

COMPUTING

OpenflowSwitch Software for SharpSwitch™ PCIE-9205

Installation and Use

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ARTESYN[™]
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Overview of Contents

This manual is divided into the following chapters and appendices.

- [Introduction on page 11](#) describes software installation, verification, and configuration of OpenflowSwitch Software on SharpSwitch™ PCIE-9205.
- [Usage and Demonstration Through ODL on page 15](#) describes how to use ODL controller to control/configure and access OpenFlow Switch.
- [Appendix A, Configuring L2 Switching/Forwarding, on page 23](#) describes the configuration of L2 switching or forwarding.
- [Appendix B, Configuring L3 Unicast Route, on page 27](#) describes the configuration of L3 Unicast Route.
- [Appendix C, Configuring L3 ECMP Route, on page 33](#) describes the configuration of L3 ECMP Route.
- [Appendix D, Configuring L2 Multicast Forwarding, on page 41](#) describes the configuration of L2 multicast forwarding to EPL, PF, and VF ports.
- [Related Documentation on page 53](#) provides a listing of related product documentation, manufacturer's documents and industry standard specifications.

Abbreviations

This document uses the following abbreviations:

Abbreviation	Definition
ARP	Address Resolution Protocol
BBS	Basic Blade Services
ECMP	Equal Cost Multi Path
EPL	Ethernet Port Logic
ODL	OpenDaylight (Lithium-SR3)
OvS	Open vSwitch (2.4.0)
OVSDB	Open vSwitch Database Management Protocol i.e. RFC 7047
PCIE	Peripheral Component Interconnect Express

Conventions

The following table describes the conventions used throughout this manual.

Notation	Description
0x00000000	Typical notation for hexadecimal numbers (digits are 0 through F), for example used for addresses and offsets
0b0000	Same for binary numbers (digits are 0 and 1)
bold	Used to emphasize a word
Screen	Used for on-screen output and code related elements or commands in body text
Courier + Bold	Used to characterize user input and to separate it from system output
<i>Reference</i>	Used for references and for table and figure descriptions
File > Exit	Notation for selecting a submenu
<text>	Notation for variables and keys
[text]	Notation for software buttons to click on the screen and parameter description
...	Repeated item for example node 1, node 2,..., node 12
.	Omission of information from example/command that is not necessary at the time being
..	Ranges, for example: 0..4 means one of the integers 0,1,2,3, and 4 (used in registers)
	Logical OR

This chapter describes software installation, verification, and configuration of OpenflowSwitch software on the SharpSwitch™ PCIe-9205 card. You can refer the *OpenFlow Abstract Switch Application Note*, for more details about the OpenFlow switch pipeline.

1.1 OpenflowSwitch Software

The OpenflowSwitch software is designed to provide Open vSwitch Database (OVSDB) and OpenFlow plug-ins for the SharpSwitch PCIe-9205 card.

1.1.1 Hardware Requirement

- MaxCore™ MC3000 platform with SharpSwitch™ PCIe-9205 card in Slot1/Slot 3/Slot 9/Slot 11.
- MaxCore™ MC4000 platform with SharpSwitch™ PCIe-9205 card in Slot1/Slot 12.

1.1.2 Software Requirement

- Open vSwitch
- Compatible Basic Blade Services (BBS)

Note: Refer *OpenflowSwitch Software for SharpSwitch PCIe-9205 Release Notes* (delivered along with the software) for the applicable software release information.

1.2 Software Installation

1.2.1 Getting Started

The OpenflowSwitch software is installed on the SharpSwitch PCIe-9205 card. It enables OpenFlow and OVSDB plug-ins on the Intel(R) FM10k (also known as Red Rock Canyon) switch.

1.2.2 Prerequisites

- To install the OpenflowSwitch software it is required to have a compatible BBS installed on the SharpSwitch PCIE-9205 card.
- The Open vSwitch 2.4.0 (OvS) should be pre-installed on the SharpSwitch PCIE-9205 card. If required, use the following command to install OvS.

```
rpm -ivh openvswitch-2.4.0-1.el7.x86_64.rpm
```

Note: The OvS RPM is also packaged as a part of the OpenflowSwitch software.

1.2.3 Installation and Verification

- Install the OpenflowSwitch software RPMs.

```
rpm -ivh openswitchsw-pcie9205-1.0.1-<version>.el7.x86_64.rpm
```
- Provide the OpenflowSwitch configuration details in the following file:

```
/opt/openswitch/config/config.in
```
- Start OpenflowSwitch modules on the SharpSwitch PCIE-9205 card:

```
/opt/openswitch/scripts/openswitch.init start
```

1.2.3.1 Verifying the Software Modules

The following software modules of OpenflowSwitch and Open vSwitch (OvS) are running on the SharpSwitch PCIE-9205 card:

1. OvS related software module:
 - `ovsdb-server` - OvS database server
2. OpenflowSwitch related software module:
 - `switchagentd` - Switch agent daemon
 - `ofagent` - OpenFlow agent
 - `ovs-switchd` - OpenflowSwitch daemon
It is a proprietary extension of the `ovs-vswitchd` module of OvS. The userspace-only mode of `ovs-switchd` extends `netdev-provider` interface to PCIE-9205 switch. The OpenFlow agent functionality of `ovs-switchd` is replaced by `ofagent` module of the OpenflowSwitch.

Verify the status of the above software modules using
`/opt/openswitch/scripts/openswitch.init status` command.

1.2.3.2 Configuring the Database

The `ovs-vsctl` utility of OvS can be used to query and configure the OvS configuration database. This release supports only the mandatory columns of the following `Open_vSwitch` database tables:

- `Open_vSwitch`
- `Bridge`
- `Port`
- `Interface`
- `Manager`

1.2.3.3 Configuring the Management Network

For the SharpSwitch PCIE-9205 card in a non-shelf host:

The SharpSwitch PCIE-9205 card connects to the management network in the MaxCore platform, using one of the PCIe ports (port 20, 21, 22, or 23) connected to the management CPU (mCPU) in the shelf host. In addition, there is a reserved VLAN that is used for the management traffic. The `/opt/openswitch/config/config.in` file contains `MGMT_NET_PORT` and `MGMT_NET_VLAN` parameters for configuring the port and VLAN respectively.

The SharpSwitch PCIE-9205 card acquires an IP address on `<PEP4 port>.MGMT_NET_VLAN` interface, by running the DHCP client program, from the DHCP server that is running on the mCPU. After the management network is UP, the OpenflowSwitch software can connect to the OpenFlow controller.

In case, the DHCP server is not available, you should statically assign IP address to the `<PEP4 port>.MGMT_NET_VLAN` interface (e.g. `enp38s0.21`) and assign the appropriate gateway IP and routes to reach the OpenFlow controller.

