# 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

# Table of Contents

# 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” and fill out your details.

   Once completed, a confirmation email will be sent, open it to activate your new account.

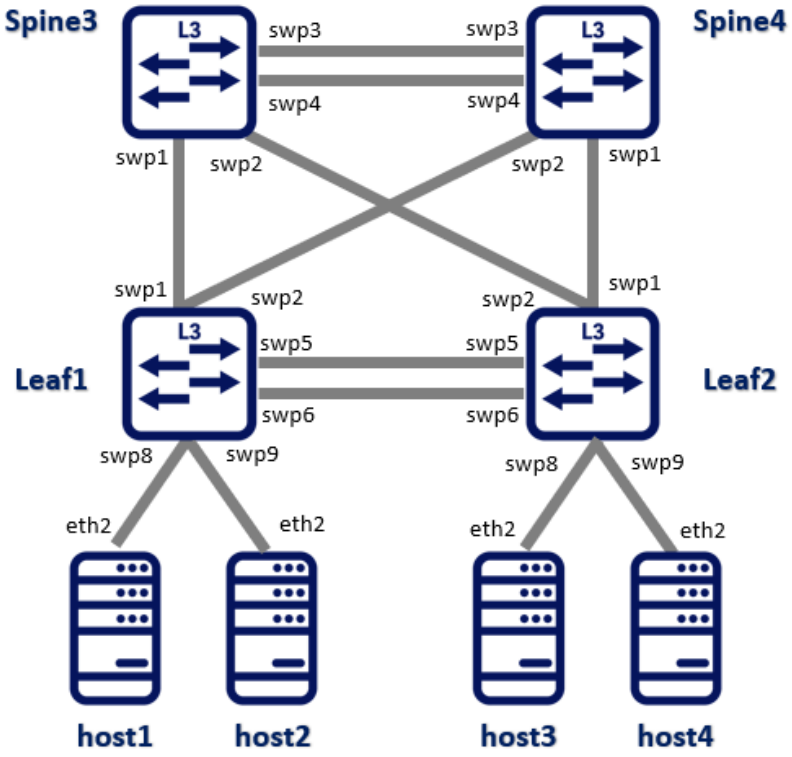
2. Once you are logged in, you will reach the “Cumulus In The Cloud” dashboard.

   Click on the Lenovo Training Lab label, and wait for the switches and servers to reload.

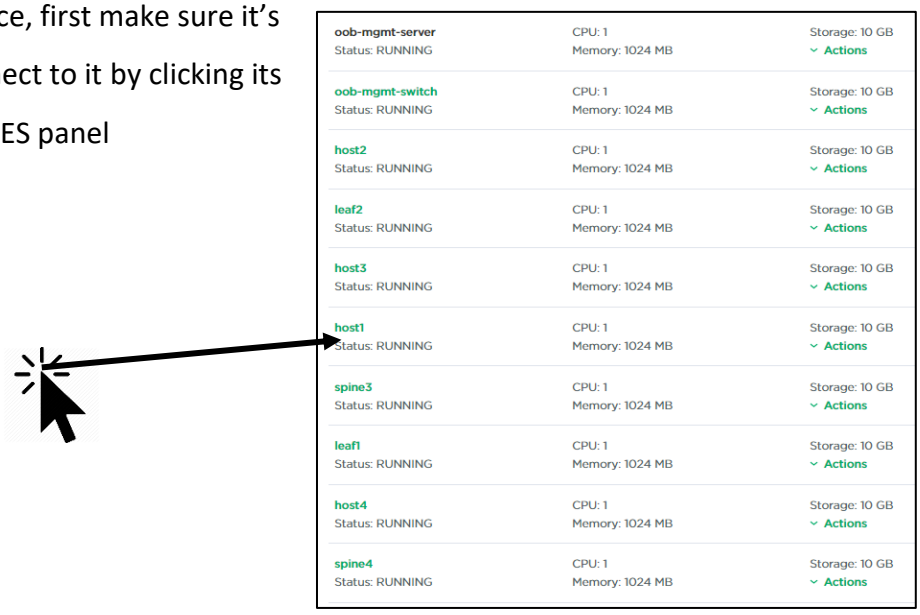
3. Wait for the devices to load and follow the instructions in this lab manual

