NVIDIA® Cumulus Linux Virtual Workshop: Lab Guide

NVIDIA Cumulus Linux Virtual Workshop

Built for NVIDIA Cumulus Linux v5.14.0

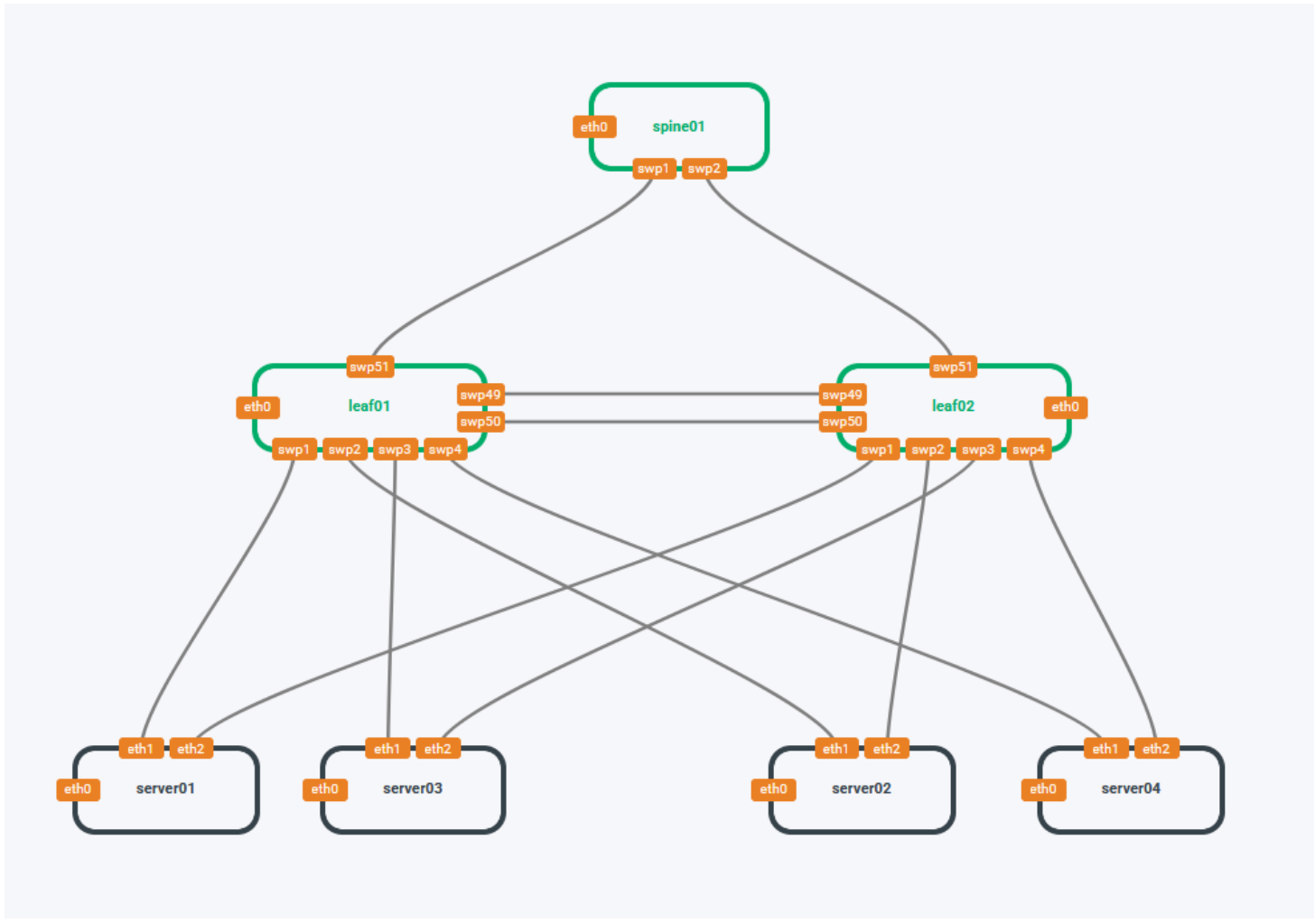
NVIDIA Cumulus Linux Workshop: Lab Guide

Contents

Table of Contents

Before you get started

The topology used for the lab is as below:



Below are the credentials used in the lab. Note that the `oob-mgmt-server` password needs to be updated on first-login.

System Name	Username	Password
oob-mgmt-server	ubuntu	nvidia
leaf01	cumulus	Cumu1usLinux!
leaf02	cumulus	Cumu1usLinux!
spine01	cumulus	Cumu1usLinux!
server01	ubuntu	nvidia
server02	ubuntu	nvidia
server03	ubuntu	nvidia
server04	ubuntu	nvidia

Lab 1: Verifying Lab Connectivity

Objective:

You will confirm that you can access your NVIDIA AIR workbench topology. This involves first visiting your AIR workbench in a web browser. You will connect to your Lab workbench via SSH to an out-of-band management server (oob-mgmt-server), from which you can access your switches.

Goals:

- **Learn how to access your Air workbench in a web browser**
- **Log into your oob-mgmt-server.**
- **From your oob-mgmt-server, access your switches via SSH.**

Procedure:

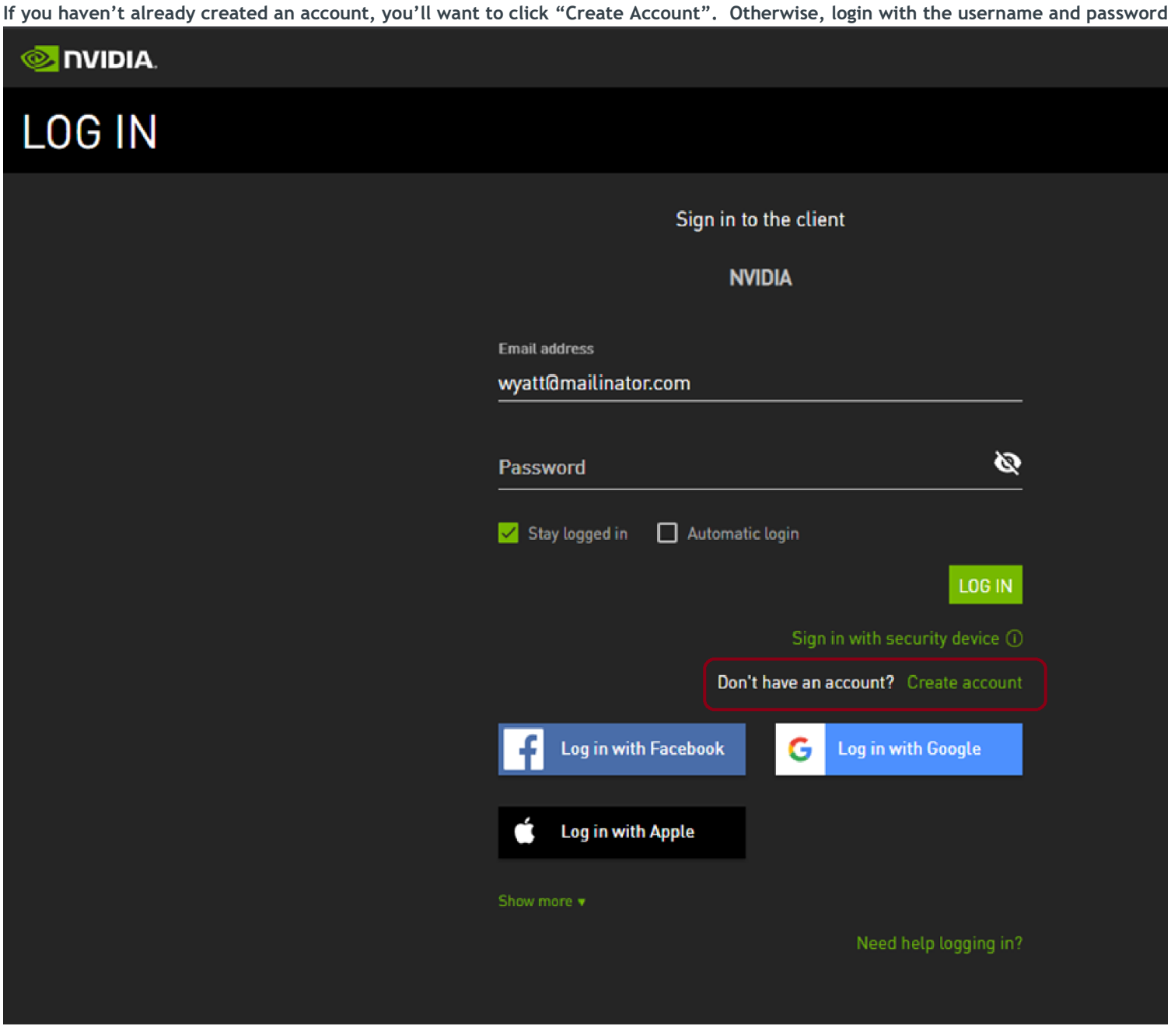
To access your lab workbench you will need to be registered with air.nvidia.com.

