Red Hat OpenStack Platform 13

Networking with Open Virtual Network

OpenStack Networking with OVN

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Abstract

A Cookbook for using OVN for OpenStack Networking Tasks.

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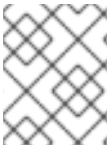
CHAPTER 1. OPEN VIRTUAL NETWORK (OVN)

Open Virtual Network (OVN) is an Open vSwitch-based software-defined networking (SDN) solution for supplying network services to instances. OVN provides platform-agnostic support for the full OpenStack Networking API. OVN allows you to programmatically connect groups of guest instances into private L2 and L3 networks. OVN uses a standard approach to virtual networking that is capable of extending to other Red Hat platforms and solutions.

NOTE

The minimum OVS version required is OVS 2.9.

This section describes the steps required to deploy OVN using director.



NOTE

OVN is supported only in an HA environment. We recommend that you deploy OVN with distributed virtual routing (DVR).

1.1. QUICK STEPS: DEPLOYING CONTAINERIZED OVN ON THE OVERCLOUD

If you are already familiar with OVN, you can use this quick step to deploy OVN with DVR in an HA configuration on the overcloud:

```
$ openstack overcloud deploy \
    --templates /usr/share/openstack-tripleo-heat-templates \
    ...
-e  /usr/share/openstack-tripleo-heat-templates/environments/services-
docker/neutron-ovn-dvr-ha.yaml
    ....
```

1.2. OVN ARCHITECTURE

The OVN architecture replaces the OVS ML2 plugin with the OVN Modular Layer 2 (ML2) plugin to support the Networking API. OVN provides robust networking services for the Red Hat OpenStack platform.

The OVN architecture consists of the following components and services:

OVN ML2 plugin

Translates the OpenStack-specific networking configuration into the platform-agnostic OVN logical networking configuration. This plugin typically runs on the Controller node.

OVN Northbound (NB) database (`ovn-nb`)

Stores the logical OVN networking configuration from the OVN ML2 plugin. This database typically runs on the Controller node and listens on TCP port **`6641`**.

OVN Northbound service (`ovn-northd`)

Converts the logical networking configuration from the OVN NB database to the logical data path flows and populates these on the OVN Southbound database. This service typically runs on the Controller node.

OVN Southbound (SB) database (`ovn-sb`)

