**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 Mellanox Academy team: <vilt@mellanox.com>

**Release Date**

Revision 1.5 – August 2020

Good Luck,   
Mellanox Academy Team

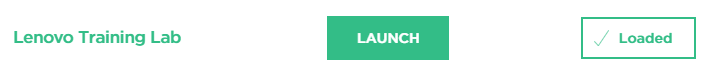
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# Prerequisites and Guidelines

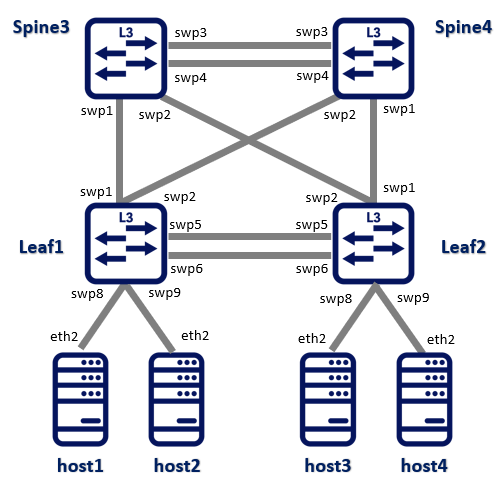
**Please perform and review the following steps before you start:**

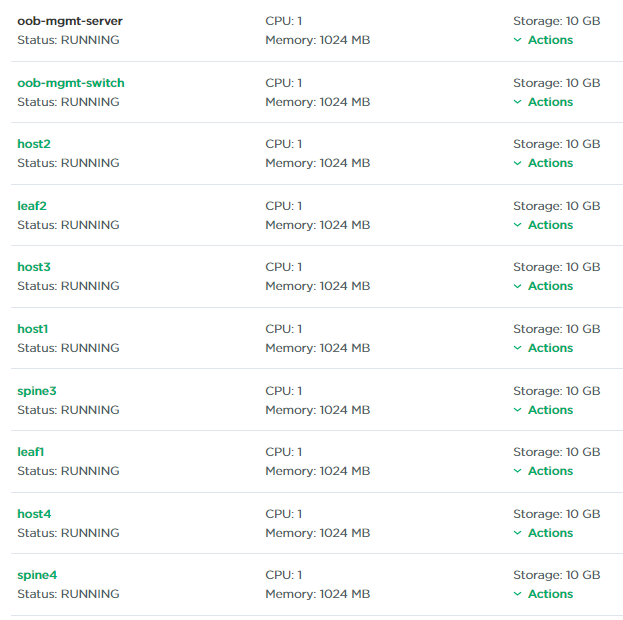
1. Enter the Cumulus Air web page, and click the “GET STARTED” button.  
   <https://air.cumulusnetworks.com/Login>  
   If you are already signed in, use your credentials to login.  
   to sign up for the first time, click “[Register](https://cumulusnetworks.com/accounts/signup/?next=%2Fo%2Fauthorize%2F%3Fresponse_type%3Dcode%26client_id%3DwpKSSeVpV57LaxXIcaTLpohbh3HlLNF5YeQBKkBv%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 Lenovo Training Lab 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

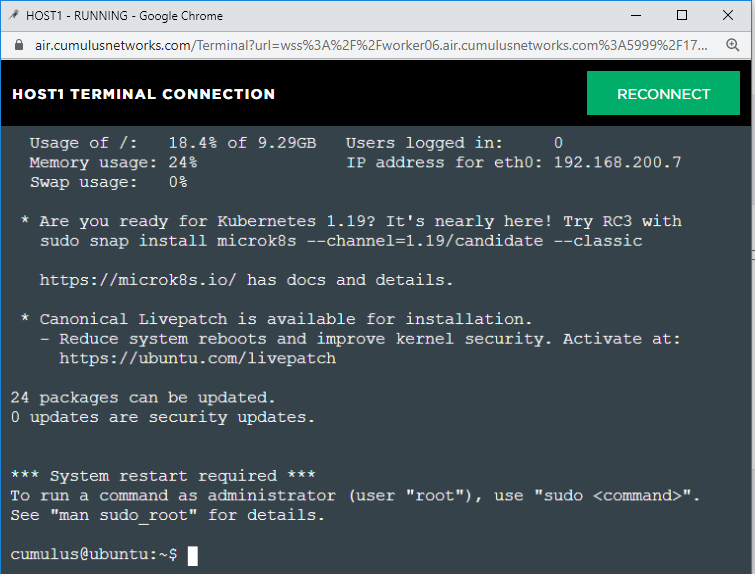
1. The training Lab is organized in the following topology:



1. To log in to a device, first make sure it’s running, and connect to it by clicking its name on the NODES panel



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.