Note: Port 24 is assigned as the PEP4 port.

1.2.3.4 Configuring the Flows

Use an OpenFlow controller like OpenDayLight (ODL) to configure flows on the PCIE-9205 switch.

Configure controller/manager IP address and Datapath ID in the following file:
`/opt/openswitch/config/config.in`

1.2.3.5 Configuring the Modes of QSFP Modules

The Upper and Lower QSFP28 modules present on the PCIE-9205 can be configured in one of the following modes:

- 40G_SR4: Group Mode, covering 1x40GBase-SR4
- 10G_SX4: Independent Mode, covering 4x10GBase-SR
- 1G_SX4: Independent Mode, covering 4x1000Base-X

Given below are the default configurations:

- Upper QSFP28 module (QSFP1) = 40G_SR4
- Lower QSFP28 module (QSFP2) = 1G_SX4

Any changes to the QSFP modes would necessitate a `openswitch.init` restart.

This chapter describes how to use the ODL controller to control, configure, and access the OpenFlow switch.

NOTICE

For Reactive flow programming, user needs to develop ODL/Controller plug-in based on the OpenFlow Switch Pipeline as described in the *OpenFlow Abstract Switch Application Note*. You can get a copy of the Application Note by contacting your local Artesyn sales office.

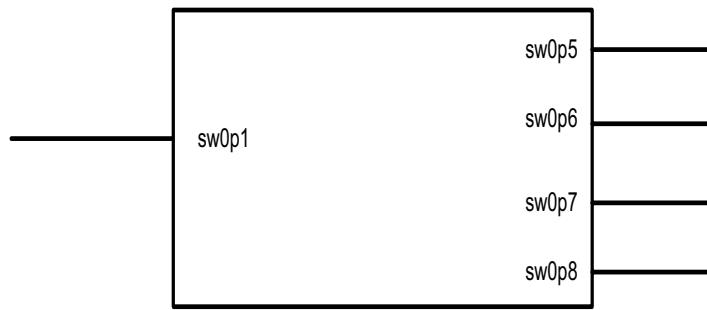
OpenFlow agent running on PCIE-9205 supports all the required functionalities to enable reactive flow programming.

2.1 Prerequisites for Demonstration

1. Install the OpenflowSwitch software on SharpSwitch PCIE-9205.
2. Install ODL Lithium-SR3 release or any standard ODL release on the SharpServer PCIE-7410 card or any external PC with the following features.
 - `feature:install odl-restconf-all`
 - `feature:install odl-openflowplugin-all`
 - `feature:install odl-ovsdb-all`
 - `feature:install odl-ovsdb-openstack`
 - `feature:install odl-dlux-all`
3. You may need to disable firewall in the controller system, so that it accepts the OpenFlow protocol messages.
4. Install the postman plug-in in Google Chrome for configuring or pushing flows.

2.2 Topology

External QSFP1 is configured in the group mode (port number 1) with bandwidth set to 40G and QSFP2 is configured in the independent mode (port number 5,6,7, and 8) each have bandwidth set to 1G.



Connect sw0p5, sw0p6, sw0p7, and sw0p8 to SmartBits as shown in the figure above.

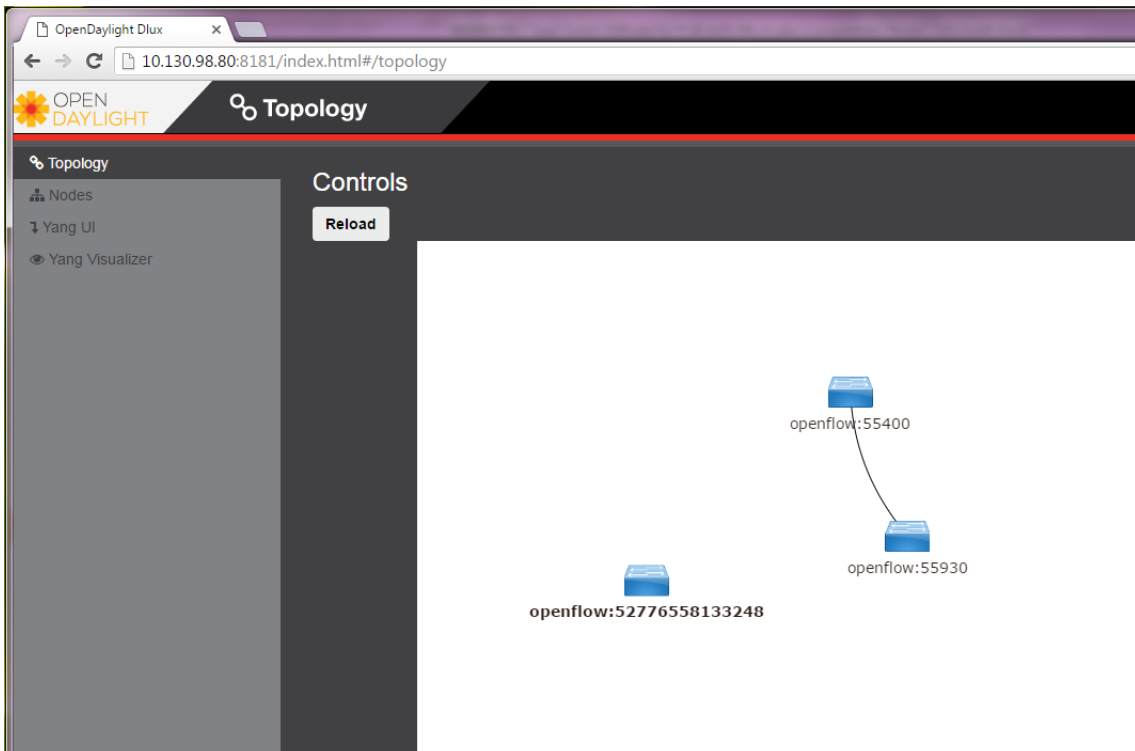
2.2.1 Demonstration

Test Cases:

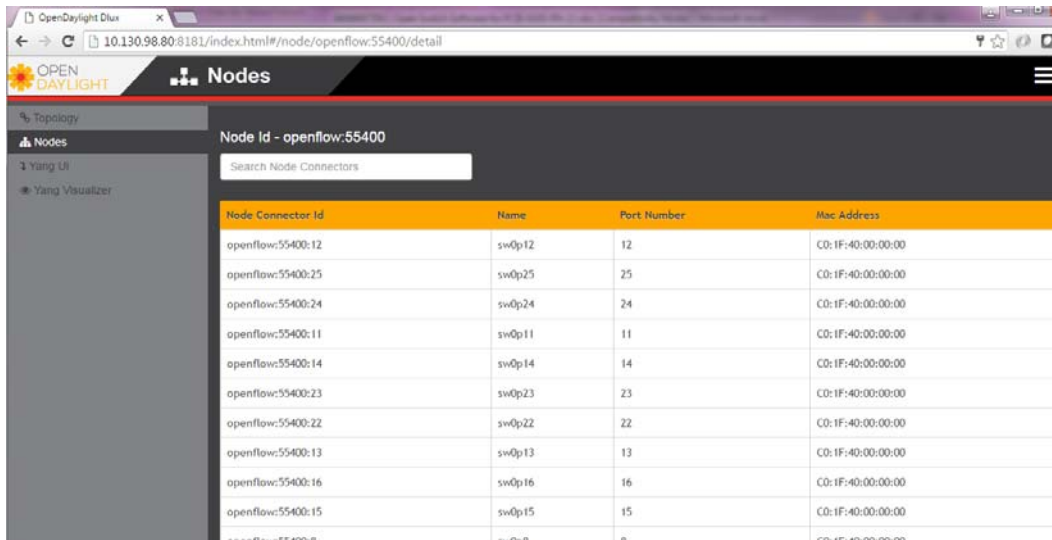
Test Case 1: Topology Detection by OpenDayLight Controller

1. Start OpenDayLight controller with required features using `./bin/karaf`
2. Configure the controller and manager IP in configuration file.
3. Start OpenflowSwitch service.
4. Once the OpenDaylight controller detects OpenFlow switch running in SharpSwitch PCIE-9205, the topology can be observed through the DLUX web URL. For more details see, <http://<controller-ip>:8181/index.html>.
5. DLUX give multiple tabs - to observe topology/Nodes/Yang.

- The Topology tab in DLUX displays the connectivity between switches/hosts. For the switches to be detected by ODL, it is required that they should forward LLDP packets. For the Hosts to be detected by ODL, they need to send GARP/ARP packets.



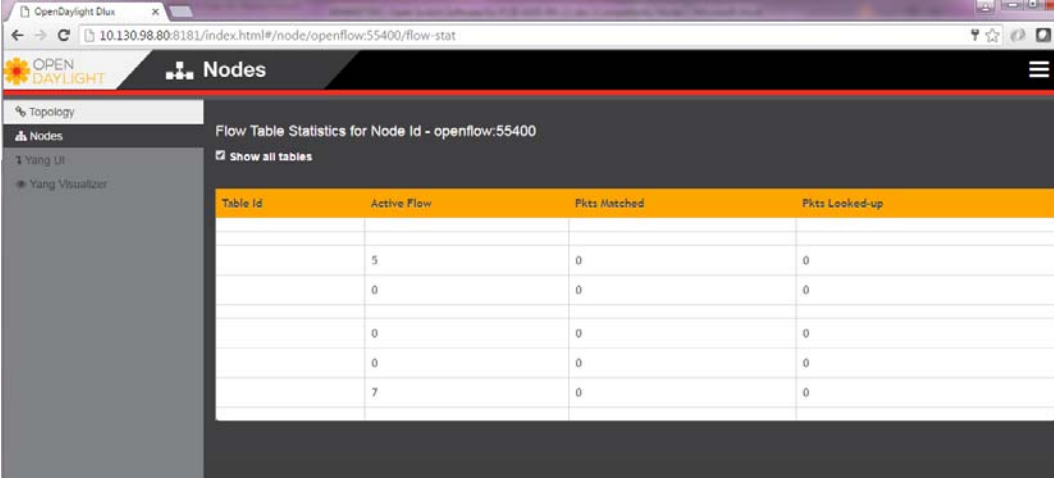
7. Select the Node tab to verify the following parameters.
 - Number of ports.



The screenshot shows the OpenDaylight GUI interface. The main content area displays the details for a specific node, identified as 'Node Id - openflow:55400'. Below this, there is a search bar for 'Node Connectors'. A table lists the node connectors, including their IDs, names, port numbers, and MAC addresses.

Node Connector Id	Name	Port Number	Mac Address
openflow:55400:12	sw0p12	12	C0:1F:40:00:00:00
openflow:55400:25	sw0p25	25	C0:1F:40:00:00:00
openflow:55400:24	sw0p24	24	C0:1F:40:00:00:00
openflow:55400:11	sw0p11	11	C0:1F:40:00:00:00
openflow:55400:14	sw0p14	14	C0:1F:40:00:00:00
openflow:55400:23	sw0p23	23	C0:1F:40:00:00:00
openflow:55400:22	sw0p22	22	C0:1F:40:00:00:00
openflow:55400:13	sw0p13	13	C0:1F:40:00:00:00
openflow:55400:16	sw0p16	16	C0:1F:40:00:00:00
openflow:55400:15	sw0p15	15	C0:1F:40:00:00:00

- Number of flows configured on different table.

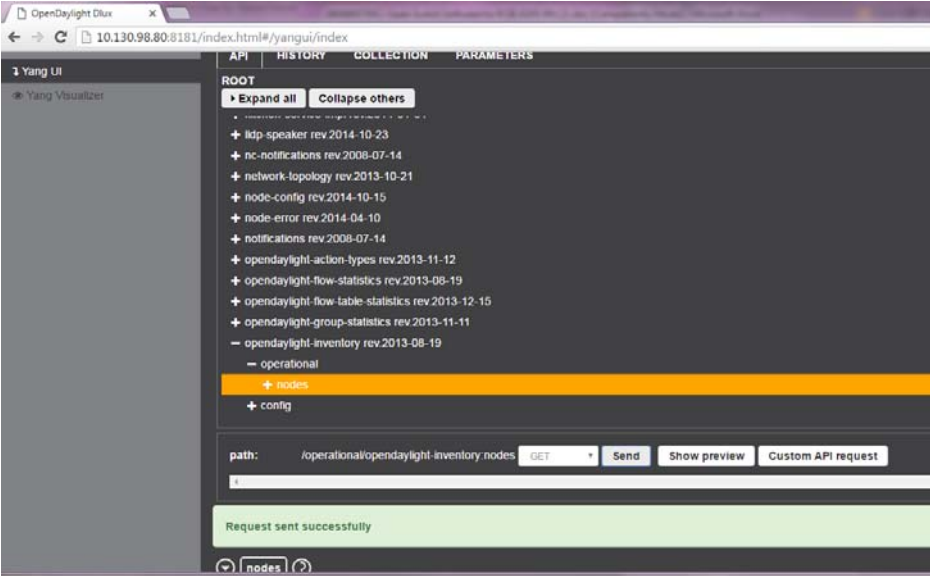


Flow Table Statistics for Node Id - openflow:55400

Show all tables

Table Id	Active Flow	Pkts Matched	Pkts Looked-up
	5	0	0
	0	0	0
	0	0	0
	0	0	0
	7	0	0

- Port statistics.