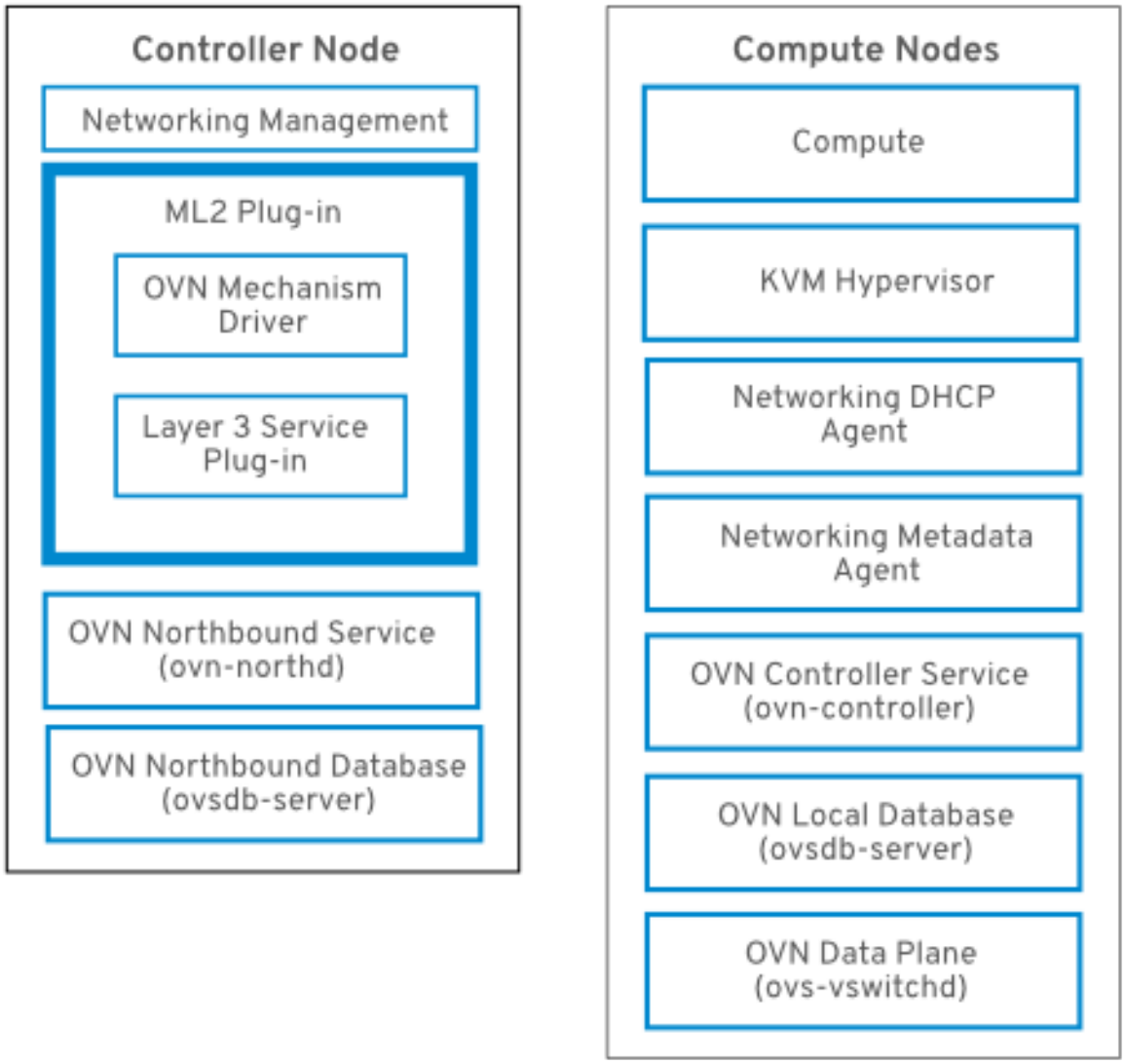
Stores the converted logical data path flows. This database typically runs on the Controller node and listens on TCP port **`6642`**.

OVN controller (`ovn-controller`)

Connects to the OVN SB database and acts as the open vSwitch controller to control and monitor network traffic. Runs on all Compute and gateway nodes where **`OS::Tripleo::Services::OVNController`** is defined.

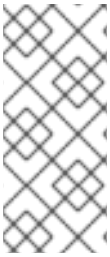
OVN metadata agent (`ovn-metadata-agent`)

Spawns the **`haproxy`** instances for managing the OVS interfaces, network namespaces and HAProxy processes used to proxy metadata API requests. Runs on all Compute and gateway nodes where **`OS::TripleO::Services::OVNMetadataAgent`** is defined.



CHAPTER 2. PLANNING YOUR OVN DEPLOYMENT

Deploy OVN in HA deployments only. We recommend you deploy with distributed virtual routing (DVR) enabled.



NOTE

To use OVN, your director deployment must use Generic Network Virtualization Encapsulation (Geneve), and not VXLAN. Geneve allows OVN to identify the network using the 24-bit Virtual Network Identifier (VNI) field and an additional 32-bit Type Length Value (TLV) to specify both the source and destination logical ports. You should account for this larger protocol header when you determine your MTU setting.

DVR HA with OVN

Deploy OVN with DVR in an HA environment. OVN is supported only in an HA environment. The **`neutron-ovn-dvr-ha.yaml`** environment file configures the required DVR-specific parameters for deployments using OVN in an HA environment.