**Topology used in this practice:**

swp1

trunk

swp8

access

swp9

access



swp8

access

swp9

access

swp2

trunk

swp2

trunk

swp1

trunk

Eth2

172.16.1.x

Eth2

172.16.1.x

Eth2

172.16.1.x

Eth2

172.16.1.x

**spine4**

**spine3**

**leaf2**

**leaf1**

**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 |

* Change server’s hostname  
  ***# hostnamectl set-hostname <new host name>***

[cumulus@ubuntu ~]# hostnamectl set-hostname host1

[cumulus@ubuntu ~]# sudo reboot

...................................................

[cumulus@host1 ~]#

* 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:**

swp2

trunk

swp1

trunk

swp8

access

swp9

access

swp8

access

swp9

access



**spine3**

**spine4**



**leaf2**

**leaf1**

VLAN 2

**VLAN 3**

VLAN 2

**VLAN 3**

swp1

trunk

**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 VLAN 2 and interface **swp9** in **VLAN 3**  
   ***# 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 VLAN 2 and VLAN 3:
   * Interfacevlan 2 will serve as the default gateway for VLAN 2
   * Interfacevlan 3 will serve as the default gateway for VLAN 3

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 ***spine4*** connected to switch ***leaf1***.   
  Switch ***leaf1*** will be configured with a regular LAG.
* Interface ‘***clag* *2***’ will aggregate ***swp2*** on ***spine3*** and ***swp1*** on ***spine4*** connected to switch ***leaf2***.   
  Switch ***leaf2*** will be configured with a regular LAG.

**Topology used in this lab:**

**VRR**

swp8

***access VLAN 2***

swp9

***access***

***VLAN 3***



swp8

***access   
VLAN 2***

swp9

***access***

***VLAN 3***

swp2

swp4

swp3

swp2

172.16.2.x

172.16.3.x

172.16.2.x

172.16.3.x

swp1

**spine3**

**spine3**

**3**

**spine4**

**leaf2**

**leaf1**

swp2

swp1

swp1

swp2

swp1

swp2

swp1

**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 ***VLAN 2*** and ***swp9*** to ***VLAN 3***:

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@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

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

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**

swp1

swp1

swp2

swp2

**spine3**

**spine4**

**leaf1**



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****.*

# ***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.

swp2

swp1

swp2

swp1

**spine3**

**spine4**

**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@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

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

**\*\* 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:**

**vlan 2 VIP: 172.16.2.254**

**vlan 3 VIP: 172.16.3.254**

swp8

***access VLAN 2***

swp9

***access***

***VLAN 3***



swp8

***access   
VLAN 2***

swp9

***access***

***VLAN 3***

swp2

swp4

swp3

swp2

172.16.2.18

172.16.3.19

172.16.2.28

172.16.3.29

swp1

**spine3**

**spine3**

**3**

**spine4**

**leaf2**

**leaf1**

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:**

**AS 65100**

**­­**

swp1

swp8

swp9



**spine3**

**spine4**

**leaf2**

**leaf1**

swp8

swp9

swp1

דומקא

swp2

swp1

swp2

swp1

**AS 65102**

**AS 65101**

swp2

swp2

**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 Unnembered**

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@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

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

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.

**spine4**

loopback

172.16.100.4

loopback

172.16.100.3

**spine3**

swp1

swp8

172.16.18.1

swp9

172.16.19.1



swp8

172.16.28.1

swp9

172.16.29.1

swp2

swp2

swp1

Eth2

172.16.18.2

Eth2

172.16.19.2

Eth2

172.16.28.2

Eth2

172.16.29.2

loopback

172.16.100.1

loopback

172.16.100.2

**leaf1**

**leaf2**

***# 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@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>*

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>*

**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>***

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

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

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 ~]# 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

[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

**\*\* 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:**

**­­**

VNI-20

VNI-10

swp1

swp8

VLAN 10

swp9

VLAN 20



**spine3**

**spine4**

**leaf2**

**leaf1**

swp8

VLAN 100

swp9

VLAN 200

swp1

swp2

swp1

swp2

swp1

**BGP Unnumbered**

swp2

swp2

Eth2

Eth2

Eth2

Eth2

172.16.20.19/24

172.16.20.29/24

172.16.10.28/24

172.16.10.18/24

**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***

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

**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 ~]# 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

[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

**\*\* 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:**

**­­**

VNI-20

VNI-10

swp1

swp8

VLAN 10

swp9

VLAN 20



**spine3**

**spine4**

**leaf2**

**leaf1**

swp8

VLAN 100

swp9

VLAN 200

swp1

swp2

swp1

swp2

swp1

**BGP Unnumbered**

swp2

swp2

Eth2

Eth2

Eth2

Eth2

IP: 172.16.20.19/24

Default-gateway:

172.16.20.254

IP: 172.16.20.29/24

Default-gateway:

172.16.20.254

IP: 172.16.10.28/24

Default-gateway:

172.16.10.254

IP: 172.16.10.18/24

Default-gateway:

172.16.10.254

**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 ~]# 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

[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