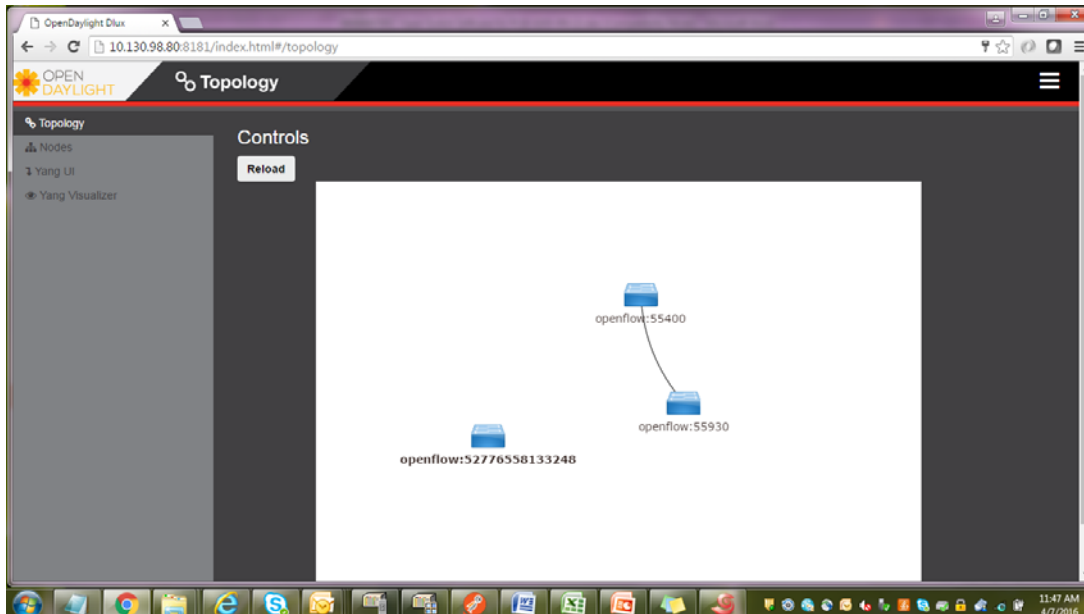


API Explorer for 'nodes' collection.

path: /operational/.opendaylight-inventory/nodes GET Send Show preview Custom API request

Request sent successfully

8. The Yang interface can be used to verify/configure different OpenDayLight features. For example, operational states of the ports can be verified and also configure interface, link state. .



9. The OpenDayLight controller sends LLDP packets to all running interfaces. The same can be confirmed with statistics in Node Tab and also in Smart.

Test Case 2: Connecting Two PCIE-9205 OpenFlow Switches

Cross-Connect either PCIE-9205 QSFP1 ports or 1 G ports.

- Start OpenDayLight controller.
- Configure controller IP in config file of OpenflowSwitch software.
- Install OpenflowSwitch Software on both PCIE-9205s.
- Once the LLDP packet exchanges are done, topology can be observed in ODL DLUX Web Interface.

Test Case 3: L2 Forwarding

1. Create L2 group entry.
2. For supporting L2 forwarding for specific port, configure the following flows.
 - Table 0, Match - Input Port sw0p5, Action - Send to Termination Mac table (Table 20).
 - Table 20, Match - Input Port 5, Action - Goto Table 50.
 - Table 50 bridging table, Match - Dest MAC, Group ID to Send to group table.
For more details see, [Appendix A, Configuring L2 Switching/Forwarding](#).

Test Case 4: L3 Unicast

Configure the following flows:

1. Create L2 group entry.
2. Create L3 group entry.
3. For L3 Unicast, configure the following flows:
 - Table 0, send to Table 20 entry. Table 20, send to Unicast table entry.
 - Table 30 Unicast Table, Match - Destination IP and send to L3 group ID.
For more details see, [Appendix B, Configuring L3 Unicast Route](#).

Test Case 5: L3 ECMP

Configure the following flows:

1. Create 3 L2 group entries.
2. Create 3 L3 group entries.
3. Create L3 ECMP group entry.
4. For L3 ECMP, configure the following flows:
 - Table 0, send to Table 20 entry. Table 20, send to Unicast table entry.
 - Table 30 Unicast Table, Match - Destination IP and send to L3 group ID.
For more details see, [Appendix C, Configuring L3 ECMP Route](#).

Configuring L2 Switching/Forwarding

A.1 Adding Flows to Configure L2 Switching or Forwarding

The following Flows are required to switch L2 packet from Port 6 to Port 5 with VLAN 10 and ethertype 0x8100 (33024).

For example,

OpenFlow Datapath ID is 55400 and Controller IP is 192.168.2.1

- Create L2 Group table Entry for VLAN 10, Port 5

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylight-inventory:nodes/node/openflow:55400/group/655365
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-type>group-indirect</group-type>
  <buckets>
    <bucket>
      <action>
        <output-action>
          <output-node-connector>5</output-node-connector>
        </output-action>
        <order>1</order>
      </action>
      <bucket-id>1</bucket-id>
    </bucket>
  </buckets>
  <barrier>>false</barrier>
  <group-name>l2_0xa0005</group-name>
  <group-id>655365</group-id>
</group>
```

- Flow (0) on Vlan Table (Table ID - 0, Flow ID - 151)

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylight-inventory:nodes/node/openflow:55400/table/0/flow/151
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<flow xmlns="urn:opendaylight:flow:inventory">
  <strict>>true</strict>
```

```
<priority>2</priority>
<match>
<in-port>6</in-port>
<vlan-match>
  <vlan-id>
    <vlan-id>10</vlan-id>
    <vlan-id-present>true</vlan-id-present>
  </vlan-id>
</vlan-match>
<ethernet-match>
  </ethernet-type>
  <type>33024</type>
</ethernet-match>
</match>
<instructions>
  <instruction>
    <order>0</order>
    <go-to-table>
      <table_id>20</table_id>
    </go-to-table>
  </instruction>
</instructions>
<id>151</id>
<table_id>0</table_id>
</flow>
```

- Flow (2) on Termination MAC Table (Table ID - 20, Flow ID - 205610)

```
<flow xmlns="urn:opendaylight:flow:inventory">
  <id>205610</id>
  <instructions>
    <instruction>
      <order>0</order>
      <go-to-table>
        <table_id>50</table_id>
      </go-to-table>
```



```

        </instruction>
    </instructions>
    <priority>2</priority>
    <table_id>20</table_id>
    <match>
        <in-port>6</in-port>
        <vlan-match>
            <vlan-id>
                <vlan-id-present>true</vlan-id-present>
                <vlan-id>10</vlan-id>
            </vlan-id>
        </vlan-match>
        <ethernet-match>
            <ethernet-type>
                <type>33024</type>
            </ethernet-type>
        </ethernet-match>
    </match>
    <strict>true</strict>
</flow>