2.1. THE OVN-CONTROLLER ON COMPUTE NODES

The **`ovn-controller`** service runs on each Compute node and connects to the OVN SB database server to retrieve the logical flows. The **`ovn-controller`** translates these logical flows into physical OpenFlow flows and adds the flows to the OVS bridge (**`br-int`**). To communicate with **`ovs-vswitchd`** and install the OpenFlow flows, the **`ovn-controller`** connects to the local **`ovsdb-server`** (that hosts **`conf.db`**) using the UNIX socket path that was passed when **`ovn-controller`** was started (for example **`unix:/var/run/openvswitch/db.sock`**).

The **`ovn-controller`** service expects certain key-value pairs in the **`external_ids`** column of the **`Open_vSwitch`** table; **`puppet-ovn`** uses **`puppet-vswitch`** to populate these fields. Below are the key-value pairs that **`puppet-vswitch`** configures in the **`external_ids`** column:

```
hostname=<HOST NAME>
ovn-encap-ip=<IP OF THE NODE>
ovn-encap-type=geneve
ovn-remote=tcp:OVN_DBS_VIP:6642
```

2.2. THE OVN COMPOSABLE SERVICE

The director has a composable service for OVN named **`ovn-dbs`** with two profiles: the base profile and the pacemaker HA profile. The OVN northbound and southbound databases are hosted by the **`ovsdb-server`** service. Similarly, the **`ovsdb-server`** process runs alongside **`ovs-vswitchd`** to host the OVS database (**`conf.db`**).

NOTE

The schema file for the NB database is located in **`/usr/share/openvswitch/ovn-nb.ovsschema`** , and the SB database schema file is in **`/usr/share/openvswitch/ovn-sb.ovsschema`**.

2.3. HIGH AVAILABILITY WITH PACEMAKER AND DVR

In addition to the required HA profile, Red Hat recommends that you deploy OVN with DVR to ensure the availability of networking services. With the HA profile enabled, the OVN database servers start on all the Controllers, and **pacemaker** then selects one controller to serve in the master role.

The **ovsdb-server** service does not currently support *active-active* mode. It does support HA with the *master-slave* mode, which is managed by Pacemaker using the resource agent Open Cluster Framework (OCF) script. Having **ovsdb-server** run in *master* mode allows write access to the database, while all the other slave **ovsdb-server** services replicate the database locally from the *master*, and do not allow write access.

The YAML file for this profile is the **tripleo-heat-templates/environments/services-docker/neutron-ovn-dvr-ha.yaml** file. When enabled, the OVN database servers are managed by Pacemaker, and **puppet-tripleo** creates a pacemaker OCF resource named **ovn:ovndb-servers**.

The OVN database servers are started on each Controller node, and the controller owning the virtual IP address (**OVN_DBS_VIP**) runs the OVN DB servers in *master* mode. The OVN ML2 mechanism driver and **ovn-controller** then connect to the database servers using the**OVN_DBS_VIP** value. In the event of a failover, Pacemaker moves the virtual IP address (**OVN_DBS_VIP**) to another controller, and also promotes the OVN database server running on that node to *master*.

2.4. LAYER 3 HIGH AVAILABILITY WITH OVN

OVN supports Layer 3 high availability (L3 HA) without any special configuration. OVN automatically schedules the router port to all available gateway nodes that can act as an L3 gateway on the specified external network. OVN L3 HA uses the **gateway_chassis** column in the OVN **Logical_Router_Port** table. Most functionality is managed by OpenFlow rules with bundled active_passive outputs. The **ovn-controller** handles the Address Resolution Protocol (ARP) responder and router enablement and disablement. Gratuitous ARPs for FIPs and router external addresses are also periodically sent by the **ovn-controller**.

NOTE

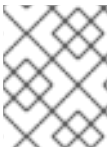
L3HA uses OVN to balance the routers back to the original gateway nodes to avoid any nodes becoming a bottleneck.

