CUMULUS LINUX TRAINING: LAB GUIDE

Scope

This workbook covers configuration of network protocols on Cumulus Linux Network Operating System.

Audience

This workbook is intended for Technical Training students.

Objectives

By the end of this workbook, students will be able to:

* Configure basic switch functions with Cumulus Linux
* Configure layer 2 and layer 3 protocols with Cumulus Linux
* Verify configuration and connectivity
* Monitor and troubleshoot networking related connectivity issues

Overview

Each student will be using the Cumulus Air © platform, exercises in this workbook on a group of devices (servers and switches).

Notice

Please follow the instructions below carefully to successfully complete the practice.   
If you encounter technical issues, please contact the Nvidia Networking Academy team: [nbu-academy-support@nvidia.com](mailto:nbu-academy-support@nvidia.com)

**Release Date**

Revision 1.6 – September 2020

Good Luck,   
Nvidia Networking Academy team

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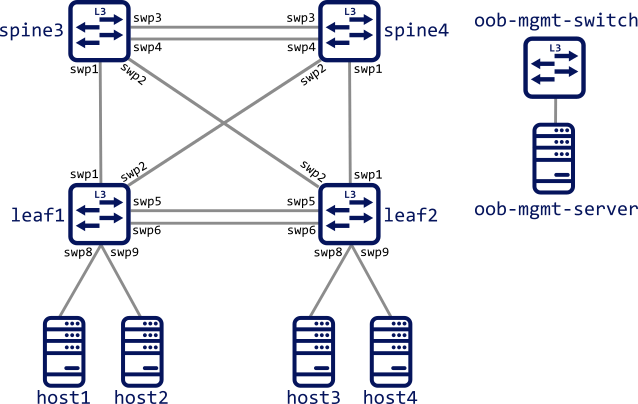
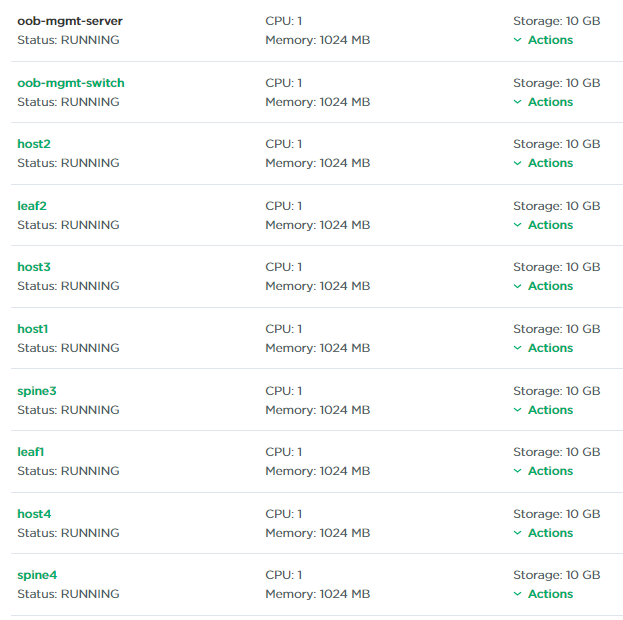
# PREREQUISITES AND GUIDELINES

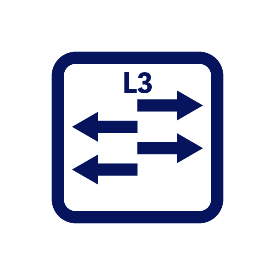
Please perform and review the following steps before you start:

1. Enter the Cumulus Air web page, and click the “GET STARTED” button.  
   <https://air.cumulusnetworks.com/Login>  
   If you are already signed in, use your credentials to login.  
   to sign up for the first time, click “[Register](https://cumulusnetworks.com/accounts/signup/?next=%2Fo%2Fauthorize%2F%3Fresponse_type%3Dcode%26client_id%3DwpKSSeVpV57LaxXIcaTLpohbh3HlLNF5YeQBKkBv%26state%3D6348283%26redirect_uri%3Dhttps%253A%252F%252Fair.cumulusnetworks.com%252Fhome)” and fill out your details.  
   Once completed, a confirmation email will be sent, open it to activate your new account.
2. Once you are logged in, you will reach the “Cumulus In The Cloud” dashboard.  
   Click on the “Academy ILT” label, and wait for the switches and servers to reload.
3. Wait for the devices to load and follow the instructions in this lab manual.

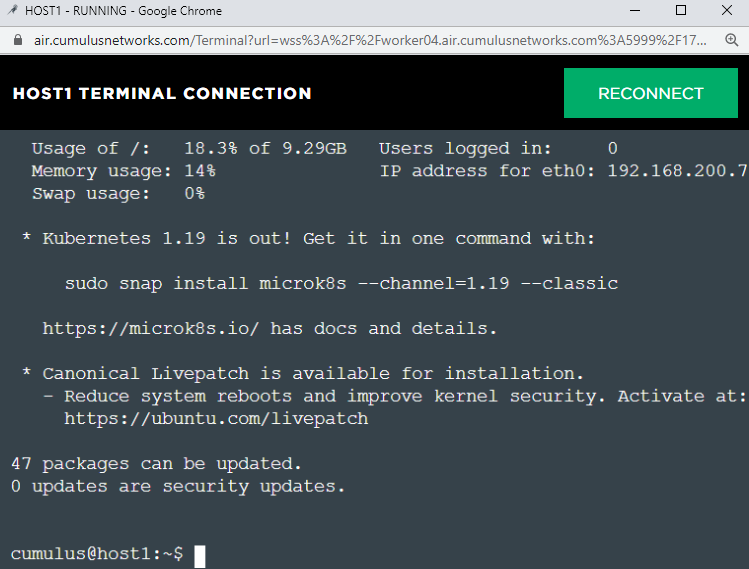


## CUMULUS AIR SERVERS AND SWITCHES ACCESS

1. The training Lab is organized in the following topology:
2. To log in to a device, first make sure it’s running, then connect to it by either clicking its name on the NODES panel or it’s icon on the diagram



1. When the login prompt appears, enter the default Cumulus Linux username – “**cumulus**”
2. When the password prompt appears, enter the default Cumulus Linux   
   password– “**CumulusLinux!**” and press Enter.
3. You should now be prompted with the server name. This indicates that you have successfully accessed the server/switch.



## PRACTICE 1: USING THE NCLU

Practice objectives:

In this practice session you will become familiar with the Cumulus Linux NCLU

* You will use ‘**net add**’ and ‘**net del**’ commands to change the configuration
* You will use ‘**net commit**’ command to apply configuration changes
* You will use ‘**net show**’ commands to validate the configuration
* Last, you will use ‘**net rollback**’ command to roll back to a   
  previous configuration

Task 1: Retrieve system information

1. Identify the switch platform and image:
2. **system**

cumulus@leaf1:~$ **net show system**

Hostname......... leaf1

**Build**............ **Cumulus Linux** 3.7.12

Uptime........... 12:53:54.640000

**Model**............ **Cumulus VX**

Memory........... 929MBVendor **Name**...... **Cumulus Networks**

Part Number...... 3.7.12

Base MAC Address. 44:38:39:00:00:1E

Serial Number.... 44:38:39:00:00:1e

Product Name..... VX

Task 2: Change the configuration with NCLU

1. Access the switch that was assigned to you and reset configuration:

**# net del all**

**# net commit**

cumulus@leaf1:~$ net del all

cumulus@leaf1:~$ net commit

1. Bring up the switch ports:

**# net add interface swp1-16**

cumulus@leaf1:~$ net add interface swp1-16

cumulus@leaf1:~$ net commit

1. Add an alias to each of the interfaces which are part of the lab topology. The alias should describe the device which is connected to the interface.   
   For example, on switch leaf1 named leaf1:

* Interface swp8 is connected to server host1
* Interface swp1 is connected to switch spine3

**# net add interface <INTERFACE> alias <TEXT>**

cumulus@leaf1:~$ net add interface swp8 alias Connected to host1:Eth2

cumulus@leaf1:~$ net add interface swp1 alias Connected to spine3:swp1

1. View the changes in the commit buffer:

**# net pending**

cumulus@leaf1:~$ net pending

--- /etc/network/interfaces 2018-03-25 12:07:38.286992779 +0000

+++ /var/run/nclu/iface/interfaces.tmp 2018-03-25 13:37:54.614290080 +0000

@@ -6,35 +6,37 @@

*<output omitted>*

auto swp1

iface swp1

**+ alias Connected to spine3:swp1**

*<output omitted>*

1. Commit the changes with a custom description:

**# net commit description <TEXT>**

cumulus@leaf1:~$ net commit **description Practice-1**

*<output omitted>*

auto swp1

iface swp1

+ alias Connected to spine3b:swp1

*<output omitted>*

net add/del commands since the last 'net commit'