```

- Flow 3 on Bridging table (Table ID - 50, Flow ID - 152) to send packet to group ID - 655365 (VLAN 10, Port 6) if the Destination MAC is 00:22:33:44:55:66

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylight-inventory:nodes/node/openflow:55400/table/50/flow/152
```

Body:

```

<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<flow xmlns="urn:opendaylight:flow:inventory">
<strict>true</strict>
    <priority>1</priority>
    <match>
        <vlan-match>

```

```
<vlan-id>
  <vlan-id>10</vlan-id>
  <vlan-id-present>true</vlan-id-present>
</vlan-id>
</vlan-match>
<ethernet-match>
  <ethernet-destination>
    <address>00:22:33:44:55:66</address>
  </ethernet-destination>
</ethernet-match>
</match>
<instructions>
  <instruction>
    <order>0</order>
    <apply-actions>
      <action>
        <order>0</order>
        <group-action>
          <group-id>655365</group-id>
        </group-action>
      </action>
    </apply-actions>
  </instruction>
</instructions>
<id>152</id>
<table_id>50</table_id>
</flow>
```

Configuring L3 Unicast Route

B.1 Adding Flows to Configure L3 Unicast Route

The following Flows are required to route packets from Port 6 to Port 5 with Destination IP 1.1.1.1/24 and Destination MAC as switch MAC.

For example,

OpenFlow Datapath ID is 55400 and Controller IP is 192.168.2.1

The following is the configuration of Headers on Postman (Rest API based application).

Headers:

Authorization: Basic

Accept: application/xml

Content-type: application/xml

- Create L2 Group table Entry for VLAN 10, Port 5

PUT:

```
http://192.168.2.1:8181/restconf/config/.opendaylight-
inventory:nodes/node/openflow:55400/group/655365
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-type>group-indirect</group-type>
  <buckets>
    <bucket>
      <action>
        <output-action>
          <output-node-connector>5</output-node-connector>
        </output-action>
        <order>1</order>
      </action>
      <bucket-id>1</bucket-id>
    </bucket>
  </buckets>
  <barrier>>false</barrier>
  <group-name>l2_0xa0005</group-name>
  <group-id>655365</group-id>
```

```
</group>
```

- L3 Group Entry Creation (L3 group type & Index) - Set Destination MAC and send to L2 group ID for port 5 VLAN 10

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylight-inventory:nodes/node/openflow:55400/group/587654321
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-type>group-indirect</group-type>
  <buckets>
    <bucket>
      <action>
        <order>0</order>
        <group-action>
          <group-id>655365</group-id>
        </group-action>
      </action>
      <action>
        <order>1</order>
        <set-field>
          <ethernet-match>
            <ethernet-destination>
              <address>00:00:00:11:11:11</address>
            </ethernet-destination>
          </ethernet-match>
        </set-field>
      </action>
    </bucket>
  </buckets>
  <barrier>false</barrier>
  <group-name>l3_0x2306e4b1</group-name>
  <group-id>587654321</group-id>
</group>
```

- Flow on Vlan Table (Table ID - 0, Flow ID - 300), Send coming to Port 5 to Table 20(Termination MAC Table)

PUT:

http://192.168.2.1:8181/restconf/config/opendaylight-inventory:nodes/node/openflow:55400/table/0/flow/300

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<flow xmlns="urn:opendaylight:flow:inventory">
  <id>0</id>
  <flow>
    <id>300</id>
    <instructions>
      <instruction>
        <order>0</order>
        <go-to-table>
          <table_id>20</table_id>
        </go-to-table>
      </instruction>
    </instructions>
    <priority>1</priority>
  <table_id>0</table_id>
  <match>
    <in-port>6</in-port>
    <vlan-match>
      <vlan-id>
        <vlan-id-present>true</vlan-id-present>
        <vlan-id>10</vlan-id>
      </vlan-id>
    </vlan-match>
  </match>
  <strict>true</strict>
</flow>
```

- Flow on Unicast table (Table ID - 30, Flow ID - 301) to send packet to group ID - 587654321 (L3 Group Entry) if the IP is 1.1.1.1/24

PUT:

http://192.168.2.1:8181/restconf/config/opendaylight-inventory:nodes/node/openflow:55930/table/30/flow/301

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<flow xmlns="urn:opendaylight:flow:inventory">
  <hard-timeout>0</hard-timeout>
```

```
<idle-timeout>0</idle-timeout>
<priority>2</priority>
<flow-name>flow1</flow-name>
<match>
  <ethernet-match>
    <ethernet-type>
      <type>2048</type>
    </ethernet-type>
  </ethernet-match>
  <ipv4-destination>1.1.1.1/24</ipv4-destination>
</match>
<instructions>
  <instruction>
    <order>0</order>
    <write-actions>
      <action>
        <order>0</order>
        <group-action>
          <group-id>587654321</group-id>
        </group-action>
      </action>
    </write-actions>
  </instruction>
</instructions>
<id>301</id>
<table_id>30</table_id>
</flow>
```

- Flow 2 -- Termination MAC Table Flow Entry

```

<flow xmlns="urn:opendaylight:flow:inventory">
  <id>2030610</id>
    <instructions>
      <instruction>
        <order>0</order>
        <go-to-table>
          <table_id>30</table_id>
        </go-to-table>
      </instruction>
    </instructions>
    <priority>2</priority>
  <table_id>20</table_id>
  <match>
    <in-port>6</in-port>
    <vlan-match>
      <vlan-id>
        <vlan-id-present>true</vlan-id-present>
        <vlan-id>10</vlan-id>
      </vlan-id>
    </vlan-match>
    <ethernet-match>
      <ethernet-destination>
        <address>02:4C:D4:1A:00:01</address>
      </ethernet-destination>
      <ethernet-type>
        <type>33024</type>
      </ethernet-type>
    </ethernet-match>
  </match>
  <strict>true</strict>
</flow>

```


Configuring L3 ECMP Route

C.1 Adding Flows to Configure L3 ECMP Route

The following Flows are required to load balance L3 packets from 5 to Ports (6,7 and 8) with Destination IP 3.3.3.0/24 and Destination MAC as switch MAC.

For example,

OpenFlow Data Path ID is 55400 and Controller IP is 192.168.2.1.