BFD monitoring

OVN uses the Bidirectional Forwarding Detection (BFD) protocol to monitor the availability of the gateway nodes. This protocol is encapsulated on top of the Geneve tunnels established from node to node.

Each gateway node monitors all the other gateway nodes in a star topology in the deployment. Gateway nodes also monitor the compute nodes to let the gateways enable and disable routing of packets and ARP responses and announcements.

Each compute node uses BFD to monitor each gateway node and automatically steers external traffic, such as source and destination Network Address Translation (SNAT and DNAT), through the active gateway node for a given router. Compute nodes do not need to monitor other compute nodes.



NOTE

External network failures are not detected as would happen with an ML2-OVS configuration.

L3 HA for OVN supports the following failure modes:

- The gateway node becomes disconnected from the network (tunneling interface).
- **`ovs-vswitchd`** stops (**`ovs-switchd`** is responsible for BFD signaling)
- **`ovn-controller`** stops (**`ovn-controller`** removes itself as a registered node).

NOTE

This BFD monitoring mechanism only works for link failures, not for routing failures.

CHAPTER 3. DEPLOYING OVN WITH DIRECTOR

The following events are triggered when you deploy OVN on the Red Hat OpenStack Platform:

1. Enables the OVN ML2 plugin and generates the necessary configuration options.
2. Deploys the OVN databases and the **`ovn-northd`** service on the controller node(s).
3. Deploys **`ovn-controller`** on each Compute node.
4. Deploys **`neutron-ovn-metadata-agent`** on each Compute node.

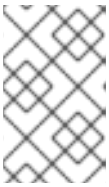
3.1. DEPLOYING OVN WITH DVR

NOTE

This guide deploys OVN with DRV in an HA environment.

To deploy OVN with DVR in an HA environment:

1. Verify that the value for **`OS::TripleO::Compute::Net::SoftwareConfig`** in the **`environments/services-docker/neutron-ovn-dvr-ha.yaml`** file is the same as the **`OS::TripleO::Controller::Net::SoftwareConfig`** value in use. This can normally be found in the network environment file in use when deploying the overcloud, for example, in the **`environments/net-multiple-nics.yaml`** file. This creates the appropriate external network bridge on the Compute node.

   NOTE

   If customizations have been made to the network configuration of the Compute node, it may be necessary to add the appropriate configuration to those files instead.

2. Configure a Networking port for the Compute node on the external network by modifying **`OS::TripleO::Compute::Ports::ExternalPort`** to an appropriate value, such as **`OS::TripleO::Compute::Ports::ExternalPort: ../network/ports/external.yaml`**

3. Include *environments/services-docker/neutron-ovn-dvr-ha.yaml* as an environment file when deploying the overcloud. For example:

```
$ openstack overcloud deploy \
    --templates /usr/share/openstack-tripleo-heat-templates \
    ...
 -e /usr/share/openstack-tripleo-heat-
templates/environments/services-docker/neutron-ovn-dvr-ha.yaml
```

For production environments (or test environments that require special customization, such as network isolation or dedicated NICs, you can use the example environments as a guide. Pay special attention to the bridge mapping type parameters used, for example, by OVS and any reference to external facing bridges.

3.2. DEPLOYING THE OVN METADATA AGENT ON COMPUTE NODES

The OVN metadata agent is configured in the **tripleo-heat-templates/docker/services/ovn-metadata.yaml** file and included in the default Compute role through **OS::TripleO::Services::OVNMetadataAgent**. As such, the OVN metadata agent with default parameters is deployed as part of the OVN deployment. See Chapter 3, *Deploying OVN with director*.

OpenStack guest instances access the Networking metadata service available at the link-local IP address: 169.254.169.254. The **neutron-ovn-metadata-agent** has access to the host networks where the Compute metadata API exists. Each HAProxy is in a network namespace that is not able to reach the appropriate host network. HaProxy adds the necessary headers to the metadata API request and then forwards the request to the **neutron-ovn-metadata-agent** over a UNIX domain socket.