## Cumulus Air Servers and Switches Access

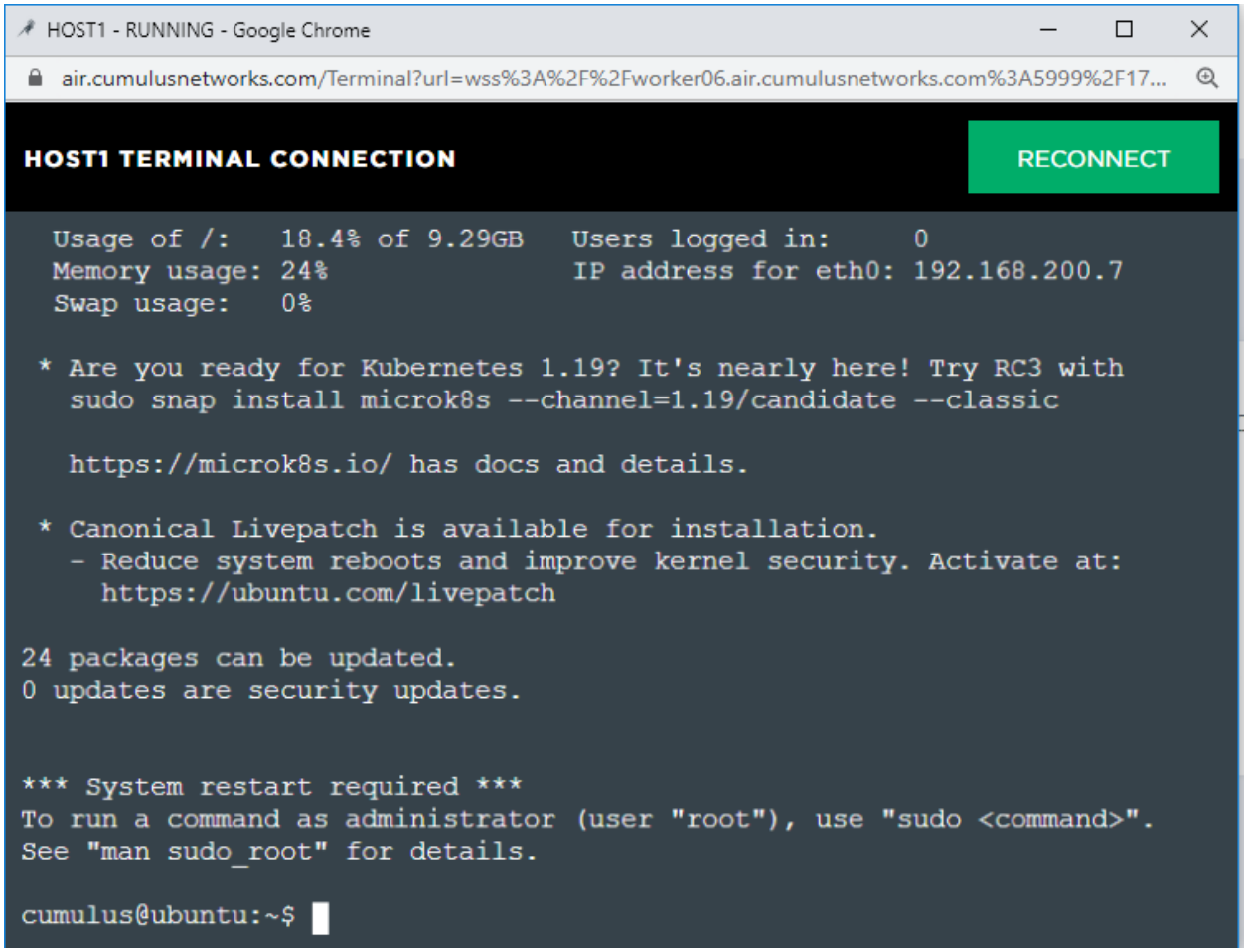
1. The training Lab is organized in the following topology:




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



3. When the login prompt appears, enter the default Cumulus Linux username – "***cumulus***"
4. When the password prompt appears, enter the default Cumulus Linux *password* – "***CumulusLinux!***" and press Enter.
5. 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

a. Identify the switch platform and image:

b. ***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

a. 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
```

b. Bring up the switch ports:

***# net add interface swp1-16***

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

c. 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
```

d. 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>
```

e. 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

a. 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
```

b. Rollback to the last commit:

***# net rollback last***

```
cumulus@leaf1:~$ net rollback last
```

c. 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.