Access your NVIDIA AIR workbench

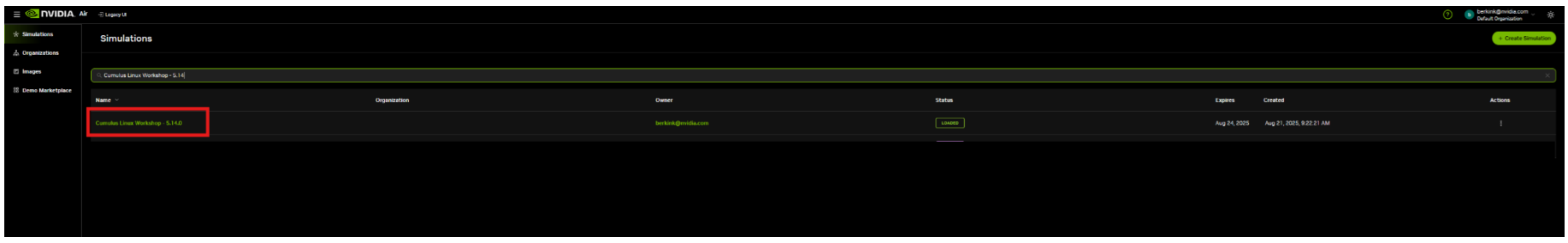
1. **Use a web browser to access and log into https://air.nvidia.com**

Type in the email address you use to sign up for this workshop.

If you haven't already created an account, you'll want to click "Create Account". Otherwise, login with the username and password you previously setup.



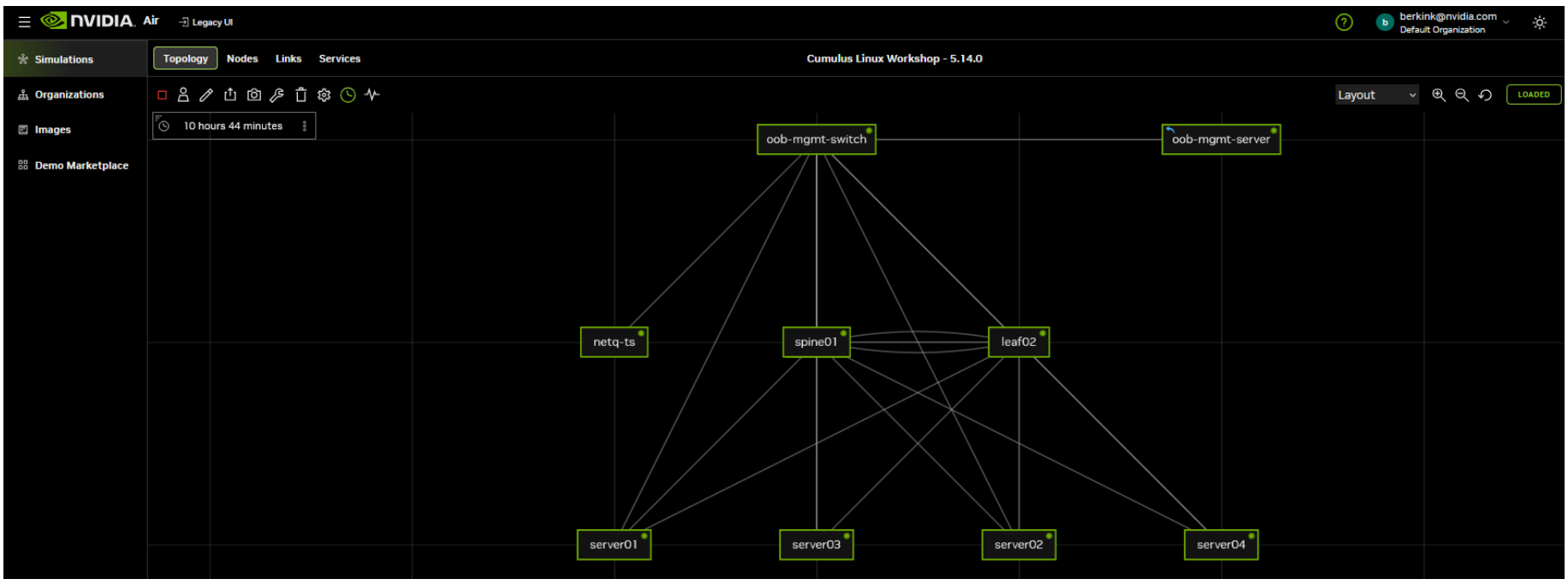
2. **Once at the Nvidia Air console, find your NVIDIA Cumulus Linux Workshop simulation**



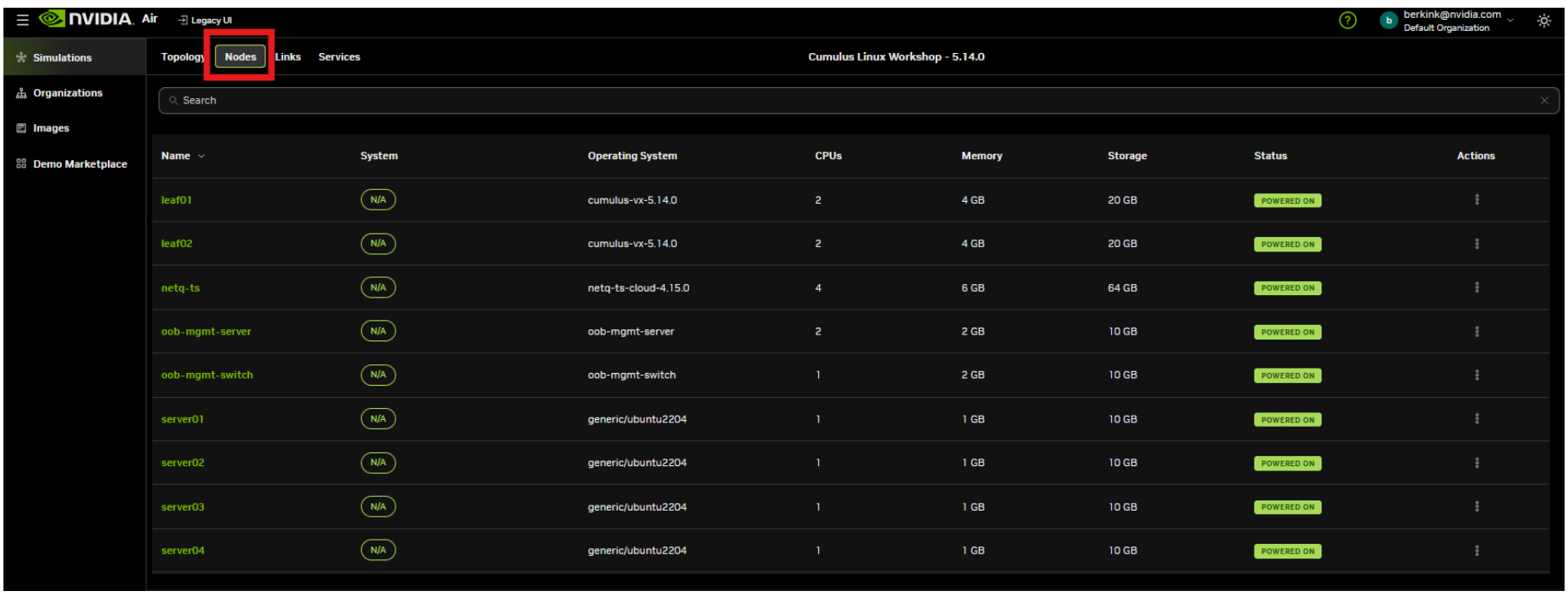
3. Click the “Cumulus Linux Workshop - 5.14.0” simulation to open your simulation console. If you do not have this simulation, it has either not been provisioned yet, as it is not close enough to the event, or you have used a different email address than the email we have for you.