================================================

User Timestamp Command

------- -------------------------- -----------------------------------------

cumulus 2018-03-25 13:36:26.822328 net add interface swp8 alias Connected to host1:Eth2

cumulus 2018-03-25 13:36:42.782146 net add interface swp1 alias Connected to spine3:swp1

cumulus 2018-03-25 14:27:52.833075 net commit **description Practice-1**

Task 3: Rollback the configuration

1. View the NCLU commit history:  
   **# net show commit history**

cumulus@leaf1:~$ net show commit history

# Date Description

--- ------------------------------- --------------------------------

166 Mon 02 Apr 2018 08:11:40 AM UTC nclu 'net commit' (user cumulus)

168 Mon 02 Apr 2018 08:13:38 AM UTC nclu 'net commit' (user cumulus)

**170 Mon 02 Apr 2018 08:14:26 AM UTC nclu Practice-1**

1. Rollback to the last commit:  
   **# net rollback last**

cumulus@leaf1:~$ net rollback last

1. Verify rollback was applied successfully:  
   **# net show configuration**

cumulus@leaf1:~$ net show configuration

<output omitted>

interface swp1

interface swp8

\*\* Please note:

* At this point all configuration is deleted because the configuration has been reverted to a point before any configuration existed.
* Alternatively, you can roll back to any commit by referencing the unique commit number or description.

## PRACTICE 2: BASIC SWITCH FUNCTIONS

Practice objectives:

In this practice session you will verify IP connectivity between servers in the lab.

* You will configure the servers IP settings – an IP address, a subnet mask and a default gateway.
* You will configure a bridge on each of the Cumulus Linux switches in your group, and add switch ports to the bridge.
* You will use ‘**ping’** utility to verify communication between servers in your group.
* Last, you will observe how the switch forwarding database – the MAC address table – is built and maintained.

A close up of a sign

Description automatically generatedA close up of a sign

Description automatically generatedTopology used in this practice:

spine4

spine3

A picture containing monitor, phone

Description automatically generatedA picture containing monitor, phone

Description automatically generatedA picture containing monitor, phone

Description automatically generatedA picture containing monitor, phone

Description automatically generatedA close up of a sign

Description automatically generatedA close up of a sign

Description automatically generated

**swp1**  
**trunk**

**swp1**  
**trunk**

**swp2**  
**trunk**

**Eth2**

**Eth2**

**Eth2**

**Eth2**

leaf1

leaf2

**swp8**  
**access**

**swp9**  
**access**

**swp8**  
**access**

**swp9**  
**access**

**swp2**  
**trunk**

**172.16.1.X**

**172.16.1.X**

**172.16.1.X**

**172.16.1.X**

Task 1: Configure servers hostname and IP settings

1. Access the server that was assigned to you and check IP settings of interface **’eth2’**:

**# ifconfig <dev>**

cumulus@ubuntu:~**$ ifconfig eth2**

eth2: flags=4098<BROADCAST,MULTICAST> mtu 1500

ether 44:38:39:00:00:11 txqueuelen 1000 (Ethernet)

RX packets 0 bytes 0 (0.0 B)

RX errors 0 dropped 0 overruns 0 frame 0

TX packets 0 bytes 0 (0.0 B)

TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

1. Configure server hostname, IP address and a subnet mask for interface **’eth2’***.*  
   If the interface's IP address is not as listed in the table below, use the following table for IP address assignment. Use /24 as the subnet mask.

|  |  |
| --- | --- |
| **Practice Lab Servers Properties** | |
| **Server** | **‘eth2’ IP Address** |
| host1 | 172.16.1.1 |
| host2 | 172.16.1.2 |
| host3 | 172.16.1.3 |
| host4 | 172.16.1.4 |

* Clear existing IP configuration:  
  **# ifconfig <dev> 0.0.0.0**
* Configure an IP address and a subnet mask:  
  **# ifconfig <dev> IP/MASK**

cumulus@host1:~$ sudo ifconfig eth2 0.0.0.0

cumulus@host1:~$ sudo ifconfig eth2 172.16.1.1/24

cumulus@host1:~$ ifconfig eth2

eth2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500

inet 172.16.1.1 netmask 255.255.255.0 broadcast 172.16.1.255

inet6 fe80::4638:39ff:fe00:11 prefixlen 64 scopeid 0x20<link>

ether 44:38:39:00:00:11 txqueuelen 1000 (Ethernet)

RX packets 3 bytes 180 (180.0 B)

RX errors 0 dropped 3 overruns 0 frame 0

TX packets 10 bytes 1086 (1.0 KB)

TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0 RX errors 0 dropped 0 overruns 0 frame 0

TX packets 270015 bytes 51701450 (49.3 MiB)

TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

1. Verify a static route entry to 172.16.0.0/16 via interface ’eth2’:

**# route**

cumulus@host1:~$ route

Kernel IP routing table

Destination Gateway Genmask Flags Metric Ref Use Iface

default \_gateway 0.0.0.0 UG 0 0 0 eth0

192.168.200.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0

* If the static route is missing, add it:  
  **# ip route add <ADDRESS/MASK> dev <DEV>**

cumulus@host1:~$ sudo ip route add 172.16.0.0/16 dev eth2

cumulus@host1:~$ route

Kernel IP routing table

Destination Gateway Genmask Flags Metric Ref Use Iface

default \_gateway 0.0.0.0 UG 0 0 0 eth0

**172.16.0.0 0.0.0.0 255.255.0.0 U 0 0 0 eth2**

172.16.1.0 0.0.0.0 255.255.255.0 U 0 0 0 eth2

192.168.200.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0

Task 2: Configure a bridge

1. Access the switch that was assigned to you and reset configuration:

**# net del all**

**# net commit**

cumulus@leaf1:~$ net del all

cumulus@leaf1:~$ net commit

1. Create a bridge and set the inter switch links (swp1 and swp2) as trunk ports:

**# net add bridge bridge ports <PORTS>**

cumulus@leaf1:~$ net add bridge bridge ports swp1-2

1. Set the host-facing ports, swp8 and swp9 on the leaf switches, as access ports in VLAN 1:  
   **# net add interface <PORTS> bridge access <VLAN-ID>**

cumulus@leaf1:~$ net add bridge bridge ports swp8-9

cumulus@leaf1:~$ net add interface swp8-9 bridge access 1

1. Commit changes:  
   **net commit**

cumulus@leaf1:~$ net commit

1. Verify configuration:  
   **net show configuration**

cumulus@leaf1:~$ net show configuration

**interface swp8**

**bridge-access 1**

**interface swp9**

**bridge-access 1**

**interface bridge**

**bridge-ports swp1 swp2 swp8 swp9**

**bridge-vids 1**

**bridge-vlan-aware yes**

1. Verify interfaces status:

**net show interface**

cumulus@leaf1:~$ net show interface

Name Master Speed MTU Mode Remote Host Remote Port Summary

------ ------- ------ ----- ------ ------------ ------------ -------

*<output omitted>*

UP swp1 bridge 100G 1500 Access/L2 spine4 swp1

UP swp2 bridge 100G 1500 Access/L2 spine3 swp2

*<output omitted>*

**UP swp8 bridge 100G 1500 Access/L2 host1 ec:0d:9a:46:9e:b5**

UP swp9 bridge 100G 1500 Access/L2

UP bridge N/A 1500 Bridge/L2

**\*\* Please note:**

* Even though swp1-2 were configured in ‘Trunk’ mode, they are displayed in the output in ‘Access’ mode. The reason is that currently only VLAN 1 is configured and no frames are sent tagged over those ports.   
  Once you configure additional VLANs, those ports will be displayed in ‘Trunk’ mode indicating they are tagging frames.

Task 3: Observe a switch’s forwarding database

1. Identify the MAC addresses of all four servers in your group.

cumulus@host1:~$ ifconfig eth2

eth2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500

inet 172.16.1.1 netmask 255.255.255.0 broadcast 172.16.1.255

inet6 fe80::4638:39ff:fe00:11 prefixlen 64 scopeid 0x20<link>

**ether 44:38:39:00:00:11** txqueuelen 1000 (Ethernet)

RX packets 3 bytes 180 (180.0 B)

RX errors 0 dropped 3 overruns 0 frame 0

TX packets 18 bytes 2371 (2.3 KB)

TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

Fill in the table with the MAC addresses of **’**eth2**’** interfaces of the servers in your group:

|  |  |
| --- | --- |
| Server | MAC address of interface **’**eth2**’** |
|  |  |
|  |  |
|  |  |
|  |  |

1. Use ‘**ping’** from one server to another server in the lab.   
   For example ping from server **host1** to server **host3**.

cumulus@host1:~$ ping 172.16.1.3

PING 172.16.1.6 (172.16.1.6) 56(84) bytes of data.