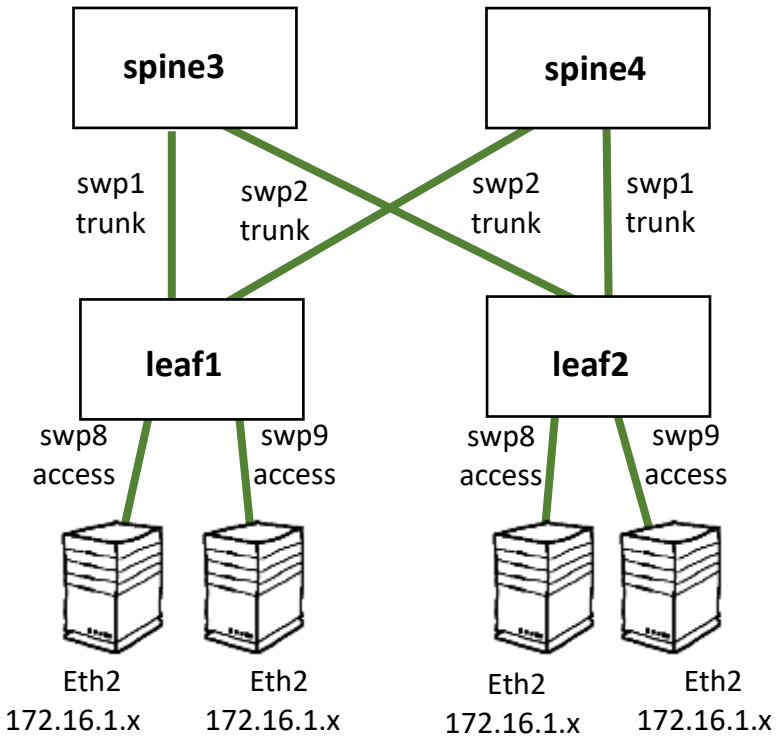
## Practice 2: Basic Switch Functions

### 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:



## Task 1: Configure servers hostname and IP settings

a. 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
```

b. 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)
```

c. 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

f. 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
```

a. 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
```

b. 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
```

c. Commit changes:
***net commit***

```
cumulus@leaf1:~$ net commit
```

d. 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
```

e. 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

a. 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'** |
|---|---|
| | |
| | |
| | |
| | |

b. 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
```

c. 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
```

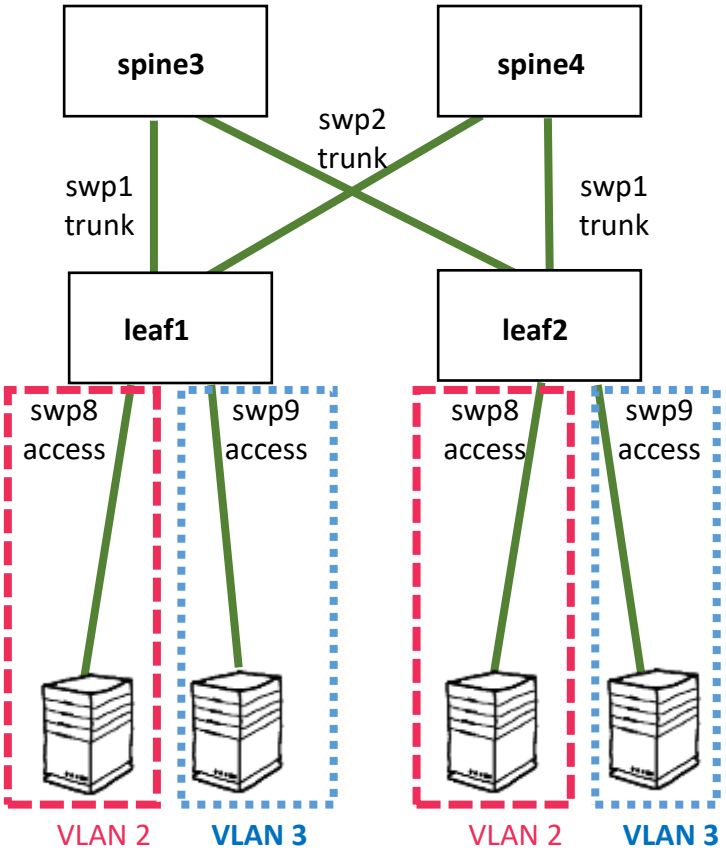
## Practice 3: VLANs and Trunking

### 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:



## Task 1: Configuring VLANs and trunking

a. 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
```

b. 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
```

c. Add VLANs 2-3 to the bridge:

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

d. 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
```

e. Commit changes:

```
cumulus@leaf1:~$ net commit
```

f. 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
```

g. 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 |

a. 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
```

b. 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
```

c. Use '**ping**' to check communication between servers in the same VLAN.
For example server ***host1*** and ***host3***.

```
[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
```

## Task 3: Configuring SVIs for inter-VLAN routing

a. On switch ***spine3*** configure two SVIs (Switch VLAN Interfaces) that will be used for routing between VLAN 2 and VLAN 3:
   - Interface vlan 2 will serve as the default gateway for VLAN 2
   - Interface vlan 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
```

b. 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 ~]# 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
```

```
[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
```