The OVN Networking service creates a unique network namespace for each virtual network that enables the metadata service. Each network accessed by the instances on the Compute node has a corresponding metadata namespace (ovnmeta-<net_uuid>).

3.2.1. Troubleshooting Metadata issues

You can use metadata namespaces for troubleshooting to access the local instances on the Compute node. To troubleshoot metadata namespace issues, run the following command as root on the Compute node:

```
# ip netns exec ovnmeta-fd706b96-a591-409e-83be-33caea824114 ssh
USER@INSTANCE_IP_ADDRESS
```

USER@INSTANCE_IP_ADDRESS is the user name and IP address for the local instance you want to troubleshoot.

3.3. DEPLOYING INTERNAL DNS WITH OVN

To deploy internal DNS with OVN:

1. Enable DNS with the **NeutronPluginExtensions** parameter:

```
parameter_defaults:
  NeutronPluginExtensions: "dns"
```

2. Set the DNS domain before you deploy the overcloud:

```
  NeutronDnsDomain: "mydns-example.org"
```

3. Deploy the overcloud:

```
$ openstack overcloud deploy \
    --templates /usr/share/openstack-tripleo-heat-templates \
    ...
 -e /usr/share/openstack-tripleo-heat-
templates/environments/services-docker/neutron-ovn-dvr-ha.yaml
```

CHAPTER 4. MONITORING OVN

You can use the **ovn-trace** command to monitor and troubleshoot OVN logical flows, and you can use the **ovs-ofctl dump-flows** command to monitor and troubleshoot OpenFlows.