Connect to your oob-mgmt-server

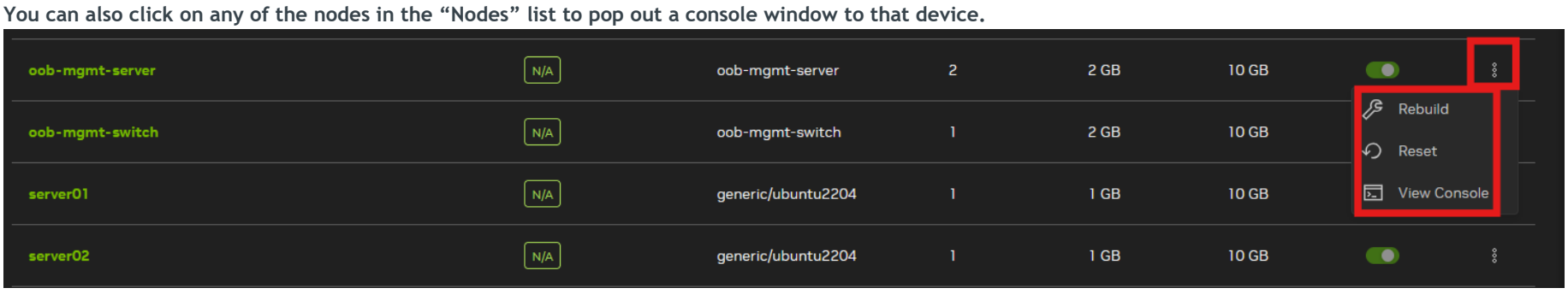
1. NVIDIA AIR GUI will show you a physical connection diagram and Simulation Guide.



2. By clicking on Nodes tab, you will see the list of all nodes in the simulation.



3. You can also click on any of the nodes in the “Nodes” list to pop out a console window to that device.



4. Log into the oob-mgmt-server. You will be asked to change your password on your first login to a new, unique password. First, login with the credentials according to the pre-login banner:

Username:	ubuntu
Password:	nvidia

Then, follow the instructions to set a new password. An example is below with the passwords unhidden. *Your new password* will be entered as the last two password entries

```
oob-mgmt-server login: ubuntu
Password: nvidia
You are required to change your password immediately (administrator enforced).
Changing password for ubuntu.
Current password: nvidia
New password: [your-new-password]
Retype new password: [your-new-password]
Welcome to Ubuntu 22.04.2 LTS (GNU/Linux 5.15.0-67-generic x86_64)

    <banner omitted for brevity>

ubuntu@oob-mgmt-server:~$
```

Run the setup playbook

1. Change directories to the folder named “Test-Drive-Automation” from the user cumulus home directory.

```
ubuntu@oob-mgmt-server:~$ cd Test-Drive-Automation
ubuntu@oob-mgmt-server:~/Test-Drive-Automation$
```

2. Perform a ‘git pull’ to sync/fetch changes

```
ubuntu@oob-mgmt-server:~/Test-Drive-Automation$ git pull
Already up-to-date.
ubuntu@oob-mgmt-server:~/Test-Drive-Automation$
```

3. Run the ‘start-lab.yml’ Ansible playbook.

```
ubuntu@oob-mgmt-server:~/Test-Drive-Automation$ ansible-playbook start-lab.yml
[WARNING]: Invalid characters were found in group names but not replaced, use
-vvvv to see details

PLAY [host] ********************************************************************

TASK [Setting up the test hosts config] ****************************************
Monday 29 July 2024  12:00:42 +0000 (0:00:00.026)       0:00:00.026 ***********
ok: [server01]
ok: [server02]

TASK [install traceroute] ******************************************************
Monday 29 July 2024  12:00:44 +0000 (0:00:01.480)       0:00:01.506 ***********
ok: [server01]
ok: [server02]

TASK [flush arp] ***************************************************************
Monday 29 July 2024  12:00:46 +0000 (0:00:01.879)       0:00:03.386 ***********
changed: [server01]
changed: [server02]

PLAY RECAP *********************************************************************
server01                   : ok=3    changed=1    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0
server02                   : ok=3    changed=1    unreachable=0    failed=0    skipped=0    rescued=0    ignored=0

Monday 29 July 2024  12:00:47 +0000 (0:00:01.077)       0:00:04.464 ***********
===============================================================================
install traceroute ------------------------------------------------------ 1.88s
Setting up the test hosts config ---------------------------------------- 1.48s
flush arp --------------------------------------------------------------- 1.08s
```

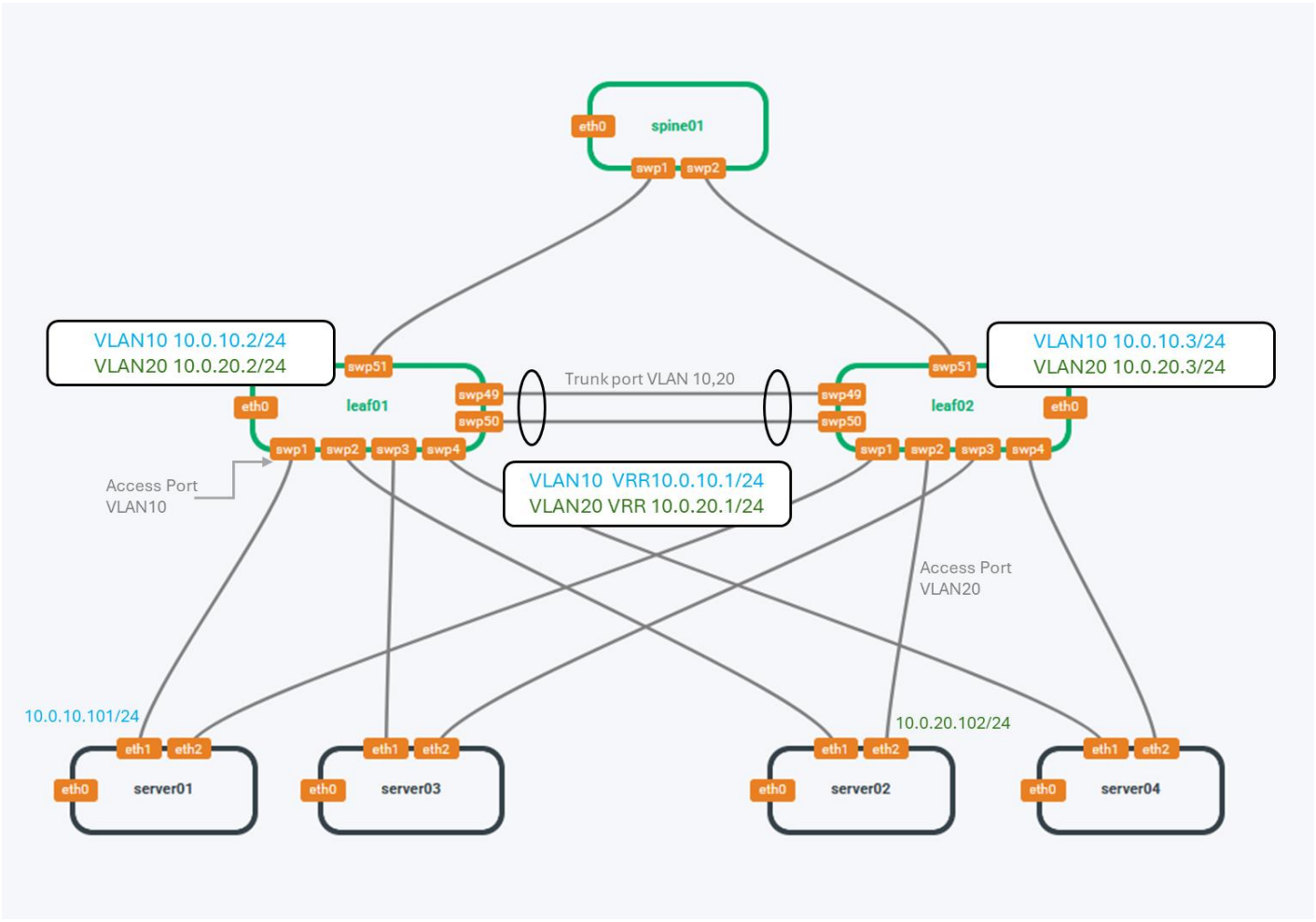
This concludes Lab 1.