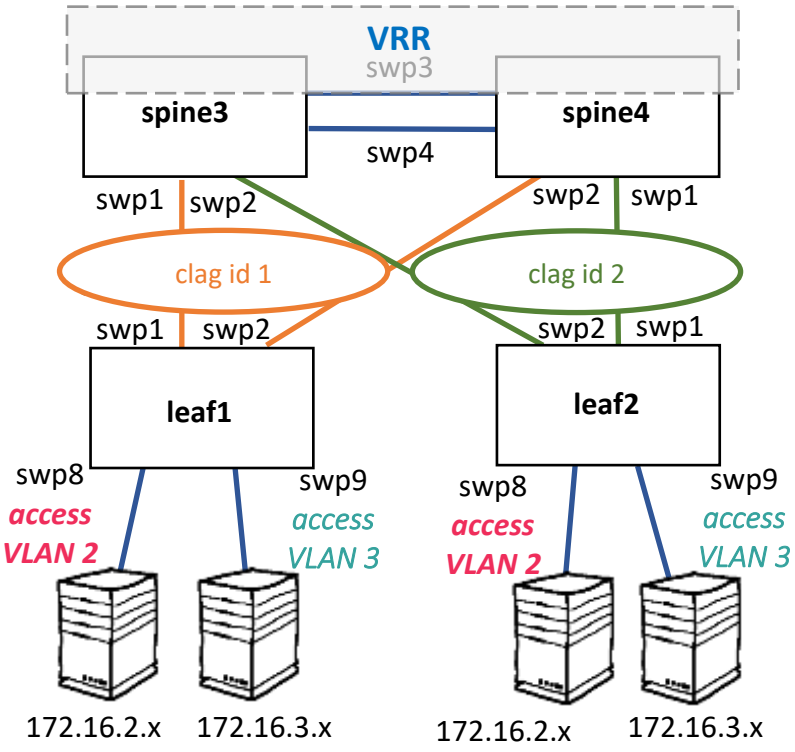
## Practice 4: Configuring MLAG and VRR

### 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:



## Task 1: LAG configuration – leaf switches

a. 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
```

b. 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
```

c. 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.

d. 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
```

e. Configure VLANs 2-3 and associate ***swp8*** 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

a. 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@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
```

```
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
```

b. 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
```

c. Configure bridge settings – VLANs and STP priority:

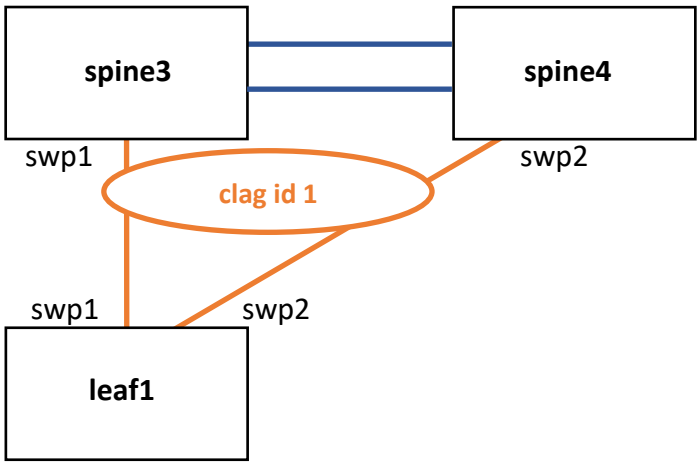
```
cumulus@spine3:~$ net add vlan 2-3
cumulus@spine3:~$ net add bridge stp treeprio 4096
cumulus@spine3:~$ net commit
```

```
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

a. 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***.

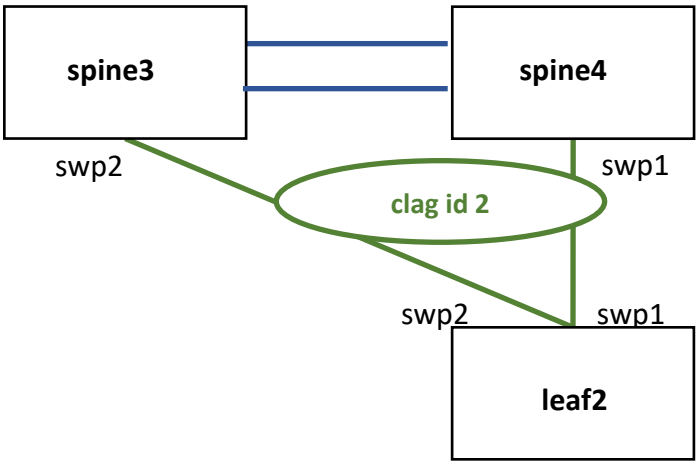



***# net add clag port bond <BONDNAME> interface <INTERFACE> clag-id <ID>***

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

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

- Interface '***clag 2***' will aggregate ***swp2*** on ***spine3*** and ***swp1*** on ***spine4*** which are connected to switch 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
```

b. 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
```