4.1. MONITORING OVN LOGICAL FLOWS

OVN uses logical flows that are tables of flows with a priority, match, and actions. These logical flows are distributed to the **ovn-controller** running on each Compute node. You can use the **ovn-sbctl lflow-list** command on the Controller node to view the full set of logical flows, as shown in this example.

```
$ ovn-sbctl --db=tcp:172.17.1.10:6642 lflow-list
    Datapath: "sw0" (d7bf4a7b-e915-4502-8f9d-5995d33f5d10)  Pipeline:
ingress
      table=0 (ls_in_port_sec_l2  ), priority=100  , match=(eth.src[40]),
action=(drop;)
      table=0 (ls_in_port_sec_l2  ), priority=100  , match=(vlan.present),
action=(drop;)
      table=0 (ls_in_port_sec_l2  ), priority=50   , match=(inport ==
"sw0-port1" && eth.src == {00:00:00:00:00:01}), action=(next;)
      table=0 (ls_in_port_sec_l2  ), priority=50   , match=(inport ==
"sw0-port2" && eth.src == {00:00:00:00:00:02}), action=(next;)
      table=1 (ls_in_port_sec_ip  ), priority=0    , match=(1), action=
(next;)
      table=2 (ls_in_port_sec_nd  ), priority=90   , match=(inport ==
"sw0-port1" && eth.src == 00:00:00:00:00:01 && arp.sha ==
00:00:00:00:00:01), action=(next;)
      table=2 (ls_in_port_sec_nd  ), priority=90   , match=(inport ==
"sw0-port1" && eth.src == 00:00:00:00:00:01 && ip6 && nd && ((nd.sll ==
00:00:00:00:00:00 || nd.sll == 00:00:00:00:00:01) || ((nd.tll ==
00:00:00:00:00:00 || nd.tll == 00:00:00:00:00:01)))), action=(next;)
      table=2 (ls_in_port_sec_nd  ), priority=90   , match=(inport ==
"sw0-port2" && eth.src == 00:00:00:00:00:02 && arp.sha ==
00:00:00:00:00:02), action=(next;)
      table=2 (ls_in_port_sec_nd  ), priority=90   , match=(inport ==
"sw0-port2" && eth.src == 00:00:00:00:00:02 && ip6 && nd && ((nd.sll ==
00:00:00:00:00:00 || nd.sll == 00:00:00:00:00:02) || ((nd.tll ==
00:00:00:00:00:00 || nd.tll == 00:00:00:00:00:02)))), action=(next;)
      table=2 (ls_in_port_sec_nd  ), priority=80   , match=(inport ==
"sw0-port1" && (arp || nd)), action=(drop;)
      table=2 (ls_in_port_sec_nd  ), priority=80   , match=(inport ==
"sw0-port2" && (arp || nd)), action=(drop;)
      table=2 (ls_in_port_sec_nd  ), priority=0    , match=(1), action=
(next;)
      table=3 (ls_in_pre_acl      ), priority=0    , match=(1), action=
(next;)
      table=4 (ls_in_pre_lb       ), priority=0    , match=(1), action=
(next;)
      table=5 (ls_in_pre_stateful ), priority=100  , match=(reg0[0] == 1),
action=(ct_next;)
      table=5 (ls_in_pre_stateful ), priority=0    , match=(1), action=
(next;)
      table=6 (ls_in_acl          ), priority=0    , match=(1), action=
(next;)
```

```
      table=7 (ls_in_qos_mark     ), priority=0    , match=(1), action=
(next;)
      table=8 (ls_in_lb           ), priority=0    , match=(1), action=
(next;)
      table=9 (ls_in_stateful     ), priority=100  , match=(reg0[1] == 1),
action=(ct_commit(ct_label=0/1); next;)
      table=9 (ls_in_stateful     ), priority=100  , match=(reg0[2] == 1),
action=(ct_lb;)
      table=9 (ls_in_stateful     ), priority=0    , match=(1), action=
(next;)
      table=10(ls_in_arp_rsp      ), priority=0    , match=(1), action=
(next;)
      table=11(ls_in_dhcp_options ), priority=0    , match=(1), action=
(next;)
      table=12(ls_in_dhcp_response), priority=0    , match=(1), action=
(next;)
      table=13(ls_in_l2_lkup      ), priority=100  , match=(eth.mcast),
action=(outport = "_MC_flood"; output;)
      table=13(ls_in_l2_lkup      ), priority=50   , match=(eth.dst ==
00:00:00:00:00:01), action=(outport = "sw0-port1"; output;)
      table=13(ls_in_l2_lkup      ), priority=50   , match=(eth.dst ==
00:00:00:00:00:02), action=(outport = "sw0-port2"; output;)
    Datapath: "sw0" (d7bf4a7b-e915-4502-8f9d-5995d33f5d10)  Pipeline:
egress
      table=0 (ls_out_pre_lb      ), priority=0    , match=(1), action=
(next;)
      table=1 (ls_out_pre_acl     ), priority=0    , match=(1), action=
(next;)
      table=2 (ls_out_pre_stateful), priority=100  , match=(reg0[0] == 1),
action=(ct_next;)
      table=2 (ls_out_pre_stateful), priority=0    , match=(1), action=
(next;)
      table=3 (ls_out_lb          ), priority=0    , match=(1), action=
(next;)
      table=4 (ls_out_acl         ), priority=0    , match=(1), action=
(next;)
      table=5 (ls_out_qos_mark    ), priority=0    , match=(1), action=
(next;)
      table=6 (ls_out_stateful    ), priority=100  , match=(reg0[1] == 1),
action=(ct_commit(ct_label=0/1); next;)
      table=6 (ls_out_stateful    ), priority=100  , match=(reg0[2] == 1),
action=(ct_lb;)
      table=6 (ls_out_stateful    ), priority=0    , match=(1), action=
(next;)
      table=7 (ls_out_port_sec_ip ), priority=0    , match=(1), action=
(next;)
      table=8 (ls_out_port_sec_l2 ), priority=100  , match=(eth.mcast),
action=(output;)
      table=8 (ls_out_port_sec_l2 ), priority=50   , match=(outport ==
"sw0-port1" && eth.dst == {00:00:00:00:00:01}), action=(output;)
      table=8 (ls_out_port_sec_l2 ), priority=50   , match=(outport ==
"sw0-port2" && eth.dst == {00:00:00:00:00:02}), action=(output;)
```