Lab 2: Interface Configuration

Objective:

This lab will configure several types of interfaces. First, a bond will be configured between leaf01 and leaf02. The bond will be configured as a trunk to pass vlan10 and vlan20. Connections between leafs and servers will be configured as access ports. Server01 and Server02 will be in different subnets, so leaf01 and leaf02 will be configured to route for each vlan using VRR to provide high availability gateways for each vlan.

By the end of this lab, we'll have the following topology implemented:



Dependencies on other Labs:

- None

Goals:

- Configure loopback addresses for leaf01 and leaf02
- Configure a bond between leaf01 and leaf02
- Configure a bridge
- Create a trunk port and access port
- Configure SVIs on leaf01 and leaf02
- Configure VRR addresses on leaf01 and leaf02

Procedure:

Configure loopback addresses on leaf01 and leaf02

Interface Configuration Details		
Interface↓ \ Switch→	leaf01	leaf02
Loopback IP	10.255.255.1/32	10.255.255.2/32

1. On leaf01: Assign an ip address to the loopback interface.

```
cumulus@leaf01:mgmt:~$ nv set interface lo ip address 10.255.255.1/32
cumulus@leaf01:mgmt:~$ nv set system hostname leaf01
cumulus@leaf01:mgmt:~$ nv config apply
/etc/cumulus/switchd.d/kernel_route_offload_flags.conf has been manually changed since the last save.  These
changes WILL be overwritten.
/etc/cumulus/ports.conf has been manually changed since the last save.  These changes WILL be overwritten.
/etc/ntp.conf has been manually changed since the last save.  These changes WILL be overwritten.
/etc/ptp4l.conf has been manually changed since the last save.  These changes WILL be overwritten.
/etc/network/interfaces has been manually changed since the last save.  These changes WILL be overwritten.
/etc/frr/frr.conf has been manually changed since the last save.  These changes WILL be overwritten.
/etc/frr/daemons has been manually changed since the last save.  These changes WILL be overwritten.
The frr service will need to be restarted because the list of router services has changed.  This will disrupt
traffic.
/etc/hostname has been manually changed since the last save.  These changes WILL be overwritten.
/etc/hosts has been manually changed since the last save.  These changes WILL be overwritten.
Are you sure? [y/N] Y
cumulus@leaf01:mgmt:~$
```

2. On leaf02: Assign an ip address to the loopback interface.

```
cumulus@leaf02:mgmt:~$ nv set interface lo ip address 10.255.255.2/32
cumulus@leaf02:mgmt:~$ nv set system hostname leaf02
cumulus@leaf02:mgmt:~$ nv config apply
```

```
/etc/cumulus/switchd.d/kernel_route_offload_flags.conf has been manually changed since the last save.  These
changes WILL be overwritten.
/etc/cumulus/ports.conf has been manually changed since the last save.  These changes WILL be overwritten.
/etc/ntp.conf has been manually changed since the last save.  These changes WILL be overwritten.
/etc/ptp4l.conf has been manually changed since the last save.  These changes WILL be overwritten.
/etc/network/interfaces has been manually changed since the last save.  These changes WILL be overwritten.
/etc/frr/frr.conf has been manually changed since the last save.  These changes WILL be overwritten.
/etc/frr/daemons has been manually changed since the last save.  These changes WILL be overwritten.
The frr service will need to be restarted because the list of router services has changed.  This will disrupt
traffic.
/etc/hostname has been manually changed since the last save.  These changes WILL be overwritten.
/etc/hosts has been manually changed since the last save.  These changes WILL be overwritten.
Are you sure? [y/N] Y
cumulus@leaf02:mgmt:~$
```

Verify loopback IP address configuration

3. **On leaf01: Check that the address has been applied.**

```
cumulus@leaf01:mgmt:~$ nv show interface lo

                        operational        applied
----------------------  -----------------  ---------------
type                    loopback           loopback
router
  ospf
    enable                                 off
  pim
    enable                                 off
  ospf6
    enable                                 off
neighbor
  [ipv4]
  [ipv6]
ip
  igmp
    enable                                 off
  ipv4
    forward                                on
  ipv6
    enable                                 on
    forward                                on
  vrf                                      default
  [address]             10.255.255.1/32    10.255.255.1/32
  [address]             127.0.0.1/8
  [address]             ::1/128
link
  mtu                   65536
  state                 up
  stats
    in-bytes            776.02 KB
    in-pkts             11960
    in-drops            0
    in-errors           0
    out-bytes           776.02 KB
    out-pkts            11960
    out-drops           0
    out-errors          0
    carrier-transitions 0
  mac                   00:00:00:00:00:00
  protodown             disabled
  oper-status           unknown
  admin-status          up
ifindex                 1
```

4. **On leaf02: Check that the address has been applied.**

```
cumulus@leaf02:mgmt:~$ nv show interface lo
                        operational        applied
----------------------  -----------------  ---------------
type                    loopback           loopback
router
  ospf
    enable                                 off
  pim
    enable                                 off
  ospf6
    enable                                 off
neighbor
  [ipv4]
  [ipv6]
ip
  igmp
    enable                                 off
  ipv4
    forward                                on
  ipv6
    enable                                 on
    forward                                on
  vrf                                      default
  [address]             10.255.255.2/32    10.255.255.2/32
  [address]             127.0.0.1/8
  [address]             ::1/128
link
  mtu                   65536
  state                 up
  stats
```

```
    in-bytes             792.01 KB
    in-pkts              12208
    in-drops             0
    in-errors            0
    out-bytes            792.01 KB
    out-pkts             12208
    out-drops            0
    out-errors           0
    carrier-transitions  0
  mac                    00:00:00:00:00:00
  protodown              disabled
  oper-status            unknown
  admin-status           up
ifindex                  1
```

Important things to observe:
- Loopback has user-defined IP address as well as home address assigned to it
- Loopback has a predefined default configuration on NVIDIA Cumulus Linux. Make sure not to delete it.
- Applied is what you have configured.
- Operational is what is currently running on the switch.
- Pending (not shown here) is what you have configured, but not applied with “nv config apply”

Configure bond between leaf01 and leaf02

Bond Configuration Details		
Bond↓ \ Switch→	leaf01	leaf02
Bond name	BOND0	BOND0
Bond members	swp49,swp50	swp49,swp50

5. On leaf01: Create a bond with members swp49 and swp50.

```
cumulus@leaf01:mgmt:~$ nv set interface bond0 bond member swp49-50
cumulus@leaf01:mgmt:~$ nv config apply
```

6. On leaf02: Create a bond with members swp49 and swp50.

```
cumulus@leaf02:mgmt:~$ nv set interface bond0 bond member swp49-50
cumulus@leaf02:mgmt:~$ nv config apply
```