64 bytes from 172.16.1.6: icmp\_seq=1 ttl=64 time=0.318 ms

64 bytes from 172.16.1.6: icmp\_seq=2 ttl=64 time=0.111 ms

1. Display the switch’s MAC address table. Identify on which switch ports the servers’ MAC addresses were learned?  
   **# net show bridge macs**

cumulus@leaf2:~$ net show bridge macs

VLAN Master Interface MAC TunnelDest State Flags LastSeen

------- ------ ---------- ----------------- ---------- --------- ----- ---------

untagged bridge **swp8 00:8a:07:cf:6a:c4** 00:14:02

untagged bridge **swp9 00:8a:07:cf:6a:e4** 00:14:02

## PRACTICE 3: VLANs AND TRUNKING

Practice objectives:

In this practice session you will configure and verify VLANs and trunking:

* You will configure two new VLANs and assign switch ports connected to servers to the configured VLANs.
* You will configure SVIs to allow inter-VLAN communication.

Topology used in this lab:



**swp1**  
**trunk**

**swp2**  
**trunk**

**swp1**  
**trunk**



leaf1

spine4

spine3

leaf2

**swp8**  
**access**

**swp9**  
**access**

**swp8**  
**access**

**swp9**  
**access**



**VLAN2**

**VLAN3**

**VLAN2**

**VLAN3**

Task 1: Configuring VLANs and trunking

1. Access the switch that was assigned to you and reset configuration:

**# net del all**

**# net commit**

cumulus@leaf1:~$ net del all

cumulus@leaf1:~$ net commit

1. Create a bridge and set the inter switch links, ***swp1*** and ***swp2***, as trunk ports:

**# net add bridge bridge ports <PORTS>**

cumulus@leaf1:~$ net add bridge bridge ports swp1-2

1. Add VLANs 2-3 to the bridge:

cumulus@leaf1:~$ net add bridge bridge vids 2,3

1. Set the host-facing ports, swp8 and swp9 on the leaf switches, as access ports and associates them to the appropriate VLAN: interface **swp8** in **VLAN2** and interface **swp9** in **VLAN3**  
   **# net add interface <PORTS> bridge access <VLAN-ID>**

cumulus@leaf1:~$ net add bridge bridge ports swp8-9

cumulus@leaf1:~$ net add interface swp8 bridge access 2

cumulus@leaf1:~$ net add interface swp9 bridge access 3

1. Commit changes:

cumulus@leaf1:~$ net commit

1. Verify configuration:

cumulus@leaf1:~$ net show configuration

**interface swp8**

**bridge-access 2**

**interface swp9**

**bridge-access 3**

**interface bridge**

**bridge-ports swp1 swp2 swp8 swp9**

**bridge-vids 2-3**

**bridge-vlan-aware yes**

1. Verify VLANs configuration:

**# net show bridge vlan**

cumulus@leaf1:~$ net show bridge vlan

Interface VLAN Flags

----------- ------ ---------------------

swp1 1 PVID, Egress Untagged

2-3

swp2 1 PVID, Egress Untagged

2-3

swp8 2 PVID, Egress Untagged

swp9 3 PVID, Egress Untagged

**\*\* Please note:**

* Access ports are shown with a single line representing the VLAN associated to the port
* Trunk ports are shown with multiple lines representing the VLANs associated with the trunk port

Task 2: Servers’ IP settings

Access the server that was assigned to you, and configure an IP address for interface ‘***eth2’*** according your group’s subnet (see tables below).  
Servers in the same VLAN will be configured with IP addresses in the same subnet, hence they will be able to communicate over the layer 2 network.

|  |  |  |
| --- | --- | --- |
| **VLAN ID** | **Server** | **‘eth2’ IP Address** |
| VLAN 2 | host1 | 172.16.2.18/24 |
| VLAN 3 | host2 | 172.16.3.19/24 |
| VLAN 2 | host3 | 172.16.2.28/24 |
| VLAN 3 | host4 | 172.16.3.29/24 |

1. Configure the server’s IP address and subnet mask:

* Clear existing IP configuration:  
  # ifconfig eth2 0.0.0.0
* Configure an IP address and a subnet mask:

# ifconfig eth2 IP\_ADDRESS/SUBNET\_MASK

* Verify IP configuration:

**# ifconfig eth2**

cumulus@host1:~$ sudo ifconfig eth2 0.0.0.0

cumulus@host1:~$ sudo ifconfig eth2 172.16.2.18/24

cumulus@host1:~$ ifconfig eth2

eth2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500

**inet 172.16.2.18** netmask 255.255.255.0 broadcast 172.16.2.255

inet6 fe80::4638:39ff:fe00:11 prefixlen 64 scopeid 0x20<link>

ether 44:38:39:00:00:11 txqueuelen 1000 (Ethernet)

RX packets 3 bytes 180 (180.0 B)

RX errors 0 dropped 3 overruns 0 frame 0

TX packets 43 bytes 7456 (7.4 KB)

TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

1. Verify a static route entry to network 172.16.0.0/16 via the default gateway’s address. If the entry is missing, add it.

**\*\* Please note:**

* Make sure to use the default gateway address in the following table

|  |  |
| --- | --- |
| **VLAN ID** | **Default gateway address** |
| vlan 2 | 172.16.2.254/24 |
| vlan 3 | 172.16.3.254/24 |

**# ip route add <NET\_ADDRESS/SUBNET\_MASK> dev <DEV> via IP\_ADDRESS**

cumulus@host1:~$ sudo ip route add 172.16.0.0/16 dev eth2 via 172.16.2.254

cumulus@host1:~$ route

Kernel IP routing table

Destination Gateway Genmask Flags Metric Ref Use Iface

default \_gateway 0.0.0.0 UG 0 0 0 eth0

**172.16.0.0 172.16.2.254 255.255.0.0 UG 0 0 0 eth2**

172.16.2.0 0.0.0.0 255.255.255.0 U 0 0 0 eth2

192.168.200.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0

1. Use ‘**ping’** to check communication between servers in the same VLAN.   
   For example server **host1**and **host3**.  
   Task 3: Configuring SVIs for inter-VLAN routing

[cumulus@host1 ~]# ping 172.16.2.28

PING 172.16.2.28 (172.16.2.28) 56(84) bytes of data.

64 bytes from 172.16.2.28: icmp\_seq=1 ttl=64 time=0.147 ms

64 bytes from 172.16.2.28: icmp\_seq=2 ttl=64 time=0.135 ms

1. On switch **spine3** configure two SVIs (Switch VLAN Interfaces) that will be used for routing between VLAN2 and VLAN3:
   * Interface **vlan2** will serve as the default gateway for **VLAN2**
   * Interface **vlan3** will serve as the default gateway for **VLAN3**

Use the following table for IP address assignment:

|  |  |
| --- | --- |
| Interface vlan 2 | 172.16.2.254/24 |
| Interface vlan 3 | 172.16.3.254/24 |

**# net add vlan 2 ip address 172.16.2.254/24**

[cumulus@spine3:~$ net add vlan 2 ip address 172.16.2.254/24

[cumulus@spine3:~$ net add vlan 3 ip address 172.16.3.254/24

[cumulus@spine3:~$ net commit

1. Use ‘**ping’** and ‘**traceroute’** utilities to verify communication between hosts in different VLANs.   
     
   For example, ping from server ‘**host1’** (in VLAN 2) to server ‘**host2’** (in VLAN3).

[cumulus@host1 ~]# traceroute 172.16.3.19

traceroute to 172.16.23.19 (172.16.3.19), 30 hops max, 60 byte packets

1 172.16.2.254 (172.16.2.254) 0.387 ms 0.394 ms 0.535 ms

2 172.16.3.19 (172.16.3.19) 0.155 ms 0.152 ms 0.137

[cumulus@host1 ~]# ping 172.16.3.19

PING 172.16.3.19 (172.16.3.19) 56(84) bytes of data.

64 bytes from 172.16.3.19: icmp\_seq=1 ttl=63 time=0.155 ms

64 bytes from 172.16.23.19: icmp\_seq=2 ttl=63 time=0.192 ms64 bytes from 172.16.23.254: icmp\_seq=2 ttl=64 time=0.362 ms

## PRACTICE 4: CONFIGURING MLAG AND VRR

Practice objectives:

In this practice session you will configure the spine switches, spine3 and spine4, with MLAG and VRR towards the leaf switches.

* MLAG will make the spine switches to look and behave like a single Layer 2 switch towards the Layer 2 network.
* VRR will make the spine switches to look and behave like a single router providing default gateway redundancy***.***
* Interface ‘clag 1*’* will aggregate swp1 on spine3 and swp2 on spine4connected to switch leaf1.   
  Switch leaf1will be configured with a regular LAG.
* Interface ‘clag 2’ will aggregate swp2 on spine3 and swp1 on spine4connected to switch leaf2.   
  Switch leaf2will be configured with a regular LAG.

