root@rhos5-allinone-jenkins ~(keystone_admin)]# keystone tenant-list
+----------------------------------+----------+---------+
|                id                |   name   | enabled |
+----------------------------------+----------+---------+
| 7a4937fa604a425e867f085427cc351e |  admin   |   True  |
| 037b382a5706483a822d0f7b3b2a9555 | alt_demo |   True  |
| 0a1bf57198074c779894776a9d002146 |   demo   |   True  |
| 28c40ac757e746f08747cdb32a83c40b | services |   True  |
+----------------------------------+----------+---------+
```

The output of the command shows the full list of tenants. For this procedure we will use the 'admin' tenant, 7a4937fa604a425e867f085427cc351e.

1. In the MidoNet CLI determine the list of available routers.

   ```
   midonet> list router
   router router0 name MidoNet Provider Router state up
   router router1 name TenantRouter state up
   ```

   Let's assume that the router whose ports you are going add to the port group is MidoNet Provider Router, router0.

2. Now list the ports on router0.

   ```
   midonet> router router0 list port
   port port0 device router0 state up mac 02:c2:0f:b0:f2:68 address 100.
   100.100.1 net 100.100.100.0/30
   port port1 device router0 state up mac 02:cb:3d:85:89:2a address 172.
   168.0.1 net 172.168.0.0/16
   port port2 device router0 state up mac 02:46:87:89:49:41 address 200.
   200.200.1 net 200.200.200.0/24 peer bridge0:port0
   port port3 device router0 state up mac 02:6b:9f:0d:c4:a8 address 169.
   254.255.1 net 169.254.255.0/30
   ```

   You want to add port0 and port1 on the router to load balance the BGP traffic on the provider router.

3. Load your tenant using the 'sett' command.

   ```
   midonet-cli> sett 7a4937fa604a425e867f085427cc351e
   tenant_id: 7a4937fa604a425e867f085427cc351e
   ```

4. Create a stateful port group using the 'port-group create' command.

   ```
   midonet-cli> port-group create name SPG stateful true
   pgroup0
   ```

5. Add the two ports on the provider router that you want to participate in load balancing, to the port group you just created.

   ```
   midonet> port-group pgroup0 add member port router0:port0
   port-group pgroup0 port router0:port0
   midonet> port-group pgroup0 add member port router0:port1
   port-group pgroup0 port router0:port1
   ```

You have successfully added both router ports to the stateful port group, which you can verify by issuing the following command:

```
midonet> port-group pgroup0 list member
port-group pgroup0 port router0:port1
port-group pgroup0 port router0:port0
```

# 5. Connecting devices

## Table of Contents



You can create a virtual topology by connecting routers to bridges, to switches, and to other routers.

## Connecting a bridge to a router

You can easily connect a virtual bridge to a virtual router via virtual ports on the two devices. Make sure you create a bridge and a router with an Interior port on each device.

### Note

See the section called "Creating a router" [16] and the section called "Adding a bridge" [17] for information about creating routers and bridges and adding router and bridge ports.

To connect a bridge to a router:

1. Enter the command to list the bridges on the current tenant:

```
midonet> list bridge
bridge bridge1 name test-bridge state up
```

2. Enter the command to list the ports on the bridge:

```
midonet> bridge bridge1 list port
port port0 device bridge1 state up
```

3. Enter the command to list the routers on the current tenant:

```
midonet> list router
router router1 name test-router state up
```

4. Enter the command to list the ports on the router:

```
midonet> router router1 list port
port port0 device router1 state up mac 02:a6:81:08:ab:5d address 10.100.
1.1 net 10.0.0.0/24
```

5. Enter the command to bind the desired router port (for example, port0 on router1) to the desired bridge port (for example, port0 on bridge1):

```
midonet> router router1 port port0 set peer bridge1:port0
```

6. Enter the command to list the ports on the router (in this example, router1):

```
midonet> router router1 list port
port port0 device router1 state up mac 02:a6:81:08:ab:5d address 10.100.
1.1 net 10.0.0.0/24 peer bridge1:port0
```

The above output shows that port0 on router1 is connected to port0 on bridge1.

# Connecting two routers

You can easily connect two virtual routers via virtual ports on each router.

Make sure you create the router ports on the two routers and assign the ports to the same subnet. See Chapter 4, "Device abstractions" [16] for information about creating routers and adding router ports.

To connect two routers:

1. Enter the command to list the routers on the current tenant:

```
midonet> list router
router router3 name test-router2 state up
router router1 name test-router state up
```

2. Enter the command to list the ports on one of the routers you want to connect:

```
midonet> router router1 list port
port port0 device router1 state up mac 02:a6:81:08:ab:5d address 10.100.
1.1 net 10.0.0.0/24 peer bridge1:port0
port port1 device router1 state up mac 02:fa:5f:87:bb:d2 address 10.100.
1.2 net 10.0.0.0/24
```

3. Enter the command to list the ports on the router you want to connect it to:

```
midonet> router router3 list port
port port0 device router3 state up mac 02:df:24:5b:19:9b address 10.100.
1.128 net 10.0.0.0/24
```

4. Enter the command to bind the port on one router (for example, port 1 on router1) to the port on another router (for example, port0 on router3):

```
midonet> router router1 port port1 set peer router3:port0
```

5. Enter the command to list the ports on one of the routers:

```
midonet> router router1 list port
port port0 device router1 state up mac 02:a6:81:08:ab:5d address 10.100.
1.1 net 10.0.0.0/24 peer bridge1:port0
port port1 device router1 state up mac 02:fa:5f:87:bb:d2 address 10.100.
1.2 net 10.0.0.0/24 peer router3:port0
```

   The above output shows that port1 on router1 is connected to port0 on router3.

# 6. Routing

## Table of Contents



Routing in a MidoNet-enabled network works the same as on physical routers. Virtual routers route packets to locally connected networks and hosts directly connected to it and forward packets to gateways for delivery to external networks.

## Routing process overview

For traffic that ingresses a router port, the router does the following:

- Attempts to match a given packet's destination with a route in its routing table based on the packet's source and destination.
- For packets with more than one matching route, uses random selection based on the routes' weight values to route the packets.
- For packets that don't match routes with matching sources and destinations, drops these packets.

The router uses information in the following fields in the routing table:

- Source: defines the IP addresses and networks to filter and evaluate for delivery to directly connected networks and hosts or forward to gateways to other networks.
- Route Type: determines the action to take on the packet.
- Next Hop Port and Next Hop Gateway: determine where to route the packet.

Below are two sample routes on a tenant router (displayed using the MidoNet CLI):

```
route route2 type normal src 0.0.0.0/0 dst 172.16.3.0/24 port router0:port1
 weight 100
route route3 type normal src 172.16.3.0/24 dst 169.254.169.254 gw 172.16.3.
2 port router0:port1 weight 100
```

### Source

Shows the route's source prefix for source-based routing. The algorithm to decide which route applies to the packet is briefly as follows:

1. Disregard all routes whose source prefix does not match the packet's source. The source prefix, 0.0.0.0/0, matches everything. Note that /0 denotes a bit mask of length zero, so the address 0.0.0.0 is ignored.
2. Find the route whose destination prefix matches the packet's destination and has the longest mask (a.k.a. longest-prefix matching).

3. If there's more than one route candidate (with equal destination prefix mask length), use weighted random selection based on the routes' Weight fields.

## Type

There are three types: Normal, Blackhole, and Reject.

- Normal: normal type of route for forwarding packets. Use Next Hop Gateway and Next Hop Port information to route packets.
- Blackhole: tells the router that when a packet matches this route, the packet should be dropped, without sending any notification. If no floating IP addresses exist on an external network, traffic is routed to a Blackhole, where the traffic is dropped.
- Reject: similar to Blackhole, except when a packet matches this route, the router returns an ICMP error (MidoNet only sends the error upon receiving the first packet of the flow, or if/when the flow is recomputed). The error is Type 3 (indicates the destination port is unreachable), the code is either Code 9 or Code 10 (the destination host/network is administratively prohibited), depending on whether the route's destination prefix has a mask of 32 bits (that is, a specific host = Code 10) or has a mask less than 32-bits (that is, a network = Code 9). For more information, see http://en.wikipedia.org/wiki/ICMP_Destination_Unreachable#Destination_unreachable

## Destination

Shows the IP address of the interface connected to a peer device (for example, router or bridge). This is the egress port for packets sent to the destination peer.

## Next Hop Gateway

The route has three options regarding what to do with a packet:

1. Drop the packet. In this case, there's no need for a next hop gateway.
2. Forward the packet directly to the destination; this only occurs if the destination is on the same L2 network as one of the router's ports. Normally this means that the packet's destination address is in the same network prefix as the router's port. Again, there's no need for a next hop gateway in this case.
3. Forward the packet towards the destination, but using an intermediary router. Such a route is known as the "next hop gateway."

The next hop gateway is the IP address of the intermediate router's port that's facing the router that owns this route. This IP address is only used to do ARP resolution (mapping the IP address to a MAC address) and to determine how to re-write the packet's destination MAC address before emitting it towards the intermediate router.

Note that normal (that is, physical) routers' routes differ from MidoNet's virtual routers in that they don't have a target/destination virtual port (the 'Normal' route in MidoNet has this; see "Type"). Therefore, normal routers use the Next Hop Gateway IP address to determine which port should be used to emit the packet (the port whose prefix matches the next hop gateway's IP address).

## Next Hop Port

Shows the ID of the port connected to the peer device.

## Weight

Can be used for load balancing for destinations with multiple paths. Higher weight values identify preferred (for example, higher bandwidth) paths. The default weight value is 100. See also "Source".

# Viewing routes

You can view the routes defined on each virtual router in MidoNet. For example, you can view information about routes to virtual bridges and to other routers, including tenant routers and the MidoNet Provider Router.

To display route information about the current tenant's routers:

1. Enter the command below to list the routers for the current tenant.

```
midonet> list router
router router0 name tenant-router state up infilter chain0 outfilter
 chain1
```

2. Enter the command below to list the route list for the router, in this case, a tenant router (router0).

```
midonet> router router0 list route
route route0 type normal src 0.0.0.0/0 dst 169.254.255.2 port
 router0:port0 weight 0
route route1 type normal src 0.0.0.0/0 dst 0.0.0.0/0 port router0:port0
 weight 100
route route2 type normal src 0.0.0.0/0 dst 172.16.3.0/24 port
 router0:port1 weight 100
route route3 type normal src 172.16.3.0/24 dst 169.254.169.254 gw 172.
16.3.2 port router0:port1 weight 100
route route4 type normal src 0.0.0.0/0 dst 172.16.3.1 port router0:port1
 weight 0
```

The route list shows the following information:

- The source (src) for the traffic to match. route3 shows a specific source network to match; 0.0.0.0/0 means match traffic from every network.
- The destination (dst) for this traffic. This can be a network or a specific interface.
  - route0 shows an example of a route to a specific interface. This is the route to the link-local address, which, in this example, is peered with the MidoNet Provider Router.
  - route2 shows a route to the 172.16.3.0/24 network, which is a private network.
  - route1 says: for traffic that matches every network (0.0.0.0/0) with a destination of any network (0.0.0.0/0), forward this traffic to port0, which is peered with the MidoNet Provider Router. For traffic that matches the source IP address, MidoNet finds the route whose destination prefix matches the packet's destination and has the longest mask (a.k.a. longest-prefix matching). If the router cannot find a destination with a longer prefix than 0.0.0.0, the router sends the traffic to this default route.
- For destinations that are not directly connected to the router, the interface to the gateway to the destination is shown (next hop gateway).

- route3 shows an example. This route says: traffic with a source that matches the 172.16.3.0/24 network (that is, traffic from the private network), with the destination, 169.254.169.254, which is the link-local address to the metadata service, forward this traffic to the gateway port, 172.16.3.2, which is the tenant router's interface to the metadata service.

- route4 says: for traffic from any network (0.0.0.0/0) with the destination of the tenant router's interface (172.16.3.1), which is the tenant router's interface to the private network, forward this traffic to port1. port 1 on the tenant router is peered with port0 on router1, which is the MidoNet Provider Router.

# Working with the Provider Router

The MidoNet Provider Router is typically configured in the Admin tenant.

To look at the MidoNet Provider Router, if necessary, use the sett command or some other means to switch to the tenant on which the MidoNet Provider Router is configured.

To list the routers on the current tenant, enter the command:

```
midonet> list router
router router1 name MidoNet Provider Router state up
```

To list the MidoNet Provider Router ports, enter the command:

```
midonet> router router1 list port
port port0 device router1 state up mac 02:fb:21:dc:49:62 address 169.254.
255.1 net 169.254.255.0/30 peer router0:port0
port port1 device router1 state up mac 02:f3:fa:89:34:c6 address 198.51.
100.1 net 198.51.100.0/24 peer bridge0:port0
```

The above output shows:

- port0 is peered with router0 (tenant-router) via the 169.254.255.1 link-local address.

- port1 is peered with port0 on bridge0.

To list information about bridge0, enter the command:

```
midonet> show bridge bridge0
bridge bridge0 name demo-ext-net state up
```

demo-ext-net is an external, public network.

To list the port information for bridge0, enter the command:

```
midonet> bridge bridge0 list port
port port1 device bridge0 state up
port port2 device bridge0 state up
port port0 device bridge0 state up peer router1:port1
```

The above output shows:

- Three ports on bridge0.

- port0 on bridge0 is peered with port1 on router1 (the MidoNet Provider Router).

To list the MidoNet Provider Router routes, enter the command:

```
midonet> router router1 list route
route route0 type blackhole src 0.0.0.0/0 dst 198.51.100.0/24 weight 100
route route1 type normal src 0.0.0.0/0 dst 198.51.100.3 port router1:port0
 weight 100
route route2 type normal src 0.0.0.0/0 dst 169.254.255.1 port router1:port0
 weight 0
route route3 type normal src 0.0.0.0/0 dst 198.51.100.2 port router1:port0
 weight 100
route route4 type normal src 0.0.0.0/0 dst 198.51.100.1 port router1:port1
 weight 0
```

Below are some notes about these routes:

- type = blackhole If no floating IP addresses exist on an external network, traffic is routed to a blackhole, where the traffic is dropped. In this case, the source to match is any network (0.0.0.0/0) and the destination is the 198.51.100.0/24 network, which is an external, public network.
- route1 shows the route to the floating IP address (198.51.100.3) of a VM.
- route2 shows the route to the link-local connection (169.254.255.1) to the tenant router.
- route3 shows the route to the gateway to the external network.
- route4 says: for traffic that matches the source any network (0.0.0.0/0) with the destination 198.51.100.1, which is the MidoNet Provider Router's interface to the external network (198.51.100/24) (demo-ext-net, bridge0), forward this traffic to port1, which is the router's interface to the network (bridge0).

In a real deployment , most of the ports connected to the MidoNet Provider Router are up-link ports, and typically there are multiple unlink ports. (In the example network described above, the network is not connected to up-link ports.) Like other virtual ports with connections outside of MidoNet, each port is bound to a device (Ethernet interface) and a host. The host is a Gateway Node that is physically connected to the upstream router that goes out to a service provider.

# Adding routes

Below are some examples of when you might want to add a route:

- You notice that a specific IP address or range is attacking your network. To prevent such attacks, you add a route to the MidoNet Provider Router; this route's source IP matches the attacking IP address or range. You specify the type as a Blackhole to configure the MidoNet Provider Router to drop packets from this source.
- If BGP dynamic routing is not available, you may configure static routes to forward traffic to the upstream router(s).

The attributes you specify are:

- dst = destination IP address or network to match
- src = source IP address or network to match
- type = for example, "normal"
- port = port to emit traffic over

To add a route using the MidoNet CLI:

1. Enter the command to add a route:

```
midonet> router router2 add route dst 169.254.255.0/30 src 0.0.0.0/0
 type normal port router2:port2
router2:route2
```

The above command contains the following instructions:

- For traffic with the source any network (0.0.0.0/0) with the destination network 169.254.255.0/30, forward this traffic over port2 on router2.

### Note

Prior to adding the above route, a port was added to router2 using the following command:

```
midonet> router router2 add port address 169.254.255.3 net
 169.254.255.0/30
router2:port2
```

2. Enter the command to list the routes on router2 to confirm the added route(s):

```
midonet> router router2 list route
route route0 type normal src 0.0.0.0/0 dst 10.100.1.1 port router2:port0
 weight 0
route route1 type normal src 0.0.0.0/0 dst 10.100.1.2 port router2:port1
 weight 0
route route2 type normal src 0.0.0.0/0 dst 169.254.255.3 port
 router2:port2 weight 0
route route3 type normal src 0.0.0.0/0 dst 169.254.255.0/30 port
 router2:port2 weight 0
```

# Deleting routes

If you are using MidoNet as a standalone SDN controller, there are many situations where you might want to delete routes; all related to managing your physical network devices.

For example, if you want to reverse something you did that required manually adding routes, you can delete the routes.

### Warning

It is not recommended to delete routes that were added automatically as a result of OpenStack Neutron operations.

To delete a route:

1. Enter the command to list the routes on a certain router:

```
midonet> router router2 list route
route route0 type normal src 0.0.0.0/0 dst 10.100.1.1 port router2:port0
 weight 0
route route1 type normal src 0.0.0.0/0 dst 10.100.1.2 port router2:port1
 weight 0
route route2 type normal src 0.0.0.0/0 dst 169.254.255.3 port
 router2:port2 weight 0
route route3 type normal src 0.0.0.0/0 dst 169.254.255.0/30 port
 router2:port2 weight 0
```

The above command lists the routes on router2.

2. Enter the command(s) to delete the desired route(s) from the desired router:

```
midonet> router router2 delete route route2
midonet> router router2 delete route route3
```

The above commands delete route2 and route3 from router2.

3. Enter the command to list the routes on the router to confirm the deletions:

```
midonet> router router2 list route
route route0 type normal src 0.0.0.0/0 dst 10.100.1.1 port router2:port0
 weight 0
route route1 type normal src 0.0.0.0/0 dst 10.100.1.2 port router2:port1
 weight 0
```

# 7. Rule chains

## Table of Contents



The routing logic for a MidoNet virtual router includes the traversal of rule chains that may modify, record state, or reject a packet.

A newly created router has two chains: one named 'pre-routing' and the other named 'post-routing'. Below are a few important facts about rule chains:

- You can put chains not only on routers, but also on bridges and ports, too.
- Pre-routing chains have access to the ingress port ID, while post-routing chains have access to both the ingress and egress port. During post-routing, the router routes the packet and both the ingress port and the egress router port are known.

## A packet's flow within a router

In order to understand rule chains, first consider how a router processes a packet:

1. Check if the packet is an ARP packet, if so handle it.
2. Look at the interface's pre-routing chain, and call the chain that processes packets on ingress ports.
3. The rule chain processes the packet by invoking its rules in turn and potentially calling chains specified by jump rules. The chain returns two values of interest:
   - Next action:
     - DROP (the packet is silently dropped)
     - REJECT (the packet is dropped and the router sends an ICMP error message)
     - ACCEPT/CONTINUE (the router continues to process the packet for forwarding)
   - New packet:
     - the rule chain may have modified the packet's headers, e.g. for port masquerading. Changes to packet headers, like for port masquerading and NAT, are applied to all packets in the flow.
4. If the router didn't drop the packet, the router now invokes the routing logic that either decides to drop the packet or chooses an egress port and the next hop IP address for the packet.

5. Look at the post-routing rule chain and call the chain that processes packets on ingress and egress ports.
6. The post-routing rule chain outputs a next_action and a new_packet just like for pre-routing.
7. If the router didn't drop the packet, the router:
   - Performs an ARP lookup of the next-hop IP address.
   - Rewrites the destination hardware address and emits the packet from the egress port. if the egress port is a logical port, then the peer virtual router's logic is invoked and the flow restarts at step 1, but with a different router.

# A packet's flow within a rule chain

A rule chain is invoked on a packet one rule at a time.

Every rule has a condition: a condition is a set of attributes to match on the packet – this is explained more below – and the packet is checked against this condition. If the packet does not meet the condition, control returns to the rule chain, which either invokes the next rule (if there is one), or returns to its caller. Note that the rule chain's caller is not necessarily the router – it may be another rule chain, invoked by a jump rule, described below. If the packet does match the rule's condition, then what happens to the packet depends on the rule's type. For a simple rule type, such as a DROP rule, the rule returns a next_action DROP to its chain, which then returns DROP to its caller, and so on, until the router's invocation of the initial (pre- or post-routing) rule chain returns and the router acts on the DROP next_action, as described in the previous section.

The invocation of a rule looks just like the invocation of a rule chain in the previous section:

- If the rule is invoked in pre-routing: process the rule on a packet on an ingress port.
- If the rule is invoked in post-routing: process the rule on a packet on an ingress, egress port.

These invocations return (next_action, new_packet) just as described for rule chains. However, the set of valid next_actions is different and is intended to instruct the rule chain on how to continue processing the flow. The valid next_actions are:

- ACCEPT: The rule chain should stop processing the packet and return (ACCEPT, new_packet) to its own caller.
- CONTINUE: The rule chain should invoke the next rule in the chain with the packet emitted by the rule. If there is no next rule, the rule chain should return (CONTINUE, new_packet) to its caller.
- DROP: The rule chain should stop processing the packet and return (DROP, new_packet) to its own caller.
- RETURN: The rule chain should stop processing the packet and return (CONTINUE, new_packet) to its own caller. Note that this is distinct from both the ACCEPT and CONTINUE actions because no more rules in this chain will be executed, but more rules in calling chains may be executed.
- REJECT: The rule chain should stop processing the packet and return (REJECT, new_packet) to its own caller.

The ways packets are handled by specific rules depend on their types. The following sections explain how each rule type is constructed and how each rule type affects the packets that match its condition.

# Rule types

This section describes the rule types.

## ACCEPT, DROP, REJECT, RETURN

These rule types do not modify packets. They simply return the action corresponding to their type/name. When constructing one of these rules, you only need to specify the type and the condition. When the rule is invoked, it checks to see whether the packet matches the rule's condition and if so, it returns the action associated with the rule's type/name, e.g. (DROP, packet) if the rule type is DROP. If the packet does not match the condition, the rule returns (CONTINUE, packet) to its caller.

There isn't a rule type CONTINUE, because such a rule would return (CONTINUE, packet) regardless of the packet's contents. Because this rule doesn't modify packets, the rule would be a useless operation.

## DNAT, SNAT

These rule types modify packets. They rewrite source/destination network addresses and TCP/UDP port numbers. When constructing one of these rules, apart from the condition for matching packets, you must specify two things:

- A list of possible translation targets for matching packets' source/destination addresses.
- The next_action to return to the call chain that invoked this rule. Legal values are: ACCEPT, CONTINUE, and RETURN.

The next_action gives you more flexibility in constructing chains. After matching a packet and therefore modifying it (translating some of its addresses) the choice of what to do next is complex and is left up to you. The available options are:

- Exit all rule chains (ACCEPT).
- Invoke the next rule in the current chain (CONTINUE).
- Exit the current chain and invoke the calling chain's next rule, if the caller is a chain and if it has another (next) rule (RETURN).

Note that DNAT and SNAT rules do not distinguish between forward and return flows/packets. Packets going in the same direction as the packet that initiated the connection belong to a forward flow and packets in the opposite direction belong to a return flow. DNAT and SNAT rules simply check for a condition and if it matches, they apply the translation and then record that state so that it can be accessed during the processing of the return flow. In other words, the translation mapping is stored and used to perform the reverse translation for the return traffic flow (see "REV_DNAT, REV_SNAT"). Therefore, it important that you correctly do the following:

- Use REV_DNAT and REV_SNAT rules to reverse the address/port translations.

- Correctly order DNAT and REV_SNAT rules in pre-routing, and SNAT and REV_DNAT in post-routing.
- Avoid using DNAT rules in post-routing and SNAT rules in pre-routing.

### REV_DNAT, REV_SNAT

These rule types modify packets. They rewrite source (SNAT)/destination (DNAT) network addresses and TCP/UDP port numbers. When constructing one of these rules, apart from the condition for matching packets, you must specify the next_action that should be returned to the rule's caller when packets match AND a reverse translation is found (otherwise, CONTINUE is returned). When a packet matches one of these rules, the rule looks up the reverse translation in a centralized map (soft state) and then applies it to the packet. That is why these rules don't need to specify the translation target like for DNAT and SNAT.

### Jump

This rule type never modifies a packet. When constructing one of these rules, apart from the condition for matching packets, you must specify the jump_target: that is, the name of the rule chain that should be invoked for packets that match. Note that the jump_target should not be the name of the chain that contains the jump rule, as this would cause a rule-chain loop; you need to avoid looping rule-chains. To help avoid loops, the forwarding logic will detect rule-chain loops and drop any packet that visits a chain it has already visited.

When a packet matches a jump rule's condition, the action taken depends on whether the rule is invoked pre- or post-routing:

- If the rule is invoked pre-routing: the rule finds the rule chain specified by its jump_target and calls the chain to process the packet on the ingress port.
- If it's invoked post-routing, the rule calls the chain that processes the packet on the ingress, egress port.
- If the chain cannot be found, the jump rule returns the default, CONTINUE. Otherwise, it returns exactly the (next_action, new_packet) returned by invoking the rule chain.

## Rule order

Rules are stored as an ordered list in a rule chain and are evaluated in the listed order.

A specific rule is not evaluated in the event any preceding rules (or rules in chains that may have been 'jumped to') matched and resulted in an action (e.g. REJECT, ACCEPT) that terminates the processing of the packet in the chain.

The position of a rule in a rule chain is not an attribute of the rule. In the REST API, the rule-creation method specifies an integer position for the new rule in the rule chain. But that position is only meaningful relative to the rules already existing in the chain and is only used to modify the current rule list.

#### Note

Please read the section called "A packet's flow within a rule chain" [30] for an overview of rule-chain processing.

# Rule conditions

Every rule has a single Condition object that a packet must match in order for the rule to be applied.

Taking a jump rule as an example, if a packet matches the jump's Condition object, then rule processing for that packet will continue in the jump's target chain; if the packet doesn't match, then processing continues with the rule following the jump in the jump's own rule-chain.

Condition objects specify a set or combination of attributes. Attributes are simple statements about the contents of a packet's headers. Examples of attributes are:

- 'the packet's TCP/UDP port number is between 500 and 1000'
- 'the packet's source IP address is in 10.0.0.0/16'

## Note

Conditions are checked against the packet in the state the packet is in when it reaches a rule. In other words, for example, if a previous rule modified the packet's port number, then the current rule's condition will be checked against the modified, not the original, port number.

In order to form a Condition, you specify a number of attributes (optionally, you can invert most attributes using the CLI). Enter an exclamation point (!) or "bang" symbol to invert it, as shown in the "CLI Rule Chain Attributes That Match Packets" table. For example, if you invert the src attribute, this matches packets whose source does not match the specified IP address or network.

Below is the list of Condition attributes (attributes, invert-flags, and arguments) and their descriptions.

## Note

The ports identified in rules are virtual ports on virtual routers or bridges. A virtual port may be bound to a specific Ethernet interface (like a tap) on a physical host OR it may be peered with another virtual port (in which case it connects two virtual devices). In either case, think of the virtual port as virtual because the rules only exist in the virtual topology AND nothing is known during rule evaluation about possible bindings of the virtual port to physical Ethernet interfaces.

### Table 7.1. CLI Rule Chain Attributes

| Attributes | Description |
|---|---|
| pos <INTEGER>: | The rule's position in the chain |
| type <TYPE>: | The rule <TYPE>; this is mostly used to distinguish between regular filtering rules and different types of NAT rules. The recognized <TYPE> values are: accept, continue, drop, jump, reject, return, dnat, snat, rev_dnat, rev_snat. |
| action accept | continue |
| return: | The rule action, meaningful for NAT rules only. |
| jump-to <CHAIN>: | The chain to jump to (if this is a jump rule). |
| target <IP_ADDRESS[-IP_ADDRESS][:INTEGER[-INTEGER]]>: | The NAT target, if this is a dnat or snat rule. At least one IP address must be given, optionally the NAT target may |

| Attributes | Description |
|---|---|
| | also contain a second address to form an address range and L4 port number or range of ports. |

## Table 7.2. CLI Rule Chain Attributes That Match Packets

| Attributes That Match Packets | Description |
|---|---|
| hw-src [!]<MAC_ADDRESS>: | The source hardware address |
| hw-dst [!]<MAC_ADDRESS>: | The destination hardware address |
| ethertype [!]<STRING>: | Sets the data link layer (EtherType) of packets matched by this rule. |
| in-ports [!]<PORT[,PORT...]>: | Matches the virtual port through which the packet ingressed the virtual device that is currently processing the packet. |
| out-ports [!]<PORT[,PORT...]>: | Matches the port through which the packet egresses the virtual device that is currently processing the packet. |
| tos [!]<INTEGER>: | The value of the packet's Type of Service (TOS) field to match Use this field to match the differentiated services value. See TOS for information. |
| proto [!]<INTEGER>: | The IP protocol number to match. See Protocol Numbers for information. Examples: ICMP = 1, IGMP = 2, TCP = 6, UDP = 17 |
| src [!]<CIDR>: | The source IP address or CIDR block |
| dst [!]<CIDR>: | The destination IP address or CIDR block |
| src-port [!]<INTEGER[-INTEGER]>: | The TCP or UDP source port or port range |
| dst-port [!]<INTEGER[-INTEGER]>: | The TCP or UDP destination port or port range |
| flow <fwd-flow\|return-flow>: | Matches the connection-tracking status of the packet. If the packet is starting a new connection, fwd-flow will match. Alternatively, if the packet belongs to a connection already known to MidoNet, return-flow will match. |
| port-group [!]<PORT_GROUP>: | Matches a port group. Port groups allow the grouping of virtual ports to ease the creation of chain rules. See the CLI commands help for information. |
| ip-address-group-src [!]<IP_ADDRESS_GROUP>: | Matches a source IP address group. IP address groups allow the grouping of IP addresses to ease the creation of chain rules. See the CLI commands help for information. |
| ip-address-group-dst [!]<IP_ADDRESS_GROUP>: | Matches a destination IP address group. IP address groups allow the grouping of IP addresses to ease the creation of chain rules. See the CLI commands help for information. |
| hw-src-mask | **Source MAC address mask** - A 48-bit bitmask in the form xxxx.xxxx.xxxx, where x is any hexadecimal digit. Specifies which bits are to be considered when applying the rule's hw-src test.<br><br>Default value = ffff.ffff.ffff: All bits are considered when applying the hw-src test, so a packet's source MAC address must match hw-src exactly.<br><br>ffff.0000.0000: Only the first sixteen bits are considered when applying the hw-src test, the first sixteen bits of a packet's source MAC address must match the first sixteen bits of hw-src.<br><br>0000.0000.0000: No bits are considered when applying the hw-src test, so any packet will match. |
| hw-dst-mask | **Destination MAC address mask** - A 48-bit bitmask in the form xxxx.xxxx.xxxx, where x is any hexadecimal digit. Specifies which bits are to be considered when applying the rule's hw-dst test.<br><br>Default value = ffff.ffff.ffff: All bits are considered when applying the hw-dst test, so a packet's destination MAC address must match hw-dst exactly. |

| Attributes That Match Packets | Description |
|---|---|
| | ffff.0000.0000: Only the first sixteen bits are considered when applying the hw-dst test, the first sixteen bits of a packet's destination MAC address must match the first sixteen bits of hw-dst.<br><br>0000.0000.0000: No bits are considered when applying the hw-dst test, so any packet will match. |
| fragment-policy header \| nonheader \| any \| unfragmented | **fragment-policy** - Specifies the fragment type to match.<br><br>ANY: Matches any packet.<br><br>HEADER: Matches any packet that has a full header,that is, a header fragment or unfragmented packet.<br><br>NONHEADER: Matches only nonheader fragments.<br><br>UNFRAGMENTED: Matches only unfragmented packets.<br><br>In general, ANY is the default policy. However, if a rule has a value for the src or dst field, the NONHEADER and ANY policies are disallowed and the default is HEADER. Furthermore, if the rule's type is dnat or snat and its target is not a single IP address with no ports specified, then the policy will default to UNFRAGMENTED, which is the only policy permitted for such rules.<br><br>Unlike other rule properties, fragment-policy may not be inverted. |

# Example condition 1

Only packets whose network source is in 10.0.0.0/16 are allowed through to network 10.0.5.0/24. You can accomplish this a few different ways.

One way is to construct a DROP or REJECT rule that has a Condition and an ACCEPT rule with these attributes specify:

1. DROP when (ethertype equal 2048) AND (src NOT equal (10.0.0.0, 16))
2. ACCEPT when (dst equal (10.0.5.0, 24))
3. DROP

## Note

The unconditional drop is needed to make rule 2 meaningful.

To create a rule chain with the above attributes:

1. If necessary, use the sett command or some other means to access the desired tenant.

```
midonet> sett 10a83af63f9342118433c3a43a329528
tenant_id: 10a83af63f9342118433c3a43a329528
```

2. Enter the command to create a new rule chain and assign it a name:

```
midonet> chain create name "drop_not_src_mynetwork_INBOUND"
chain5
```

3. Enter the command to drop IPv4 traffic that does not have the source 10.0.0.0/16:

```
midonet> chain chain5 add rule ethertype 2048 src !10.0.0.0/16 type drop
chain5:rule0
```

4. Enter the command to accept IPv4 traffic with the destination 10.0.5.0/24:

```
midonet> chain chain5 add rule ethertype 2048 dst 10.0.5.0/24 pos 2 type
 accept
chain5:rule2
```

5. Enter the command to list the rules added to the new rule chain:

```
midonet> chain chain5 list rule
rule rule3 ethertype 2048 src !10.0.0.0/16 proto 0 tos 0 pos 1 type drop
rule rule2 ethertype 2048 dst 10.0.5.0/24 proto 0 tos 0 pos 2 type
 accept
```

## Example condition 2

Same as Example Condition 1, except here assume that you're structuring your rules differently. You want to have one DROP rule at the end of the chain that matches all packets; earlier in the chain you place ACCEPT rules that match packets/flows that are specifically allowed through.

The ACCEPT rule for the traffic allowed by Example Condition 1 would have a Condition with these attributes:

In the rule language, the chain would have:

ACCEPT when src=(10.0.0.0, 16) OR dst=(10.0.5.0, 24)

Rule at the end:

DROP all other packets

To create a rule chain with the above attributes:

1. If necessary, use the sett command or some other means to access the desired tenant.

```
midonet> sett 10a83af63f9342118433c3a43a329528
tenant_id: 10a83af63f9342118433c3a43a329528
```

2. Enter the command to create a new rule chain and assign it a name:

```
midonet> chain create name "accept_src_dst_mynetwork_INBOUND"
chain11
```

3. Enter the command to accept IPv4 traffic from the source 10.0.0.0/16:

```
midonet> chain chain11 add rule ethertype 2048 src 10.0.0.0/16 type
 accept
chain11:rule0
```

4. Enter the command to accept IPv4 traffic with the destination 10.0.5.0/24:

```
midonet> chain chain11 add rule ethertype 2048 dst 10.0.5.0/24 type
 accept
chain11:rule1
```

5. Enter the command to drop all IPv4 traffic (that didn't match the attributes in the preceding rules):

```
midonet> chain chain11 add rule ethertype 2048 pos 3 type drop
chain11:rule2
```

6. Enter the command to list the rules added to the new rule chain:

```
midonet> chain chain11 list rule
rule rule1 ethertype 2048 dst 10.0.5.0/24 proto 0 tos 0 pos 1 type
 accept
rule rule0 ethertype 2048 src 10.0.0.0/16 proto 0 tos 0 pos 2 type
 accept
rule rule3 ethertype 2048 proto 0 tos 0 pos 3 type drop
```

# MidoNet rule chain example

This example shows how you can use the MidoNet CLI to display the rule chains used to implement security groups.

MidoNet implements security groups by configuring rule chains on a port basis, as well as on bridges and routers (pre/post filtering).

## Assumptions

For this example, assume the following network conditions:

- A tenant named "demo"
- A network (bridge) named demo-private-net
- A VM with a private network IP address of 172.16.3.3 and a MAC address of fa:16:3e:fb:19:07

You configured a security group that allowed:

- Ingress traffic from TCP port 5900 (Virtual Network Computing)
- Ingress traffic from TCP port 22 (SSH)
- Ingress traffic from TCP port 80 (HTTP)
- Ingress ICMP traffic

## Listing the Bridges for the Tenant

Rule chains relating to OpenStack security groups are implemented on the network (bridge) ports.

To list the bridge(s) on the tenant and show the demo-private-net network (bridge):

1. Enter the command:

```
midonet> list bridge
bridge bridge0 name demo-private-net state up
```

## Listing the Ports on the Bridge

To list information about the rule chains configured on the bridge ports, enter the command:

```
midonet> bridge bridge0 list port
port port0 device bridge0 state up
port port1 device bridge0 state up infilter chain2 outfilter chain3
port port2 device bridge0 state up peer router1:port1
```

### Note

Ports with infilter (pre-routing) and outfilter (post-routing) chains are connected to VMs. port1 is connected to a VM.

## Listing the Rules for the Inbound Chain on a Port

To list the pre-routing rule chain for port 1:

1. Enter the command:

```
midonet> chain chain2 list rule
rule rule0 ethertype 2048 src !172.16.3.3 proto 0 tos 0 pos 1 type drop
rule rule1 hw-src !fa:16:3e:fb:19:07 proto 0 tos 0 pos 2 type drop
rule rule2 proto 0 tos 0 flow return-flow pos 3 type accept
rule rule3 proto 0 tos 0 pos 4 type jump jump-to chain4
rule rule4 ethertype !2054 proto 0 tos 0 pos 5 type drop
```

The pre-routing rule chain contains the following instructions:

- rule0 says: for packets that match the ethertype 2048 (IPv4) that do not match the source IP address 172.16.3.3 (the private IP address of the VM), drop these packets. This prevents the port's VM from sending packets with a forged IP address.
- rule1 says: for packets with a hardware source that does not match the listed source MAC address (the VM's MAC address), drop these packets. This prevents the VM from sending packets with a forged MAC address.
- rule2 says: for packets that match a return flow (that is, a packet that belongs to a connection already known to MidoNet), accept these packets.
- rule3 says: for packets that were not dropped or accepted as a result of matching previous rules, allow these packets to jump to the indicated chain (chain4).
- rule4 says: for packets that do not match the ethertype 2054 (ARP packets), drop these packets.

## Listing the OpenStack Security Group Rule Chain

You can list all the rule chains and then look at the rule chain for the OpenStack security group.

To list all the rule chains and examine specific rule chains:

1. Enter the command:

```
midonet> list chain
chain chain5 name OS_SG_050593ed-56ad-44ef-8489-4052d02d99ff_INGRESS
chain chain0 name OS_PRE_ROUTING_5a151b0b-dea7-4918-bd17-876c1f7f5c64
chain chain1 name OS_POST_ROUTING_5a151b0b-dea7-4918-bd17-876c1f7f5c64
chain chain6 name OS_SG_01fce1b8-c277-4a37-a8cc-86732eea186d_INGRESS
chain chain4 name OS_SG_050593ed-56ad-44ef-8489-4052d02d99ff_EGRESS
chain chain7 name OS_SG_01fce1b8-c277-4a37-a8cc-86732eea186d_EGRESS
chain chain2 name OS_PORT_6f72342b-4947-432f-8d01-0cf4e4b8d049_INBOUND
chain chain3 name OS_PORT_6f72342b-4947-432f-8d01-0cf4e4b8d049_OUTBOUND
```

Note chain5, identified as a chain for an OpenStack security group (OS_SG) for INGRESS traffic.

To look at rule chain5:

2. Enter the command:

```
midonet> chain chain5 list rule
rule rule0 ethertype 2048 src 0.0.0.0/0 proto 6 tos 0 dst-port 5900 pos
 1 type accept
rule rule1 ethertype 2048 src 0.0.0.0/0 proto 1 tos 0 pos 2 type accept
rule rule2 ethertype 2048 src 0.0.0.0/0 proto 6 tos 0 dst-port 22 pos 3
 type accept
rule rule3 ethertype 2048 src 0.0.0.0/0 proto 6 tos 0 dst-port 80 pos 4
 type accept
```

The above output shows the rule chain used to implement the security group you configured in OpenStack. These rules contain the following instructions:

- All the rules match ethertype 2048 (IPv4) packets.
- All the rules match traffic from any source network (0.0.0.0/0).
- All the rules, except rule1, match packets of IP protocol 6 (TCP) and accept them. rule1 matches packets of the ICMP type and accepts them.
- In addition to the other matches already mentioned, the rules match and accept the packets according to the security group rules you defined in OpenStack, specifically, packets with the destinations:
- TCP port 5900 (VNC)
- TCP port 22 (SSH)
- TCP port 80 (HTTP)

# Listing the bridges for the tenant

Rule chains relating to OpenStack security groups are implemented on the network (bridge) ports.

To list the bridge(s) on the tenant and show the demo-private-net network (bridge) enter the command:

```
midonet> list bridgebridge bridge0 name demo-private-net state up
```

## Listing the ports on the bridge

To list information about the rule chains configured on the bridge ports, enter the command:

```
midonet> bridge bridge0 list port
port port0 device bridge0 state up
port port1 device bridge0 state up infilter chain2 outfilter chain3
port port2 device bridge0 state up peer router1:port1
```

### Note

ports with infilter (pre-routing) and outfilter (post-routing) chains are connected to VMs. port1 is connected to a VM.

## Listing the rules for the pre-routing rule chain

To list the pre-routing rule chain for port 1 enter the command:

```
midonet> chain chain2 list rule
rule rule0 ethertype 2048 src !172.16.3.3 proto 0 tos 0 pos 1 type drop
rule rule1 hw-src !fa:16:3e:fb:19:07 proto 0 tos 0 pos 2 type drop
rule rule2 proto 0 tos 0 flow return-flow pos 3 type accept
rule rule3 proto 0 tos 0 pos 4 type jump jump-to chain4
rule rule4 ethertype !2054 proto 0 tos 0 pos 5 type drop
```

The pre-routing rule chain contains the following instructions:

- rule0 says: for packets that match the ethertype 2048 (IPv4) that do not match the source IP address 172.16.3.3 (the private IP address of the VM), drop these packets.
- rule1 says: for packets with a hardware source that does not match the listed source MAC address (the VM's MAC address), drop these packets.
- rule2 says: for packets that match a return flow (that is, a packet that belongs to a connection already known to MidoNet), accept these packets.
- rule3 says: for packets that were not dropped as a result of matching previous drop rules, allow these packets to jump to the indicated chain (chain4).
- rule4 says: for packets that do not match the ethertype 2054 (ARP packets), drop these packets.

# Listing the OpenStack security group rule chain

You can list all the rule chains and then look at the rule chain for the OpenStack security group.

- To list all the rule chains and examine specific rule chains enter the command:

```
midonet> list chain
chain chain5 name OS_SG_050593ed-56ad-44ef-8489-4052d02d99ff_INGRESS
chain chain0 name OS_PRE_ROUTING_5a151b0b-dea7-4918-bd17-876c1f7f5c64
chain chain1 name OS_POST_ROUTING_5a151b0b-dea7-4918-bd17-876c1f7f5c64
chain chain6 name OS_SG_01fce1b8-c277-4a37-a8cc-86732eea186d_INGRESS
chain chain4 name OS_SG_050593ed-56ad-44ef-8489-4052d02d99ff_EGRESS
chain chain7 name OS_SG_01fce1b8-c277-4a37-a8cc-86732eea186d_EGRESS
chain chain2 name OS_PORT_6f72342b-4947-432f-8d01-0cf4e4b8d049_INBOUND
chain chain3 name OS_PORT_6f72342b-4947-432f-8d01-0cf4e4b8d049_OUTBOUND
```

  Note chain5, identified as a chain for an OpenStack security group (OS_SG) for INGRESS traffic.

- To look at rule chain5 enter the command:

```
midonet> chain chain5 list rule
rule rule0 ethertype 2048 src 0.0.0.0/0 proto 6 tos 0 dst-port 5900 pos 1
 type accept
rule rule1 ethertype 2048 src 0.0.0.0/0 proto 1 tos 0 pos 2 type accept
rule rule2 ethertype 2048 src 0.0.0.0/0 proto 6 tos 0 dst-port 22 pos 3
 type accept
rule rule3 ethertype 2048 src 0.0.0.0/0 proto 6 tos 0 dst-port 80 pos 4
 type accept
```

The above output shows the rule chain used to implement the security group you configured in OpenStack. These rules contain the following instructions:

- All the rules match ethertype 2048 (IPv4) packets.
- All the rules match traffic from any source network (0.0.0.0/0).

- All the rules, except rule1, match packets of IP protocol 6 (TCP) and accept them. rule1 matches packets of the ICMP type and accepts them.
- In addition to the other matches already mentioned, the rules match and accept the packets according to the security group rules you defined in OpenStack, specifically, packets with the destinations:
  - TCP port 5900 (VNC)
  - TCP port 22 (SSH)
  - TCP port 80 (HTTP)

# 8. Network Address Translation

## Table of Contents



To demonstrate how MidoNet uses static NAT, this chapter shows how MidoNet implements floating IP addresses by examining a floating IP address configuration.

# Static NAT

This section demonstrates how MidoNet uses static NAT to implement floating IP addresses.

MidoNet implements floating IP addresses in a two-stage process:

1. Bring traffic to a floating IP address (that is, bring traffic from an external network to a tenant router).

2. Perform network address translation from the external network's public IP address to a private IP address and in the reverse direction.

## Assumptions

To view this example, this section assumes you have configured:

- A project
- A MidoNet Provider Router
- An external network
- A tenant router
- A private network (bridge)
- At least one VM connected to the bridge
- A floating IP address assigned to at least one VM.

# Viewing NAT rule chain information

You can use the MidoNet CLI to list the routers for a tenant and list rule chains configured on the router.

The example below explains how MidoNet uses rule chains to implement source and destination NAT and shows how to use the MidoNet CLI to:

- Display information about the infilter (pre-routing) and outfilter (post-routing) chains configured on a tenant router.
- List the rules for the rule chains.

## Assumptions

For the example below, assume the following network conditions exist:

- A tenant router named "tenant-router"
- A private network with a 172.16.3.0/24 network address
- A public network with a 198.51.100.0/24 network address
- A VM with a 172.16.3.3 private IP address and a 198.51.100.3 public (floating) IP address

## Viewing a Pre-Routing rule

To list routers on the current tenant and the router rule-chain information on the router(s), enter the command:

```
midonet> list router
router router0 name tenant-router state up infilter chain0 outfilter chain1
```

As shown in the above output, chain0 is the router's pre-routing (infilter) rule chain and chain1 is the post-routing (outfilter) rule chain.

To list information about the router's pre-routing rule chain, enter the command:

```
midonet> chain chain0 list rule
rule rule0 dst 198.51.100.3 proto 0 tos 0 in-ports router0:port0 pos 1 type
 dnat action accept target 172.16.3.3
rule rule1 dst 198.51.100.2 proto 0 tos 0 in-ports router0:port0 pos 2 type
 rev_snat action accept
```

rule0 of the pre-routing rule chain on the tenant router contains the following instructions:

- For packets with the destination of 198.51.100.3 (the floating IP address associated with the VM):
  - Perform a destination NAT (DNAT) translation to change the destination IP address from the VM's floating IP address (198.51.100.3) to the VM's private IP address (172.16.3.3).

## Viewing a Post-Routing rule

To list the post-routing rule on the tenant router, enter the command:

```
midonet> chain chain1 list rule
rule rule0 src 172.16.3.3 proto 0 tos 0 out-ports router1:port0 pos 1 type
 snat action accept target 198.51.100.3
rule rule1 proto 0 tos 0 out-ports router1:port0 pos 2 type snat action
 accept target 198.51.100.2:1--1
```

rule0 of the post-routing rule on tenant-router contains the following instructions:

- For packets from the source IP address 172.16.3.3 (the private IP address of the VM):
  - Perform a source NAT (SNAT) translation to change the source IP address from the VM's private IP address (172.16.3.3) to the VM's floating IP address (198.51.100.3).

# Configuring SNAT, DNAT, and REV_DNAT

The sections below describe how to configure SNAT, DNAT, and REV_DNAT using rule-chains.

To configure SNAT and DNAT rule chains, you need to specify:

- The rule type, for example, snat or dnat
- The action, for example, accept
- The translation target(s)

Using the MidoNet CLI, you don't have to specify an address or port range if it only has one member. However, when configuring Dynamic SNAT you must explicitly set ports or port ranges with the CLI command, otherwise, it will be considered a static NAT and connection tracking will not work.

Below are examples of valid NAT targets in the CLI syntax:

```
192.168.1.1:80
192.168.1.1-192.168..1.254
192.168.1.1:80-88
192.168.1.1-192.168.1.254:80-88
```

The in-port you specify in DNAT rules matches the virtual port on a virtual router or bridge through which the packet ingressed the virtual device that is currently processing the packet. The out-port you specify in SNAT rules matches the port through which the packet egresses the virtual device that is currently processing the packet.

For REV_SNAT and REV-DNAT rules, as mentioned earlier, when a packet matches one of these rules, the rule looks up the reverse translation in a centralized map (soft state) and then applies it to the packet. That is why these rules don't need to specify the translation target like for DNAT and SNAT.

Below is a CLI example of a DNAT rule:

```
chain chain9 add rule dst 198.51.100.4 in-ports router1:port0 pos 1 type
 dnat action accept target 10.100.1.150
```

# DNAT/REV_DNAT example

This example shows how to use MidoNet CLI commands to configure DNAT and REV_DNAT on a router.

Below are the assumptions regarding the rule chain for this example:

- You have two subnets: a public subnet (198.51.100.0/24) and a private subnet (10.0.0.0/24).
- You have a virtual machine connected to the tenant router with a public IP address of 198.51.100.4 and a private IP address of 10.100.1.150.

- You want to translate traffic with the VM's public IP address to the VM's private IP address.
- You want to perform a reverse destination address translation.

To create the rule chain for the above DNAT configuration:

1. Create a new rule chain:

```
midonet> chain create name "dnat-test"
chain10
```

2. Create a rule that accepts traffic on a router port with the destination 198.51.100.4 and translates the destination to 10.100.1.150:

```
midonet> chain chain10 add rule dst 198.51.100.4 in-ports router1:port0
 pos 1 type dnat action accept target 10.100.1.150
chain10:rule2
```

3. Create a rule that accepts traffic with the destination of the router's gateway to the public network and performs a reverse address translation from the public network address to the private network address.

```
midonet> chain chain10 add rule dst 198.51.100.2 in-ports router0:port0
 pos 2 type rev_snat action accept
chain10:rule3
```

4. List the rules to check them:

```
midonet> chain chain10 list rule
rule rule2 dst 198.51.100.4 proto 0 tos 0 in-ports router1:port0 pos 1
 type dnat action accept target 10.100.1.150
rule rule3 dst 198.51.100.2 proto 0 tos 0 in-ports router0:port0 pos 2
 type rev_snat action accept
```

# SNAT example

This example shows how to use MidoNet CLI commands to configure SNAT on a router port.

For example, you might want to configure SNAT for a network device (like a VM) with a private IP address and a public floating IP address that sends data to a destination outside its local network.

Below are the assumptions regarding the rule chain for this example:

- You have two subnets: a public subnet (198.51.100.0/24) and a private subnet (10.0.0.0/24).
- You have a virtual machine connected to the tenant router with a public IP address of 198.51.100.4 and a private IP address of 10.100.1.150.
- You want to translate traffic with the VM's private IP address to the VM's public IP address.

To create the rule chain for the above SNAT configuration:

1. Create a new rule chain:

```
midonet> chain create name "snat-test"
chain7
```

2. Create a rule that accepts traffic on a router port with the source 10.100.1.150 and translates the destination to 198.51.100.4:

```
midonet> chain chain7 add rule src 10.100.1.150 out-ports router1:port0
 pos 1 type snat action accept target 198.51.100.4
chain7:rule2
```

3. Create a rule that accepts traffic from the private network and performs SNAT to translate the source IP address to the IP address of the router's gateway to the public network.

```
midonet> chain chain7 add rule out-ports router1:port0 pos 2 type snat
 action accept target 198.51.100.2
```

# 9. Layer 4 Load Balancing

## Table of Contents



The load balancer service in MidoNet provides Layer 4 (L4) load balancing. A typical use case involves a tenant wishing to balance traffic (load) from floating IP addresses to private IP addresses.

Generally, the traffic comes in from external/publicly routable addresses (for example, from users of the service all over the world) to a virtual IP address (VIP) (often a public, floating IP address, but assigned to the load balancer instead of a VM), and is then load-balanced to numerous private IP addresses within the cloud. The load balancer sends the traffic to the private IP addresses of the back-end servers – in MidoNet's case, these back-end servers are VMs. The load balancer does not terminate the connection, nor is it really transparent because it's translating the destination IP.

**Configuration overview**

As part of the configuration, you define a pool of back-end servers (VMs) to which traffic is load-balanced. The pool members typically have private IP addresses. The placement of the VMs is flexible but must take into account where the load balancer is configured. A general rule is that the VM private addresses **must be** reachable from the router to which the load balancer is attached. Therefore, pool members may

- all belong to a single subnet of the router, or
- they may be placed in two or more subnets of the router

Finally, note that because the load balancer leaves the request source address unmodified, the load balancer must be placed in the path of the return traffic – otherwise return traffic will go directly to the request source without giving the load balancer a chance to reverse the VIP#back-end-IP translation that was applied on the forward packets.

**Health monitoring**

In addition, you can configure a health monitor to perform checks on the back-end servers. The health monitor automatically removes unhealthy nodes from the pool and adds them back when they return to health.

**MidoNet load balancer limitations**

MidoNet uses the Neutron API to set up load balancers (as documented in https://wiki.openstack.org/wiki/Neutron/LBaaS/API_1.0) but not all the Neutron LBaaS features are supported in MidoNet:

- L7 load balancing is not supported.
- There are no pool statistics.
- Only round robin is supported in as the load balancer method.

- The Neutron provider model is not supported (for example, assigning a specific provider for each pool is not supported).
- Only one health monitor per pool (the first one in the list).
- Only TCP health check (no UDP, HTTP).
- Only Source IP session persistence (or cookie or URL).
- You cannot associate a floating IP to a virtual IP address (VIP).
- A VIP must not be on the same subnet as the pool member IF health monitoring is enabled.
- No ICMP for health checks.
- There is no connection limit.
- Only one health monitor per pool.
- Only TCP load balancing is supported.
- When using sticky-source IP, directly connecting to the selected back-end host on the same port that is being used by the load balancer is not possible.

# Load balancer configuration

This procedure provides the steps required to create and configure a load balancer in MidoNet, with examples of CLI commands used to achieve that.

Let's start by determining the list of routers we have available in our MidoNet deployment:

```
midonet> list router
router router0 name TenantRouter state up infilter chain0 outfilter chain1
router router1 name MidoNet Provider Router state up
```

As you can see, your tenant router where you are going to create a load balancer is router0.

### Important

In MidoNet, routers have inbound and outbound filters. If the load balancer on a router balances traffic, these filters will be skipped. When using MidoNet with OpenStack, these filters usually only contain NAT rules that are irrelevant to load-balanced traffic, but this is worth taking into account if you are adding custom rules to the router's filters.

1. Create a load balancer and assign it to the tenant router.

   ```
   midonet> load-balancer create
   lb0
   midonet> router router0 set load-balancer lb0
   ```

   The load balancer assigned to the router will act on traffic flowing through that router.

2. Create a pool to which target back-end servers will be assigned.

```
midonet> load-balancer lb0 create pool lb-method ROUND_ROBIN
lb0:pool0
midonet> load-balancer lb0 pool pool0 show
pool pool0 load-balancer lb0 lb-method ROUND_ROBIN state up
```

3. Next, add target back-end servers to the pool you just created.

```
midonet> load-balancer lb0 pool pool0 create member address 192.168.100.
1 protocol-port 80
lb0:pool0:pm0
midonet> load-balancer lb0 pool pool0 member pm0 show
pm pm0 address 192.168.100.1 protocol-port 80 weight 0 state up
```

   For each back-end server you must add its IP address and port to the pool.

4. Create a virtual IP address (VIP) and assign it to the pool against which load balancing will be performed (lb0:pool0). Typically, a VIP is an IP address from the public IP space.

```
midonet> load-balancer lb0 pool pool0 list vip
midonet> load-balancer lb0 pool pool0 create vip address 203.0.113.2
 persistence SOURCE_IP protocol-port 8080
lb0:pool0:vip0
midonet> load-balancer lb0 pool pool0 vip vip0 show
vip vip0 load-balancer lb0 address 203.0.113.2 protocol-port 8080
 persistence SOURCE_IP state up
```

**Note**

Port 8080 is just an example. To use a port for load balancing traffic you need to make sure first, it's not taken.

5. Lastly, you must insert an appropriate routing rule on the provider router (router1) so that a packet sent from an external network to the VIP is able to find its way to the tenant router.

   a. First, identify the ports on the provider router, using the router router1 list port command, like so:

```
midonet> router router1 list port
port port0 device router1 state up mac 02:c2:0f:b0:f2:68 address 100.
100.100.1 net 100.100.100.0/30
port port1 device router1 state up mac 02:cb:3d:85:89:2a address 172.
168.0.1 net 172.168.0.0/16
port port2 device router1 state up mac 02:46:87:89:49:41 address 200.
200.200.1 net 200.200.200.0/24 peer bridge0:port0
port port3 device router1 state up mac 02:6b:9f:0d:c4:a8 address 203.
0.113.2 net 203.0.113.0/30 peer router0:port0
...
```

      A quick look at the listing reveals the port on the provider router that is used to route traffic to the tenant router (router0). It's router port3.

   b. Next, add the route to the provider router port3 to the MidoNet configuration.

```
midonet> router router1 add route dst 203.0.113.2/32 src 0.0.0.0/0
 type normal port router1:port3
router1:route11
```

      This rule matches any incoming traffic (src 0.0.0.0/0) to the provider router, that is sent to the VIP on the provider router 203.0.113.2 (dst 203.0.113.2/32) and sends it out provider router port3 (router1:port3).

# Sticky source IP

On many occasions, you want a load balancer to keep track of the sessions. To accomplish this, the MidoNet load balancer provides sticky-source IP address persistence.

When configured on a virtual IP (VIP), the source IP address of the packet is used to determine the destination server, and all the subsequent traffic from the same source IP address gets sent to the same server.

**Session persistence example**

The example below shows how to use the MidoNet CLI to configure a load balancer. As shown, the VIP has the persistence set to SOURCE_IP.

```
midonet> load-balancer create
lb0
midonet> router router0 set load balancer lb0
midonet> load-balancer lb0 create pool lb-method ROUND_ROBIN
b0:pool0
midonet> load-balancer lb0 pool pool0 create member address 192.168.100.1
 protocol-port 80
b0:pool0:pm0
midonet> load-balancer lb0 pool pool0 list vip
midonet> load-balancer lb0 pool pool0 create vip address 192.168.0.1
 persistence SOURCE_IP protocol-port 8080
lb0:pool0:vip0
midonet> router router1 add route dst 192.168.0.1/32 src 0.0.0.0/0 type
 normal port router1:port0
router1:route11
```

### Note

Port 8080 is just an example. To use a port for load balancing traffic you need to make sure first, it's not taken.

### Important

- If you toggle on/off sticky source IP address mode on a VIP, existing connections using that VIP will be dropped.
- If you disable a pool member while in sticky source IP address mode, existing connections that are balanced to that member will be dropped.
- If you disable a pool member while NOT in sticky source IP address mode, existing connections that are balanced to that member will be allowed to finish, but no new connections will be sent to that member.
- Stickiness remains active for one day. If a session is inactive for more than a day, the stickiness goes away and the subsequent traffic will be load balanced normally.

# Health monitor

Health monitoring is the act of checking a set of pool members for "aliveness". This usually means HTTP, TCP, UDP, or ICMP connectivity is possible to the node.

In MidoNet's case, only TCP connectivity is checked. Health monitors work by sending packets to the pool members and checking whether or not they receive a reply. The

node is considered ACTIVE if the pool member responds to the packet within a certain amount of time, and after a certain amount of retries. Therefore, health monitors act on the following three variables:

- max_retries: How many times the health monitor sends a packet to the pool member without receiving a response before the health monitor considers the node to be INACTIVE
- delay: Amount of time between each transmission of a packet from the health monitor to the pool member
- timeout: Additional timeout after a connection has been established

The health monitor keeps track of the current state of all pool members it is assigned to. Load balancing decisions can then be made based on the "aliveness" of a pool member.

## HAProxy configuration

When using a Layer 4 load balancer, you can configure a health monitor to perform checks on the back-end servers.

Only a single host runs all health monitor instances at a given time. If that host goes down for any reason, a new host will come up and spawn the necessary HAProxy instances. The HAProxy instances are managed by the MidoNet Agent (midolman) and do not require setup. However, you need to choose hosts that can potentially hold the HAProxy instances.

To configure this, add an haproxy_health_monitor section to the agent section in mn-conf(1) for the desired hosts, and set health_monitor_enable to true, as shown in the example below.

```
agent.haproxy_health_monitor.health_monitor_enable = true
```

Additionally, the hosts running the HAProxy instances must have a group called "nogroup" and a user called "nobody", otherwise HAProxy will not be able to start. While this is a default configuration on Ubuntu, on Red Hat you must create this user and group.

**How the Health Monitor works in the MidoNet Agent**

- The MidoNet Agent (midolman) does not implement its own health monitor. Instead, it leverages the health checker that is a part of the haproxy package (the haproxy version used is 1.4). The MidoNet Agent leverages HAProxy by doing the following:
  - Whenever a user attaches a health monitor to a pool, the MidoNet Agent starts up an HAProxy instance associated with that pool.
  - The HAProxy process then receives information about all of the pool members it must watch.
  - The MidoNet Agent periodically polls HAProxy about the status of its nodes. If it detects a change in status, the MidoNet Agent will update its own database with the status information.
- The following configuration settings (inside mn-conf(1)) tell the MidoNet Agent how to act with respect to health monitoring:

  - health_monitor_enable: true indicates the MidoNet Agent host is eligible to set up HAProxy for health monitoring. By default, this is set to false.
  - namespace_cleanup: true indicates the MidoNet Agent host needs to clean up any left over HAProxy namespaces on the host that are still present after the MidoNet Agent has gone down and is no longer the designated HAProxy host. By default, this is set to false.
  - namespace_suffix: String appended to the end of the namespace names that hold the HAProxy instances. This is to allow you to easily identify the namespaces being created for HAProxy. _MN is the default value.
  - haproxy_file_loc: identifies the location in the file system where the config files for HAProxy will be created. The default value is: /etc/midolman/l4lb/.
- At any given time, there is only one host containing all of the HAProxy instances. This host will be one of the MidoNet Agent hosts that has health_monitor_enable=true defined in its configuration. If this host goes down for any reason, one of the other hosts with the health_monitor_enable=true setting will take over and spawn any required HAProxy instances.

# Enabling Health Monitoring in a Pool

To enable health monitoring on a pool you can do perform one of the following:

- Create a health monitor object using the CLI or API server, and set the relevant delay, timeout, and max_retries values (see "Health Monitor" for information).
- Attach the health monitor object to the pool that you want to be monitored. A single health monitor can be attached to any number of pools, but pools may only have a single health monitor.
- Set the admin_state_up on the health monitor object to true.

**CLI Example**

The example below shows how to use the MidoNet CLI to configure health monitoring.