c. 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

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

| 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 |

d. 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)
```

e. 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
```

f. 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
```

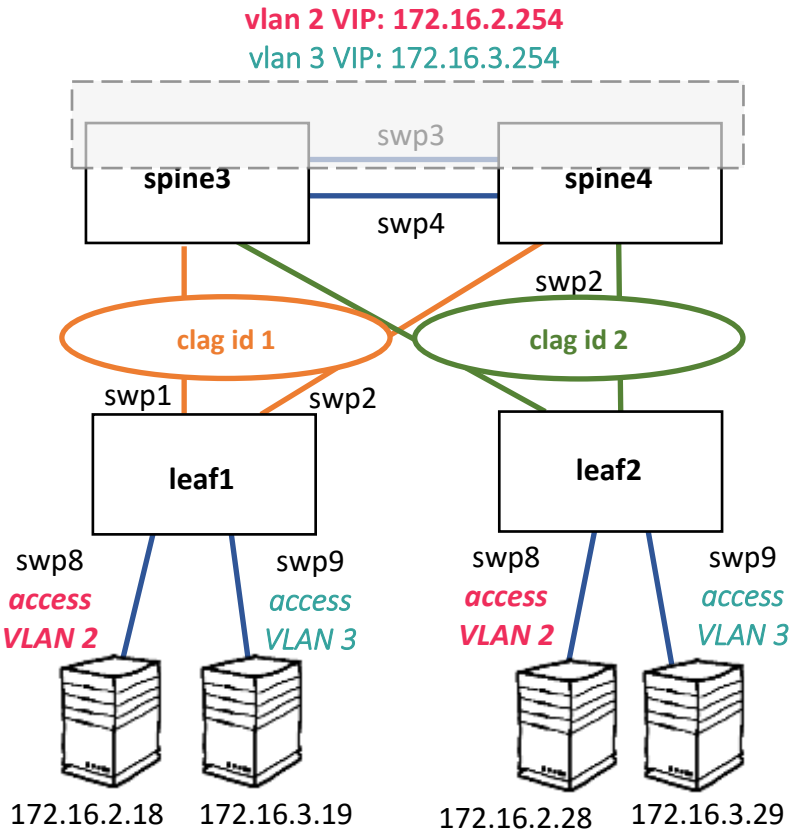
```
cumulus@spine4:~$ net show bridge macs

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:



a. 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@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
```

```
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
```

b. 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
```