7. On leaf01 and leaf02: Check status of the bond between two switches. Verify that the bond is operational by checking the status of the bond and its members. See the red highlighted output below to verify that your lab output matches.

```
cumulus@leaf01:mgmt:~$ nv show interface bond0
                        operational             applied
----------------------  ----------------------  ----------
type                    bond                    bond
router
  pbr
    [map]
  ospf
    enable                                      off
  pim
    enable                                      off
  adaptive-routing
    enable                                      off
  ospf6
    enable                                      off
lldp
  dcbx-pfc-tlv          off
  dcbx-ets-config-tlv   off
  dcbx-ets-recomm-tlv   off
  state                 enabled
  [neighbor]
bond
  down-delay            0                       0
  lacp-bypass           off                     off
  lacp-rate             fast                    fast
  mode                  lacp                    lacp
  up-delay              0                       0
  [member]              swp49                   swp49
  [member]              swp50                   swp50
  mlag
    enable                                      off
bridge
  [domain]              br_default              br_default
evpn
  multihoming
    uplink                                      off
    segment
      enable                                    off
ptp
  enable                off                     off
[acl]
neighbor
  [ipv4]
  [ipv6]
sflow
  state                                         enabled
```

```
parent                    br_default
ip
  vrrp
    enable                                  off
  igmp
    enable                                  off
  neighbor-discovery
    enable                                  on
    router-advertisement
      enable                                off
    home-agent
      enable                                off
    [rdnss]
    [dnssl]
    [prefix]
  ipv4
    forward                                 on
  ipv6
    enable                                  on
    forward                                 on
  vrf                                       default
  [gateway]
link
  auto-negotiate          off
  duplex                  full              full
  speed                   2G                auto
  mac-address             48:b0:2d:a8:ea:7b
  fec                                       auto
  mtu                     9216              9216
  [flag]                  broadcast
  [flag]                  multicast
  [flag]                  master
  [flag]                  up
  [flag]                  lower-up
  state                   up                up
  flap-protection
    enable                                  on
  stats
    in-bytes              6.36 KB
    in-pkts               45
    in-drops              0
    in-errors             0
    out-bytes             6.00 KB
    out-pkts              48
    out-drops             1
    out-errors            0
    carrier-transitions   1
    carrier-up-count      1
    carrier-down-count    0
  protodown               disabled
  oper-status             up
  admin-status            up
  oper-status-last-change 2025/08/21 11:38:23.614
ifindex                   18
cumulus@leaf01:mgmt:~$
```

```
cumulus@leaf02:mgmt:~$ nv show interface bond0
                        operational             applied
----------------------  ----------------------  ----------
type                    bond                    bond
router
  pbr
    [map]
  ospf
    enable                                      off
  pim
    enable                                      off
  adaptive-routing
    enable                                      off
  ospf6
    enable                                      off
lldp
  dcbx-pfc-tlv            off
  dcbx-ets-config-tlv     off
  dcbx-ets-recomm-tlv     off
  state                   enabled
  [neighbor]
bond
  down-delay              0                     0
  lacp-bypass             off                   off
  lacp-rate               fast                  fast
  mode                    lacp                  lacp
  up-delay                0                     0
  [member]                swp49                 swp49
  [member]                swp50                 swp50
  mlag
    enable                                      off
bridge
  [domain]                br_default            br_default
evpn
  multihoming
    uplink                                      off
    segment
      enable                                    off
ptp
  enable                  off                   off
[acl]
neighbor
  [ipv4]
```

```
  [ipv6]
sflow
  state                                 enabled
parent                  br_default
ip
  vrrp
    enable                              off
  igmp
    enable                              off
  neighbor-discovery
    enable                              on
    router-advertisement
      enable                            off
    home-agent
      enable                            off
    [rdnss]
    [dnssl]
    [prefix]
  ipv4
    forward                             on
  ipv6
    enable                              on
    forward                             on
  vrf                                   default
  [gateway]
link
  auto-negotiate          off
  duplex                  full          full
  speed                   2G            auto
  mac-address             48:b0:2d:d5:21:b4
  fec                                   auto
  mtu                     9216          9216
  [flag]                  broadcast
  [flag]                  multicast
  [flag]                  master
  [flag]                  up
  [flag]                  lower-up
  state                   up                    up
  flap-protection
    enable                              on
  stats
    in-bytes              39.51 KB
    in-pkts               355
    in-drops              0
    in-errors             0
    out-bytes             37.06 KB
    out-pkts              292
    out-drops             1
    out-errors            0
    carrier-transitions   1
    carrier-up-count      1
    carrier-down-count    0
  protodown               disabled
  oper-status             up
  admin-status            up
  oper-status-last-change 2025/08/21 11:38:23.845
ifindex                   18
cumulus@leaf02:mgmt:~$
```

Important things to observe:

- **The speed of the bond is the cumulative speed of all member interfaces**

Configure bridge and access ports on leaf01 and leaf02

Bridge Configuration Details		
Bridge↓ \ Switch→	leaf01	leaf02
Bridge vlans	10,20	10,20
Bridge members	BOND0,swp1	BOND0,swp2
Bridge access port	swp1	swp2
Bridge access vlan	10	20

8. On leaf01: Create a bridge with vlans 10 and 20.

```
cumulus@leaf01:mgmt:~$ nv set bridge domain br_default vlan 10,20
```

9. On leaf01: Add swp1 and bond0 as a member to the bridge. *Note: The name bond0 is case sensitive in all places.*

```
cumulus@leaf01:mgmt:~$ nv set interface swp1,bond0 bridge domain br_default
```

10. On leaf01: Make swp1 (connecting to server01) an access port for vlan 10.

```
cumulus@leaf01:mgmt:~$ nv set interface swp1 bridge domain br_default access 10
```

11. On leaf01: Commit the changes.

```
cumulus@leaf01:mgmt:~$ nv config apply
```

12. On leaf02: Repeat the same steps but use swp2 as the access port towards the server (server02).

```
cumulus@leaf02:mgmt:~$ nv set bridge domain br_default vlan 10,20
cumulus@leaf02:mgmt:~$ nv set interface swp2,bond0 bridge domain br_default
cumulus@leaf02:mgmt:~$ nv set interface swp2 bridge domain br_default access 20
cumulus@leaf02:mgmt:~$ nv config apply
```

Note: The section below is provided for easier copying and pasting.

```
nv set bridge domain br_default vlan 10,20
nv set interface swp2,bond0 bridge domain br_default
nv set interface swp2 bridge domain br_default access 20
nv config apply
```

Verify bridge configuration on leaf01 and leaf02

13. On leaf01: Verify the configuration on leaf01 by checking that swp1 and BOND0 are part of the bridge.

```
cumulus@leaf01$ nv show bridge domain br_default vlan

Vlan  Ptp State  Source IP  VNI
----  ---------  ---------  ---
10    off        0.0.0.0
20    off        0.0.0.0
```

14. On leaf02: Verify the same configuration on leaf02 by checking that swp2 and BOND0 are part of the bridge.

```
cumulus@leaf02$ nv show bridge domain br_default vlan

Vlan  Ptp State  Source IP  VNI
----  ---------  ---------  ---
10    off        0.0.0.0
20    off        0.0.0.0
```

Important things to observe:
- Vlan information has not been completed yet

On leaf01:
- swp1 should be an access port in vlan 10
- BOND0 should be a trunk for vlan10 and vlan20, with a native vlan of 1 (PVID)

On leaf02:
- swp2 should be an access port in vlan 20
- BOND0 should be a trunk for vlan10 and vlan20, with a native vlan of 1 (PVID)

Configure SVI and VRR on leaf01 and leaf02

VRR Configuration details

Setting↓ \ Switch→	leaf01	leaf02
VLAN10 real IP address	10.0.10.2/24	10.0.10.3/24
VLAN10 VRR IP address	10.0.10.1/24	10.0.10.1/24
VLAN10 VRR MAC address	00:00:00:00:1a:10	00:00:00:00:1a:10
VLAN20 real IP address	10.0.20.2/24	10.0.20.3/24
VLAN20 VRR IP address	10.0.20.1/24	10.0.20.1/24
VLAN20 VRR MAC address	00:00:00:00:1a:20	00:00:00:00:1a:20
SERVER01 vlan	10	10
SERVER02 vlan	20	20

15. On leaf01: Create an SVI for vlan10

```
cumulus@leaf01:mgmt:~$ nv set interface vlan10 ip address 10.0.10.2/24
```

16. On leaf01: Create an SVI for vlan 20.

```
cumulus@leaf01:mgmt:~$ nv set interface vlan20 ip address 10.0.20.2/24
```

17. On leaf01: Apply a VRR address for vlan10.

```
cumulus@leaf01:mgmt:~$ nv set interface vlan10 ip vrr address 10.0.10.1/24
cumulus@leaf01:mgmt:~$ nv set interface vlan10 ip vrr mac-address 00:00:00:00:1a:10
cumulus@leaf01:mgmt:~$ nv set interface vlan10 ip vrr state up
```

18. On leaf01: Apply a VRR address for vlan20.

```
cumulus@leaf01:mgmt:~$ nv set interface vlan20 ip vrr address 10.0.20.1/24
cumulus@leaf01:mgmt:~$ nv set interface vlan20 ip vrr mac-address 00:00:00:00:1a:20
cumulus@leaf01:mgmt:~$ nv set interface vlan20 ip vrr state up
```