The following is the configuration of Headers on Postman (Rest API based application)

Headers:

Authorization: Basic

Accept: application/xml

Content-type: application/xml

- Create L2 Group table Entry for VLAN 10, Port 6

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/655366
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>655366</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>0xa0006</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>1</order>
        <output-action>
          <output-node-connector>6</output-node-connector>
        </output-action>
      </action>
    </bucket>
  </buckets>
</group>
```

- Create L2 Group table Entry for VLAN 10, Port 7

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/655367
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>655367</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>0xa0007</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>1</order>
        <output-action>
          <output-node-connector>7</output-node-connector>
        </output-action>
      </action>
    </bucket>
  </buckets>
</group>
```

- Create L2 Group table Entry for VLAN 10, Port 8

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/655368
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>655368</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>0xa0008</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>1</order>
        <output-action>
          <output-node-connector>8</output-node-connector>
        </output-action>
      </action>
    </bucket>
  </buckets>
</group>
```

```

    </buckets>
</group>

```

- L3 Group Entry Creation (L3 group type & Index) - Set Destination MAC and send to L2 group ID for port 6 VLAN 10

PUT:

```

http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/537526278

```

Body:

```

<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>537526278</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>l3_0x200a0006</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>0</order>
        <group-action>
          <group-id>655366</group-id>
        </group-action>
      </action>
      <action>
        <order>1</order>
        <set-field>
          <ethernet-match>
            <ethernet-destination>
              <address>00:00:00:00:00:64</address>
            </ethernet-destination>
          </ethernet-match>
        </set-field>
      </action>
    </bucket>
  </buckets>
</group>

```

- L3 Group Entry Creation (L3 group type & Index) - Set Destination MAC and send to L2 group ID for port 7 VLAN 10

PUT:

```

http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/537526279

```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>537526279</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>l3_0x200a0007</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>0</order>
        <group-action>
          <group-id>655367</group-id>
        </group-action>
      </action>
      <action>
        <order>1</order>
        <set-field>
          <ethernet-match>
            <ethernet-destination>
              <address>00:00:00:00:00:65</address>
            </ethernet-destination>
          </ethernet-match>
        </set-field>
      </action>
    </bucket>
  </buckets>
</group>
```

- L3 Group Entry Creation (L3 group type & Index) - Set Destination MAC and send to L2 group ID for port 8 VLAN 10

PUT:

<http://192.168.2.1:8181/restconf/config/opendaylightinventory:nodes/node/openflow:55400/group/537526280>

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>537526280</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>l3_0x200a0008</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
```

```

        <action>
            <order>0</order>
            <group-action>
                <group-id>655368</group-id>
            </group-action>
        </action>
        <action>
            <order>1</order>
            <set-field>
                <ethernet-match>
                    <ethernet-destination>
                        <address>00:00:00:00:00:66</address>
                    </ethernet-destination>
                </ethernet-match>
            </set-field>
        </action>
    </bucket>
</buckets>
</group>

```

- ECMP L3 Group Entry Creation (ECMP group type & Index) - Set Group Action as Multiple L3 group entries with different bucket id

PUT:

<http://192.168.2.1:8181/restconf/config/opendaylightinventory:nodes/node/openflow:55400/group/1879048213>

Body:

```

<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>1879048213</group-id>
  <group-type>group-select</group-type>
  <barrier>>false</barrier>
  <group-name>ecmp_0x10001</group-name>
  <buckets>
    <bucket>
      <bucket-id>3</bucket-id>
      <action>
        <order>0</order>
        <group-action>
          <group-id>537526280</group-id>
        </group-action>
      </action>
    </bucket>
    <bucket>
      <bucket-id>2</bucket-id>

```

```
        <action>
          <order>0</order>
          <group-action>
            <group-id>537526279</group-id>
          </group-action>
        </action>
      </bucket>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>0</order>
        <group-action>
          <group-id>537526278</group-id>
        </group-action>
      </action>
    </bucket>
  </buckets>
</group>
```

- Flow on Vlan Table (Table ID - 0, Flow ID - 1020510), Send coming to Port 5 to Table 20(Termination MAC Table)

PUT:

http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/table/0/flow/1020510

Body:

```
<flow xmlns="urn:opendaylight:flow:inventory">
  <table_id>0</table_id>
  <id>1020510</id>
  <instructions>
    <instruction>
      <order>0</order>
      <go-to-table>
        <table_id>20</table_id>
      </go-to-table>
    </instruction>
  </instructions>
  <priority>10</priority>
  <match>
    <in-port>5</in-port>
    <vlan-match>
      <vlan-id>
        <vlan-id-present>true</vlan-id-present>
        <vlan-id>10</vlan-id>
      </vlan-id>
    </vlan-match>
  </match>
</flow>
```

```

        </vlan-match>
    </match>
    <strict>true</strict>
</flow>

```

- Flow on Termination MAC Table (Table ID - 20, Flow ID - 2030510), Send coming to Port 5 vlan 10 packets to Table 30(Unicast Table)

PUT:

```

http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/table/20/flow/2030510

```

Body:

```

<flow xmlns="urn:opendaylight:flow:inventory">
    <table_id>20</table_id>
    <id>2030510</id>
    <instructions>
        <instruction>
            <order>0</order>
            <go-to-table>
                <table_id>30</table_id>
            </go-to-table>
        </instruction>
    </instructions>
    <priority>10</priority>
    <match>
        <in-port>5</in-port>
        <vlan-match>
            <vlan-id>
                <vlan-id-present>true</vlan-id-present>
                <vlan-id>10</vlan-id>
            </vlan-id>
        </vlan-match>
        <ethernet-match>
            <ethernet-destination>
                <address>02:4C:D4:1A:00:01</address>
            </ethernet-destination>
            <ethernet-type>
                <type>33024</type>
            </ethernet-type>
        </ethernet-match>
    </match>
    <strict>true</strict>
</flow>

```

- Flow on Unicast table (Table ID - 30, Flow ID - 30021) to send packet to group ID - 1879048213 (L3 ECMP Group Entry) if the IP is 3.3.3.0/24

PUT:

http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55930/table/30/flow/30021

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<flow xmlns="urn:opendaylight:flow:inventory">
  <table_id>30</table_id>
  <id>30021</id>
  <instructions>
    <instruction>
      <order>0</order>
      <write-actions>
        <action>
          <order>0</order>
          <group-action>
            <group-id>1879048213</group-id>
          </group-action>
        </action>
      </write-actions>
    </instruction>
  </instructions>
  <flow-name>flow1</flow-name>
  <match>
    <ethernet-match>
      <ethernet-type>
        <type>2048</type>
      </ethernet-type>
    </ethernet-match>
    <ipv4-destination>3.3.3.0/24</ipv4-destination>
  </match>
  <hard-timeout>0</hard-timeout>
  <priority>2</priority>
  <idle-timeout>0</idle-timeout>
</flow>
```


Configuring L2 Multicast Forwarding

D.1 Adding Flows to Configure L2 Multicast Forwarding to VF Ports

The following flows are required for the L2 multicast forwarding from port 5 to the VF ports with multicast destination MAC address 01:00:5e:01:02:03 and the corresponding multicast destination IP 233.1.2.3/32 (ODL accepts L3 only).