c. 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
```

d. 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:

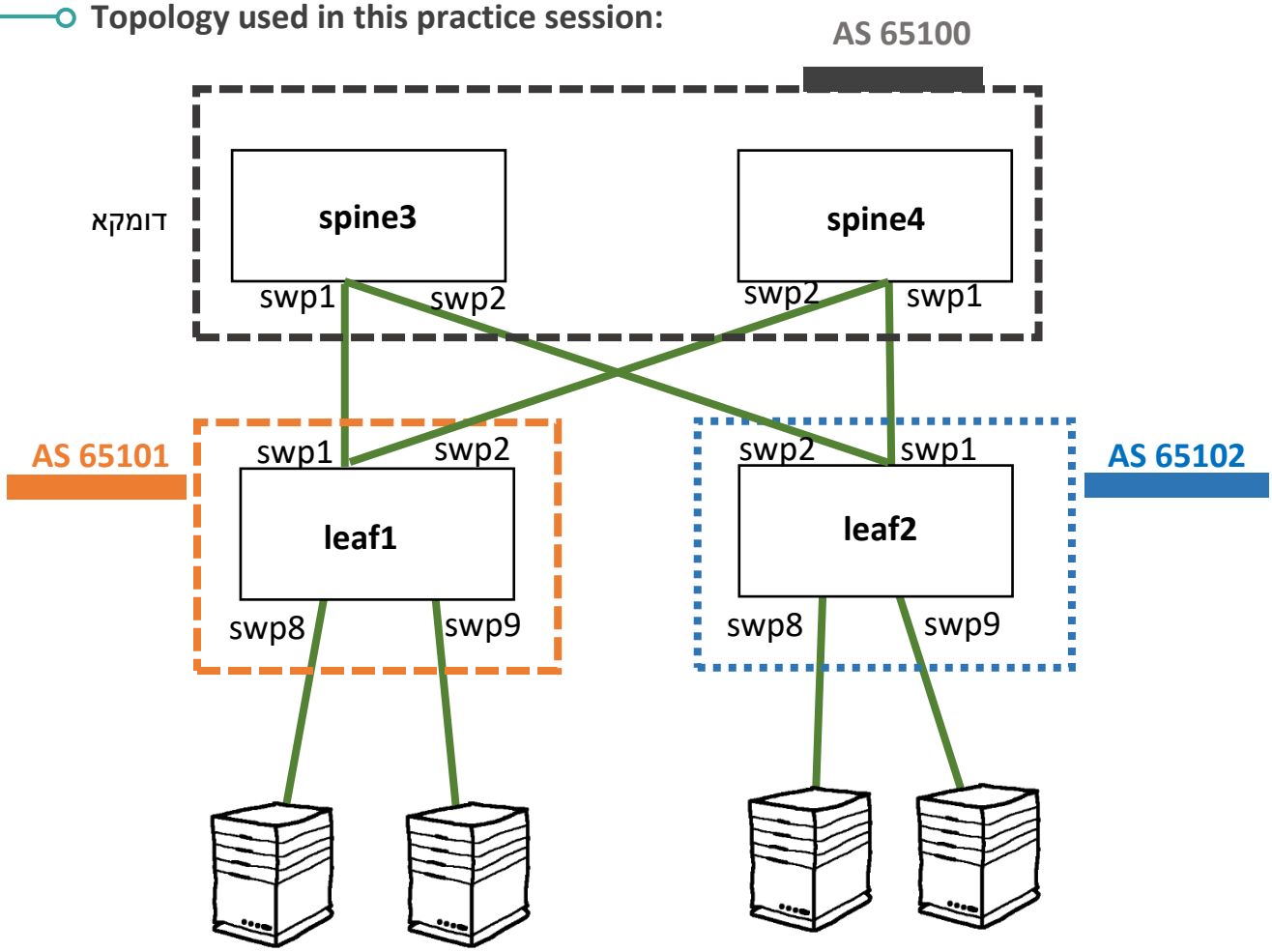
In this practice session you will configure BGP Unnumbered:

- 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:



## Task 1: Starting FRR

a. 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
```

b. 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
```

c. Restart FRR Service.

```
cumulus@leaf1:~$ sudo systemctl restart frr
```

** **Please note**:

- '**sudo**' privileges are required for those actions.

## Task 2: Configuring BGP Unnembered

a. Configure BGP unnumbered:

```
# net add bgp autonomous-system <LOCAL-AS>
# net add bgp neighbor <INTERFACE> interface remote-as external
```

```
cumulus@leaf1:~$ net add bgp autonomous-system 65101
cumulus@leaf1:~$ net add bgp neighbor swp1-2 interface remote-as external
cumulus@leaf1:~$ net commit
```

```
cumulus@spine3:~$ net add bgp autonomous-system 65100
cumulus@spine3:~$ net add bgp neighbor swp1-2 interface remote-as external
cumulus@spine3:~$ net commit
```

b. 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
```

c. 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

a. 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:

| 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 |

***# 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
```

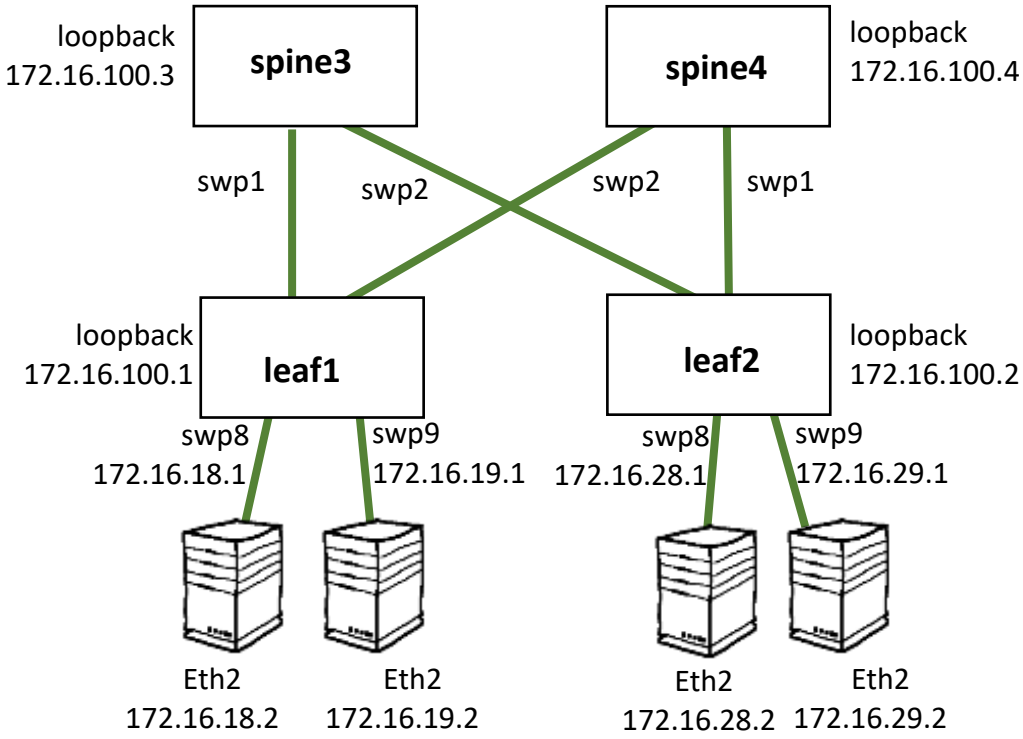
b. Verify loopback prefixes are reachable:
- Each switch should have in its routing table the prefixes of the other switches loopback interfaces.
***# net show route bgp***