Topology used in this lab:



**swp1**

**swp1**

**swp2**

**Eth2**

**Eth2**

**Eth2**

**Eth2**

**access  
VLAN2**

**swp2**

**172.16.2.X**

**172.16.3.X**

**172.16.2.X**

**172.16.3.X**

**swp8**

**swp9**

**access  
VLAN3**

**swp8**

**swp9**

**access  
VLAN3**

**access  
VLAN2**

**swp1**

**swp2**

**swp1**

**swp2**

**VRRR**

Task 1: LAG configuration – leaf switches

1. Access the switch that was assigned to you and reset configuration:

**# net del all**

**# net commit**

cumulus@leaf1:~$ net del all

cumulus@leaf1:~$ net commit

1. On the leaf switches **leaf1**and **leaf2:**create a bond named ‘BOND-TO-SPINES’, where bonds slaves are interfaces **swp1** and **swp2**.

**# net add bond <BOND-NAME> bond slaves <INTERFACES>**

cumulus@leaf1:~$ net add bond BOND-TO-SPINES bond slaves swp1-2

1. Verify bonds configuration:

cumulus@leaf1:~$ net show interface bonds

Name Speed MTU Mode Summary

-- -------------- ----- ---- ------- --------------------------------

**DN BOND-TO-SPINES N/A 1500 802.3ad Bond Members: swp1(UP), swp2(UP)**

**\*\* Please note:**

* The bond interface is down because its peer (the MLAG switches) was not configured yet.

1. Create a bridge and add the bond interface, **BOND-TO-SPINES**, and the host facing interfaces, **swp8**and **swp9**, to the bridge:

cumulus@leaf1:~$ net add bridge bridge ports swp8-9,BOND-TO-SPINES

1. Configure VLANs 2-3 and associate **swp*8*** to **VLAN2** and **swp9** to **VLAN3**:

cumulus@leaf1:~$ net add

cumulus@leaf1:~$ net add interface swp8 bridge access 2

cumulus@leaf1:~$ net add interface swp9 bridge access 3

cumulus@leaf1:~$ net commit

**\*\* Please note:**

* Switch **leaf2** should be configured similarly.

Task 2: Configuring MLAG – spine switches

1. Access the switch that was assigned to you and reset configuration:

**# net del all**

**# net commit**

cumulus@spine3:~$ net del all

cumulus@spine3:~$ net commit

* Write down, on a side note, the IP addresses on the switches management ports, **eth0**. Those IP addresses will be configured as the MLAG backup-IPs.

cumulus@spine4:~$ **net show interface eth0**

Name MAC Speed MTU Mode

-- ------ ----------------- ------- ----- ------

UP eth0 ec:0d:9a:38:df:3a 1G 1500 Mgmt

IP Details

------------------------- ----------------

**IP: 10.143.33.188/24**

cumulus@spine3:~$ **net show interface eth0**

Name MAC Speed MTU Mode

-- ------ ----------------- ------- ----- ------

UP eth0 ec:0d:9a:38:dd:72 1G 1500 Mgmt

IP Details

------------------------- ----------------

**IP: 10.143.33.187/24**

1. Configure the spine switches, **spine3** and **spine4**, as MLAG peers.

# net add clag peer \

sys-mac <MAC> \

interface <PEERLINK-INTERFACES> \

<ROLE> \

backup-ip <IP>

**\*\* Please note:**

* Interfaces **swp3** and **swp4** will be configured as the MLAG **peerlink**.
* Switch **spine3** is configured as the MLAG **primary** and **spine4** as the **secondary*.***
* On switch **spine3** use **spine4’s** IP as the backup-IP and vice-versa.

cumulus@spine3:~$ net add clag peer \

**sys-mac 44:38:39:FF:00:01 \**

**interface swp3-4 \**

**primary \**

**backup-ip 10.143.33.188**

cumulus@spine3:~$ net commit

cumulus@spine4:~$ net add clag peer \

**sys-mac 44:38:39:FF:00:01 \**

**interface swp3-4 \**

**secondary \**

**backup-ip 10.143.33.187**

cumulus@spine4:~$ net commit

1. Configure bridge settings – VLANs and STP priority:

cumulus@spine3:~$ net add vlan 2-3

cumulus@spine3:~$ net add bridge stp treeprio 4096

cumulus@spine3:~$ net commit

cumulus@spine4:~$ net add vlan 2-3

cumulus@spine4:~$ net add bridge stp treeprio 4096

cumulus@spine4:~$ net commit

Task 3: Configuring CLAG interfaces - spine switches

1. Configure two CLAG *interfaces* on each of the spine switches.

* Interface **‘clag 1’**will aggregate**swp1**on**spine3**and**swp2**on**spine4**which are connected to switch **leaf1**



**swp2**

**swp1**

leaf1

spine4

spine3



**swp2**

**swp1**

# **net add clag port bond <BONDNAME> interface <INTERFACE> clag-id <ID>**

cumulus@spine4:~$ net add clag port bond LEAF1 interface swp2 clag-id 1

cumulus@spine4:~$ net commit

cumulus@spine3:~$ net add clag port bond LEAF1 interface swp1 clag-id 1

cumulus@spine3:~$ net commit

* Interface ‘**clag 2**’ will aggregate **swp2** on **spine3** and **swp1** on **spine4** which are connected to switch **leaf2**.



**swp1**

**swp2**

**swp2**

**swp1**

**swp2**



spine4

spine3

leaf2

cumulus@spine3:~$ net add clag port bond LEAF2 interface swp2 clag-id 2

cumulus@spine3:~$ net commit

cumulus@spine4:~$ net add clag port bond LEAF2 interface swp1 clag-id 2

cumulus@spine4:~$ net commit

1. View MLAG resulting configuration:

cumulus@spine3:~$ **net show configuration**

interface LEAF1

bond-slaves swp1

clag-id 1

interface LEAF2

bond-slaves swp2

clag-id 2

interface bridge

bridge-ports peerlink LEAF1 LEAF2

bridge-vlan-aware yes

interface peerlink

bond-slaves swp3 swp4

interface peerlink.4094

address 169.254.1.1/30

clagd-backup-ip 10.143.33.188

clagd-peer-ip 169.254.1.2

clagd-priority 1000

clagd-sys-mac 44:38:39:FF:00:01

cumulus@spine4:~$ **net show configuration**

interface LEAF1

bond-slaves swp2

clag-id 1

interface LEAF2

bond-slaves swp1

clag-id 2

interface bridge

bridge-ports peerlink LEAF1 LEAF2

bridge-vlan-aware yes

interface peerlink

bond-slaves swp3 swp4

interface peerlink.4094

address 169.254.1.2/30

clagd-backup-ip 10.143.33.187

clagd-peer-ip 169.254.1.1

clagd-priority 2000

clagd-sys-mac 44:38:39:FF:00:01

1. Verify that MLAG protocol is up:  
   **# net show clag**

cumulus@spine3:~$ **net show clag**

The peer is alive

Our Priority, ID, and Role: 1000 24:8a:07:cf:6a:50 primary

Peer Priority, ID, and Role: 2000 24:8a:07:cf:6d:d0 secondary

Peer Interface and IP: peerlink.4094 169.254.1.2

Backup IP: 10.143.33.188 (active)

System MAC: 44:38:39:ff:00:01

CLAG Interfaces

Our Interface Peer Interface CLAG Id Conflicts Proto-Down Reason

---------------- ---------------- ------- -------------------- -----------------

LEAF1 LEAF1 1 - -

LEAF2 LEAF2 2 - -

Task 4: Servers’ IP settings

|  |  |  |
| --- | --- | --- |
| **VLAN ID** | **Server** | **‘eth2’ IP Address** |
| VLAN 2 | host1 | 172.16.2.18/24 |
| VLAN 3 | host2 | 172.16.3.19/24 |
| VLAN 2 | host3 | 172.16.2.28/24 |
| VLAN 3 | host4 | 172.16.3.29/24 |

Access the server that was assigned to you, and configure an IP address for interface ‘**eth2’** (see tables below).