```
midonet> health-monitor list
midonet> health-monitor create type TCP delay 100 max-retries 50 timeout
 500
hm0
midonet> load-balancer lb0 pool pool0 set health-monitor hm0
midonet> load-balancer lb0 pool pool0 health-monitor show
hm hm0 delay 100 timeout 500 max-retries 50 state down
midonet> health-monitor hm0 pool list
pool pool0 load-balancer lb0 health-monitor hm0 lb-method ROUND_ROBIN state
 up
```

# Disabling Health Monitoring

To disable health monitoring on a pool you can do perform one of the following:

- Set the admin_state_up on the health monitor to false. Note that all pools that are using this health monitor will have health monitoring disabled.
- Set the health_monitor_id on the pool to null.

- Delete the health monitor object.

# 10. L2 address masking

## Table of Contents



You can use L2 address masking to filter out specific L2 frames, such as multicast frames. This allows you to add a single rule with a specific mask, which reduces the number of rules needed.

Below a couple of important facts about L2 address masking in MidoNet:

- OpenStack security group rules don't match L2 fields, so this feature is provided for customers who directly access/use MidoNet's API and CLI.
- Old rules that do not include values for the hw-dst-mask attribute in the CLI should be interpreted as having the values for this field/attribute set to the default: ffff.ffff.ffff

See Chapter 7, "Rule chains" [29] for information about rule chains, including information about the hw-src-mask and hw-dst-mask attributes used to implement this feature.

# L2 address mask rule chain example

This is an example of L2 Address Mask Rule Chain creation.

1. Create a chain (this creates chain alias, "chain0" in the example, pointing to the chain created):

```
create chain name "l2-mask"
```

2. Add a rule to the chain that drops traffic with a src (source) MAC not starting with 12:34:56:

```
chain chain0 create rule hw-src !12:34:56:78:90:ab hw-src-mask ffff.
ff00.0000 type drop
```

**Example**

Here's an example for how you might use hw-dst-mask.

You decide to block (DROP) all multicast traffic on a specific L2 virtual network (bridge). The 8th (least significant) bit of the first (most significant) octet of a MAC address is 1 if the address is multicast, 0 if it's unicast.

However, a MAC broadcast address has all octets set to FF. It's best not to drop broadcast packets,for example, ARP requests. Therefore, you add the following two rules to the pre-bridging rule-chain of the virtual bridge:

- at position 1: ACCEPT if hw-dst is "ff:ff:ff:ff:ff:ff"

```
midonet> chain chain0 add rule hw-dst ff:ff:ff:ff:ff:ff type accept
```

- at position 2: DROP if hw-dst has bit 0100.0000.0000 set

```
chain chain0 add rule hw-dst 01:00:00:00:00:00 hw-dst-mask 0100.0000.0000
 pos 2 type drop
```

# 11. Handling fragmented packets

## Table of Contents



If you observe that MidoNet is encountering fragmented packets, this section describes how you can handle this situation.

You can configure IP fragment matching in rules to configure how fragmented packets are handled when L4 rules are applied in the virtual topology. This feature allows IP fragments to pass through the virtual topology instead of being dropped. With this feature implementation, you have the following options:

- If you are writing an L2/L3 firewall, you can be IP fragment agnostic: no special handling of IP fragments is required. (L3 NAT handles IP fragments correctly.)
- If you are writing an L4 firewall, you can specify special handling for IP fragments.

## Definitions and allowed values

- header = the Condition matches non-fragmented packets AND header fragments. header refers to a non-fragmented packet or to the first fragment (the header fragment) of a fragmented packet. The header fragment is the only one whose IPv4 "fragment offset" field is set to zero. header is the only allowed value if the rule's Condition matches L4 fields OR the rule is dynamic (that is, port modifying) DNAT or SNAT
- nonheader = the Condition matches only non-header fragments. nonheader refers to the second and subsequent fragments.
- any = the Condition matches any fragment AND non-fragmented packets.
- unfragmented = the Condition matches any non-fragmented packet.

### Note

If the fragment-policy argument is not set, then it is treated like the setting is any, unless header is the only allowed value.

### Note

When you run OpenStack Icehouse against MidoNet with the Condition semantics described above, the handling of fragments will change as follows:

Instead of dropping fragments when they pass through L4 rules, these fragments will be ignored by L4 rules, and therefore, may potentially allow the packets through filters.

A single L4 flow may generate up to two different flows: one to handle non-header fragments, another to handle all other packets.

# Fragmented packets rule chain creation example

Create a chain (this creates a rule chain with an alias, "chain0" in the example, pointing to the chain created):

```
create chain name chain0
```

Add a rule to the chain that drops header fragments:

```
chain chain0 add rule fragment-policy header pos 2 header type drop
```

**Example 1 Firewall, Does Not Account for Fragmented Packets**

The example below only handles non-fragmented packets. These are the firewall rules you start with before you decide to handle fragmented packets.

Initially, you design your firewall to:

- Only allow incoming TCP port 80 (HTTP) traffic
- Drop all other packets

Without addressing fragmented packets, you create a rule chain with the following two rules:

- Rule at position 1
  - By default, this rule matches only non-fragmented packets and header fragments.
  - ACCEPTs packets with protocol=TCP and destination=80.

    ```
    midonet> chain chain0 add rule ethertype 2048 src 0.0.0.0/0 proto 6 in-
    ports router2:port0 dst-port 80 pos 1 type accept
    ```

- Rule at position 2
  - DROPs all packets.

    ```
    midonet> chain chain0 add rule ethertype 2048 src 0.0.0.0/0 dst 0.0.0.
    0/0 in-ports router2:port0 pos 2 type drop
    ```

```
midonet> chain chain0 list rule
rule rule0 ethertype 2048 src 0.0.0.0/0 proto 6 tos 0 dst-port 80 in-ports
 router2:port0 pos 1 type accept
rule rule1 ethertype 2048 src 0.0.0.0/0 dst 0.0.0.0/0 proto 0 tos 0 in-
ports router2:port0 pos 2 type drop
```

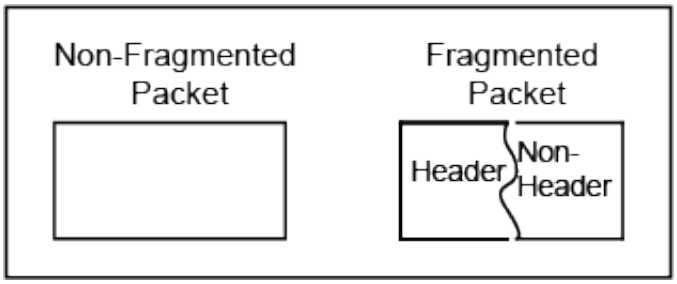
With the above rule chain, MidoNet handles fragmented packet with the destination TCP port 80 as follows:

- The first half of the packet, which contains the TCP header, reaches the rule at position 1, and is accepted.

- However, the second half of the fragmented, which does not have the destination port, reaches the rule at position 1, does not match the rule's condition, and is dropped. This means the fragmented packets do not reach the Web server.

**Example 2 Firewall, Addresses Fragmented Packets**

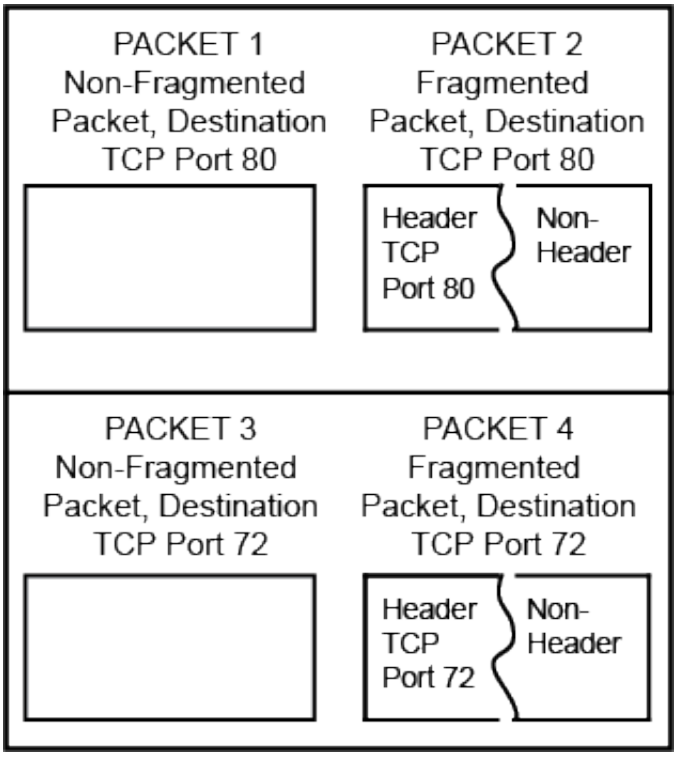
To address this problem, MidoNet provides a mechanism to handle the fragmented packets. This mechanism allows the fragmented packets to reach their destination, as shown in the following example. The drawing below simply depicts a whole, non-fragmented packet and a fragmented packet that consists of two parts, a header and non-header.




# Non-Fragmented and Fragmented Packets

For this example, consider the following packets:

- Non-fragmented packet with the destination, TCP port 80
- Fragmented packet with the destination, TCP port 80
- Non-fragmented packet with the destination, TCP port 72
- Fragmented packet with the destination, TCP port 72



# Fragmented and Non-Fragmented Packets with Different Destinations

Given the above packets and the rule in example 1, MidoNet processes the packets as follows:

- Packet 1 matches the rule in position 1 and is accepted.
- The header part of packet 2 matches the rule in position 1 and is accepted; the non-header fragment, which doesn't contain the destination, does not match the rule and is dropped.
- Packet 3's destination does not match the rule in position 1 and is dropped, same thing for the header part of packet 4. The non-header part of packet 4 does not contain destination information and is dropped.

The first objective is to accept the part of the packet fragments that contains the headers. To do this, you create the same rule at position 1. The change is to add a new rule at position 2, to drop all packets that contain TCP/UDP headers.

- Rule at position 1
  - By default, this rule matches only non-fragmented packets and header fragments.
  - ACCEPTs packets from in-ports=router2:port0 with protocol=TCP and destination=80.

```
midonet> chain chain18 add rule ethertype 2048 src 0.0.0.0/0 proto 6
 in-ports router2:port0 dst-port 80 pos 1 type accept
```

- Rule at position 2
  - Drop packets that contain TCP/UDP headers

```
midonet> chain chain18 add rule ethertype 2048 src 0.0.0.0/0 in-ports
 router2:port0 fragment-policy header pos 2 type drop
```

- Rule at position 3
  - Accept all other packets

```
midonet> chain chain18 add rule ethertype 2048 src 0.0.0.0/0 in-ports
 router2:port0 dst 0.0.0.0/0 pos 3 type accept
```

Look at the packets in the above figure, starting with the packets destined for port 72, and how they the progress through this new rule chain:

- Packet 3's destination is port 72, not port 80, does not match the rule in position number 1, and continues to the rule at position number 2.
- Packet 3 contains a TCP header and therefore matches the rule at position number 2 and isdropped.
- The header fragment of packet 4 contains a destination of port 72, does not match the rule at position 1 and continues to the rule at position number 2.
- This fragment contains a TCP header, matches the rule at position number 2, and is dropped.

- The non-header fragment of packet 4 does not contain a header (and therefore, has no destination information), does not match the rule at position 1, and continues to the rule at position 2.
- This non-header packet fragment does not contain a TCP/UDP header, does not match the rule at position 2, and continues to the rule at position 3.
- The rule at position 3 accepts all packets that reach it and accepts this packet fragment. Because this packet does not have any associated header information it will not be reassembled and sent to an application and will eventually be dropped.

Looking at packets 1 and 2:

- Packet 1 is destined for TCP port 80, matches the rule at position 1, and is accepted.
- For packet 2, the packet fragment with the header contains a destination of TCP port 80, matches the rule at position 1, and is accepted.
- The non-header packet fragment of packet number 2 does not contain a header, does not match the rule at position number 1, and continues to the rule at position number 2.
- This non-header packet fragment does not contain a TCP/UDP header, therefore does not match the rule at position number 2, is not dropped, and continues to the rule at position number 3.
- The rule at position number 3 accepts all packets, so this packet fragment is accepted.

This change allows non-header fragments to get past both the rules at positions 1 and 2, and exit the chain with an ACCEPT. With this change, the firewall now lets all non-header fragments through, but you decided that the level of risk is acceptable and are just trying to fix the broken HTTP flows. This is not a problem, as an unwanted non-header fragment will be discarded if the corresponding header fragment is never received.

# 12. MidoNet resource protection

## Table of Contents



This section describes how to protect the MidoNet Agent against DOS attacks carried out by potentially rogue VMs.

## Introduction

MidoNet provides resource protection/isolation among tenants running VMs on the same hypervisor. Specifically, MidoNet provides protection against a VM initiating a Denial of Service (DoS) attack against the MidoNet Agent by emitting packets that miss the kernel flow table as fast as possible. Without resource protection, new flows to/from other VMs are prevented from being handled in a timely manner or at all because the rogue VM would capture most of the Agent's capacity to process packets. In a public cloud setting, where tenants are not necessarily trusted, this may be considered a serious problem.

## Expected Behavior

There are two major requirements that this solution addresses:

- VMs are guaranteed to have their fair share of the MidoNet Agent's processing capacity. Even if another VM sends packets at a rate that exceeds the total capacity of the Agent, other VMs will still be able to set up new flows at the expected rate and latency.
- The Agent fairly redistributes the processing capacity allocated to VMs that are not fully using it.

The MidoNet Agent applies a hierarchical token bucket (HTB) to all packets that miss the kernel flow table and go up to userspace, so as to fairly share processing capacity among all ports.

The HTB is set up in such a way that tunnel traffic between MidoNet hosts and through a VTEP is guaranteed 50% of the resources while the remaining 50% is distributed among VM ports.

At the top of the hierarchy is a bucket whose size defines the total burst capacity of the system. Below this bucket lie three other buckets, one for tunnel traffic, another for VTEP traffic and another for VM traffic. They evenly share processing capacity, with the tunnel traffic and VTEP buckets having a non-zero size. Below the VM-shared bucket there is a bucket for every VM. The VM-shared bucket has zero capacity, meaning that it accumulates no tokens: if all the VM leaf buckets are full, excess capacity goes to either the tunnel traffic or VTEP buckets, or to the top-level bucket.

# Configuration

You can specify resource protection configuration parameters using mn-conf(1), in the agent.datapath section. The available parameters are:

- global_incoming_burst_capacity - this sets the size of the top-level bucket and also defines the total number of tokens in the system (corresponding to in-flight packets) that will be divided among the different levels in the HTB; the rate at which tokens are placed back in the bucket is a function of the rate at which they are processed.
- tunnel_incoming_burst_capacity - this sets the capacity of the bucket associated with tunnel traffic, enforcing the rate at which a MidoNet Agent can communicate with the other Agents.
- vm_incoming_burst_capacity - this sets the capacity of each VM leaf bucket, which is below the shared VM bucket. This parameter enforces the rate at which individual VMs can sendtraffic.
- vtep_incoming_burst_capacity - this sets the capacity of the bucket associated with the VxLAN VTEP functionality, which enforces the rate at which the MidoNet Agent can communicate with the VxLAN domain.

See the mn-conf(1) schemas for more information about the above parameters.

Recommended values for these properties depend on the role of the MidoNet host (Gateway vs. Compute Node) and interaction with other resource-related properties, like JVM-memory and flow-table size. Midolman RPM and Debian packages include versions of each configuration tuned for Compute/Gateway hosts respectively. You can find these configurations in /etc/midolman, alongside the default configuration files. See "Recommended Values" for a table of recommended values.

# Disabling Resource Protection

You can disable the resource protection feature.

To disable resource protection:

1. Specify a size value of "0" for all the parameters described in the Configuration section, except for the global_incoming_burst_capacity parameter.

This will cause all tokens to accumulate in the global bucket and all the traffic will be distributed from this single bucket.

# 13. MidoNet monitoring

## Table of Contents



MidoNet is composed of various services; each service exposes a variety of metrics that can be fetched from typical monitoring services, such as Zabbix™, Munin, and so on.

This chapter describes the main available metrics for each service, as well as a procedure to configure a basic monitoring infrastructure based on Munin, based on scripts provided with the MidoNet deployment package.

# Metering

**Note**: This feature is in **experimental** status.

## Overview

The goal of metering is to provide packets and bytes traffic counters for arbitrary slices of the traffic that travels through MidoNet.

A meter is a counter of bytes and packets, associated with a name. In order to be incremented, the meter needs to have flows associated with it. MidoNet agents will automatically associate flows with certain meters, and users can create their own custom meters setting the `meterName` attribute in chain rules.

For example, all traffic going through bridge with uuid F00 in MidoNet be counted under meter `meters:device:`F00. All traffic egressing port BAR will also be reflected in meter `meters:port:tx:`BAR.

MidoNet agents offer these counters for their partial view of overlay traffic. In other words, each agent will provide meters that only account for the traffic that agent has simulated. For a given meter, the MidoNet-wide real value is the sum of the value of this meter across all agents.

**Note**: Metering data is meant to be polled and stored by a monitoring layer onto a time series database. Thus agents don't persist the metering data they gather, and meter values will reset to zero when an agent reboots. **Any metering data collection layer should account for this effect and detect counter resets.**

## Querying meters

Agents publish meters over JMX and a command line tool, `mm-meter`, uses their JMX interface to list, fetch and monitor meter values.

For example code on the JMX interface, the best source is the code of `mm-meter` itself.

Querying meters with `mm-meter` is very simple:

```
$ mm-meter --help
  -h, --host  <arg>   Host (default = localhost)
  -p, --port  <arg>   JMX port (default = 7200)
      --help          Show help message

Subcommand: list - list all active meters
      --help   Show help message
Subcommand: get
  -n, --meter-name  <arg>   name of the meter
      --help                Show help message

 trailing arguments:
  delay (not required)   delay between updates, in seconds. If no delay is
                       specified, only one report is printed. (default = 0)
  count (not required)   number of updates, defaults to infinity
                       (default = 2147483647)
```

The `list` command will print a list of all meters known to this agent:

```
$ mm-meter list
meters:user:port0-on-the-bridge
meters:port:rx:cf453c9d-94c4-4c27-ba32-529b7cbacf1d
meters:device:845a54bf-b702-4dc2-8958-bbe7156bc4ef
meters:port:tx:cf453c9d-94c4-4c27-ba32-529b7cbacf1d
meters:port:tx:9182485b-8f86-462d-a8be-62586060eeb9
meters:device:f0d1f093-2de7-49a1-a5ec-898f94769e34
meters:device:9182485b-8f86-462d-a8be-62586060eeb9
meters:port:rx:9182485b-8f86-462d-a8be-62586060eeb9
meters:device:cf453c9d-94c4-4c27-ba32-529b7cbacf1d
```

And the `get` command will print the *current*, *local* counters for a meter. It takes a delay, in which case it will poll the meter and print deltas periodically:

```
$ mm-meter get -n meters:port:rx:cf453c9d-94c4-4c27-ba32-529b7cbacf1d 10
    packets         bytes
     568935   4215888475
          0            0
          0            0
         23         5834
          0            0
```

# Creating a custom meter

Operators may want to meter a custom slice of their virtual network traffic. This is possible by matching on that slice using one or several chain rules in the virtual topology. The `meterName` property in chain rules will assign matching flows to the meter referred to by its value, in addition to the meters that flow would naturally feed.

Besides using the REST API, operators can use `midonet-cli` to set up such rules. The following rule will assign to meter `my-meter` all traffic that hits the rule after having traversed device `9182485b-8f86-462d-a8be-62586060eeb9`:

```
midonet> chain chain0 list rule
rule rule0 proto 0 tos 0 traversed-device 9182485b-8f86-462d-
a8be-62586060eeb9 fragment-policy any pos 1 type accept meter my-meter
```

Note that, when inspecting meters `my-meter` will turn into `meters:user:my-meter`, to avoid naming conflicts with built-in meters.

# Monitoring with Munin

Munin is composed of a master node with a cron-based process that regularly fetches values from slave nodes.

Slave nodes run munin-node to extract metrics from a variety of sources (Java Management Extensions (JMX) included) and expose them for the master. The data is fed to RRDTool databases and used to generate graphs.

Adding monitoring for a given service involves configuring munin-node in each host where an instance of the service runs, and then configuring Munin on the master node to fetch data from this node.

The MidoNet deployment repository contains automated scripts to configure all supported monitoring at monitoring/munin/.

This information in this guide and automated configuration scripts are based on munin 1.4.6-3ubuntu3.3. For more information, see http://munin-monitoring.org/.

## Configuring Munin

Follow the instructions from the Munin documentation; this information is pretty straight forward and contains basic configuration files that work out of the box.

**Master node**

Install the **munin** and **munin-plug-ins-extra** packages. Also, install jmx2munin from its GitHub repository (https://github.com/tcurdt/jmx2munin).

To add two new slaves to your master's configuration, just append these sample configs to /etc/munin/munin.conf:

```
[MidoStorage;node1]address 10.0.0.1 use_node_name yes
```

```
[MidoStorage;node2]address 10.0.0.2 use_node_name yes
```

### Note

The addresses above are only samples, they should be the IP addresses of the node.

This causes the Munin master to start to fetch data files from the given slaves. The "MidoStorage" name appears in the Munin interface as a group containing both of the nodes. Later sections in this guide explain how to add service-specific graphs.

**Slave Nodes**

Install the **munin-node** and **munin-plugin-extra** packages. Also, install jmx2munin from its GitHub repository. You can reuse /etc/munin/munin-node.conf.sample and simply update the master's IP address.

**Plugins**

Munin provides several default plugins that show metrics for disk, memory, CPU, and so on. You may not want to use these now. You can easily remove them by deleting the symlinks at /etc/munin/plugins in each of the slaves.

#### MidoNet plugins

Fetching metrics for the MidoNet subsystems simply requires adding new plugins on the relevant slaves. There is an automated script that will do most of the work. Assuming you cloned the MidoNet deployment repository at the current directory, you just need to run the following commands on each of the slaves:

```
sudo ./install_plugins.sh
sudo service munin-node restart
```

On RedHat Enterprise Linux 7, you should use:

```
sudo systemctl restart munin-node
```

This installs all available plugins, and updates Munin configurations.

You shouldn't have to take any action on the master. When the Munin fetch process runs, it should start fetching the data. If you are impatient, you can execute the following command on the master to trigger the Munin cron job that pulls data from the slaves:

```
sudo -u munin munin-cron
```

# Monitoring with Zabbix

This section describes how to integrate Zabbix with MidoNet for monitoring events.

Zabbix is a popular monitoring tool that provides a way for system administrators to monitor their networks. See https://www.zabbix.com/ and navigate to Documentation for details about Zabbix usage.

#### Basic Steps for Using Zabbix

In Zabbix, you can monitor log files stored on the filesystem. You need to run the Zabbix agent for each node, and set up a log monitoring configuration with the file location, update interval, etc.

- Run Zabbix on each Gateway and Compute host.
- Configure log file monitoring; this includes the following tasks:
  - Verify agent parameters.
  - Configure items (an item is a piece of metric data you want to retrieve from a host).
  - Specify the path to the log file to monitor, along with the regular expressions to match.
  - Configure triggers to notify users when specified events occur.

See https://www.zabbix.com/documentation/2.0/manual/config/items/itemtypes/log_items for more details.

# Monitoring Network State Database

The Network State Database is deployed with Cassandra and ZooKeeper instances. Both offer JMX bindings.

The configuration provided with MidoNet uses only a subset of the most relevant for our use cases. Details in the sections below provide additional information about the metrics configured by MidoNet's deployment scripts, as well as an explanation about what to watch.

# Cassandra

By default, Cassandra uses port 7199 for JMX service from all its nodes and you can connect using jconsole for a comprehensive view.

Additionally, Cassandra's own nodetool utility offers commands like cfstats and tpstats that allow access to valuable stats into keyspaces, tables, column families, and so on on a given node.

For a rich reference into Cassandra monitoring, visit the official documentation (go to http://www.datastax.com/, and search for "monitoring a Cassandra cluster").

Below are descriptions of the graphs resulting from the example Munin configurations provided in the MidoNet deployment repository. The graphs are built from a subset of the Cassandra JMX service. The available graphs are:

**Cache Reqs vs. Hits**

This is self-descriptive, ideally you want the cache hits to be as close to the requests as possible. Note that by default MidoNet Cassandra nodes only enable the Partition Key Cache, but not Row Cache, so it's normal that these stay at 0. For MidoNet the Partition Key Cache should effectively be very similar to the Row Key Cache because our column families (CF) have only one column and therefore rows are not spread across several SSTables.

**Compactions**

This indicates the number of bytes being compacted. Typical workloads will present regular small spikes when the minor compaction jobs are run, and infrequent large spikes when major compactions are run. A large number of compactions indicates the need to add capacity to the cluster.

**Internal Tasks**

These are internal Cassandra tasks. The most important are:

- Gossip: MidoNet's Cassandra nodes are expected to spend a fair amount of their time busy in Gossip (wherein state information transfers among peers).
- MemTable Post Flusher: memtable flushes that are waiting to be written to the commit log. These should be as low as possible, and definitely not sustained.
- Hinted Handoff tasks: the appearance of these tasks indicates cases where replicas are detected as unavailable, so non-replica nodes need to temporarily store data until the replicas become available. Frequent Hinted Handoff spikes may hint at nodes being partitioned from the cluster.
- Anti-Entropy spikes: indicate data inconsistencies detected and being resolved.
- Stream activity: involves transferring or requesting data from other nodes. Ideally these should be infrequent and short-spaced.

**Messaging Service Tasks**

These are tasks received and responded to each of the peer nodes. Expect an even distribution with all peers.

**NAT Column Family Latency**

This is a key metric that informs about the read and write latency to the NAT mapping cache. High latency, especially in reads, is problematic because it causes high latency in traffic traversing those virtual routers that apply the NAT rules. Due to Cassandra's own guarantees, write latency can be expected to be lower. Note that higher replication levels have a significant impact in latency (nodes have to retrieve/receive ACK from n replicas). Spikes in latency can be correlated to events like compactions, especially in cache misses, because Cassandra needs to go to disk to fetch data during high I/O load due to compactions.

**NAT Column Family Memtable**

Shows data size and column count. This is in-memory data. Expect a see-saw pattern because most of the data expires after the mapping time to lives (TTLs) expire.

**NAT Column Family Disk Usage**

Shows overall disk usage, including that used for the bloom filters used to save trips to cache when keys are not present.

**NAT Column Family Ops**

Shows read and writes on each node. The aggregated views are probably more valuable to help you spot bad distribution of load across the cluster.

**Node Load**

Shows the disk space used in the node.

**Number of Nodes in Cluster**

This is the view each node has of the rest of the cluster, and can help you spot partitions.

**Request Task Completed by Stage**

Shows tasks completed by the node. Mutations are changes in data, request responses are data sent to requesting peers. The Read-repair task appears as a result of nodes detecting inconsistent data and asking to perform a read to update the data; obviously, this task should be as infrequent as possible.

**StorageProxy Operation Count**

Shows overall read/write operations in the node.

**StorageProxy Recent and Total Latency**

Shows overall read/write latency in the cluster. Watch for big discrepancies between NAT Column Family (CF) Latency and this metric, because that would help determine whether problems are related to a single CF or the entire storage. More importantly: it indicates what features may be impacted in Midolman agents.

In the aggregated view, an additional "clock" category configured in Munin shows the result of the time command in each of the nodes. Expect to see a straight line, as close

as possible with the lines of all Cassandra nodes overlapping. Otherwise, this indicates divergences in the host's clocks that will almost certainly end up causing problems on conflict resolution. You should attend to this urgently and ensure that all hosts are using the Network Time Protocol (NTP).

The installation script also provides graphs to monitor the state of Cassandra's Java virtual machine (JVM):

- JVM garbage-collection (GC) times
- JVM Heap Summary
- JVM Non-Heap Summary

Descriptions of these graphs are beyond the scope of this guide, but high JVM GC times are the best indication that Cassandra may be consuming too much time on garbage collection. This will correlate with high latency accessing Midolman's column families, which will propagate to Midolman. The Midolman agent will increase simulation latency and also degrade the utilization of CPU resources (experiencing more idle time while waiting for responses from Cassandra).

## ZooKeeper

The install_plugins.sh script also installs a set of Munin plugins and configuration files to generate graphs from ZooKeeper's exposed JMX metrics.

However, on each node, you need to indicate the ZooKeeper replica number; the script provides clear guidance on how to do this.

You can find ZooKeeper stats in the "zookeeper" category of the MidoStorage group. ZooKeeper classifies metrics in separate MBeans for leader/follower, so each node will report some values twice, one in the "Follower" role, another in the "Leader" role. Take into account that a given node may change roles (for example, if the leader shuts down, a follower node may be promoted to leader). You can easily spot these events. For example, the line in the "Connection Count as Follower" will suddenly blank out, and another will appear in the "Connection Count as Leader" graph.

Below are descriptions of the graphs resulting from the example Munin configurations provided in the MidoNet deployment repository. The graphs are built from a subset of the ZooKeeper JMX service. The available graphs are:

**Connection Count (as Follower/Leader)**

These two graphs display the number of live connections to this node in its role at a givenpoint in time.

**In Memory Data Tree (as Follower/Leader)**

Exposes the size of the in-memory znode database, both data nodes and watch count.

**Latency (as Follower/Leader)**

Exposes the average and maximum latency experienced in connections.

**Packet Count (as Follower/Leader)**

Exposes the count of packets sent/received by the node in its role at a given point in time.

**Quorum Size**

Exposes each node's view of the number of nodes agreeing on the leader's election.

ZooKeeper also exposes some information about each specific connection, this may be useful to watch for troubleshooting. Using jconsole (go to http://www.oracle.com/technetwork/java/index.html and search on "jconsole" for information), you can:

1. Connect to any ZooKeeper node at port 9199.
2. Navigate to org.apache.ZooKeeperService, ReplicatedServer_idX.
3. Choose the desired replica.
4. Go into Leader or Follower, Connections to see a list of IP addresses of the connected clients. Information shown here includes:
   - latency
   - packet sent/received count
   - session ID, etc. for that specific client.

Some of the MBeans whose values are exposed in our graphs also contain (computationally intensive) operations that also offer interesting information. Using jconsole, expand org.apache.ZooKeeperService, and then the appropriate replica, and either Leader or Follower, according to its role:

- InMemoryDataTree.approximateDataSize: tells the size of the in-memory data store.
- InMemoryDataTree.countEphemerals: tells the count of ephemeral nodes.

The installation script also provides graphs to monitor the state of ZooKeeper's JVM:

- JVM GC times
- JVM Heap Summary
- JVM Non-Heap Summary

Descriptions of these graphs are beyond the scope of this document, but high JVM GC times are the best indication that ZooKeeper may be the source of problems in Midolman, which will be exhibited in high latency and under-utilization of CPU resources. ZooKeeper uses the Parallel collector, and the JVM GC times track the time of the last collection in all spaces from the java.lang:type=GarbageCollector,name=PS Scavenge MBean, which deals with all generations.

# Monitoring Midolman Agents

MidoNet Agents expose a set of internal metrics that you can use to monitor the performance and health of agent nodes.

The install_plugins.sh script can configure all the relevant Munin plugins.

Below are descriptions of the graphs resulting from the example Munin configurations provided in the MidoNet deployment repository. The graphs are built from a subset of the Midolman JMX service. The available graphs are:

**Current Pended Packets**

Midolman simulates a single packet for each wildcard-flow match. When a packet A is being simulated, if another packet B with the same flow match appears, it will be pended until A finishes its simulation. At this point, B will be sent straight to the datapath with the same actions as A applied. This metric displays the total count of pended packets at a given point in time. Ideally, this value should be as low as possible. Large values indicate that Midolman is being flooded with packets with identical matches. A steadily growing figure may also indicate that pended packets are not being executed, which is likely caused by a bug.

**Datapath Flows**

Shows the count of currently active flows in the datapath, and the rate of creation. This depends significantly on the nature of the traffic.

**Wildcard Flows**

Shows the count of currently active wildcard flows inside Midolman. This number should be similar to the Datapath Flow count, but not necessarily equal.

**Simulation Latency**

Shows the time taken by Midolman to run the simulation of packets through the virtual topology. This value is fundamental for network latency.

**Wildcard Flow Table Latency**

Shows the access times to Midolman's internal wildcard-flow table. This value is relevant for network latency.

**Throughput**

Shows the packets per second that are being processed and dropped. When Midolman becomes saturated, the expected behavior is to stabilize processed packets in a relatively flat line, increasing the dropped rate with any additional traffic. However, pressure from the Netlink queue may cause performance degradation.

Additionally, some graphs are provided to monitor the state of the JVM running Midolman.

**JVM Non-Heap Summary**

Shows off-heap memory usage, which consists of mainly buffer pools used for messages to/from the Netlink layer.

**JVM Heap Summary**

Shows per-generation stats. Midolman has very specific memory-usage constraints because it aims for a very low memory and CPU footprint. At the same time, simulations generate a significant amount of short-lived garbage.

- Eden is configured as the largest generation trying to hold as much garbage as possible. However, it is likely that it fills up frequently under high traffic, which may imply that some short-lived objects get promoted to the old generation and garbage is collected soon afterward.
- The Old Generation is expected to contain a baseline of long-lived objects that get reused during simulations. An amount of short-lived objects may also be pushed from the young generation, eventually also filling the old generation and triggering a GC event that will collect them. This will show as a see-saw pattern in the "Old used". The

see-saw should converge to oscillating between stable max./min. values on top of the long-lived objects baseline.

  - Large spikes indicate higher CPU consumption in GC and are usually associated with a certain throughput degradation. You may slightly alleviate this by increasing the size of the Eden.

- JVM GC times: shows the duration of the last garbage collection performed by the ConcurrentMarkSweep's collector, (which runs only on the old generation). It is closely associated with the see-saw pattern described above.

  - Note that these times do not stop the application completely, because part of the work is done concurrently. The main impact is in CPU "stolen" from Midolman.

Munin offers some generic metrics that are very relevant to understanding the performance of Midolman.

**CPU Usage**

Under high traffic, Midolman should tend to saturate all CPUs, reflecting in the graph as high "user" utilization and little or no "idle". Note that "user" may include other processes, so especially in Gateway Nodes, you should verify that only Midolman is consuming most of CPU time dedicated to user processes. High "system", "iowait" indicators are clear indication of high load, excessive context switching, and contention or other problems on the host.

# Monitoring events

This section describes how MidoNet's event system works so you can monitor the system's day-to-day operations.

**Overview**

This section provides a high-level overview of the information covered regarding event monitoring.

**Categories of Event Messages**

Below are the following types of events defined in the MidoNet system:

- Changes in the virtual topology
- Events concerning the MidoNet API server, including:
  - Changes to the connection status to the Network State Database
- Events concerning MidoNet Agents, including:
  - Changes to the connection status to the Network State Database
  - Changes affecting the status of network interfaces (for example, physical network interfaces and taps)
  - Daemons starting and exiting

## Configuration

Each event message is generated with logback (http://logback.qos.ch/).

The configuration files are located at the following locations, depending on the type of the node.

### Table 13.1. Configuration Files/Locations

| Type of Node | Location of the Configuration File |
|---|---|
| MidoNet Network Agent | /etc/midolman/logback.xml |
| MidoNet API server | /usr/share/midonet-api/WEB-INF/classes/logback.xml |

Below are the behaviors with the default configuration shipped with the MidoNet release, but you can configure the behaviors as you like. See http://logback.qos.ch/manual/index.html for instructions on how to configure the logback.xml file.

## Event log files locations

Event messages are stored locally on the filesystem in a separate file, in addition to the ordinary log file.

### Table 13.2. Event Message Files/Locations

| Type of Node | Location |
|---|---|
| MidoNet Network Agent | /var/log/midolman/midolman.event.log |
| MidoNet API server | /var/log/tomcat6/midonet-api.event.log (on Red Hat)<br>/var/log/tomcat7/midonet-api.event.log (on Ubuntu) |

### Tip

In addition to midolman.event.log, /var/log/midolman/midolman.log contains additional debug information. You do not normally need to use it, but it may contain useful troubleshooting information.

## Message format

By default, event messages have the following format.

```
<pattern>%d{yyyy.MM.dd HH:mm:ss.SSS} ${HOSTNAME} %-5level %logger - %m%n
%rEx </pattern>
```

See http://logback.qos.ch/manual/layouts.html for details about the above placeholders.

## List of event messages

This section lists the event messages.

The event messages are organized in the following major categories:

- Virtual topology events
- API server events
- MidoNet Agent events

### Virtual topology events

This section describes the messages associated with virtual topology events.

## Router

| | |
|---|---|
| Logger | org.midonet.event.topology.Router.CREATE |
| Message | CREATE routerId={0}, data={1}. |
| Level | INFO |
| Explanation | Router with routerId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Router.UPDATE |
| Message | UPDATE routerId={0}, data={1}. |
| Level | INFO |
| Explanation | Router with routerId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Router.DELETE |
| Message | DELETE routerId={0}. |
| Level | INFO |
| Explanation | Router with routerId={0} was deleted. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Router.ROUTE_CREATE |
| Message | ROUTE_CREATE routerId={0}, data={1}. |
| Level | INFO |
| Explanation | Route={1} was created in routerId={0}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Router.ROUTE_DELETE |
| Message | ROUTE_DELETE routerId={0}, routeId={1}. |
| Level | INFO |
| Explanation | routeId={1} was deleted in routerId={0}. |
| Corrective Action | N/A |

## Bridge

| | |
|---|---|
| Logger | org.midonet.event.topology.Bridge.CREATE |
| Message | CREATE bridgeId={0}, data={1}. |
| Level | INFO |
| Explanation | Bridge with bridgeId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Bridge.UPDATE |
| Message | UPDATE bridgeId={0}, data={1}. |
| Level | INFO |
| Explanation | Bridge with bridgeId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Bridge.DELETE |
| Message | DELETE bridgeId={0}. |
| Level | INFO |
| Explanation | Bridge with bridgeId={0} was deleted. |
| Corrective Action | N/A |

## Port

| | |
|---|---|
| Logger | org.midonet.event.topology.Port.CREATE |
| Message | CREATE portId={0}, data={1}. |
| Level | INFO |
| Explanation | Port with portId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Port.UPDATE |
| Message | UPDATE portId={0}, data={1}. |
| Level | INFO |
| Explanation | Port with portId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Port.DELETE |
| Message | DELETE portId={0}. |
| Level | INFO |
| Explanation | Port with portId={0} was deleted. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Port.LINK |
| Message | LINK portId={0}, data={1}. |
| Level | INFO |
| Explanation | Port with portId={0} was linked. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Port.UNLINK |
| Message | UNLINK portId={0}, data={1}. |
| Level | INFO |
| Explanation | Port with portId={0} was unlinked. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Port.BIND |
| Message | BIND portId={0}, data={1}. |
| Level | INFO |
| Explanation | Port with portId={0} was bound. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Port.UNBIND |
| Message | UNBIND portId={0}. |
| Level | INFO |
| Explanation | Port with portId={0} was unbound. |
| Corrective Action | N/A |

## Chain

| | |
|---|---|
| Logger | org.midonet.event.topology.Chain.CREATE |
| Message | CREATE chainId={0}, data={1}. |
| Level | INFO |
| Explanation | Chain with chainId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Chain.DELETE |
| Message | DELETE chainId={0}. |
| Level | INFO |
| Explanation | Chain with chainId={0} was deleted. |
| Corrective Action | N/A |

## Rule

| | |
|---|---|
| Logger | org.midonet.event.topology.Rule.CREATE |
| Message | CREATE ruleId={0}, data={1}. |
| Level | INFO |
| Explanation | Rule with ruleId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Rule.DELETE |
| Message | DELETE ruleId={0}. |
| Level | INFO |
| Explanation | Rule with ruleId={0} was deleted. |
| Corrective Action | N/A |

## Tunnel Zone

| | |
|---|---|
| Logger | org.midonet.event.topology.TunnelZone.CREATE |
| Message | CREATE tunnelZoneId={0}, data={1}. |
| Level | INFO |
| Explanation | TunnelZone with tunnelZoneId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.TunnelZone.UPDATE |
| Message | UPDATE tunnelZoneId={0}, data={1}. |
| Level | INFO |
| Explanation | TunnelZone with tunnelZoneId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.TunnelZone.DELETE |
| Message | DELETE tunnelZoneId={0}. |
| Level | INFO |
| Explanation | TunnelZone with tunnelZoneId={0} was deleted. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.TunnelZone.MEMBER_CREATE |
| Message | MEMBER_CREATE tunnelZoneId={0}, data={1}. |
| Level | INFO |
| Explanation | TunnelZone member={1} was added to tunnel-ZoneId={0}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.TunnelZone.MEMBER_DELETE |
| Message | MEMBER_DELETE tunnelZoneId={0}, data={1}. |
| Level | INFO |
| Explanation | TunnelZone member={1} was deleted from tunnel-ZoneId={0}. |

| | |
|---|---|
| Corrective Action | N/A |

## BGP

| | |
|---|---|
| Logger | org.midonet.event.topology.Bgp.CREATE |
| Message | CREATE bgpId={0}, data={1}. |
| Level | INFO |
| Explanation | Bgp with bgpId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Bgp.UPDATE |
| Message | UPDATE bgpId={0}, data={1}. |
| Level | INFO |
| Explanation | Bgp with bgpId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Bgp.DELETE |
| Message | DELETE bgpId={0}. |
| Level | INFO |
| Explanation | Bgp with bgpId={0} was deleted. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Bgp.ROUTE_CREATE |
| Message | ROUTE_CREATE bgpId={0}, data={1}. |
| Level | INFO |
| Explanation | Route={1} was added to bgpId={0}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Bgp.ROUTE_DELETE |
| Message | ROUTE_DELETE bgpId={0}, data={1}. |
| Level | INFO |
| Explanation | Route={1} was deleted from bgpId={0}. |
| Corrective Action | N/A |

## LoadBalancer

| | |
|---|---|
| Logger | org.midonet.event.topology.LoadBalancer.CREATE |
| Message | CREATE loadBalancerId={0}, data={1}. |
| Level | INFO |
| Explanation | LoadBalancer with loadBalancerId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.LoadBalancer.UPDATE |
| Message | UPDATE loadBalancerId={0}, data={1}. |
| Level | INFO |
| Explanation | LoadBalancer with loadBalancerId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.LoadBalancer.DELETE |
| Message | DELETE loadBalancerId={0}. |
| Level | INFO |

| | |
|---|---|
| Explanation | LoadBalancer with loadBalancerId={0} was deleted. |
| Corrective Action | N/A |

## VIP

| | |
|---|---|
| Logger | org.midonet.event.topology.VIP.CREATE |
| Message | CREATE vipId={0}, data={1}. |
| Level | INFO |
| Explanation | VIP with vipId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.VIP.UPDATE |
| Message | UPDATE vipId={0}, data={1}. |
| Level | INFO |
| Explanation | VIP with vipId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.VIP.DELETE |
| Message | DELETE vipId={0}. |
| Level | INFO |
| Explanation | VIP with vipId={0} was deleted. |
| Corrective Action | N/A |

## Pool

| | |
|---|---|
| Logger | org.midonet.event.topology.Pool.CREATE |
| Message | CREATE poolId={0}, data={1}. |
| Level | INFO |
| Explanation | Pool with poolId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Pool.UPDATE |
| Message | UPDATE poolId={0}, data={1}. |
| Level | INFO |
| Explanation | Pool with poolId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.Pool.DELETE |
| Message | DELETE poolId={0}. |
| Level | INFO |
| Explanation | Pool with poolId={0} was deleted. |
| Corrective Action | N/A |

## PoolMember

| | |
|---|---|
| Logger | org.midonet.event.topology.PoolMember.CREATE |
| Message | CREATE poolMemberId={0}, data={1}. |
| Level | INFO |
| Explanation | PoolMember with poolMemberId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.PoolMember.UPDATE |

| | |
|---|---|
| Message | UPDATE poolMemberId={0}, data={1}. |
| Level | INFO |
| Explanation | PoolMember with poolMemberId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.PoolMember.DELETE |
| Message | DELETE poolMemberId={0}. |
| Level | INFO |
| Explanation | PoolMember with poolMemberId={0} was deleted. |
| Corrective Action | N/A |

### HealthMonitor

| | |
|---|---|
| Logger | org.midonet.event.topology.HealthMonitor.CREATE |
| Message | CREATE healthMonitorId={0}, data={1}. |
| Level | INFO |
| Explanation | HealthMonitor with healthMonitorId={0} was created. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.HealthMonitor.UPDATE |
| Message | UPDATE healthMonitorId={0}, data={1}. |
| Level | INFO |
| Explanation | HealthMonitor with healthMonitorId={0} was updated to {1}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.topology.HealthMonitor.DELETE |
| Message | DELETE healthMonitorId={0}. |
| Level | INFO |
| Explanation | HealthMonitor with healthMonitorId={0} was deleted. |
| Corrective Action | N/A |

## API server events

This section describes the messages associated with API server events.

### NSDB (Network State Database)

| | |
|---|---|
| Logger | org.midonet.event.api.Nsdb.CONNECT |
| Message | CONNECT Connected to the NSDB cluster. |
| Level | INFO |
| Explanation | API server was connected to the NSDB cluster. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.api.Nsdb.DISCONNECT |
| Message | DISCONNECT Disconnected from the NSDB cluster. |
| Level | WARNING |
| Explanation | API server was disconnected from the NSDB cluster. |
| Corrective Action | If the connection is restored after this event, no corrective action is required. If this event continues, check the network connection between the API server and the NSDB cluster. |

| | |
|---|---|
| Logger | org.midonet.event.api.Nsdb.CONN_EXPIRE |
| Message | CONN_EXPIRE Connection to the NSDB cluster expired. |
| Level | ERROR |
| Explanation | The connection from the API server to the NSDB cluster expired. |
| Corrective Action | Check the network connection between the API server and the NSDB cluster and restart the MidoNet API server so it reconnects to the NSDB cluster. |

# MidoNet Agent events

This section describes the messages associated with MidoNet Agent events.

## NSDB

| | |
|---|---|
| Logger | org.midonet.event.agent.Nsdb.CONNECT |
| Message | CONNECT Connected to the NSDB cluster. |
| Level | INFO |
| Explanation | MidoNet Agent was connected to the NSDB cluster. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.agent.Nsdb.DISCONNECT |
| Message | DISCONNECT Disconnected from the NSDB cluster. |
| Level | WARNING |
| Explanation | MidoNet Agent was disconnected from the NSDB cluster. |
| Corrective Action | If the connection is restored after this event, no corrective action is required. If this event continues, check the network connection between the MidoNet Agent and the NSDB cluster. |

| | |
|---|---|
| Logger | org.midonet.event.agent.Nsdb.CONN_EXPIRE |
| Message | CONN_EXPIRE Connection to the NSDB cluster expired. Shutting down the MidoNet Agent. |
| Level | ERROR |
| Explanation | The connection from the MidoNet Agent to the NSDB cluster expired. Shutting down the MidoNet Agent. |
| Corrective Action | Check the network connection between the MidoNet Agent node and the NSDB cluster and restart the MidoNet Agent service on the node so it reconnects to the NSDB cluster. |

## Interface

| | |
|---|---|
| Logger | org.midonet.event.agent.Interface.DETECT |
| Message | NEW interface={0} |
| Level | INFO |
| Explanation | MidoNet Agent detected a new interface={0}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.agent.Interface.UPDATE |
| Message | UPDATE interface={0} was updated. |
| Level | INFO |
| Explanation | MidoNet Agent detected an update in interface={0}. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.agent.Interface.DELETE |
| Message | DELETE interface={0} was deleted. |
| Level | INFO |
| Explanation | MidoNet Agent detected that interface={0} was deleted. |
| Corrective Action | N/A |

### Service

| | |
|---|---|
| Logger | org.midonet.event.agent.Service.START |
| Message | START Service started. |
| Level | INFO |
| Explanation | Service started. |
| Corrective Action | N/A |

| | |
|---|---|
| Logger | org.midonet.event.agent.Service.EXIT |
| Message | EXIT Service exited. |
| Level | WARNING |
| Explanation | Service exited. |
| Corrective Action | Restart the MidoNet Agent service if this event happened unintentionally. If this event recurs, file a ticket in the bug tracker for further investigation by developers. |

# Packet Tracing

To configure packet tracing (via logging) in a MidoNet Agent (Midolman), the 'mm-trace' command can be used.

A MidoNet Agent can hold a set of filters that, when matching on an incoming packet, will cause it to log everything about its simulation to the agent's log file, regardless of the configured log level.

All trace messages have a "cookie:" prefix to identify its packet, and that can be used as a grep expression to filter out any non-tracing messages.

### Important

The filters are not persistent, they are lost every time the agent is rebooted.

However, mm-trace prints the filters in exactly the same syntax that it will accept to re-add them again, allowing operators to easily replay the commands.

## Usage

All available options can be displayed with the '–help' option:

```
$ mm-trace --help
  -h, --host  <arg>   Host (default = localhost)
  -p, --port  <arg>   JMX port (default = 7200)
      --help          Show help message

Subcommand: add - add a packet tracing match
  -d, --debug                logs at debug level
      --dst-port  <arg>      match on TCP/UDP destination port
      --ethertype  <arg>     match on ethertype
```

```
      --ip-dst  <arg>        match on ip destination address
      --ip-protocol  <arg>   match on ip protocol field
      --ip-src  <arg>        match on ip source address
  -l, --limit  <arg>         number of packets to match before disabling
 this trace
      --mac-dst  <arg>       match on destination MAC address
      --mac-src  <arg>       match on source MAC address
      --src-port  <arg>      match on TCP/UDP source port
  -t, --trace                logs at trace level
      --help                 Show help message
Subcommand: remove - remove a packet tracing match
  -d, --debug                logs at debug level
      --dst-port  <arg>      match on TCP/UDP destination port
      --ethertype  <arg>     match on ethertype
      --ip-dst  <arg>        match on ip destination address
      --ip-protocol  <arg>   match on ip protocol field
      --ip-src  <arg>        match on ip source address
  -l, --limit  <arg>         number of packets to match before disabling
 this trace
      --mac-dst  <arg>       match on destination MAC address
      --mac-src  <arg>       match on source MAC address
      --src-port  <arg>      match on TCP/UDP source port
  -t, --trace                logs at trace level
      --help                 Show help message
Subcommand: flush - clear the list of tracing matches
  -D, --dead-only   flush expired tracers only
      --help        Show help message
Subcommand: list - list all active tracing matches
  -L, --live-only   list active tracers only
      --help        Show help message
```

## Example

```
$ mm-trace list
$ mm-trace add --debug --ip-dst 192.0.2.1
$ mm-trace add --trace --ip-src 192.0.2.1 --dst-port 80
$ mm-trace list
tracer: --debug --ip-dst 192.0.2.1
tracer: --trace --ip-src 192.0.2.1 --dst-port 80
$ mm-trace remove --trace --ip-src 192.0.2.1 --dst-port 80
Removed 1 tracer(s)
$ mm-trace flush
Removed 1 tracer(s)
```

# 14. VXLAN configuration

## Table of Contents



MidoNet supports the Virtual Extensible LAN (VXLAN) technology.

**What is VXLAN?**

VXLAN is a network virtualization technology that uses a VLAN-like encapsulation technique to encapsulate MAC-based OSI layer 2 Ethernet frames within layer 3 UDP packets.

This type of encapsulation (Ethernet-in-IP) is much better suited to Software Defined Networks than either VLANs (802.1q) or even stacked VLANs (Q-in-Q).

Another important advantage of VXLAN over traditional VLAN is its 24-bit VXLAN ID thanks to which VXLAN can scale up to over 16 million logical networks. By comparison - the maximum number of VLANs is 4096.

**How is VXLAN supported in MidoNet?**

MidoNet provides VXLAN implementation through:

- VXLAN Gateway, to bridge the overlay with physical L3 hosts in the underlay.
- VXLAN tunneling between MidoNet hosts.

# VXLAN Gateway

The VXLAN Gateway (VXGW) allows a virtual bridge to be extended to a physical L2 segment that is reachable via an L3 network and a VXLAN-capable physical switch.

A VXLAN-capable physical switch is also referred to as a "hardware VTEP" (VXLAN Tunnel End Point). The VXGW allows creating one or many VXLAN-based Logical Switches that span any number of hardware VTEPs and a single MidoNet-ODP cloud.

The VXGW has the following advantages:

- Provides L2 connectivity between VMs in an overlay and servers in a physical L2 segment.
- Provides L2 connectivity across an L3 transport network. This is useful when the L2 fabric doesn't reach all the way from the racks hosting the VMs to the physical L2 segment of interest.
- Compared to a pure L2 gateway, the VXGW scales better for overlay solutions:

- in a pure L2 solution, traffic between VMs and the physical segment must be routed through a few gateway nodes that are physically connected to the L2 segment. The physical connections are inherently limited; additionally, their use is limited by protocols like STP.
- with the VXGW, traffic between VMs and the physical segment can be routed directly between any of the compute hosts and the hardware VTEP.

**VXGW Management**

A VXGW will be formed by binding a Neutron network to any number of port-vlan pairs on one or multiple VTEPs.

VTEPs implement an abstraction called Logical Switch, independent from MidoNet. A Logical Switch represents a virtual L2 segment that connects VLANs on some of the VTEP's ports. For example, in a given VTEP "A", with ports p1, p2, a Logical Switch can be formed by binding (p1, vlan 40) and (p2, vlan 30). A Logical Switch can also extend the L2 segment to ports on a different VTEP, whereby both devices would tunnelling traffic on the Logical Switch.

A port-vlan pair can only be bound to a single Logical Switch. However, a given port may be configured multiple Logical Switches as long as the binding combines different VLANs.

The MidoNet Coordinator (the section called "VXLAN Coordinator" [83]) is able to connect to the Management Service of VTEPs, create and configure Logical Switches in its OVSDB instance according to the settings applied through the MidoNet API. Additionally, the Coordinator is able to extend the Logical Switch functions described above to a Neutron network.

MidoNet simplifies and automates these configuration details which remain invisible to the user. It uses some conventions that may be useful for two reasons: troubleshooting purposes, and making MidoNet usage of the VTEP compatible with non-MidoNet related ones.

- MidoNet will create a single Logical Switch in the VTEP to group all port-vlan pairs bound to each Neutron network.
- The Logical Switch name will be formed by prepending "mn-" to the Neutron network ID, being thus unique in a single MidoNet deployment. Operators are free to create Logical Switches with any name format, but should never create VTEPs with names prefixed with "mn-".
- The Logical Switch tunnel key (VNID) is automatically generated by MidoNet, monotonically increasing from 10000. Operators are free to use VNIs from 1 to 9999 for their own purposes.
- When a Neutron network is bound to port-vlan pairs on multiple VTEPs, a Logical Switch will be created on each VTEP's database. However, all will share the same name and VNID, following the conventions above.

The MidoNet controller will handle the exchange of learned MACs among all VTEPs and MidoNet's Network State Database (NSDB) automatically.

# VXLAN Coordinator

The Coordinator is the component of the MidoNet architecture responsible for VXLAN support.

The Coordinator has the following responsibilities:

- Exposing VTEP state through the MidoNet REST API.
- Configuring the VTEP switch in order to implement the bindings configured through the MidoNet REST API.
- Acting as an L2 control plane for traffic flowing between MN and the VTEP.

# Connecting to the VTEP

Use this procedure to connect MidoNet to a hardware VTEP. This step is required before any Neutron networks can be bound to port/vlan pairs on that VTEP.

1. Refer to the documentation of your switch to enable VXLAN on it, then configure it as a VTEP with all the required parameters.

   MidoNet will expect that the Physical_Switch table on the VTEP contains a record with the management IP, management port and tunnel IP of this VTEP. Keep these details at hand as they will be needed to configure the VTEP and any bindings to Neutron networks. Use the following command to dump the contents of this table:

   ```
   vtep-ctl list Physical_switch
   ```

   Make sure that your VTEP also registers all the physical ports. You can verify this by examining the Physical_Ports table in the VTEP. Only ports present in this table will be available for binding to a Neutron network, Use the following command would display all physical ports, replacing <vtep-name> with the name assigned to the Physical_Switch (you can check this using the previous "vtep-ctl list Physical_Switch" command).

   ```
   vtep-ctl list-ports <vtep-name>
   ```

2. After setting up the VTEP you might need to test connectivity to both the tunnel and management interfaces. Both should be 'up'.

   To test the connection to the management database, you can run:

   ```
   $ telnet <management-ip> <management-port>
   Trying <management-ip>...
   Connected to <management-ip>
   Escape character is '^]'.
   ```

   At this point, paste this on the console:

   ```
   {"method":"list_dbs","id":"list_dbs","params":[]}
   ```

   And you should see this reply:

   ```
   {"id":"list_dbs","error":null,"result":["hardware_vtep"]}
   ```

   This just verified that the OVSDB server that holds the configuration of this VTEP is active and handling connections. If you did not get a similar reply, please review the configuration of the VTEP.

3. Enable VXLAN service in Midonet, by modifying the midonet-api config file /usr/share/midonet-api/WEB-INF/web.xml.

   a. Locate this snippet in the midonet-api config file /usr/share/midonet-api/WEB-INF/web.xml:

```
<!-- VXLAN gateway configuration -->
<context-param>
    <param-name>midobrain-vxgw_enabled</param-name>
    <param-value>false</param-value>
</context-param>
```

and change the value of the <param-value> tag to 'true'.

b. Restart Tomcat to apply the change.

4. Having ensured that the VTEP has been properly configured, now you're ready to add the VTEP to the MidoNet configuration.

   For information, see the section called "Adding a VTEP" [93].

**Important**

Apart from the information on the VLAN-port assignment, and VTEP management interface IP and port, you will also need the identifier of a TunnelZone of type "VTEP". All the hosts running MidoNet Agent daemons that you want to create VXLAN tunnels with the VTEP should be members of this tunnel zone, using the local IP that each host uses as a VXLAN tunnel endpoint.

After you successfully add a VTEP to the MidoNet configuration, the API Server connects to its (VTEP's) management interface and collects all the required information for creating a Logical Bridge. For more information, see the "Logical Bridge" section.

# Setting up a connection between a VTEP and a Neutron network

Use this procedure to set up a connection between a VTEP and a Neutron network in MidoNet.

For this procedure you will need to know the VTEP's management IP and port, the physical port on the VTEP and the VLAN ID at this port to which you are connecting, the UUID of the Neutron network which you want to connect to the VTEP, and the IP addresses of all the hosts on the Neutron network that you want to communicate with the VTEP.

1. Create a tunnel zone of type'vtep'.

   All hosts that want to communicate with the VTEP using VXLAN tunnels are required to belong to a tunnel zone of type VTEP, using the IP that each of them will use as VXLAN tunnel endpoint.

   To create a tunnel zone issue the following command in the MidoNet CLI:

```
midonet> tunnel-zone create name vtep_zone1 type vtep
tzone1
```

   As you can see you just created a 'vtep' type tunnel zone, tzone1.

2. Add a VTEP to MidoNet and assign it to the 'vtep' tunnel zone that you created, using the local IP that this host it meant to use in VXLAN tunnels to the VTEP. Note that this IP may be the same that the host uses to communicate with other MidoNet hosts.

```
midonet> vtep add management-ip 192.168.2.11 management-port 6632
 tunnel-zone tzone1
name vtep1 description OVS VTEP Emulator management-ip 192.168.2.11
 management-port 6632 tunnel-zone tzone1 connection-state CONNECTED
```

If your VTEP had been added successfully you should see a similar message, saying 'connection-state CONNECTED'.

3. Create a binding between the VTEP and a Neutron network behind a MidoNet bridge. For that, you will need the UUID of the Neutron network behind that bridge. To find out the UUID use these commands:

```
midonet> list bridge
bridge bridge0 name public state up
midonet> show bridge bridge0 id
765cf657-3cf4-4d79-9621-7d71af38a298
```

The Neutron network you are binding the VTEP to is behind bridge0, and it has the UUID of 765cf657-3cf4-4d79-9621-7d71af38a298 as you can see in the output of the command.

4. For the hosts on the Neutron network to be able to communicate with the VTEP, their IP addressed have to be in the same tunnel zone as the VTEP.

   a. To find out their addresses, use these commands:

```
midonet> host list
host host0 name rhos5-allinone-jenkins.novalocal alive true
midonet> host host0 list interface
iface veth1 host_id host0 status 3 addresses [u'172.16.0.2',
 u'fe80:0:0:0:fc2a:9eff:fef2:aa6c'] mac fe:2a:9e:f2:aa:6c mtu 1500
 type Virtual endpoint DATAPATH
...
```

   b. Add the host's IP address to the same tunnel zone as the VTEP:

```
midonet> tunnel-zone tzone1 add member host host0 address 172.16.0.1
```

Repeat these steps for every host in the Neutron network that you want to communicate with the VTEP.

### Important

Normally, a host may only be assigned to one tunnel zone, gre or vxlan type. A host connecting to a VTEP is an exception because you may assign it to two tunnel zones, a gre/vxlan one and a vtep one. Note that a host can still use the same IP for both tunnel zones.

5. Create a binding between the VTEP's vlan 10 and the Neutron network behind the bridge0.

   In this example you are connecting the hosts on vlan 10 with the Neutron network 765cf657-3cf4-4d79-9621-7d71af38a298 behind the bridge0:

```
midonet> vtep management-ip 192.168.2.11 binding add network-id
 765cf657-3cf4-4d79-9621-7d71af38a298 physical-port swp1s2 vlan 10
```

Congratulations, you have just created a binding between the network behind the VTEP's vlan 10 physical port swp1s2 and the Neutron network with the UUID 765cf657-3cf4-4d79-9621-7d71af38a298 in MidoNet.

### Tip

To be able to test the connection between the VTEP and MidoNet (i.e. to "ping" MidoNet from a host on the VTEP) you have to modify the default ingress security rule, by adding to it the IP address of the host (pinging the host from MidoNet should work without any additional configuration). For more information, see the section called “Enabling connection between VTEP and MidoNet hosts” [87].

# Enabling connection between VTEP and MidoNet hosts

By default Neutron includes a security rule on all networks that restricts forwarding only to traffic addressed to IP/MAC of VMs on that network.

By binding a network to physical ports in a VTEP, we’re effectively adding hosts to the L2 segment of this Neutron network that Neutron itself doesn’t know about, and thus traffic addressed to these physical hosts will be dropped.

The following procedure describes changes ton the default ingress security rule in order to allow traffic to hosts on the VTEP.

1. In the MidoNet CLI find out what the ingress default security rule is by issuing this command:

   ```
   midonet> list chain
   chain chain0 name OS_SG_64d9f3df-9875-4896-ad0c-ffc5bba84c5e_INGRESS
   chain chain1 name OS_SG_64d9f3df-9875-4896-ad0c-ffc5bba84c5e_EGRESS
   ...
   ```

   Locate the ingress security rule that is assigned to the neutron network. In this case, we’ll use chain0 (OS_SG_64d9f3df-9875-4896-ad0c-ffc5bba84c5e_INGRESS) rule chain, the ingress chain.

2. List the rules that implement this security rule by issuing this command:

   ```
   midonet> chain chain0 list rule
   rule rule0 ethertype 2048 proto 0 tos 0 ip-address-group-src ip-address-
   group0 fragment-policy unfragmented pos 1 type accept
   rule rule1 ethertype -31011 proto 0 tos 0 ip-address-group-src ip-
   address-group0 fragment-policy unfragmented pos 2 type accept
   ```

   The security group that is responsible for controlling ICMP packets (ethertype 2048=IP) is ip-address-group0.

3. Now, go ahead and add the IP address of the host on the VTEP to the security group ip-address-group0.

   For example, if the IP address of the host is 172.16.0.3, issue this command:

   ```
   midonet> ip-address-group ip-address-group0 add ip address 172.16.0.3
   address 172.16.0.3
   ```

You should now be able to ping a host in MidoNet from host 172.16.0.3 on the VTEP (providing they are in the same tunnel zone).

# Troubleshooting VTEP/VXGW configuration

VTEP deployments have a relatively large number of moving pieces and potential failure points. This guide will focus on troubleshooting MidoNet and the integration with the VTEP. For specifics on the configuration of the logical switch please refer to your vendor's documentation.

**Is the MidoNet API able to connect to the VTEP**

After following the procedure to add a VTEP as described in the section called "Adding a VTEP" [93], the expected output should be as follows:

```
midonet> vtep add management-ip 119.15.120.123 management-port 6633 tunnel-
zone tzone0
management-ip 119.15.120.123 management-port 6633 tunnel-zone tzone0
 connection-state CONNECTED
```

The same output should appear for VTEPs already added to MidoNet.

Note that the state is CONNECTED. An ERROR state will indicate that the VTEP's management IP is unreachable from the MidoNet API.

**Is the VTEP well configured?**

A typical reason for the VTEP being on ERROR state is a misconfiguration of the VTEP OVDSB instance. You can verify this by executing the following command on the console:

```
ovsdb-client dump hardware_vtep
```

Scroll down to the Physical_Switch table, which will look like this:

```
Physical_Switch table
_uuid                                description         management_ips
  name        ports                                   switch_fault_status
 tunnel_ips
------------------------------------ ------------------- ----------------
 ----------- ---------------------------------------- ------------------
 ------------
3647f020-9ecf-4854-8f75-9011b8c9996a "VTEP DESCRIPTION"  ["192.168.2.14"]
 "VTEP NAME" [698ede89-31f8-4797-a885-1b2dd4c585e3] []
 ["10.0.0.1"]
```

Verify that an entry exists, and the management_ips and tunnel_ips fields correspond to the physical configuration. The management IP is the one you'll be using on the "vtep add" command. The tunnel IP is not relevant at this point, however, MidoNet expects that a value is present in this field.

**Is the OVSDB instance running and accessible?**

If the MidoNet API shows an ERROR on the VTEP list, and your configuration is correct, you should verify that the OVSDB instance is listening on the same management-port that you're specifying in the vtep add call.

From the host running the MidoNet REST API (and Coordinator) try to establish a Telnet connection to the VTEP management interface IP and port, assuming these are 192.168.2.13 and 6632:

```
telnet 192.168.2.13 6632
```

If the connection is successful, you should see the following output:

```
Trying 192.168.2.13..
Connected to localhost.
Escape character is '^]'.
```

This means that we have a TCP socket listening on the right port. We can now verify that the OVSDB is responsive. If this is not the case, then check your switch manual to listen for connections at the selected TCP port.

If the output was correct, then enter the following input into the console:

```
{"method":"list_dbs","id":"list_dbs","params":[]}
```

The desired output is:

```
{"id":"list_dbs","result":["hardware_vtep"],"error":null}
```

The content of the brackets after "result" may vary, but we must see a "hardware_vtep", indicating that there is a VTEP schema on this instance of the OVSDB. If you fail to see this output, the VTEP likely doesn't contain a hardware_vtep schema in its OVSDB instance. Refer to your switch documentation for instructions to configure it.

**VTEP and bindings are added but no traffic goes through**

Verify first that you enabled the VxLAN Gateway Service in the MidoNet API. This service is not enabled by default, but is required to configure the VTEP and synchronize state. Open the MidoNet API configuration file:

```
vi /usr/share/midonet-api/WEB-INF/web.xml
```

And scroll down until you find this section:

```
<!-- VXLAN gateway configuration -->
<context-param>
    <param-name>midobrain-vxgw_enabled</param-name>
    <param-value>true</param-value>
</context-param>
```

Note that the value is set to "true" in all MidoNet API instances that you want to participate in VxLAN Gateway coordination.

**Verify that the VxLAN Gateway service is started**

The VxLAN Gateway service may be enabled in several MidoNet API instances. All of them will coordinate through the Network State Database (NSDB) to elect a leader that will perform all coordination tasks. When a MidoNet API instance takes over leadership the following INFO message is displayed in the logs (/var/log/tomcat/catalina.out):

```
"I am the VxLAN Gateway leader! \o/"
```

If another instance is already a leader, all other instances will display the following INFO message:

```
"I am no longer VxLAN Gateway leader, going passive"
```

At least one instance of the MidoNet API should display the positive message indicating that it became the VxLAN Gateway Leader. This is the instance that should be watched for further log messages.

**Verify that the VxLAN Gateway leader picks up VTEPs and Networks**

VxLAN Gateway services will scan all the Neutron networks in MidoNet's NSDB and proceed to monitor those that are bound to any VTEPs.

Whenever a Neutron network is bound to a VTEP, the following message will appear in the INFO logs. Note that all log messages relevant for a given Neutron network will be tagged with the appropriate UUID:

```
INFO c68fa502-62e5-4b33-9f2f-d5d0257deb4f - Successfully processed update
```

You can filter updates relevant to specific networks by editing:

```
vi /usr/share/midonet-api/WEB-INF/classes/logback.xml
```

Follow the instructions detailed in this file to enable different processes in the coordinator. For brevity, log messages mentioned below will omit the Network UUID tag.

As mentioned above, you should be seeing a message like the following for each Neutron network:

```
Network <NETWORK_UUID> is now part of a VxLAN Gateway
```

Failures during this phase typically indicate errors accessing the NSDB, for example:

```
Cannot retrieve network state
```

The MidoNet controller will WARN in the logs whenever a recoverable error is found, and try to restore connectivity to the NSDB. Non recoverable errors will be marked as ERROR.

If the logs show problems connecting to the NSDB verify that the NSDB is active, and MidoNet API is successfully able to access it.

**Verify that the MidoNet coordinator synchronizes MAC with the VTEPs**

After fetching Neutron network configuration from the NDSB, the MidoNet API logs should display the following messages (note that they may appear mixed with other messages):

```
Starting to watch MAC-Port table in <NEUTRON_UUID>
Starting to watch ARP table in <NEUTRON_UUID>
Network state now monitored
```

These indicate that the MidoNet coordinator is monitoring the network's state, which will be synchronized to the VTEP.

**Verify that the MidoNet coordinator connects to the VTEP(s)**

The MidoNet coordinator will also bootstrap a process to exchange state among the network, and all VTEPs with port-vlan pairs bound to it. When the controller detects any port-vlan pair in a new VTEP, it'll show the following message (assuming management ip and management port are 192.168.2.13 and 6632):

```
Bindings to new VTEP at 192.168.2.13:6632
```

At this point it will ensure that a connection is stablished to this VTEP's management IP and that the bindings configured through the MidoNet REST API are correctly reflected in the VTEP. Normal output will look like this (note that they may appear mixed with other messages):

```
Consolidate state into OVSDB for <VXLAN GATEWAY DESCRIPTION>
Logical switch <LOGICAL_SWITCH_NAME> exists: ..
Syncing port/vlan bindings: <PORT_VLAN PAIRS>
```

If the coordinator reports any errors connecting to the VTEP it will automatically try to connect, but you should verify that the VTEP is up and accessible.

Following a successful consolidation of state, MidoNet will start the synchronization of MACs and ARP entries:

```
Joining <VXLAN_GATEWAY_DESCRIPTION> and pre seeding <NUMBER> remote MACs
Emitting snapshot with <NUMBER> local MACs
Advertise unknown-dst to receive flooded traffic ..
```

Connection errors to the VTEP are possible at this point, but should be handled gracefully by the coordinator.

If MidoNet finds a non recoverable error, the following WARN will be displayed (assuming same management port and id as above):

```
Failed to bootstrap VTEP at 192.168.2.13:6632
```

The MidoNet coordinator will ignore this Neutron network until it's updated again. It should however be able to continue operating with all other configured networks.

**Verify that the MidoNet coordinator synchronizes state**

If no errors are displayed up to here, edit the logback.xml file mentioned above and enable DEBUG logs in the vxgw processes:

```
<!-- <logger name="org.midonet.vxgw" level="DEBUG" /> -->
```

Remove the `<!--` and `-#` tags to enable this configuration and wait for a few seconds until the API logs start showing DEBUG messages. Choose TRACE instead of DEBUG for more exhaustive information (none will be too verbose to have a significant performance impact).

Messages like the following show that the MidoNet coordinator is successfully exchanging MACs among Midonet and VTEPs.

```
TRACE c68fa502-62e5-4b33-9f2f-d5d0257deb4f - Learned: MacLocation
 { logicalSwitchName=mn-c68fa502-62e5-4b33-9f2f-d5d0257deb4f, mac=
96:8f:e8:12:33:55, vxlanTunnelEndpoint=192.168.2.16 }
```

This message indicates that an update about the given MAC was detected on the Logical Switch that belongs to Neutron network c68fa502-62e5-4b33-9f2f-d5d0257deb4f. In this case, the vxlanTunnelEndpoint was 192.168.2.16, indicating that the MAC can be found at that tunnel endpoint. The removal of a MAC from a port can be identified because the vxlanTunnelEndpoint=null (that can be read as "the MAC is at no port").

**Verify that VxLAN tunnels are being established**

If the coordinator is working normally, but traffic is still not flowing, you should verify that the VTEPs and MidoNet hosts are able to stablish VxLAN tunnels successfully.

While keeping a ping active from the VM to the server you're trying to communicate with, log in to the MidoNet compute hosting the VM that you're trying to communicate with a server on the VTEP. Run the following command:

```
tcpdump -leni any port 4789
```

Assuming that the MidoNet compute is 192.168.2.14, and the VTEP's tunnel IP is 192.168.2.17, the output should be similar to this (depending on your tcpdump version):

```
15:51:28.183233 Out fa:16:3e:df:b7:53 ethertype IPv4 (0x0800), length 94:
 192.168.2.14.39547 > 192.168.2.17.4789: VXLAN, flags [I] (0x08), vni 10012
```

```
aa:aa:aa:aa:aa:aa > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806), length 42:
 Request who-has 10.0.0.1 tell 10.0.0.10, length 28
15:51:28.186891  In fa:16:3e:52:d8:f3 ethertype IPv4 (0x0800), length 94:
 192.168.2.17.59630 > 192.168.2.13.4789: VXLAN, flags [I] (0x08), vni 10012
cc:dd:ee:ee:ee:ff > aa:aa:aa:aa:aa:aa, ethertype ARP (0x0806), length 42:
 Reply 10.0.0.10 is-at cc:dd:ee:ee:ee:ff
```

The first line shows that the MidoNet Agent (192.168.2.14) is emitting a tunnelled packet towards the VTEP (192.168.2.17:4789), using 10012 as VNID. The encapsulated packet is shown on the second line, and corresponds to an ARP REQUEST from a VM with ip 10.0.0.10 regarding server 10.0.0.1.

In this example, the VTEP is responding correctly on the third line, showing a return packet with the same VNID.

The same example can be applied in reverse on the VTEP. A ping from the physical server connected to the VTEP should generate a tunnelled packet towards a MidoNet Agent, and receive similar return packets.

**The MidoNet agent is not emitting traffic**

Verify the VXLAN-related options in mn-conf(1). Examine the MidoNet Agent logs in debug mode and look for simulations on the Neutron network that might be dropping packets, or throwing errors on the simulation.

**The VTEP is not emitting traffic on the tunnel**

Ensure that the VTEP configuration reflects the bindings configured throught the MidoNet REST API. Use the following command to list the VTEPs present in the switch:

```
vtep-ctl list-ls
```

This will display all Logical Switches present in the switch. If you bound a Neutron network with UUID c68fa502-62e5-4b33-9f2f-d5d0257deb4f, then you should see the following item in the list:

```
mn-c68fa502-62e5-4b33-9f2f-d5d0257deb4f
```

Now list the bindings on the port that you used to create the port-vlan binding in the midonet-cli. Let's assume we have port1, and created a binding with port1 and vlan 93. The expected output would be:

```
vtep-ctl list-bindings <VTEP_NAME> port1
0093 mn-c68fa502-62e5-4b33-9f2f-d5d0257deb4f
```

You can find out the VTEP_NAME using the "vtep-ctl list-ps" command.

If any of these outputs is not as expected, the MidoNet coordinator is most likely not being able to consolidate the configuration from the NSDB. Verify the MidoNet API logs and locate the relevant errors in order to correct them.

**Verify that MACs are being synchronized correctly to the VTEP**

Finally, you can list the local and remote MACs present in the VTEP's database:

```
vtep-ctl list-local-macs mn-c68fa502-62e5-4b33-9f2f-d5d0257deb4f
```

This should show all the MACs learned by the VTEP from traffic observed on local ports. If the local server is correctly configured, you will typically see the server's MAC here.

The following command will display the remote MACs:

```
vtep-ctl list-remote-macs mn-c68fa502-62e5-4b33-9f2f-d5d0257deb4f
```

The list here will show MACs in MidoNet VMs or other VTEPs, which are injected by the MidoNet coordinator.

If any of these steps don't show an expected output, the synchronisation processes may be failing. Inspect the MidoNet API logs for more details.

# CLI commands used for working with the VXGW

This section describes the CLI commands that you can use to work with the VXGW and VTEPs.

## Obtaining a list of VTEPs

Use this command to obtain the list of hardware VTEPs of which MidoNet is aware.

**Syntax**

```
list vtep
```

**Result**

For each VTEP, the command returns this information:

- name
- description
- management IP address
- management port
- tunnel IPs
- connection state (one of: connected, disconnected, error. The state is error if the end-point is not a VXLAN End Point)
- ports - a list of (port_name, port_description, port_bindings) triplets, where port_bindings is a list of (vlan, neutronNetworkId, logicalSwitchName).

**Example**

```
midonet> list vtep
vtep vtep0 name br0 management-ip 119.15.112.22 management-port 6633
 connection-state CONNECTED
```

## Adding a VTEP

Use this command to add a hardware VTEP to MidoNet.

**Syntax**

```
vtep add management-ip vtep-ip-address management-port vtep-port tunnel-
zone-id tunnel-zone-id
```

where *vtep-ip-address* and *vtep-port* are the VTEP's management IP address and port, and *tunnel-zone-id* is used to determine the interface that will be used as the other end point of the VXLAN tunnel (in MidolMan).

**Result**

If the command runs successfully it writes the information you provided with it to Zookeeper. The command returns an error message, if a VTEP with these parameters already exists.

**Examples**

An example of a successful command:

```
midonet> vtep add management-ip 119.15.120.123 management-port 6633 tunnel-
zone tzone0
management-ip 119.15.120.123 management-port 6633 tunnel-zone tzone0
 connection-state CONNECTED
```

An example of a unsuccessful command:

```
midonet> vtep add management-ip 119.15.120.123 management-port 6633
Internal error: {"message":"Validation error(s) found","code":400,
"violations":[{"message":"Tunnel zone ID is not valid.",
"property":"tunnelZoneId"}]}
```

# Obtaining information about a VTEP

Use this command to obtain information about a selected VTEP.

**Syntax**

```
vtep management-ip vtep-ip-address show property
```

where *property* is one of the following VTEP's attributes:

- name
- description
- management-ip
- management-port

**Result**

The command returns the following information about the VTEP:

- name
- description
- management IP address (the same as the IP used with the command)
- mgmt_port (the same as the port values used by the command)
- tunnel IPs
- connection state (one of: connected, disconnected, error. The state is error if the endpoint is not a VXLAN End Point)
- ports - a list of (port_name, port_description, port_bindings) triplets, where port_bindings is a list of (vlan, neutronNetworkId, logicalSwitchName).

**Example**

Successful command:

```
midonet> vtep management-ip 119.15.112.22 show name
br0
```

```
midonet> vtep vtep0 show management-ip
119.15.112.22
```

Unsuccessful command:

```
midonet> vtep management-ip 119.15.112.22 show id
Syntax error at: ...id
```

# Adding a VTEP binding

Use this command to bridge the port-VLAN pair on a VTEP to a specified Neutron network.

**Syntax**

```
vtep management-ip vtep-ip-address add binding physical-port port-id vlan
 vlan-id network-id neutron-network-id
```

where *neutron-network-id* is the VNI (Virtual Network Id, equivalent to the vxlan tunnel key) of the Neutron network to which the port-VLAN assignment is to be made.

**Result**

If the command is successful, the result is a description of a MidoNet vbridge "vxlan" port that represents the Neutron network's wiring to the VTEP (VTEP=mngmnt_ip used with the command). The vxlan port may already have existed if another port-VLAN pair on that VTEP was already bound to the same Neutron network.

A vxlan port's description includes:

- a list of all the port-vlan bindings specific to that Neutron network AND hardware VTEP.
- the Name of the logical bridge that represents the Neutron network on the VTEP side. It's a combination of the Neutron network name and UUID.
- the VNI (Virtual Network Id, equivalent to the VXLAN tunnel key) that was assigned to this Neutron network. The selected VNID is unique within that VTEP.

The command will fail in these conditions:

- if a given port-VLAN pair is already bridged to another Neutron network.
- if the Neutron network is already bridged to a port-VLAN pair on another hardware VTEP.

**Example**

Successful command:

```
midonet> vtep management-ip 119.15.112.22 add binding physical-port in1
 vlan 143 network-id 9082e813-38f1-4795-8844-8fc35ec0b19b
management-ip 119.15.112.22 physical-port in1 vlan 143 network-id
 9082e813-38f1-4795-8844-8fc35ec0b19b
```

Unsuccessful command:

```
midonet> vtep management-ip 119.15.112.22 add binding physical-port in1
 vlan 143 network-id 9082e813-38f1-4795-8844-8fc35ec0b19b
Internal error: {"message":"An internal server error has occurred, please
 try again.","code":500}
midonet> vtep management-ip 119.15.112.22 add binding physical-port in1
 vlan 144 network-id 9082e813-38f1-4795-8844-8fc35ec00000
Internal error: {"message":"No bridge with ID
 9082e813-38f1-4795-8844-8fc35ec00000 exists.","code":400}
```

# Obtaining descriptions of VTEP bindings

The MidoNet CLI offers a command to obtain the descriptions of all bindings on a given VTEP, as well as all the VTEPs to which a specific Neutron network is bound to.

**All bindings in a VTEP**

First, list all the VTEPs in order to identify the desired management IP:

```
midonet> vtep list
name vtep0 description Vtep1 management-ip 192.168.2.13 management-port
 6632 tunnel-zone tzone0 connection-state CONNECTED
```

**Result**

The successful command returns the descriptions of all VXLAN ports and their Neutron network bindings on the selected VTEP:

```
vtep management-ip 192.168.2.13 list binding
binding binding0 management-ip 192.168.2.13 physical-port Te 0/2 vlan 908
 network-id bc3afc36-6274-4603-9109-c29f1c12ba33
binding binding1 management-ip 192.168.2.13 physical-port Te 0/2 vlan 439
 network-id 1d475afc-d892-4dc7-af72-9bd88e565dde
binding binding4 management-ip 192.168.2.13 physical-port in1 vlan 119
 network-id bc3afc36-6274-4603-9109-c29f1c12ba33
```

From the output you can see a list of all the port-vlan pairs applied on a given VTEP. The following information is displayed (the first line will be used as example):

- The alias of the binding (e.g., binding0).
- The management IP of the VTEP (e.g., 192.15.112.22).
- The physical port (e.g., Te 0/2) and VLAN (908).
- The UUID of the Neutron network to which the port-vlan pair is bound (e.g., bc3afc36-6274-4603-9109-c29f1c12ba33)

**VTEPs bound in a Neutron network**

First chose the MidoNet bridge corresponding to the desired Neutron network:

```
midonet> bridge list
bridge bridge0 name my_network state up
```

We can verify the id of this bridge, which will be the same as the Neutron network:

```
midonet> bridge bridge0 show id
bc3afc36-6274-4603-9109-c29f1c12ba33
```

List the ports on the bridge:

```
midonet> bridge bridge0 port list
```

```
port port0 device bridge0 state up
port port1 device bridge0 state up
port port2 device bridge0 state up management-ip 192.168.2.13 vni 10012
port port3 device bridge0 state up management-ip 192.168.2.14 vni 10012
```

**Result**

The bridge will complete the list of ports with one entry for each of the VTEPs that contain at least one binding. In this case we see that the Neutron network is bound to port-vlan pairs at VTEPs 192.168.2.13 (as shown in the "list binding" example above) and 192.68.2.14 (not shown for conciseness).

# Removing a VTEP binding

Use this command to disassociate a port-VLAN pair from the Neutron network's LogicalSwitch.

**Syntax**

```
vtep management-ip vtep-ip-address binding delete network-id neutron-
network-id
```

**Result**

You can delete a single VTEP binding to a Neutron network. If that was the VTEP's last remaining port-VLAN pair bound to the network, then the Neutron network's vxlan port gets deleted.

**Example**

Examples of successfully run commands:

```
midonet> vtep management-ip 119.15.112.22 delete binding physical-port in1
 vlan 143
```

An example of a unsuccessful command:

```
midonet> vtep management-ip 119.15.112.22 delete binding
Syntax error at: ...binding
midonet> vtep management-ip 119.15.112.22 delete binding physical-port in1
Syntax error at: ...binding physical-port in1
```

# Deleting a VTEP

Use this command to delete a VTEP.

**Syntax**

```
vtep management-ip vtep-ip-address delete
```

**Result**

Issuing this command completely deletes a VTEP from the MidoNet's list of known VTEPs.

The command will fail if any of the VTEP's port-VLAN pairs are bound to any Neutron networks.

**Example**

```
midonet> vtep management-ip 119.15.120.123 delete
```

### Note

Alternatively, you can delete a vxlan port to disassociate all VTEP's port-VLAN pairs from a Neutron network.

# 15. Setting up an L2 gateway

## Table of Contents



This section describes how to set up an L2 gateway between MidoNet's virtual bridges and physical switches.

### Important

This feature is not currently implemented in OpenStack Neutron. Therefore, you cannot use an L2 gateway to extend a MidoNet network (or bridge) to a Neutron bridge.

**Topology**

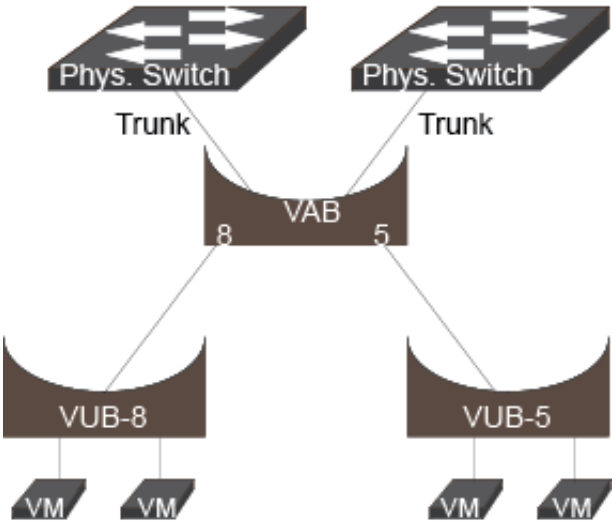
You can configure MidoNet's bridge virtual ports with a single VLAN ID, thereby introducing a change in the behavior of the processing of VLAN-tagged frames.

This guide refers to a bridge that owns one or more VLAN-configured ports as a "VLAN Aware Bridge" or VAB. A VAB may contain multiple virtual ports configured with a VLAN ID, but these tags must be unique in the VAB. A VAB may contain any number of trunk ports (that is, ports configured to support VLAN trunk links), but only one of the ports is expected to be active, according to the high-availability mechanism.

This guide refers to any bridge that has no virtual ports configured with a VLAN ID as a "VLAN Unaware Bridge" or VUB. VUBs may only have one virtual port linked to a VAB.

The diagram below depicts a typical L2 gateway topology.

**Figure 15.1. Topology with VLANs and L2 Gateway**




The VAB in this example has two trunk ports that are bound to physical interfaces (either on the same or different physical hosts). Each of these ports has L2 connectivity to physical switches and may carry VLAN-tagged traffic.

The VAB also has two other virtual ports, both configured with different VLAN-IDs. These virtual ports are linked to peers at two VUBs (VUB-8 and VUB-5), which in turn are linked to two VMs through two virtual ports each.

The VAB examines the VLAN tags of all traffic ingressing from the two trunk ports. For frames tagged with the same VLAN-ID as any of its other virtual ports (in the example, 5 or 8), the VAB removes the VLAN-ID and sends the frames to the appropriate port. For frames ingressing the VAB from a virtual port configured with a VLAN-ID, the VAB adds the corresponding VLAN-ID to the frames, and then sends the frames to the appropriate trunk port according to the bridge's MAC-port table.

### Note

Neutron networks can only be mapped to the VUBs, so the VMs linked to the VABs are managed outside of OpenStack. This means that IP address management in Neutron cannot be used for the VMs on VABs.

# Configuring an L2 gateway

Use this procedure to configure an L2 gateway.

Below is an example of a configuration showing how to use the MidoNet CLI to replicate the topology shown in Figure 15.1, "Topology with VLANs and L2 Gateway" [99].

1. Create the VAB and two ports configured with the appropriate VLAN IDs:

```
midonet> bridge create name vab
midonet> bridge bridge0 port add vlan 8
bridge0:port0
midonet> bridge bridge0 port add vlan 5
bridge0:port1
```

2. Create the two VUBs and their virtual ports:

```
midonet> bridge add name vub-8
bridge1
midonet> bridge add name vub-5
bridge2
midonet> bridge bridge1 port add
bridge1:port0
midonet> bridge bridge2 port add
bridge2:port0
```

3. Link the ports:

   midonet> bridge bridge0 port port0 set peer bridge1:port0 midonet> bridge bridge0 port port1 set peer bridge2:port0

4. Add the VAB's trunk ports:

```
midonet> bridge bridge0 port add
bridge0:port2
midonet> bridge bridge0 port add
bridge0:port3
```

5. Assuming that there are two interfaces, host0:eth0 and host1:eth1, connected to the physical switches' trunks, bind them to the VAB's trunk ports:

```
midonet> host host0 binding add interface eth0 port bridge0:port2
```

```
midonet> host host1 binding add interface eth1 port bridge0:port3
```

# Fail-over/Fail-back

In combination with the Spanning Tree Protocol (STP) enabled on the physical bridges, MidoNet VABs are able to provide fail-over capabilities by forwarding Bridge Protocol Data Unit (BPDU) frames across their trunk ports.

Assuming that both physical switches belong to the same bridged network, as a result of the STP, both devices detect a loop through MidoNet's VAB and one switch chooses to block its trunk. For example, let's assume the left switch blocks. The VAB only sees ingress traffic from the right trunk, and thus associates all source MAC addresses seen in those frames to the right trunk.

A variety of events, including failures in the network, may result in the switches deciding to invert the state of the trunks. An example could be MidoNet losing connection to the left switch, and thus stop forwarding BPDUs to/from the right bridge and undoing the loop.

In such a fail-over scenario, traffic would start flowing from the other switch. With this change, MidoNet now detects ingress traffic on a new port, and thus updates its internal MAC-port associations. If the former state of the topology is restored (that is, MidoNet recovers connectivity to the left switch), MidoNet will again react and update its MAC-port associations.

The fail-over/fail-back times depend on the STP configuration on the switches, mainly the "forward delay," and the nature of the traffic. With standard values, and continuous traffic ingressing from the trunks, fail-over and fail-back cycles should be completed in 50 seconds, plus MAC learning time.

# 16. Working with the MidoNet CLI

## Table of Contents



You can explore and edit all of MidoNet's virtual topology through the CLI, however, you should use write operations with caution, as they are likely to create inconsistencies between MidoNet's idea of the virtual network and OpenStack's view of it.

### Note

When using MidoNet with OpenStack, please be careful not to introduce inconsistencies between OpenStack and MidoNet virtual topologies.

With that warning in mind, there are certain tasks for which the CLI can be particularly useful:

- Creating a MidoNet's provider router
- Setting up the cloud's up-link using the Border Gateway Protocol (BGP)
- Upgrading MidoNet
- Registering MidoNet Agents
- Setting up an L2 gateway
- Troubleshooting problems with the MidoNet API. Because the CLI uses the MidoNet API directly, it's the easiest way to make requests to it to verify that it works.
- Viewing and exploring MidoNet's virtual topology and the status and network addresses of all hosts running the MidoNet agent

# Using the MidoNet CLI

To use the MidoNet CLI you need to connect to the MidoNet host running it.

1. Using SSH to connect to the host running the MidoNet CLI.

   You must know the IP address of the machine you are connecting to as well as your login credentials, that is your username and password. Example of an SSH command:

   ```
   $ ssh root@192.168.17.5
   root@192.168.17.5's password:
   ```

   You have already provided your username, 'root' as part of the command, and now the server is prompting you for a password. Type in your password to get in.

2. The CLI is documented in a set of man pages. To view the man pages, from the system command line, enter:

   ```
   $ man midonet-cli
   ```

3. To start the midonet-cli, at the system prompt, enter:

```
$ midonet-cli
midonet>
```

The midonet> prompt that gets displayed indicates system readiness to accept MidoNet commands. Type in help and hit Enter to get a list of all available commands. You can also infer proper usage and syntax from context-aware auto-complete and by using the describe command.

# 17. Advanced configuration and concepts

## Table of Contents



This section describes configuration options that aren't essential when deploying MidoNet and provides information for professional services and advanced MidoNet users.

# MidoNet Configuration: mn-conf(1)

MidoNet stores its configuration in the same ZooKeeper cluster that it uses to store network topology data.

Configuration can be read and managed via the mn-conf(1) command line tool. Refer to its manpage for its full documentation, and to the next paragraphs for a light introduction.

## Bootstrapping

The entire configuration of MidoNet is stored in ZooKeeper, however operators need to point mn-conf itself to the ZooKeeper cluster. The same is true for any MidoNet processes, such as its agent. They will fetch configuration from ZooKeeper but need its address to bootstrap that process.

Bootstrap configuration is read, in order of preference, from these sources:

- The MIDO_ZOOKEEPER_HOSTS and MIDO_ZOOKEEPER_ROOT_KEY environment variables.
- ~/.midonetrc
- /etc/midonet/midonet.conf
- /etc/midolman/midolman.conf (for backwards compatibility).

These files should have .ini format, and look like this:

```
[zookeeper]
zookeeper_hosts = 127.0.0.1:2181
root_key = /midonet/v1
```

### Warning

Do not modify the root key unless you know what you are doing.

## Configuration sources

mn-conf can store and manage a few different configuration documents:

- Node specific configuration. These contain configuration keys that will apply only to a particular MidoNet node, identified by its UUID.
- Configuration templates. These are chunks of configuration, stored by a user-given name that can be assigned to a set of MidoNet nodes.
- The "default" configuration template. Configuration keys found here will be used by every MidoNet node in the system. But only if the first two sources don't override their values.
- The configuration schemas. These are read only and contain default values and *documentation* strings for every configuration key in MidoNet. The defaults found in these schemas will only apply if they are not overriden by one of the higher priority sources.

A single mn-conf command will dump the schemas, effectively getting the full list of all existing MidoNet configuration keys, their default values and their documentation:

```
$ mn-conf dump -s
```

# Recommended configurations

This section contains information on recommended configurations that impact MidoNet performance.

## Overview of Performance-Impacting Configuration Options

**agent.midolman configuration section in mn-conf(1)**

simulation_threads - Number of threads to dedicate to packet processing

output_channels - Number of output channels to use for flow creation and packet execution. Each channel gets a dedicated thread.

input_channel_threading - The MidoNet Agent creates dedicated Netlink channels to receive packets from each datapath port. This option tunes the threading strategy for reading on those channels: one_to_many will make the Agent use a single thread for all input channels. one_to_one will make the Agent use one thread for each input channel.

**agent.datapath section in mn-conf(1)**

global_incoming_burst_capacity - Incoming packets are rate-limited by a Hierarchical Token Bucket (HTB) that gets refilled as packets are processed and exit the system. This setting controls the size in packets of the root bucket in the HTB. It is the number of packets that the daemon will accept in a burst (at a higher rate that it can handle) before it starts dropping packets. It's also the maximum number of in-flight packets in the system. Changes to this value affect latency at high-throughput rates.

tunnel_incoming_burst_capacity - Tunnel ports get their own bucket in the HTB, allowing them to accumulate burst capacity if they are not sending at the max. rate. This setting controls the size in packets of that bucket.

vm_incoming_burst_capacity - Each VM port gets its own bucket in the HTB, allowing the ports to accumulate burst capacity if they are not sending at the max. rate. This setting controls the size in packets of that bucket.

**agent.loggers section in mn-conf(1)**

**root**

level - Default process-wide log level. The DEBUG setting is meant for development and troubleshooting only because it severely affects performance and is highly verbose.

**midolman-env.sh**

MAX_HEAP_SIZE - Total amount of memory to allocate for the JVM.

HEAP_NEWSIZE - The total amount of the JVM memory that will be dedicated to the Eden garbage-collection generation. 75% of the total is a good ballpark figure, as the Agent uses most of the memory for short-lived objects during packet processing. == Recommended Values

### Table 17.1. Recommended Configuration Values

| File | Section | Option | Compute | Gateway | L4 Gateway |
|---|---|---|---|---|---|
| logback.xml | root | level | INFO | INFO | INFO |
| midolman-env.sh | - | MAX_HEAP_SIZE | 2048M | 6144M | 6144M |
| midolman-env.sh | - | HEAP_NEWSIZE | 1536M | 5120M | 5120M |
| mn-conf(1) | [agent.midolman] | simulation_threads | 1 | 4 | 16 |
| mn-conf(1) | [agent.midolman] | output_channels | 1 | 2 | 2 |
| mn-conf(1) | [agent.midolman] | input_channel_threading | one_to_many | one_to_many | one_to_many |
| mn-conf(1) | [agent.datapath] | global_incoming_burst_capacity | 128 | 256 | 128 |
| mn-conf(1) | [agent.datapath] | tunnel_incoming_burst_capacity | 64 | 128 | 64 |
| mn-conf(1) | [agent.datapath] | vm_incoming_burst_capacity | 16 | 32 | 16 |

# MidoNet Agent (Midolman) configuration options

This section covers all configuration options for the MidoNet Agent.

We don't recommend making changes to the default values, except possibly the zookeeper.session_gracetime and agent.datapath.send_buffer_pool_buf_size_kb setting values.

### Warning

Do not modify the root key, cluster name, or keyspace unless you know what you are doing.

# MidoNet behavior after ZooKeeper cluster failure

Nodes running the MidoNet Agent, Midolman, depend on a live ZooKeeper session to load pieces of a virtual network topology on-demand and watch for updates to those virtual devices.

When ZooKeeper becomes inaccessible, a MidoNet Agent instance will continue operating for as long as there's a chance to recover connectivity while keeping the same

ZooKeeper session. The amount of operating time is thus dictated by the session timeout, which you can control by editing the zookeeper session_gracetime setting in mn-conf(1).

Once the session expires, the MidoNet Agent will give up and shut itself down, prompting upstart to re-launch it. If the ZooKeeper connection and session are recovered within the session_gracetime, MidoNet Agent operation will resume uneventfully. The MidoNet Agent will learn of all the updates that happened to the virtual topology while it was disconnected and will update its internal state and flow tables accordingly.

While the MidoNet Agent is running disconnected from ZooKeeper, waiting for the session to come back, traffic will still be processed, but with reduced functionality, as follows:

- The MidoNet Agent will not see updates to the virtual topology, thus packets may be processed with a version of the network topology that's up to session_gracetime too old.
- The MidoNet Agent will be unable to load new pieces of the network topology. Packets that traverse devices that had never been loaded on a particular MidoNet Agent will error out.
- The MidoNet Agent will not be able to perform or see updates to Address Resolution Protocol (ARP) tables and Media Access Control (MAC) learning tables.

As time passes, a disconnected MidoNet Agent will become less and less useful. The trade-offs presented above are key to choosing a sensible session_gracetime value; the default is 30 seconds.

ZooKeeper connectivity is not an issue for the MidoNet API server. The API requests are stateless and will simply fail when there is no ZooKeeper connectivity.

## ZooKeeper configuration

You may use the ZooKeeper configuration section in mn-conf(1) to adjust:

- the ZooKeeper session timeout value (in milliseconds). This value determines when the system considers the connection between ZooKeeper and the MidoNet Agent to be interrupted.
- the session grace timeout value (in milliseconds). This value determines the period of time during which the Agent can reconnect to ZooKeeper without causing node outage.
- the root path for MidoNet data.

```
zookeeper {
    zookeeper_hosts = <comma separated IPs>
    session_timeout = 30000
    root_key = /midonet/v1
    session_gracetime = 30000
}
```

## Cassandra configuration

You may use the Cassandra configuration section to adjust:

- the database replication factor

- the MidoNet cluster name

```
cassandra {
    servers = <comma separated IPs>
    replication_factor = 1
    cluster = midonet
}
```

## MidoNet Agent datapath configuration

The agent uses a pool of reusable buffers to send requests to the datapath. You may use the options in the agent.datapath of mn-conf(1) to tune the pool's size and its buffers. One pool is created for each output channel, the settings defined here will apply to each of those pools.

If you notice decreased performance because packet sizes exceed the maximum buffer size, you can increase the value for the buf_size_kb setting. This setting controls the buffer size (in KB). Be aware that the buffer size puts a limit on the packet size that the MidoNet Agent can send. In a network that jumbo frames traverse, adjust the size so one buffer will accommodate a whole frame, plus enough room for the flow's actions.

## BGP failover configuration

The default BGP fail-over time is 2-3 minutes. However, you can reduce this time by changing some parameters on both ends of the session: in mn-conf(1) (the MidoNet side) and the remote end BGP peer configuration. The example below shows how to reduce the BGP fail-over time to one minute on the MidoNet side:

```
agent {
    midolman {
        bgp_connect_retry=1
        bgp_holdtime=3
        bgp_keepalive=1
    }
}
```

The settings in mn-conf must match those on the remote end BGP peer configuration. For more information about how to set them, see the section called "BGP failover configuration on a BGP peer" [4].

# Advanced MidoNet API configuration options

This section describes the configuration elements advanced users can employ.

You can use the configuration elements below to perform advanced MidoNet configuration operations. MidoNet API configuration is stored in the /usr/share/midonet-api/WEB-INF/web.xml file.

## rest_api-base_uri

This value overrides the default base URI of each HTTP request. You typically set this if you configured a proxy server for the MidoNet API server and the base URI that the clients use to access the MidoNet API server is different from the actual server's base URI:

```
<context-param>
    <param-name>rest_api-base_uri</param-name>
```

```
    <param-value>http://example.com:8080/</param-value>
</context-param>
```

## cors-access_control_allow_origin

This value specifies the origin domains that the MidoNet API server grants access from. This information is required when accessing the MidoNet API server from client-side scripting whose origin domain is different from the MidoNet API server domain.

'*' means allow everything:

```
<context-param>
    <param-name>cors-access_control_allow_origin</param-name>
    <param-value>*</param-value>
</context-param>
```

The example below shows how to allow access from 'http://example.com':

```
<context-param>
    <param-name>cors-access_control_allow_origin</param-name>
    <param-value>http://example.com</param-value>
</context-param>
```

## cors-access_control_allow_headers

Indicates which HTTP headers can be used when making the API request for client-side scripting:

```
<context-param>
    <param-name>cors-access_control_allow_headers</param-name>
    <param-value>Origin, X-Auth-Token, Content-Type, Accept</param-value>
</context-param>
```

## cors-access_control_allow_methods

Indicates which HTTP methods can be used when making the API request for client-side scripting:

```
<context-param>
    <param-name>cors-access_control_allow_methods</param-name>
    <param-value>GET, POST, PUT, DELETE, OPTIONS</param-value>
</context-param>
```

## cors-access_control_expose_headers

Specifies a white list of header fields that the server exposes to the client:

```
<context-param>
    <param-name>cors-access_control_expose_headers</param-name>
    <param-value>Location</param-value>
</context-param>
```

## auth-tenant_admin_role

Specifies the name of the tenant admin role in MidoNet. The tenant admin has read and write access to the resources owned by that tenant. You need to map the MidoNet tenant admin to the equivalent role in the external authentication service:

```
<context-param>
    <param-name>auth-tenant_admin_role</param-name>
```

```
    <param-value>mido_tenant_admin</param-value>
</context-param>
```

## auth-tenant_user_role

Specifies the name of the tenant user role in MidoNet. The tenant user has read-only access to the resources owned by that tenant. You need to map the MidoNet tenant user to the equivalent role in the external authentication service:

```
<context-param>
    <param-name>auth-tenant_user_role</param-name>
    <param-value>mido_tenant_user</param-value>
</context-param>
```

## zookeeper-use_mock

Indicates whether to mock ZooKeeper when running the API:

```
<context-param>
    <param-name>zookeeper-use_mock</param-name>
    <param-value>false</param-value>
</context-param>
```

## zookeeper-midolman_root_key

Identifies the root directory in ZooKeeper:

```
<context-param>
    <param-name>zookeeper-midolman_root_key</param-name>
    <param-value>/midonet</param-value>
</context-param>
```

# Cassandra cache

This section describes details relative to the Cassandra-based implementation of the Cassandra cache used for connection tracking and NAT mappings.

**Client library and normal operation**

Cassandra operations are now asynchronous, so losing connectivity to Cassandra should not impact simulations.

The loss of connectivity to a majority of nodes creates a risk that connections will break on vport migration or MidoNet restart. But this is a low risk if the operator can avoid vport migrations and MidoNet Agent restarts until Cassandra is returned to normal operation.

To summarize, MidoNet can function with Cassandra down (but vport migrations and agent restarts may break connections) so it should only be tolerated for very brief periods.

## Agent behavior on node failure

The MidoNet Agent writes to Cassandra asynchronously after processing a packet that produced stateful connection data, such as NAT mappings or connection tracking keys.

The data written to Cassandra is purely a back up, as MidoNet agents share all stateful connection data directly amongst themselves. The back up is used upon agent reboot

(to prevent lost connections across the reboot) and upon port migration. An agent binding a port will fetch the existing connection state from Cassandra for all connections traversing that port.

Should a Cassandra node fail, agents connected to it will fail over to other nodes in the Cassandra cluster. If the host tries to bind a port during that interval it may fail to fetch the state for the port, breaking pre-existing connections on that port. Additionally, state for flows processed during that interval may not be written to Cassandra, making it unavailable if it's needed later in the process of binding a port. State is refreshed every minute, thus a port migration would only break connections that were established in the minute prior to the port migration and only if the disconnection happened in that interval.

# Network State Database connectivity

In order to modify the MidoNet Network State Database, you must configure the following parameters in your web.xml file:

- zookeeper-zookeeper_hosts
- zookeeper-session_timeout
- cassandra-servers

Below are example web.xml snippets.

### Note

The rest of the configuration is cloud-controller dependent and is covered in the relevant sections of the documentation.

## zookeeper-zookeeper_hosts

Lists the ZooKeeper hosts used to store the MidoNet configuration data. The entries are comma delimited:

```
<context-param>
    <param-name>zookeeper-zookeeper_hosts</param-name>
    <param-value>192.168.1.100:2181,192.168.1.101:2181,192.168.1.102:2181</
param-value>
</context-param>
```

## zookeeper-session_timeout

Sets the timeout value (in milliseconds) after which ZooKeeper considers clients to be disconnected from the ZooKeeper server:

```
<context-param>
    <param-name>zookeeper-session_timeout</param-name>
    <param-value>30000</param-value>
</context-param>
```

# Improving Tomcat startup time

In some situations it may take Tomcat some time before it is ready to serve, sometimes even up to 10 minutes.

This is very likely to happen when your Midonet API is deployed on Ubuntu 14.04 with Tomcat 7. A good way to improve Tomcat startup time is to set this in the /usr/share/tomcat7/bin/catalina.sh file:

```
JAVA_OPTS="$JAVA_OPTS -Djava.security.egd=file:/dev/./urandom"
```

For more details, refer to http://wiki.apache.org/tomcat/HowTo/FasterStartUp.

# 18. MidoNet and OpenStack TCP/UDP service ports

## Table of Contents



This section lists the TCP/UDP ports used by services in MidoNet and OpenStack.

## Services on the Controller node

This section lists the TCP/UDP ports used by the services on the Controller node.

| Category | Service | Prot ocol | Port | Self | Controller | Compute | Mgmt. PC |
|---|---|---|---|---|---|---|---|
| OpenStack | glance-api | TCP | 9292 | x | x | x | x |
| OpenStack | httpd (Horizon) | TCP | 80 | x | | | x |
| MidoNet | midonet-api | TCP | 8080 | x | x | | x |
| OpenStack | swift-object-server | TCP | 6000 | x | x | x | |
| OpenStack | swift-container-server | TCP | 6001 | x | x | x | |
| OpenStack | swift-account-server | TCP | 6002 | x | x | x | |
| OpenStack | keystone | TCP | 35357 | x | x | x | x |
| OpenStack | neutron-server | TCP | 9696 | x | x | x | x |
| OpenStack | nova-novncproxy | TCP | 6080 | x | x | | x |
| OpenStack | heat-api | TCP | 8004 | x | x | | x |
| OpenStack | nova-api | TCP | 8773 | x | x | | x |
| Tomcat | Tomcat shutdown control channel | TCP | 8005 | x | x | | |
| OpenStack | nova-api | TCP | 8774 | x | x | x | x |
| OpenStack | nova-api | TCP | 8775 | x | x | x | x |
| OpenStack | glance-registry | TCP | 9191 | x | x | x | |
| OpenStack | qpidd | TCP | 5672 | x | x | x | |
| OpenStack | keystone | TCP | 5000 | x | x | x | x |
| OpenStack | cinder-api | TCP | 8776 | x | x | x | x |
| Tomcat | Tomcat management port (not used) | TCP | 8009 | x | x | | |
| OpenStack | ceilometer-api | TCP | 8777 | x | x | x | x |

| Category | Service | Prot ocol | Port | Self | Controller | Compute | Mgmt. PC |
|---|---|---|---|---|---|---|---|
| OpenStack | mongod (ceilometer) | TCP | 27017 | x | x | x | |
| OpenStack | MySQL | TCP | 3306 | x | x | x | |

# Services on the Network State Database nodes

This section lists the TCP/UDP ports used by the services on the Network State Database nodes.

| Category | Service | Prot ocol | Port | Self | Controller | NSDB | Compute | Comment |
|---|---|---|---|---|---|---|---|---|
| MidoNet | ZooKeeper communication | TCP | 3888 | x | | x | | |
| MidoNet | ZooKeeper leader | TCP | 2888 | x | | x | | |
| MidoNet | ZooKeeper/Cassandra | TCP | random | x | | | | ZooKeeper/Cassandra "LISTEN" to a TCP high number port. The port number is randomly selected on each ZooKeeper/Cassandra host. |
| MidoNet | Cassandra Query Language (CQL) native transport port | TCP | 9042 | | | | | |
| MidoNet | Cassandra cluster communication | TCP | 7000 | x | | x | | |
| MidoNet | Cassandra cluster communication (Transport Layer Security (TLS ) support) | TCP | 7001 | x | | x | | |
| MidoNet | Cassandra JMX | TCP | 7199 | x | | | | JMX monitoring port If you're using this port to monitor Cassandra health, enable communication from the monitoring server. |
| MidoNet | ZooKeeper client | TCP | 2181 | x | x | x | x | |
| MidoNet | Cassandra clients | TCP | 9160 | x | x | x | x | |

# Services on the Compute nodes

This section lists the TCP/UDP ports used by the services on the Compute nodes.

| Category | Service | Protocol | Port | Self | Controller | Comment |
|---|---|---|---|---|---|---|
| OpenStack | qemu-kvm vnc | TCP | From 5900 to 5900 + # of VM | | x | |
| MidoNet | midolman | TCP | random | x | | midolman "LISTEN"s to a TCP high number port. The port number is randomly selected on each MN Agent host. |
| OpenStack | libvirtd | TCP | 16509 | x | x | |
| MidoNet | midolman | TCP | 7200 | x | | JMX monitoring port If you're using this port to monitor health, enable communication from the monitoring server. |

# Services on the Gateway Nodes

This section lists the TCP/UDP ports used by the services on the Gateway Nodes.

| Category | Service | Prot ocol | Port | Self | Misc. | Comment |
|---|---|---|---|---|---|---|
| MidoNet | midolman | TCP | random | x | | midolman LISTEN"s to a TCP high number port. The port number is randomly selected on each MN Agent host. |
| MidoNet | midolman | TCP | 7200 | x | x | JMX monitoring port If you're using this port to monitor health, enable communication from the monitoring server. |
| MidoNet | quagga bgpd control | TCP | 2606 | x | | Network-NameSpace mbgp[Peer Number]_ns |
| MidoNet | quagga bgpd bgp | TCP | 179 | | BGP neighbor | Network-NameSpace mbgp[Peer Number]_ns |