19. On leaf01: Commit the changes.

```
cumulus@leaf01:mgmt:~$ nv config apply
```

20. On leaf02: Repeat steps these steps.

```
cumulus@leaf02:mgmt:~$ nv set interface vlan10 ip address 10.0.10.3/24
cumulus@leaf02:mgmt:~$ nv set interface vlan20 ip address 10.0.20.3/24
cumulus@leaf02:mgmt:~$ nv set interface vlan10 ip vrr address 10.0.10.1/24
cumulus@leaf02:mgmt:~$ nv set interface vlan10 ip vrr mac-address 00:00:00:00:1a:10
cumulus@leaf02:mgmt:~$ nv set interface vlan10 ip vrr state up
cumulus@leaf02:mgmt:~$ nv set interface vlan20 ip vrr address 10.0.20.1/24
cumulus@leaf02:mgmt:~$ nv set interface vlan20 ip vrr mac-address 00:00:00:00:1a:20
cumulus@leaf02:mgmt:~$ nv set interface vlan20 ip vrr state up
cumulus@leaf02:mgmt:~$ nv config apply
```

Note: The section below is provided for easier copying and pasting.

```
nv set interface vlan10 ip address 10.0.10.3/24
nv set interface vlan10 ip vrr address 10.0.10.1/24
nv set interface vlan10 ip vrr mac-address 00:00:00:00:1a:10
nv set interface vlan10 ip vrr state up
nv set interface vlan20 ip address 10.0.20.3/24
nv set interface vlan20 ip vrr address 10.0.20.1/24
nv set interface vlan20 ip vrr mac-address 00:00:00:00:1a:20
nv set interface vlan20 ip vrr state up
nv config apply
```

Test VRR connectivity

21. On server01: Test connectivity from server01 to the VRR gateway address. The login and password on the servers is ubuntu/nvidia

```
ubuntu@server01:~$ ping 10.0.10.1
PING 10.0.10.1 (10.0.10.1) 56(84) bytes of data.
64 bytes from 10.0.10.1: icmp_seq=1 ttl=64 time=0.686 ms
64 bytes from 10.0.10.1: icmp_seq=2 ttl=64 time=0.922 ms
^C
--- 10.0.10.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.686/0.804/0.922/0.118 ms
```

22. On server01: Test connectivity from server01 to leaf01 real IP address.

```
ubuntu@server01:~$ ping 10.0.10.2
PING 10.0.10.2 (10.0.10.2) 56(84) bytes of data.
64 bytes from 10.0.10.2: icmp_seq=1 ttl=64 time=0.887 ms
64 bytes from 10.0.10.2: icmp_seq=2 ttl=64 time=0.835 ms
^C
--- 10.0.10.2 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.835/0.861/0.887/0.026 ms
```

23. On server01: Test connectivity from server01 to leaf02 real IP address.

```
ubuntu@server01:~$ ping 10.0.10.3
PING 10.0.10.3 (10.0.10.3) 56(84) bytes of data.
64 bytes from 10.0.10.3: icmp_seq=1 ttl=64 time=0.528 ms
64 bytes from 10.0.10.3: icmp_seq=2 ttl=64 time=0.876 ms
^C
--- 10.0.10.3 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.528/0.702/0.876/0.174 ms
```

24. On server01: Check the IP neighbor table which is similar to the ARP table, to view each MAC address. It also includes ipv6 neighbors. The arp table could also be evaluated using the “arp -a” command.

```
ubuntu@server01:~$ ip neighbor show
192.168.200.1 dev eth0 lladdr 44:38:39:00:00:11 REACHABLE
10.0.10.1 dev eth1 lladdr 00:00:00:00:1a:10 STALE
10.0.10.2 dev eth1 lladdr 44:38:39:00:00:05 STALE
10.0.10.3 dev eth1 lladdr 44:38:39:00:00:0b STALE
fe80::4638:39ff:fe00:5 dev eth1 lladdr 44:38:39:00:00:05 router STALE
fe80::4638:39ff:fe00:12 dev eth0 lladdr 44:38:39:00:00:12 router STALE
fe80::4638:39ff:fe00:b dev eth1 lladdr 44:38:39:00:00:0b router REACHABLE
```

25. On server02: Repeat the same connectivity tests in step 21-24 from server02 to switch IP addresses.

```
ubuntu@server02:~$ ping 10.0.20.1
PING 10.0.20.1 (10.0.20.1) 56(84) bytes of data.
64 bytes from 10.0.20.1: icmp_seq=1 ttl=64 time=1.22 ms
```

```
64 bytes from 10.0.20.1: icmp_seq=2 ttl=64 time=0.672 ms
^C
--- 10.0.20.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.672/0.949/1.226/0.277 ms
```

```
ubuntu@server02:~$ ping 10.0.20.2
PING 10.0.20.2 (10.0.20.2) 56(84) bytes of data.
64 bytes from 10.0.20.2: icmp_seq=1 ttl=64 time=0.735 ms
64 bytes from 10.0.20.2: icmp_seq=2 ttl=64 time=1.02 ms
^C
--- 10.0.20.2 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.735/0.882/1.029/0.147 ms
```

```
ubuntu@server02:~$ ping 10.0.20.3
PING 10.0.20.3 (10.0.20.3) 56(84) bytes of data.
64 bytes from 10.0.20.3: icmp_seq=1 ttl=64 time=0.993 ms
64 bytes from 10.0.20.3: icmp_seq=2 ttl=64 time=1.08 ms
^C
--- 10.0.20.3 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 0.993/1.040/1.087/0.047 ms
```

```
ubuntu@server02:~$ ip neighbor show
192.168.200.1 dev eth0 lladdr 44:38:39:00:00:11 REACHABLE
10.0.20.2 dev eth2 lladdr 44:38:39:00:00:05 REACHABLE
10.0.20.3 dev eth2 lladdr 44:38:39:00:00:0b REACHABLE
10.0.20.1 dev eth2 lladdr 00:00:00:00:1a:20 STALE
fe80::4638:39ff:fe00:5 dev eth2 lladdr 44:38:39:00:00:05 router STALE
fe80::4638:39ff:fe00:12 dev eth0 lladdr 44:38:39:00:00:12 router STALE
fe80::4638:39ff:fe00:b dev eth2 lladdr 44:38:39:00:00:0b router STALE
```

Important things to observe:

- Pings to the VRR and unique SVI IP addresses should all be successful for all Vlans

26. On server01 and server02: Ping to verify connectivity between server01 and server02.

```
ubuntu@server01:~$ ping 10.0.20.102
PING 10.0.20.102 (10.0.20.102) 56(84) bytes of data.
64 bytes from 10.0.20.102: icmp_seq=1 ttl=63 time=0.790 ms
64 bytes from 10.0.20.102: icmp_seq=2 ttl=63 time=1.35 ms
^C
--- 10.0.20.102 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.790/1.070/1.351/0.282 ms
```

```
ubuntu@server02:~$ ping 10.0.10.101
PING 10.0.10.101 (10.0.10.101) 56(84) bytes of data.
64 bytes from 10.0.10.101: icmp_seq=1 ttl=63 time=1.08 ms
64 bytes from 10.0.10.101: icmp_seq=2 ttl=63 time=1.36 ms
^C
--- 10.0.10.101 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 1.089/1.225/1.361/0.136 ms
```

27. On server01 and server02: traceroute to server02.

```
ubuntu@server01:~$ traceroute 10.0.20.102
traceroute to 10.0.20.102 (10.0.20.102), 30 hops max, 60 byte packets
 1  10.0.10.1 (10.0.10.1)  1.628 ms  1.672 ms  1.855 ms
 2  10.0.20.102 (10.0.20.102)  7.947 ms  7.973 ms  8.155 ms
cumulus@server01:~$
```

```
ubuntu@server02:~$ traceroute 10.0.10.101
traceroute to 10.0.10.101 (10.0.10.101), 30 hops max, 60 byte packets
 1  10.0.20.1 (10.0.20.1)  2.813 ms  2.776 ms  3.307 ms
 2  10.0.10.101 (10.0.10.101)  9.199 ms  7.836 ms  7.766 ms
cumulus@server02:~$
```