1. Configure the server’s IP address and subnet mask:

* Clear existing IP configuration:  
  **# ifconfig eth2 0.0.0.0**
* Configure an IP address and a subnet mask:

**# ifconfig eth2 IP\_ADDRESS/SUBNET\_MASK**

* Verify IP configuration:

**# ifconfig eth2**

cumulus@host1:~$ sudo ifconfig eth2 0.0.0.0

cumulus@host1:~$ sudo ifconfig eth2 172.16.2.18/24

cumulus@host1:~$ ifconfig eth2

eth2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500

**inet 172.16.2.18** netmask 255.255.255.0 broadcast 172.16.2.255

inet6 fe80::4638:39ff:fe00:11 prefixlen 64 scopeid 0x20<link>

ether 44:38:39:00:00:11 txqueuelen 1000 (Ethernet)

RX packets 3 bytes 180 (180.0 B)

1. Verify a static route entry to network 172.16.0.0/16 via the default gateway’s address. If the entry is missing, add it.

**\*\* Please note:**

* Make sure to use the following table for default gateway assignment.

|  |  |
| --- | --- |
| **VLAN ID** | **Default gateway address** |
| vlan 2 | 172.16.2.254/24 |
| vlan 3 | 172.16.3.254/24 |

**# ip route add <NET\_ADDRESS/SUBNET\_MASK> dev <DEV> via IP\_ADDRESS**

cumulus@host1:~$ sudo ip route add 172.16.0.0/16 dev eth2 via 172.16.2.254

cumulus@host1:~$ route

Kernel IP routing table

Destination Gateway Genmask Flags Metric Ref Use Iface

default \_gateway 0.0.0.0 UG 0 0 0 eth0

**172.16.0.0 172.16.2.254 255.255.0.0 UG 0 0 0 eth2**

172.16.2.0 0.0.0.0 255.255.255.0 U 0 0 0 eth2

192.168.200.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0

1. Use ‘**ping’** to check communication between servers in the same VLAN.   
   For example server **host1**and **host3** in group B.

[cumulus@host1 ~]# ping 172.16.2.28

PING 172.16.2.28 (172.16.2.28) 56(84) bytes of data.

64 bytes from 172.16.2.28: icmp\_seq=1 ttl=64 time=0.147 ms

64 bytes from 172.16.2.28: icmp\_seq=2 ttl=64 time=0.135 ms

Verify that the MLAG switches have their MAC address tables synchronized.

cumulus@spine4:~$ net show bridge macs

VLAN Master Interface MAC TunnelDest State Flags LastSeen

-------- ------ --------- ----------------- ---------- --------- ----- --------

2 bridge LEAF1 ec:0d:9a:6f:97:0b 00:02:14

2 bridge LEAF2 ec:0d:9a:46:9e:b5 00:02:14

3 bridge LEAF1 ec:0d:9a:6f:96:fb 00:02:14

3 bridge LEAF2 ec:0d:9a:46:9f:8d 00:02:14

cumulus@spine3:~$ net show bridge macs

VLAN Master Interface MAC TunnelDest State Flags LastSeen

-------- ------ --------- ----------------- ---------- --------- ----- --------

2 bridge LEAF1 ec:0d:9a:6f:97:0b 00:23:43

2 bridge LEAF2 ec:0d:9a:46:9e:b5 00:23:43

3 bridge LEAF1 ec:0d:9a:6f:96:fb 00:23:43

3 bridge LEAF2 ec:0d:9a:46:9f:8d 00:23:43

**\*\* Please note:**

* Once the MLAG configuration is completed, the spine switches appear as a single Layer 2 switch towards to Layer 2 network. Hence, they are capable to provide an efficient load balancing and better network utilization for the layer 2 network.
* In the following task additionally, the spine switches will be configured as VRR routers. Thus, they will provide default gateway redundancy and efficient load balancing towards the layer 3 network.

Task 5: Configuring VRR

**Topology used in this task:**



**swp4**

access  
VLAN2

**swp2**

**swp8**

**swp9**

access  
VLAN3

**swp8**

**swp9**

access  
VLAN3

access  
VLAN2

**swp1**

**swp2**

**swp3**

172.16.2.18

172.16.2.19

172.16.2.28

172.16.2.29



Vlan 2 VIP: 172.16.2.254

Vlan 3 VIP: 172.16.3.254

1. Configure two SVIs (Switch Virtual Interfaces) on each of the spine switches, interface vlan 2 and interface vlan 3.
   * Configure an IP for each of the vlan interfaces.
   * Configure a VIP (Virtual IP) and a VMAC (Virtual MAC).
   * Use the following table for address assignment.
   * Use /24 as the subnet mask.

|  |  |  |  |
| --- | --- | --- | --- |
| **Switch spine3** | | | |
| **VLAN** | **SVI** | **VIP** | **VMAC** |
| vlan 2 | 172.16.2.252/24 | 172.16.2.254/24 | 00:00:5e:00:01:02 |
| vlan 3 | 172.16.3.252/24 | 172.16.3.254/24 | 00:00:5e:00:01:03 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Switch spine4** | | | |
| **VLAN** | **SVI** | **VIP** | **VMAC** |
| vlan 2 | 172.16.2.253/24 | 172.16.2.254/24 | 00:00:5e:00:01:02 |
| vlan 3 | 172.16.3.253/24 | 172.16.3.254/24 | 00:00:5e:00:01:03 |

**# net add vlan <VLAN\_ID> ip address <IP\_ADDRESS/SUBNET\_MASK>**

**# net add vlan <VLAN\_ID> ip address-virtual <VMAC> <VIP/SUBNET\_MASK>**

cumulus@spine4:~$ net add vlan 2 ip address 172.16.2.253/24

cumulus@spine4:~$ net add vlan 2 ip address-virtual 00:00:5e:00:01:02 172.16.2.254/24

cumulus@spine4:~$ net add vlan 3 ip address 172.16.3.253/24

cumulus@spine4:~$ net add vlan 3 ip address-virtual 00:00:5e:00:01:03 172.16.3.254/24

cumulus@spine4:~$ net commit

cumulus@spine3:~$ net add vlan 2 ip address 172.16.2.252/24

cumulus@spine3:~$ net add vlan 2 ip address-virtual 00:00:5e:00:01:02 172.16.2.254/24

cumulus@spine3:~$ net add vlan 3 ip address 172.16.3.252/24

cumulus@spine3:~$ net add vlan 3 ip address-virtual 00:00:5e:00:01:03 172.16.3.254/24

cumulus@spine3:~$ net commit

1. Use show commands to verify VRR configuration:

cumulus@spine3:~$ **net show interface**

State Name Spd MTU Mode LLDP Summary

----- ------------- ---- ----- ------------ ----------- -------------------

UP vlan2 N/A 1500 Interface/L3 IP: 172.16.2.252/24

UP vlan2-v0 N/A 1500 Interface/L3 IP: 172.16.2.254/24

UP vlan3 N/A 1500 Interface/L3 IP: 172.16.3.252/24

UP vlan3-v0 N/A 1500 Interface/L3 IP: 172.16.3.254/24

cumulus@spine3:~$ **net show interface vlan2-v0**

Name MAC Speed MTU Mode

-- -------- ----------------- ----- ---- ------------

UP vlan2-v0 00:00:5e:00:01:02 N/A 1500 Interface/L3

IP Details

------------------------- ---------------

IP: 172.16.2.254/24

IP Neighbor(ARP) Entries: 0

1. Verify VRR operation.  
   Use ‘**ping’** and ‘**traceroute’** utilities to verify communication between hosts in different VLANs.   
   For example, in group B ping from server ‘**host1’** (in VLAN 2) to server ‘**host2’**   
   (in VLAN3).

[cumulus@host1 ~]# ping 172.16.3.19

PING 172.16.3.19 (172.16.3.19) 56(84) bytes of data.

64 bytes from 172.16.3.19: icmp\_seq=1 ttl=63 time=0.175 ms

64 bytes from 172.16.3.19: icmp\_seq=2 ttl=63 time=0.081 ms

64 bytes from 172.16.3.19: icmp\_seq=3 ttl=63 time=0.103 ms

[cumulus@host1 ~]# traceroute 172.16.3.19

traceroute to 172.16.3.19 (172.16.3.19), 30 hops max, 60 byte packets

1 172.16.2.254 (172.16.2.254) 0.195 ms 0.187 ms 0.194 ms

2 172.16.3.19 (172.16.3.19) 0.109 ms 0.099 ms 0.116 ms

1. Verify MLAG/VRR failover.  
     
   Use continuous ‘**ping’** between hosts in different VLANs.   
   For example, in group B ping from server ‘**host1’** (in VLAN 2) to server ‘**host2’** (in VLAN 3).

|  |
| --- |
| While **‘ping’** is running, reboot switch **spine3**. Was the traffic disrupted? |
| After switch **spine3**reboots, reboot switch **spine4**. Was the traffic disputed now? |
| What are your conclusions regarding MLAG/VRR failover? |

## PRACTICE 5: CONFIGURING BGP UNNUMBERED

Practice objectives:

In this practice session you will configure BGP Unnumbered:

* Spine switches will be configured in the same AS and each of the leaf switches will be configured in its own AS.
* BGP unnumbered will be configured on all four switches.
* eBGP sessions will be established between the spine and leaf switches.
* Leaf switches will advertise their local IP prefixes.
* By the end of this practice session you will achieve end-to-end connectivity between all servers in your group, over the BGP Autonomous Systems.