Key differences between OVN and OpenFlow include:

- OVN ports are logical entities that reside somewhere on a network, not physical ports on a single switch.
- OVN gives each table in the pipeline a name in addition to its number. The name describes the purpose of that stage in the pipeline.
- The OVN match syntax supports complex Boolean expressions.
- The actions supported in OVN logical flows extend beyond those of OpenFlow. You can implement higher level features, such as DHCP, in the OVN logical flow syntax.

See the OpenStack and OVN Tutorial for a complete walk through of OVN monitoring options with this command.

ovn-trace

The **ovn-trace** command can simulate how a packet travels through the OVN logical flows, or help you determine why a packet is dropped. Provide the **ovn-trace** command with the following parameters:

DATAPATH

The logical switch or logical router where the simulated packet starts.

MICROFLOW

The simulated packet, in the syntax used by the **ovn-sb** database.

This example displays the **--minimal** output option on a simulated packet and shows that the packet reaches its destination:

```
$ ovn-trace --minimal sw0 'inport == "sw0-port1" && eth.src ==
00:00:00:00:00:01 && eth.dst == 00:00:00:00:00:02'
    #
reg14=0x1,vlan_tci=0x0000,dl_src=00:00:00:00:00:01,dl_dst=00:00:00:00:00:0
2,dl_type=0x0000
    output("sw0-port2");
```

In more detail, the **--summary** output for this same simulated packet shows the full execution pipeline:

```
$ ovn-trace --summary sw0 'inport == "sw0-port1" && eth.src ==
00:00:00:00:00:01 && eth.dst == 00:00:00:00:00:02'
#
reg14=0x1,vlan_tci=0x0000,dl_src=00:00:00:00:00:01,dl_dst=00:00:00:00:00:0
2,dl_type=0x0000
ingress(dp="sw0", inport="sw0-port1") {
    outport = "sw0-port2";
    output;
    egress(dp="sw0", inport="sw0-port1", outport="sw0-port2") {
        output;
        /* output to "sw0-port2", type "" */;
    };
};
```

The example output shows:

- The packet enters the **sw0** network from the **sw0-port1** port and runs the ingress pipeline.

- The *outport* variable is set to **sw0-port2** indicating that the intended destination for this packet is **sw0-port2**.
- The packet is output from the ingress pipeline, which brings it to the egress pipeline for **sw0** with the *outport* variable set to **sw0-port2**.
- The output action is executed in the egress pipeline, which outputs the packet to the current value of the *outport* variable, which is **sw0-port2**.

See the **ovn-trace** man page for complete details.

4.2. MONITORING OPENFLOWS

You can use **ovs-ofctl dump-flows** command to monitor the OpenFlow flows on a logical switch in your network.

```
$ ovs-ofctl dump-flows br-int
NXST_FLOW reply (xid=0x4):
 cookie=0x0, duration=72.132s, table=0, n_packets=0, n_bytes=0,
idle_age=72, priority=10,in_port=1,dl_src=00:00:00:00:00:01
actions=resubmit(,1)
 cookie=0x0, duration=60.565s, table=0, n_packets=0, n_bytes=0,
idle_age=60, priority=10,in_port=2,dl_src=00:00:00:00:00:02
actions=resubmit(,1)
 cookie=0x0, duration=28.127s, table=0, n_packets=0, n_bytes=0,
idle_age=28, priority=0 actions=drop
 cookie=0x0, duration=13.887s, table=1, n_packets=0, n_bytes=0,
idle_age=13, priority=0,in_port=1 actions=output:2
 cookie=0x0, duration=4.023s, table=1, n_packets=0, n_bytes=0, idle_age=4,
priority=0,in_port=2 actions=output:1
```