Verify MAC address table on leaf01 and leaf02

28. On leaf01 and leaf02 : Check to verify that the MAC addresses are learned correctly.

```
cumulus@leaf01:mgmt:~$ nv show bridge domain br_default mac-table

entry-id  MAC address        vlan  interface   remote-dst  src-vni  entry-type  last-update  age
--------  -----------------  ----  ----------  ----------  -------  ----------  -----------  -------
1         48:b0:2d:db:95:44  10    swp1                                         0:00:00      0:01:43
2         48:b0:2d:f8:3d:4c        swp1                                 permanent   0:16:37      0:16:37
3         48:b0:2d:46:ba:d2  20    bond0                                        0:00:29      0:07:15
4         00:00:00:00:1a:20  20    bond0                                        0:00:39      0:10:08
5         44:38:39:22:01:c8  20    bond0                                        0:00:24      0:10:08
6         44:38:39:22:01:c8  10    bond0                                        0:01:43      0:04:22
7         44:38:39:22:01:c8  1     bond0                                        0:14:17      0:14:19
```

```
8         48:b0:2d:44:7b:d7  1     bond0                                 0:00:27      0:16:27
9         48:b0:2d:4e:b6:de  1     bond0                                 0:00:27      0:16:27
10        48:b0:2d:8b:5f:13  1     bond0                       permanent 0:16:37      0:16:37
11        48:b0:2d:8b:5f:13        bond0                       permanent 0:16:37      0:16:37
12        00:00:00:00:1a:10        br_default                  permanent
13        44:38:39:22:01:80  20    br_default                  permanent 0:10:34      0:10:34
14        00:00:00:00:1a:10  10    br_default                  permanent 0:10:34      0:10:34
15        44:38:39:22:01:80  10    br_default                  permanent 0:10:34      0:10:34
16        44:38:39:22:01:80  1     br_default                  permanent 0:16:37      0:16:37
17        44:38:39:22:01:80        br_default                  permanent 0:16:37      0:16:37
cumulus@leaf01:mgmt:~$
```

```
cumulus@leaf02:mgmt:~$ nv show bridge domain br_default mac-table

 entry-id  MAC address        vlan  interface   remote-dst  src-vni  entry-type  last-update  age
--------  -----------------  ----  ----------  ----------  -------  ----------  -----------  -------
1         48:b0:2d:46:ba:d2  20    swp2                                         0:00:30      0:02:11
2         48:b0:2d:cc:6c:c4        swp2                                permanent 0:16:04      0:16:04
3         48:b0:2d:db:95:44  10    bond0                                        0:01:07      0:07:25
4         44:38:39:22:01:80  20    bond0                                        0:02:11      0:02:11
5         44:38:39:22:01:80  10    bond0                                        0:01:09      0:12:17
6         48:b0:2d:19:9b:8a  1     bond0                                        0:00:09      0:15:39
7         48:b0:2d:8b:5f:13  1     bond0                                        0:00:00      0:16:02
8         48:b0:2d:44:7b:d7  1     bond0                       permanent        0:16:04      0:16:04
9         48:b0:2d:44:7b:d7        bond0                       permanent        0:16:04      0:16:04
10        00:00:00:00:1a:10        br_default                  permanent
11        00:00:00:00:1a:20        br_default                  permanent
12        00:00:00:00:1a:20  20    br_default                  permanent        0:11:50      0:11:50
13        44:38:39:22:01:c8  20    br_default                  permanent        0:11:50      0:11:50
14        44:38:39:22:01:c8  10    br_default                  permanent        0:11:50      0:11:50
15        00:00:00:00:1a:10  10    br_default                  permanent        0:11:50      0:11:50
16        44:38:39:22:01:c8  1     br_default                  permanent        0:16:04      0:16:04
17        44:38:39:22:01:c8        br_default                  permanent        0:16:04      0:16:04
cumulus@leaf02:mgmt:~$
```

Important things to observe:

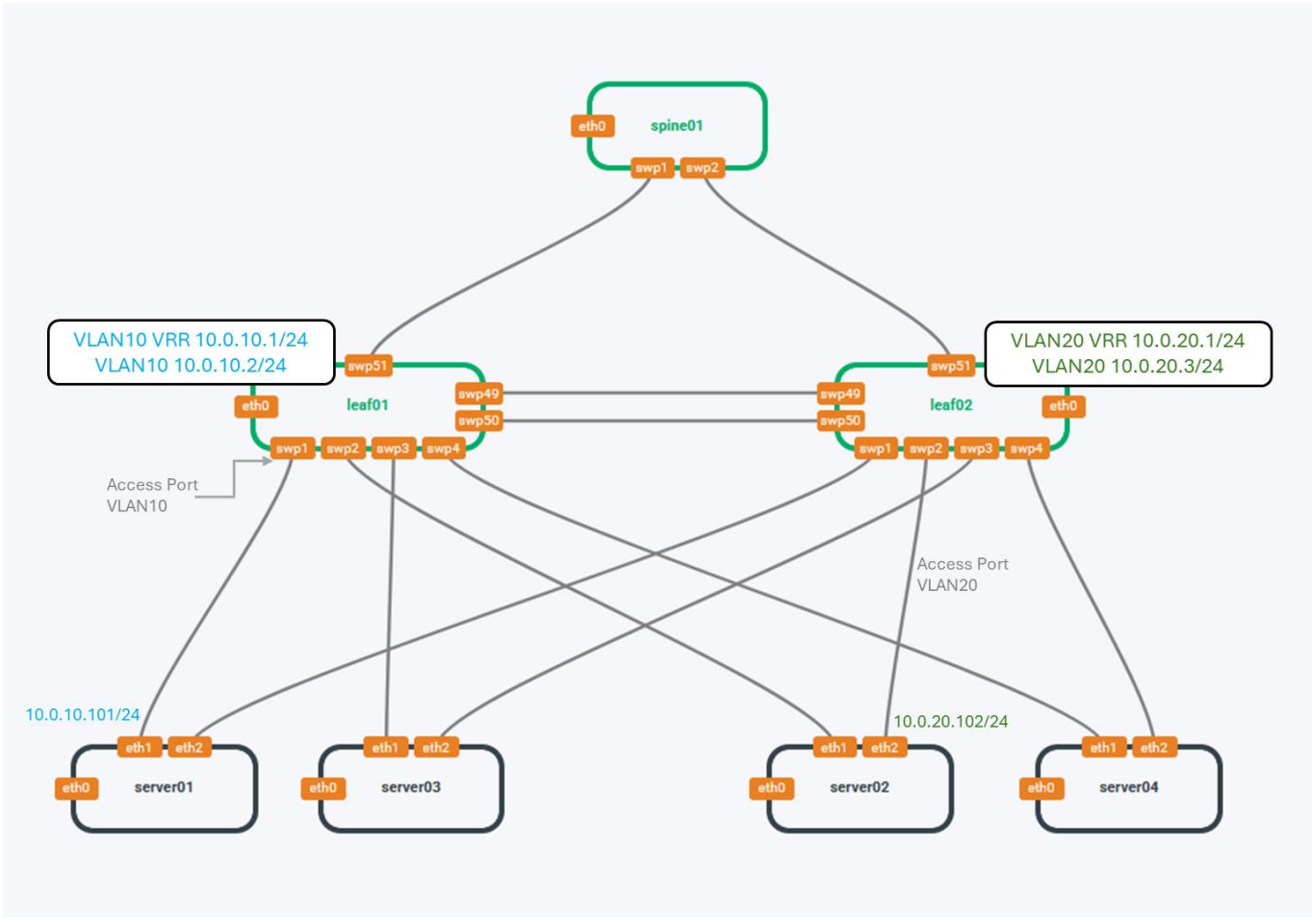
- **MAC addresses of servers should be learned on BOND0 and swp interface of switch**

This concludes Lab 2.

Lab 3: BGP Unnumbered and VRF-Lite configuration

Objective:

This lab will configure BGP unnumbered between the leaf01/leaf02 to spine01. This configuration will share the ip addresses of the loopback interfaces on each device as well as the vlan10 and vlan20 subnets on the leaf01 and leaf02 devices.
As a second step this lab covers VRF-lite configuration in combination with BGP (unnumbered) peering to carry VRF specific prefixes.



Dependencies on other Labs:

- None. Running Lab3.yml playbook configures all prerequisites.