VF ports Multicast configuration from host

In this scenario, we are using the VF ports of PF p3p1 of SharpSwitch PCIE-9205. We are creating four VFs: p3p1_0, p3p1_1, p3p1_2, and p3p1_3, along with VLAN 10 on these VFs.

Add link from the VF interface to the VLAN on that VF interface.

```
ip link add link <VF_IFACE> name <VF_IFACE.10> type vlan id 10
```

For example, `ip link add link p3p1_0 name p3p1_0.10 type vlan id 10`

Create multicast group on these VFs.

```
ip maddr add <Multicast DMAC> dev <VF_IFACE>
```

For example, `ip maddr add 01:00:5e:01:02:03 dev p3p1_0`

Verify the multicast group entry.

```
ip maddr show p3p1_0
```

Multicast flows configuration from ODL

To create flows for the OpenFlow data path ID 55400 and controller IP 192.168.2.1, configure the headers on Postman (REST API based application) as:

Authorization: Basic

Accept: application/xml

Content-type: application/xml

L2 Group

To send packets to VFs, you should create the corresponding PF to PEP port L2 group entry. In this case, as the PF is p3p1, the corresponding PEP port is 24.

- Create L2 Group table entry for VLAN 10, Port 24

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/655384
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>655384</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>0xa0018</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>1</order>
        <output-action>
          <output-node-connector>24</output-node-connector>
        </output-action>
      </action>
    </bucket>
  </buckets>
</group>
```

Multicast Group

- For the L2 multicast group entry creation, set the Group Action as Single/Multiple L2 group entries with a different bucket id.

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/1610612760
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>1610612760</group-id>
  <group-type>group-all</group-type>
  <barrier>>false</barrier>
  <group-name>0x60000000</group-name>
  <buckets>
```

```

    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>0</order>
        <group-action>
          <group-id>655384</group-id>
        </group-action>
      </action>
    </bucket>
  </buckets>
</group>

```

- Flow entry on the VLAN table (Table ID=0, Flow ID=1020510), Ingress port 5 to Table 20 (termination on MAC table).

PUT:

`http://192.168.2.1:8181/restconf/config/opendaylightinventory:nodes/node/openflow:55400/table/0/flow/1020510`

Body:

```

<flow xmlns="urn:opendaylight:flow:inventory">
  <table_id>0</table_id>
  <id>1020510</id>
  <instructions>
    <instruction>
      <order>0</order>
      <go-to-table>
        <table_id>20</table_id>
      </go-to-table>
    </instruction>
  </instructions>
  <priority>10</priority>
  <match>
    <in-port>5</in-port>
    <vlan-match>
      <vlan-id>
        <vlan-id-present>true</vlan-id-present>
        <vlan-id>10</vlan-id>
      </vlan-id>
    </vlan-match>
  </match>
  <strict>true</strict>
</flow>

```

- Flow entry on the termination MAC table (Table ID=20, Flow ID=2040510), Ingress port 5 VLAN 10 packets to Table 40 (multicast flow table).

PUT:

http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/table/20/flow/2040510

Body:

```
<flow xmlns="urn:opendaylight:flow:inventory">
  <table_id>20</table_id>
  <id>2040510</id>
  <instructions>
    <instruction>
      <order>0</order>
      <go-to-table>
        <table_id>40</table_id>
      </go-to-table>
    </instruction>
  </instructions>
  <priority>10</priority>
  <match>
    <in-port>5</in-port>
    <vlan-match>
      <vlan-id>
        <vlan-id-present>true</vlan-id-present>
        <vlan-id>10</vlan-id>
      </vlan-id>
    </vlan-match>
    <ethernet-match>
      <ethernet-destination>
        <address>01:00:5e:01:02:03</address>
      </ethernet-destination>
      <ethernet-type>
        <type>33024</type>
      </ethernet-type>
    </ethernet-match>
  </match>
  <strict>true</strict>
</flow>
```

- Flow entry on the multicast flow table (Table ID=40, Flow ID=40024), to send packet to group ID=1610612760 (multicast group) with the DST IP=233.1.2.3/32.

PUT:

http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55930/table/40/flow/40024

Body:

```

<flow xmlns="urn:opendaylight:flow:inventory">
  <table_id>40</table_id>
  <id>40024</id>
  <instructions>
    <instruction>
      <order>0</order>
      <write-actions>
        <action>
          <order>0</order>
          <group-action>
            <group-id>1610612760</group-id>
          </group-action>
        </action>
      </write-actions>
    </instruction>
  </instructions>
  <priority>2</priority>
  <table_id>40</table_id>
  <match>
    <vlan-match>
      <vlan-id>
        <vlan-id-present>>true</vlan-id-present>
        <vlan-id>10</vlan-id>
      </vlan-id>
    </vlan-match>
    <ethernet-match>
      <ethernet-type>
        <type>2048</type>
      </ethernet-type>
    </ethernet-match>
    <ipv4-destination>233.1.2.3/32</ipv4-destination>
  </match>
  <strict>>true</strict>
</flow>

```

D.2 Adding Flows to Configure L2 Multicast Forwarding to EPL, PF, and VF Ports

The following flows are required for the L2 multicast forwarding from port 5 to the EPL (port 6 and 7), PF (p3p1), and VF ports with the multicast destination MAC address 01:00:5e:01:02:03 and the corresponding multicast destination IP 233.1.2.3/32 (ODL accepts L3 only).

PF/VF ports Multicast configuration from host

In this scenario, we are using the VF ports of PF p3p1 of SharpSwitch PCIE-9205. We are creating four VFs: p3p1_0, p3p1_1, p3p1_2, and p3p1_3, along with VLAN 10 on these VFs.

Add link from the PF interface to the VLAN on the PF interface.

```
ip link add link <PF/VF_IFACE> name <PF/VF_IFACE.10> type vlan id 10
```

For example, use the following command to add VLAN on the PF interface:

```
ip link add link p3p1 name p3p1.10 type vlan id 10
```

Create multicast group on these PF/VFs.

```
ip maddr add <Multicast DMAC> dev <PF/VF_IFACE>
```

For example, use the following command to add PF on multicast group:

```
ip maddr add 01:00:5e:01:02:03 dev p3p1
```

Verify the multicast group entry.

```
ip maddr show p3p1
```

Multicast flows configuration from ODL

To create flows for OpenFlow data path ID 55400 and controller IP 192.168.2.1, configure the headers on Postman (REST API based application) as:

Authorization: Basic

Accept: application/xml

Content-type: application/xml

L2 Group for EPL

To send packets to EPL, you should create the corresponding EPL port L2 group entry. In this case, the EPL ports are 6 and 7.