```
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

a. 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.




***# 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
```

b. 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

a. 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)
```

b. 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
```

c. 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:

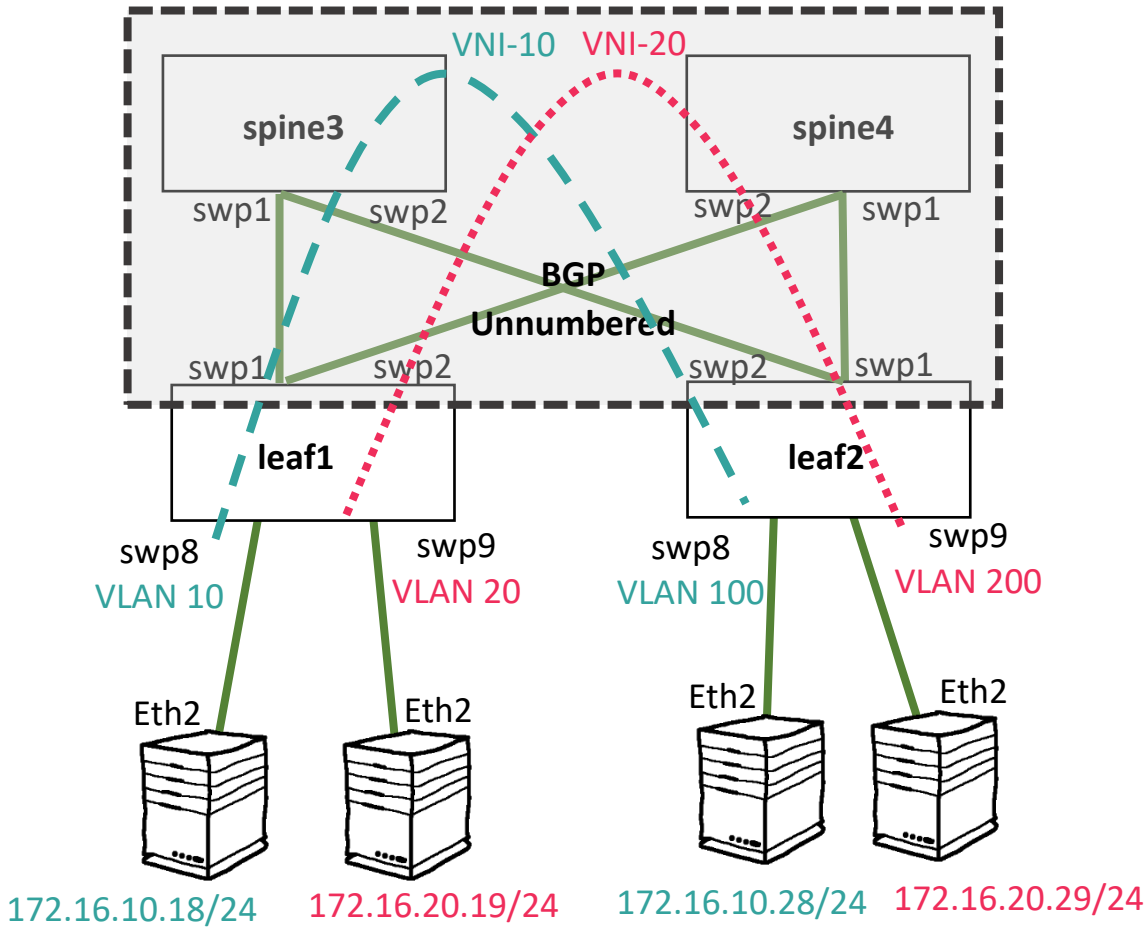
In this practice session you will configure VXLAN with EVPN:

- 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:



## Task 1: Configuring servers IP settings

a. 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
```