**\*\* Please note:**

* Commands are demonstrated on switches **leaf1** and **spine3** in group B, named **leaf1** and **spine3.**You should apply similar commands on the other two switches in your group.

**Topology used in this practice session:**

**­­**



**swp2**

**swp2**

**swp8**

**swp9**

**swp1**

**swp2**



**swp2**

**swp1**

**swp8**

**swp9**

**swp1**



**swp1**

**AS 65101**

**AS 65102**

**AS 65100**

Task 1: Starting FRR

1. Access the switch that was assigned to you and reset configuration:

**# net del all**

**# net commit**

cumulus@leaf1:~$ net del all

cumulus@leaf1:~$ net commit

1. Start FRR routing daemons.   
   Edit the **/etc/frr/daemons** file. Set to ‘**yes**’ both **zebra** and **bgpd**.  
   Save and exit.

cumulus@leaf1:~$ sudo vi /etc/frr/daemons

**zebra=yes**

**bgpd=yes**

1. Restart FRR Service.

cumulus@leaf1:~$ sudo systemctl restart frr

**\*\* Please note**:

* **‘sudo’** privileges are required for those actions.

Task 2: Configuring BGP Unnumbered

1. Configure BGP unnumbered:

**# net add bgp autonomous-system <LOCAL-AS>**

**# net add bgp neighbor <INTERFACE> interface remote-as**

**external**

cumulus@spine3:~$ net add bgp autonomous-system 65100

cumulus@spine3:~$ net add bgp neighbor swp1-2 interface remote-as external

cumulus@spine3:~$ net commit

cumulus@leaf1:~$ net add bgp autonomous-system 65101

cumulus@leaf1:~$ net add bgp neighbor swp1-2 interface remote-as external

cumulus@leaf1:~$ net commit

1. Verify configuration:

cumulus@leaf2:~$ net show configuration

*<output omitted>*

interface swp1

interface swp2

router bgp 65102

**neighbor swp1 interface remote-as external**

**neighbor swp2 interface remote-as external**

1. Verify eBGP sessions were established:   
   Each switch should be able to see two eBGP neighbors, via interfaces **swp1** and **swp2**.  
   **# net show bgp summary**

cumulus@leaf1:~$ net show bgp summary

show bgp ipv4 unicast summary

=============================

BGP router identifier 10.143.33.185, local AS number 65101 vrf-id 0

BGP table version 0

RIB entries 0, using 0 bytes of memory

Peers 2, using 39 KiB of memory

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

**spine3(swp1) 4 65100 11** 13 0 0 0 00:00:26 0

**spine4(swp2) 4 65100 8** 8 0 0 0 00:00:18 0

Total number of neighbors 2

Task 3: Configuring loopback interfaces

|  |  |
| --- | --- |
| **Switch** | **Loopback IP address** |
| leaf1 | 172.16.100.1/32 |
| leaf2 | 172.16.100.2/32 |
| spine3 | 172.16.100.3/32 |
| spine4 | 172.16.100.4/32 |

1. On each of the switches configure a loopback interface and advertise its prefix in the BGP process.  
   Use the following table for IP address assignment:

**# net add loopback lo ip address IP/MASK**

**# net add bgp network IP/MASK**

cumulus@leaf1:~$ net add loopback lo ip address 172.16.100.1/32

cumulus@leaf1:~$ net add bgp network 172.16.100.1/32

cumulus@leaf1:~$ net commit

cumulus@spine3:~$ net add loopback lo ip address 172.16.100.3/32

cumulus@spine3:~$ net add bgp network 172.16.100.3/32

cumulus@spine3:~$ net commit

1. Verify loopback prefixes are reachable:

* Each switch should have in its routing table the prefixes of the other switches loopback interfaces.

**# net show route bgp**

cumulus@leaf1:~$ net show route bgp

RIB entry for bgp

=================

Codes: K - kernel route, C - connected, S - static, R - RIP,

O - OSPF, I - IS-IS, B - BGP, P - PIM, E - EIGRP, N - NHRP,

T - Table, v - VNC, V - VNC-Direct, A - Babel,

> - selected route, \* - FIB route

B>\* 172.16.100.2/32 [20/0] via fe80::268a:7ff:fecf:6a58, swp1, 00:03:57

\* via fe80::268a:7ff:fecf:6ddc, swp2, 00:03:57

B>\* 172.16.100.3/32 [20/0] via fe80::268a:7ff:fecf:6a58, swp1, 00:04:13

B>\* 172.16.100.4/32 [20/0] via fe80::268a:7ff:fecf:6ddc, swp2, 00:03:57

**\*\* Please note:**

* NEXT-HOP is the neighbor’s IPv6 Link Local Address
* BGP multipath is enabled

T­­ask 4: Advertise local IP prefixes

1. On the leaf switches, assign IP addresses for the host-facing interface, **swp8** and **swp9**.  
   Advertise the IP prefixes in the BGP process.  
   Use the IP addresses listed in the below topology. Use /24 for the subnet mask.

**swp1**

**Swp8**

**Swp9**



172.16.18.2

172.16.19.2

172.16.28.2

172.16.29.2

172.16.18.1

172.16.19.1

**Swp8**

**Swp9**

172.16.28.1

172.16.29.1

**loopback**

172.16.100.1

172.16.100.2

**loopback**

172.16.100.4

**loopback**

**loopback**

172.16.100.3



**swp2**

**swp2**

**swp1**

**# net add interface <INTERFACE> ip add IP/MASK**

**# net add bgp network IP/MASK**

cumulus@leaf1:~$ net add interface swp8 ip add 172.16.18.1/24

cumulus@leaf1:~$ net add interface swp9 ip add 172.16.19.1/24

cumulus@leaf1:~$ net add bgp network 172.16.18.0/24

cumulus@leaf1:~$ net add bgp network 172.16.19.0/24

cumulus@leaf1:~$ net commit

cumulus@leaf2:~$ net add interface swp8 ip add 172.16.28.1/24

cumulus@leaf2:~$ net add interface swp9 ip add 172.16.29.1/24

cumulus@leaf2:~$ net add bgp network 172.16.28.0/24

cumulus@leaf2:~$ net add bgp network 172.16.29.0/24

cumulus@leaf2:~$ net commit

1. Verify that the remote leaf switch has learned the IP prefixes:

* Switch **leaf1** should have in its routing table the IP prefixes advertise by switch **leaf2**:
  + 172.16.28.1/24
  + 172.16.29.0/24
* Switch **leaf2** should have in its routing table the IP prefixes advertise by switch **leaf1**:
  + 172.16.18.1/24
  + 172.16.19.0/24

**# net show route bgp**

cumulus@leaf1:~$ net show route bgp

RIB entry for bgp

=================

Codes: K - kernel route, C - connected, S - static, R - RIP,

O - OSPF, I - IS-IS, B - BGP, P - PIM, E - EIGRP, N - NHRP,

T - Table, v - VNC, V - VNC-Direct, A - Babel,

> - selected route, \* - FIB route

B>\* 172.16.28.0/24 [20/0] via fe80::268a:7ff:fecf:6a58, swp1, 00:19:09

\* via fe80::268a:7ff:fecf:6ddc, swp2, 00:19:09

B>\* 172.16.29.0/24 [20/0] via fe80::268a:7ff:fecf:6a58, swp1, 00:19:09

\* via fe80::268a:7ff:fecf:6ddc, swp2, 00:19:09

*<output omitted>*

cumulus@leaf2:~$ net show route bgp

RIB entry for bgp

=================

Codes: K - kernel route, C - connected, S - static, R - RIP,

O - OSPF, I - IS-IS, B - BGP, P - PIM, E - EIGRP, N - NHRP,

T - Table, v - VNC, V - VNC-Direct, A - Babel,

> - selected route, \* - FIB route

B>\* 172.16.18.0/24 [20/0] via fe80::268a:7ff:fecf:6a5c, swp2, 00:21:52

\* via fe80::268a:7ff:fecf:6dd8, swp1, 00:21:52

B>\* 172.16.19.0/24 [20/0] via fe80::268a:7ff:fecf:6a5c, swp2, 00:21:52

\* via fe80::268a:7ff:fecf:6dd8, swp1, 00:21:52

*<output omitted>*

Task 5: Verify end-to-end connectivity

1. Configure the servers IP settings. Configure an IP address and a subnet mask for interface ’**eth2**’*.* Use the following tables for IP address assignment.   
   Use /24 as the subnet mask.