- Create L2 Group table entry for VLAN 10, port 6.

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylightinventory:
```

nodes/node/openflow:55400/group/655366

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>655366</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>0xa0006</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>1</order>
        <output-action>
          <output-node-connector>6</output-node-connector>
        </output-action>
      </action>
    </bucket>
  </buckets>
</group>
```

- Create L2 Group table entry for VLAN 10, Port 7

PUT:

http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/655367

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>655367</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>0xa0007</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>1</order>
        <output-action>
          <output-node-connector>7</output-node-connector>
        </output-action>
      </action>
    </bucket>
  </buckets>
```

```
</group>
```

L2 Group for PF/VF

To send packets to VFs, you should create the corresponding PF to PEP port L2 group entry. In this case, as the PF is p3p1, the corresponding PEP port is 24.

- Create L2 Group table entry for VLAN 10, Port 24

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/655384
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>655384</group-id>
  <group-type>group-indirect</group-type>
  <barrier>>false</barrier>
  <group-name>0xa0018</group-name>
  <buckets>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>1</order>
        <output-action>
          <output-node-connector>24</output-node-connector>
        </output-action>
      </action>
    </bucket>
  </buckets>
</group>
```

Multicast Group

- For the L2 multicast group entry creation, set the Group Action as Single/Multiple L2 group entries with different bucket id: EPL (port 6 and 7) and PF (port p3p1) port L2 groups.

PUT:

```
http://192.168.2.1:8181/restconf/config/opendaylightinventory:
nodes/node/openflow:55400/group/1610612773
```

Body:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
```



```
<group xmlns="urn:opendaylight:flow:inventory">
  <group-id>1610612773</group-id>
  <group-type>group-all</group-type>
  <barrier>>false</barrier>
  <group-name>0x60000000</group-name>
  <buckets>
    <bucket>
      <bucket-id>3</bucket-id>
      <action>
        <order>0</order>
        <group-action>
          <group-id>655384</group-id>
        </group-action>
      </action>
    </bucket>
    <bucket>
      <bucket-id>2</bucket-id>
      <action>
        <order>0</order>
        <group-action>
          <group-id>655367</group-id>
        </group-action>
      </action>
    </bucket>
    <bucket>
      <bucket-id>1</bucket-id>
      <action>
        <order>0</order>
        <group-action>
          <group-id>655366</group-id>
        </group-action>
      </action>
    </bucket>
  </buckets>
</group>
```

- Flow entry on the VLAN table (Table ID=0, Flow ID=1020510), Ingress port 5 to Table 20 (termination on MAC table).

PUT:

<http://192.168.2.1:8181/restconf/config/opendaylightinventory:nodes/node/openflow:55400/table/0/flow/1020510>

Body:

```
<flow xmlns="urn:opendaylight:flow:inventory">
```

```
<table_id>0</table_id>
<id>1020510</id>
<instructions>
  <instruction>
    <order>0</order>
    <go-to-table>
      <table_id>20</table_id>
    </go-to-table>
  </instruction>
</instructions>
<priority>10</priority>
<match>
  <in-port>5</in-port>
  <vlan-match>
    <vlan-id>
      <vlan-id-present>true</vlan-id-present>
      <vlan-id>10</vlan-id>
    </vlan-id>
  </vlan-match>
</match>
<strict>true</strict>
</flow>
```

- Flow entry on the termination MAC table (Table ID=20, Flow ID=2040510), Ingress port 5 VLAN 10 packets to Table 40 (multicast flow table).

PUT:

<http://192.168.2.1:8181/restconf/config/opendaylightinventory:nodes/node/openflow:55400/table/20/flow/2040510>

Body:

```
<flow xmlns="urn:opendaylight:flow:inventory">
  <table_id>20</table_id>
  <id>2040510</id>
  <instructions>
    <instruction>
      <order>0</order>
      <go-to-table>
        <table_id>40</table_id>
      </go-to-table>
    </instruction>
  </instructions>
  <priority>10</priority>
  <match>
    <in-port>5</in-port>
    <vlan-match>
      <vlan-id>
```

```

                <vlan-id-present>true</vlan-id-present>
                <vlan-id>10</vlan-id>
            </vlan-id>
        </vlan-match>
    <ethernet-match>
        <ethernet-destination>
            <address>01:00:5e:01:02:03</address>
        </ethernet-destination>
        <ethernet-type>
            <type>33024</type>
        </ethernet-type>
    </ethernet-match>
</match>
<strict>true</strict>
</flow>

```

- Flow entry on the multicast flow table (Table ID=40, Flow ID=40024), to send packet to group ID=1610612773 (multicast group) with the DST IP=233.1.2.3/32.

PUT:

<http://192.168.2.1:8181/restconf/config/opendaylightinventory:nodes/node/openflow:55930/table/40/flow/40037>

Body:

```

<flow xmlns="urn:opendaylight:flow:inventory">
    <table_id>40</table_id>
    <id>40037</id>
    <instructions>
        <instruction>
            <order>0</order>
            <write-actions>
                <action>
                    <order>0</order>
                    <group-action>
                        <group-id>1610612773</group-id>
                    </group-action>
                </action>
            </write-actions>
        </instruction>
    </instructions>
    <priority>2</priority>
    <table_id>40</table_id>
    <match>
        <vlan-match>
            <vlan-id>
                <vlan-id-present>true</vlan-id-present>
                <vlan-id>10</vlan-id>
            </vlan-id>
        </vlan-match>
    </match>
</flow>

```

```
        </vlan-id>
    </vlan-match>
    <ethernet-match>
        <ethernet-type>
            <type>2048</type>
        </ethernet-type>
    </ethernet-match>
    <ipv4-destination>233.1.2.3/32</ipv4-destination>
</match>
<strict>>true</strict>
</flow>
```

Related Documentation

E.1 Artesyn Embedded Technologies - Embedded Computing Documentation

The publications listed below are referenced in this manual. You can obtain electronic copies of Artesyn Embedded Technologies - Embedded Computing publications by contacting your local Artesyn sales office. For released products, you can also visit our Web site for the latest copies of our product documentation.

1. Go to www.artesyn.com/computing.
2. Under SUPPORT, click **TECHNICAL DOCUMENTATION**.
3. Under FILTER OPTIONS, click the Document types drop-down list box to select the type of document you are looking for.
4. In the **Search** text box, type the product name and click GO.

Table E-1 Artesyn Embedded Technologies - Embedded Computing Publications

Document Title	Publication Number
Switch Software for SharpSwitch PCIE-9205 CLI Guide	6806800T85
SharpSwitch PCIE-9205 Quick Start Guide	6806800U04



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