## Task 2: Configuring VLANs

a. 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

a. 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@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
```

```
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
```

## Task 4: Configuring EVPN

a. 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
```

b. 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
```

c. 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:

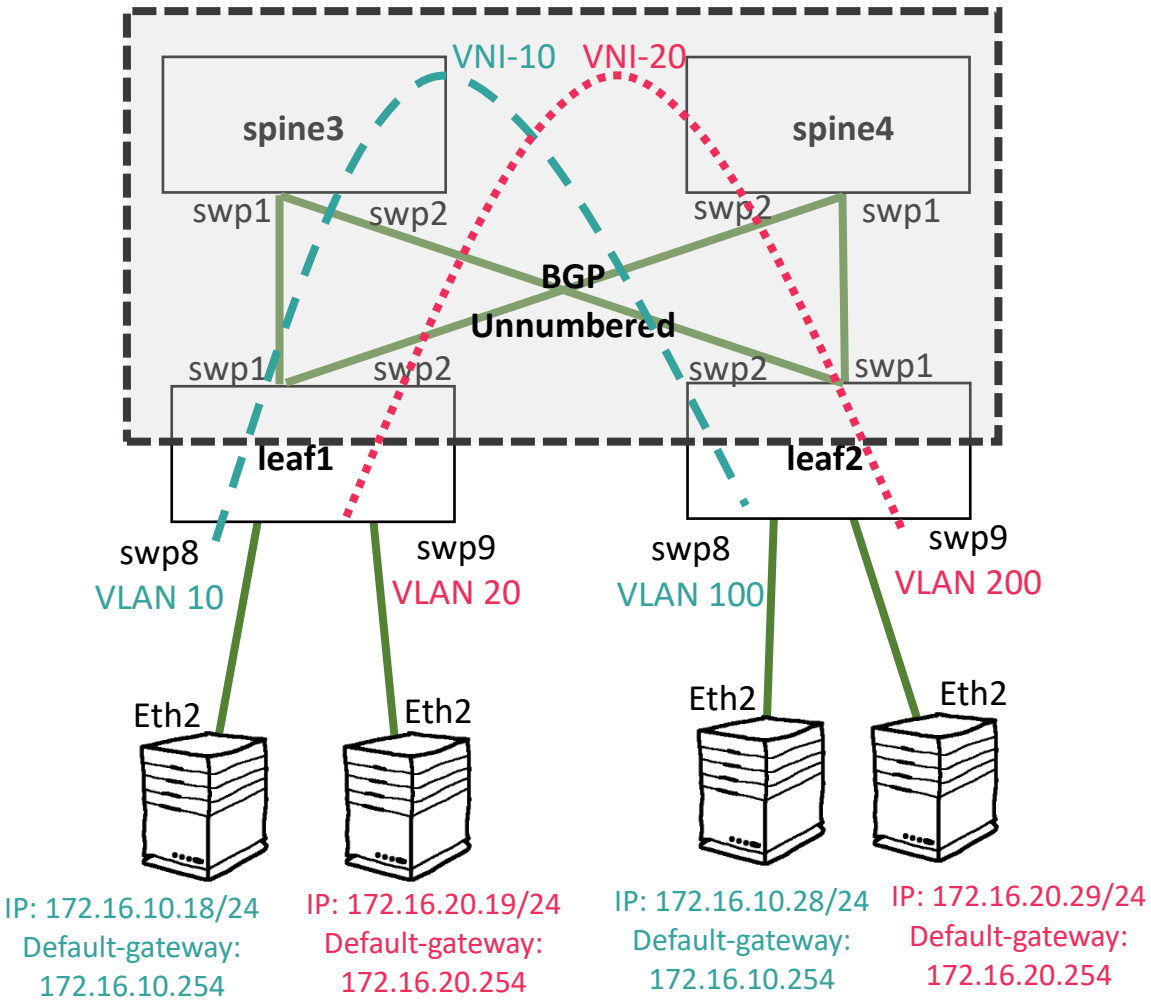
In this practice session you will configure distributed asymmetric VXLAN routing.

- 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:



## Task 1: Configuring servers IP settings

a. 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
```

b. 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

a. 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@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
```

```
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
```

***** 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

a. 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
```