|  |  |  |
| --- | --- | --- |
| **Server** | ’**eth2**’ **IP Address** | **Next Hop to 172.16.0.0/16** |
| host1 | 172.16.18.2 | 172.16.18.1 |
| host2 | 172.16.19.2 | 172.16.19.1 |
| host3 | 172.16.28.2 | 172.16.28.1 |
| host4 | 172.16.29.2 | 172.16.29.1 |

* Clear existing IP configuration:  
  **# ifconfig <dev> 0.0.0.0**
* Configure an IP address and a subnet mask:  
  **# ifconfig <dev> IP/MASK**

cumulus@host1:~$ sudo ifconfig eth2 0.0.0.0

cumulus@host1:~$ sudo ifconfig eth2 172.16.18.2/24

cumulus@host1:~$ ifconfig eth2

eth2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500

inet 172.16.18.2 netmask 255.255.255.0 broadcast 172.16.18.255

inet6 fe80::4638:39ff:fe00:11 prefixlen 64 scopeid 0x20<link>

ether 44:38:39:00:00:11 txqueuelen 1000 (Ethernet)

RX packets 3 bytes 180 (180.0 B)

RX errors 0 dropped 0 overruns 0 frame 0

TX packets 270015 bytes 51701450 (49.3 MiB)

TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

1. Add a route entry to 172.16.0.0/16 via interface **’eth2’**:  
   **# ip route add <ADDRESS/MASK> dev <DEV> via <IP\_ADDRESS>**

cumulus@host1:~$ route

Kernel IP routing table

Destination Gateway Genmask Flags Metric Ref Use Iface

default \_gateway 0.0.0.0 UG 0 0 0 eth0

172.16.0.0 172.16.18.1 255.255.0.0 UG 0 0 0 eth2

172.16.2.0 0.0.0.0 255.255.255.0 U 0 0 0 eth2

192.168.200.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0

umulus@host1:~$ sudo ip route add 172.16.0.0/16 dev eth2 via 172.16.18.1

1. Use ‘**ping’** and ‘**traceroute’** utilities to verify communication between servers in different Autonomous Systems.   
     
   For example, in group B ping from server ‘**host1’** (AS 65101) to server ‘**host3’**   
   (in AS 65102).

[cumulus@host1 ~]# traceroute 172.16.28.2

traceroute to 172.16.28.2 (172.16.28.2), 30 hops max, 60 byte packets

1 172.16.18.1 (172.16.18.1) 0.316 ms 0.273 ms 0.263 ms

2 172.16.100.4 (172.16.100.4) 0.318 ms 0.293 ms 0.305 ms

3 172.16.100.2 (172.16.100.2) 0.272 ms 0.301 ms 0.316 ms

4 172.16.28.2 (172.16.28.2) 0.224 ms 0.187 ms 0.146 ms

[cumulus@host1 ~]# ping 172.16.28.2

PING 172.16.28.2 (172.16.28.2) 56(84) bytes of data.

64 bytes from 172.16.28.2: icmp\_seq=1 ttl=61 time=0.211 ms

64 bytes from 172.16.28.2: icmp\_seq=2 ttl=61 time=0.114 ms

**Please note:**

* The next practice relies on BGP Unnumbered configuration. Please make sure to save the configuration before exiting.

## PRACTICE 6: CONFIGURING VXLAN WITH EVPN

Practice objectives:

In this practice session you will configure VXLAN with EVPN:

* The leaf switches will be configured as the VTEPs
  + EVPN will be configured as the VXLAN control plane
  + Two VXLAN Network IDs (VNIs) will be configured:
    - **VNI-10** will connect **VLAN 10** on switch **leaf1** and **VLAN 100** on switch **leaf2*.***
    - **VNI-20** will connect **VLAN 20** on switch **leaf1** and **VLAN 200** on switch **leaf2*.***
* Hosts in each VNI will be able to communicate in layer 2 over the underlay layer 3 network.

**\*\* Please note:**

The configuration in this practice session relies on the previous practice.   
Make sure that BGP Unnumbered is properly configured and fully operational.

**Topology used in this practice session:**

**­­**



**swp1**

**Swp8**

**Swp9**



**Swp8**

**Swp9**

**swp2**

**swp1**



VLAN10

VLAN20

VLAN100

VLAN200

172.16.10.18/24

172.16.20.19/24

172.16.10.28/24

172.16.20.29/24

**swp2**

**swp2**

**swp1**

**swp2**

**swp1**

**VNI-10**

**VNI-20**

Task 1: Configuring servers IP settings

1. Configure an IP address and a subnet mask for interface ’**eth2**’*.*Use the following tables for IP address assignment. Use /24 as the subnet mask.

|  |  |
| --- | --- |
| **Server** | ’***eth2***’ **IP Address** |
| host1 | 172.16.10.18 |
| host2 | 172.16.20.19 |
| host3 | 172.16.10.28 |
| host4 | 172.16.20.29 |

* Clear existing IP configuration:  
  **# ifconfig <dev> 0.0.0.0**
* Configure an IP address and a subnet mask:  
  **# ifconfig <dev> IP/MASK**

Task 2: Configuring VLANs

1. Access the leaf switch that was assigned to you and configure the host-facing ports **swp8** and **swp9**. First clear any existing configuration, then assign the ports to the appropriate VLAN:
   * Switch **leaf1**- assign swp8 to VLAN 10 and swp9 to VLAN 20
   * Switch **leaf2**- assign swp8 to VLAN 100 and swp9 to VLAN 200

**# net add interface <INTERFACE> bridge access <VLAN>**

cumulus@leaf1:~$ net del interface swp8-9

cumulus@leaf1:~$ net **add interface swp8 bridge access 10**

cumulus@leaf1:~$ net **add interface swp9 bridge access 20**

cumulus@leaf1:~$ net commit

cumulus@leaf2:~$ net del interface swp8-9

cumulus@leaf2:~$ net **add interface swp8 bridge access 100**

cumulus@leaf2:~$ net **add interface swp9 bridge access 200**

cumulus@leaf2:~$ net commit

Task 3: Configuring VNIs

1. Access the leaf switch that was assigned to you and configure the VNIs:
   * Create a VXLAN interface with a unique ID
   * Map the VXLAN to a VLAN
   * Configure the VXLAN’s local tunnel IP (use the VTEPs loopback)

**# net add vxlan <VXLAN-NAME> vxlan id <VXLAN-ID>**

**# net add vxlan <VXLAN-NAME> bridge access <VLAN-ID>**

**# net add vxlan <VXLAN-NAME> vxlan local-tunnelip <IP-ADRESS>**

**# net commit**

* On switch **leaf1**:   
  VNI-10 will be mapped to VLAN 10 and VNI-20 will be mapped to VLAN 20***.***VXLAN’s local tunnel IP is 172.16.100.1
* On switch **leaf2**:   
  VNI-10 will be mapped to VLAN 100 and VNI-20 will be mapped to VLAN 200***.***VXLAN’s local tunnel IP is 172.16.100.2

cumulus@leaf2:~$ net add vxlan VNI-10 vxlan id 10

cumulus@leaf2:~$ net add vxlan VNI-10 bridge access 100

cumulus@leaf2:~$ net add vxlan VNI-10 vxlan local-tunnelip 172.16.100.2

cumulus@leaf2:~$ net add vxlan VNI-20 vxlan id 20

cumulus@leaf2:~$ net add vxlan VNI-20 bridge access 200

cumulus@leaf2:~$ net add vxlan VNI-20 vxlan local-tunnelip 172.16.100.2

cumulus@leaf2:~$ net commit

cumulus@leaf1:~$ net add vxlan VNI-10 vxlan id 10

cumulus@leaf1:~$ net add vxlan VNI-10 bridge access 10

cumulus@leaf1:~$ net add vxlan VNI-10 vxlan local-tunnelip 172.16.100.1

cumulus@leaf1:~$ net add vxlan VNI-20 vxlan id 20

cumulus@leaf1:~$ net add vxlan VNI-20 bridge access 20

cumulus@leaf1:~$ net add vxlan VNI-20 vxlan local-tunnelip 172.16.100.1

cumulus@leaf1:~$ net commit

Task 4: Configuring EVPN

1. Access the spine switch that was assigned and configure EVPN.   
   Switch **spine4** should be configured similarly.

**# net add bgp evpn neighbor <INTERFACE> activate**

cumulus@cl-spine3:~$ net add bgp evpn neighbor swp1-2 activate

cumulus@cl-spine3:~$ net commit

1. Access the leaf switch that was assigned and configure EVPN to advertise all VNIs (EVPN allows VTEPs to exchange VNI membership information).  
   Switch **leaf2** should be configured similarly.

**# net add bgp evpn neighbor <INTERFACE> activate**

**# net add bgp evpn advertise-all-vni**

cumulus@leaf1:~$ net add bgp evpn neighbor swp1-2 activate

cumulus@leaf1:~$ net add bgp evpn advertise-all-vni

cumulus@leaf1:~$ net commit

cumulus@leaf1:~$ net commit

1. Verify VXLAN Information

**# net show evpn vni <VNI>**

cumulus@leaf1:~$ net show evpn vni 10

VNI: 10

Type: L2

Tenant VRF: Default-IP-Routing-Table

VxLAN interface: VNI-10

VxLAN ifIndex: 21

Local VTEP IP: 172.16.100.1

Remote VTEPs for this VNI:

172.16.100.2

Number of MACs (local and remote) known for this VNI: 2

Task 5: Verify end-to-end communication

* Each VNI is a logical layer 2 network over the underlay layer 3 network.  
  Logically there are no layer 3 hops between hosts in the same VNI.
* Use ‘**ping**’ and ‘**traceroute**’ utilities to verify end-to-end communication between hosts in a VNI. For example in Group B ping from host ‘**host1’** to ‘**host3’** that are configured in VNI-10.

[cumulus@host1 ~]# ping 172.16.10.28

PING 172.16.10.28 (172.16.10.28) 56(84) bytes of data.

64 bytes from 172.16.10.28: icmp\_seq=1 ttl=64 time=0.221 ms

64 bytes from 172.16.10.28: icmp\_seq=2 ttl=64 time=0.098 ms

[cumulus@host1 ~]# traceroute 172.16.10.28

traceroute to 172.16.10.28 (172.16.10.28), 30 hops max, 60 byte packets

1 172.16.10.28 (172.16.10.11) 0.143 ms 0.103 ms 0.144 ms

**\*\* Please note:**

The next practice relies on VXLAN with EVPN configuration.   
Please make sure to save the configuration before exiting.

## PRACTICE 7: CONFIGURING DISTRIBUTED ASYMMETRIC VXLAN ROUTING

Practice objectives:

In this practice session you will configure distributed asymmetric VXLAN routing.

* VTEPs (leaf switches) will be configured as the distributed anycast default gateway, i.e., each VTEP will be configured with a VIP and VMAC for each of the subnets.  
  Each VTEP will serve as the default gateway for its locally connected hosts.
* In asymmetric VXLAN routing only the ingress VTEP perform the routing, while the egress VTEP perform VXLAN bridging only.

**\*\* Please note:**

* The configuration in this practice session relies on the previous practice. Make sure that BGP Unnumbered and VXLAN with EVPN are properly configured and fully operational.

**Topology used in this practice session:**

**­­**



**swp1**

**Swp8**

**Swp9**

**Swp8**

**Swp9**

**swp2**

**swp1**



VLAN10

VLAN20

VLAN100

VLAN200

172.16.10.18/24

172.16.20.19/24

172.16.10.28/24

172.16.20.29/24

**swp2**

**swp2**

**swp1**

**swp2**

**swp1**

**VNI-10**

**VNI-20**

Default-gateway:  
172.16.10.254

Default-gateway:  
172.16.20.254

Default-gateway:  
172.16.10.254

Default-gateway:  
172.16.20.254



**BGP Unnumbered**

Task 1: Configuring servers IP settings

1. Configure an IP address and a subnet mask for interface **’eth2’***.*  
   If the interface's IP address is not as listed in the table below, use the following table for IP address assignment. Use /24 as the subnet mask.

|  |  |  |
| --- | --- | --- |
| **Server** | ’**eth2**’ **IP Address** | **Default gateway** |
| host1 | 172.16.10.18 | 172.16.10.254 |
| host2 | 172.16.20.19 | 172.16.20.254 |
| host3 | 172.16.10.28 | 172.16.10.254 |
| host4 | 172.16.20.29 | 172.16.20.254 |

* Clear existing IP configuration:  
  **# ifconfig <dev> 0.0.0.0**
* Configure an IP address and a subnet mask:  
  **# ifconfig <dev> IP/MASK**

cumulus@host1:~$ sudo ifconfig eth2 172.16.10.18/24

cumulus@host1:~$ ifconfig eth2

eth2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500

**inet 172.16.10.18 netmask 255.255.255.0** broadcast 172.16.10.255

inet6 fe80::4638:39ff:fe00:11 prefixlen 64 scopeid 0x20<link>

ether 44:38:39:00:00:11 txqueuelen 1000 (Ethernet)

RX packets 3 bytes 180 (180.0 B)

RX errors 0 dropped 3 overruns 0 frame 0

TX packets 43 bytes 7456 (7.4 KB)

TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0 RX errors 0 dropped 0 overruns 0 frame 0

TX packets 270015 bytes 51701450 (49.3 MiB)

TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

1. Add a static route entry to network 172.16.0.0/16 via the default gateway’s IP:  
   In group B for example:

* Servers ‘host1’ and ‘host3’ are in VNI-10, their default gateway is 172.16.10.254
* Servers ‘host2’ and ‘host4’ are in VNI-20, their default gateway is 172.16.20.254

**# ip route add <ADDRESS/MASK> dev <DEV> via <IP>**

[cumulus@host1 ~]# sudo ip route add 172.16.0.0/16 dev eth2 via 172.16.10.254

Task 2: Configuring SVIs on the VTEPs

1. Access the leaf switch that was assigned to you and configure the SVIs and the anycast default gateway’s VMAC and VIP.   
   Assign IP addresses according the following tables. Use /24 as the subnet mask.

**Switch leaf1:**

|  |  |  |  |
| --- | --- | --- | --- |
| **SVI** | **IP** | **Default gateway’s VIP** | **Default gateway’s VMAC** |
| vlan 10 | 172.16.10.252 | 172.16.10.254 | 00:00:5e:00:01:01 |
| vlan 20 | 172.16.20.252 | 172.16.20.254 | 00:00:5e:00:01:02 |

**Switch leaf2:**

|  |  |  |  |
| --- | --- | --- | --- |
| **SVI** | **IP** | **Default gateway’s VIP** | **Default gateway’s VMAC** |
| vlan 100 | 172.16.10.253 | 172.16.10.254 | 00:00:5e:00:01:01 |
| vlan 200 | 172.16.20.253 | 172.16.20.254 | 00:00:5e:00:01:02 |

**# net add vlan <VLAN> ip address <VLAN>**

**# net add vlan <VLAN> ip address-virtual <VMAC> <VIP/MASK>**

cumulus@leaf2:~$ net add vlan 100 ip address 172.16.10.253/24

cumulus@leaf2:~$ net add vlan 100 ip address-virtual 00:00:5e:00:01:01 172.16.10.254/24

cumulus@leaf2:~$ net add vlan 200 ip address 172.16.20.253/24

cumulus@leaf2:~$ net add vlan 200 ip address-virtual 00:00:5e:00:01:02 172.16.20.254/24

cumulus@leaf2:~$ net commit

cumulus@leaf1:~$ net add vlan 10 ip address 172.16.10.252/24

cumulus@leaf1:~$ net add vlan 10 ip address-virtual 00:00:5e:00:01:01 172.16.10.254/24

cumulus@leaf1:~$ net add vlan 20 ip address 172.16.20.252/24

cumulus@leaf1:~$ net add vlan 20 ip address-virtual 00:00:5e:00:01:02 172.16.20.254/24

cumulus@leaf1:~$ net commit

**\*\* Please note:**

The VMAC and VIP must be identical on both VTEPs in order to implement anycast default gateway and to allow proper inter-VXLAN routing.

Task 3: Test inter-VXLAN communication

1. Use ‘**ping**’ and ‘**traceroute**’ utilities to verify end-to-end communication between hosts in different VNIs.   
   For example in Group B ping from host ‘**host1’** in VNI-10 to ‘**host4’** in VNI-20.   
   In this case the egress switch **leaf1** will perform VXLAN routing between the source and destination VNIs, while the egress switch **leaf2**will bridge between destination VNI and the destination VLAN.

[cumulus@host1 ~]# traceroute 172.16.20.29

traceroute to 172.16.20.29 (172.16.20.29), 30 hops max, 60 byte packets

1 172.16.10.254 (172.16.10.254) 0.275 ms 0.248 ms 0.244 ms

2 172.16.20.29 (172.16.20.28) 0.165 ms 0.171 ms 0.142 ms

[cumulus@host1 ~]# ping 172.16.20.29

PING 172.16.20.29 (172.16.20.29) 56(84) bytes of data.

64 bytes from 172.16.20.29: icmp\_seq=37 ttl=63 time=0.152 ms

64 bytes from 172.16.20.29: icmp\_seq=38 ttl=63 time=0.157 ms

64 bytes from 172.16.20.29: icmp\_seq=39 ttl=63 time=0.138 ms