Goals:

- Configure BGP unnumbered on spine01
- Configure BGP unnumbered on leaf01/leaf02
- Advertise loopback addresses into BGP
- Advertise SVI subnets of leafs into BGP
- Verify BGP peering
- Verify BGP route advertisements
- Verify routed connectivity and path between servers
- Configure VRF-lite across leaf01, spine01 and leaf02
- Configure BGP peering between VRF member subinterfaces
- Advertise prefixes into VRF
- Verify connectivity

Procedure:

Run Lab3 setup playbook

1. On oob-mgmt-server: Run the playbook named ‘lab3.yml’. Even if you fully completed Lab2, you must run this playbook.

```
ubuntu@oob-mgmt-server:~/Test-Drive-Automation$ ansible-playbook lab3.yml

[WARNING]: Invalid characters were found in group names but not replaced, use -vvvv to see details

PLAY [Getting you ready for lab3]
*********************************************************************************************

TASK [Dropping in config]
*********************************************************************************************************
Wednesday 11 May 2022  17:32:27 +0000 (0:00:00.018)       0:00:00.018 *********
ok: [server02]
ok: [server01]

PLAY [Getting you ready for lab3]
*********************************************************************************************

TASK [Drop the nvue yaml]
*********************************************************************************************************
Wednesday 11 May 2022  17:32:28 +0000 (0:00:01.362)       0:00:01.381 *********
changed: [leaf01]
changed: [leaf02]

RUNNING HANDLER [nvue config replace]
*********************************************************************************************
Wednesday 11 May 2022  17:32:29 +0000 (0:00:01.063)       0:00:02.445 *********
changed: [leaf02]
changed: [leaf01]

RUNNING HANDLER [nvue config apply]
*********************************************************************************************
```

```
Wednesday 11 May 2022  17:32:30 +0000 (0:00:01.088)       0:00:03.533 *********
changed: [leaf02]
changed: [leaf01]

PLAY RECAP
*********************************************************************************************************************
***
leaf01                     : ok=3    changed=3    unreachable=0    failed=0    skipped=0    rescued=0    ignored=
leaf02                     : ok=3    changed=3    unreachable=0    failed=0    skipped=0    rescued=0    ignored=
server01                   : ok=1    changed=0    unreachable=0    failed=0    skipped=0    rescued=0    ignored=
server02                   : ok=1    changed=0    unreachable=0    failed=0    skipped=0    rescued=0    ignored=

Wednesday 11 May 2022  17:32:35 +0000 (0:00:05.243)       0:00:08.777 *********
===============================================================================
nvue config apply ------------------------------------------------------------------------------------------------
------- 5.24s
Dropping in config -----------------------------------------------------------------------------------------------
------- 1.36s
nvue config replace ----------------------------------------------------------------------------------------------
------- 1.09s
Drop the nvue yaml -----------------------------------------------------------------------------------------------
------- 1.06s
```

Apply loopback address to spine01

Loopback Configuration			
Configuration↓ \ Switch→	leaf01	leaf02	spine01
Loopback IP address	10.255.255.1/32	10.255.255.2/32	10.255.255.101/32

2. On spine01: Configure a loopback interface

```
cumulus@spine01:mgmt:~$ nv set interface lo ip address 10.255.255.101/32
cumulus@spine01:mgmt:~$ nv set system hostname spine01
cumulus@spine01:mgmt:~$ nv config apply
```

Leaf01 and Leaf02 loopback addresses are already configured.

Configure BGP unnumbered on spine01, leaf01 and leaf02

3. On spine01: Configure a BGP Autonomous System (AS) number for the routing instance.

```
cumulus@spine01:mgmt:~$ nv set vrf default router bgp autonomous-system 65201
cumulus@spine01:mgmt:~$ nv set vrf default router bgp path-selection multipath aspath-ignore on
cumulus@spine01:mgmt:~$ nv set router bgp router-id 10.255.255.101
```

4. On spine01: Configure BGP peering on swp1 towards leaf01 and swp2 towards leaf02.

```
cumulus@spine01:mgmt:~$ nv set vrf default router bgp neighbor swp1 remote-as external
cumulus@spine01:mgmt:~$ nv set vrf default router bgp neighbor swp2 remote-as external
cumulus@spine01:mgmt:~$ nv set interface swp1 link state up
cumulus@spine01:mgmt:~$ nv set interface swp2 link state up
```

5. On spine01: Commit the changes.

```
cumulus@spine01:mgmt:~$ nv config apply
```

6. On leaf01: Repeat steps 2-5.

```
cumulus@leaf01:mgmt:~$ nv set vrf default router bgp autonomous-system 65101
cumulus@leaf01:mgmt:~$ nv set vrf default router bgp path-selection multipath aspath-ignore on
cumulus@leaf01:mgmt:~$ nv set vrf default router bgp router-id 10.255.255.1
cumulus@leaf01:mgmt:~$ nv set vrf default router bgp neighbor swp51 remote-as external
cumulus@leaf01:mgmt:~$ nv set interface swp51 link state up
cumulus@leaf01:mgmt:~$ nv config apply
```

For copy/paste convenience:

```
nv set vrf default router bgp autonomous-system 65101
nv set vrf default router bgp path-selection multipath aspath-ignore on
nv set vrf default router bgp router-id 10.255.255.1
nv set vrf default router bgp neighbor swp51 remote-as external
nv set interface swp51 link state up
nv config apply
```

7. On leaf02: Repeat steps 2-5.

```
cumulus@leaf02:mgmt:~$ nv set vrf default router bgp autonomous-system 65102
cumulus@leaf02:mgmt:~$ nv set vrf default router bgp path-selection multipath aspath-ignore on
cumulus@leaf02:mgmt:~$ nv set vrf default router bgp router-id 10.255.255.2
cumulus@leaf02:mgmt:~$ nv set vrf default router bgp neighbor swp51 remote-as external
cumulus@leaf02:mgmt:~$ nv set interface swp51 link state up
cumulus@leaf02:mgmt:~$ nv config apply
```

For copy/paste convenience:

```
nv set vrf default router bgp autonomous-system 65102
nv set vrf default router bgp path-selection multipath aspath-ignore on
nv set vrf default router bgp router-id 10.255.255.2
nv set vrf default router bgp neighbor swp51 remote-as external
nv set interface swp51 link state up
nv config apply
```

Verify BGP connectivity between fabric nodes

8. **On spine01: Verify BGP peering between spine and leafs.**

```
cumulus@spine01:mgmt:~$ sudo vtysh -c "show ip bgp summary"

IPv4 Unicast Summary (VRF default):
BGP router identifier 10.255.255.101, local AS number 65201 vrf-id 0
BGP table version 5
RIB entries 9, using 1728 bytes of memory
Peers 2, using 40 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
leaf01(swp1)    4      65101        83        83        0    0    0 00:03:51            2        5 N/A
leaf02(swp2)    4      65102        78        78        0    0    0 00:03:38            2        5 N/A

Total number of neighbors 2
```

or

```
cumulus@spine01:mgmt:~$ nv show vrf default router bgp neighbor brief

AS - Remote Autonomous System, PeerEstablishedTime - Peer established time in
UTC format, UpTime - Last connection reset time in days,hours:min:sec, Afi-Safi
- Address family, PfxSent - Transmitted prefix counter, PfxRcvd - Recieved
prefix counter

Neighbor  AS     State        PeerEstablishedTime   UpTime   MsgRcvd  MsgSent  Afi-Safi      PfxSent  PfxRcvd
--------  -----  -----------  --------------------  -------  -------  -------  ------------  -------  -------
swp1      65101  established  2025-05-09T11:26:39Z  0:01:34  36       36       ipv4-unicast  5        2
swp2      65102  established  2025-05-09T11:26:39Z  0:01:34  36       36       ipv4-unicast  5        2
```

9. **On leaf01: Verify BGP peering between leafs and spine**

```
cumulus@leaf01:mgmt:~$ sudo vtysh -c "show ip bgp summary"

IPv4 Unicast Summary (VRF default):
BGP router identifier 10.255.255.1, local AS number 65101 vrf-id 0
BGP table version 5
RIB entries 9, using 1728 bytes of memory
Peers 1, using 20 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
spine01(swp51)  4      65201        92        93        0    0    0 00:04:18            3        5 N/A

Total number of neighbors 1
```

```
cumulus@leaf02:mgmt:~$ sudo vtysh -c "show ip bgp summary"

IPv4 Unicast Summary (VRF default):
BGP router identifier 10.255.255.2, local AS number 65102 vrf-id 0
BGP table version 5
RIB entries 9, using 1728 bytes of memory
Peers 1, using 20 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
cumulus(swp51)  4      65201        96        97        0    0    0 00:04:31            3        5 N/A

Total number of neighbors 1
```

Or

```
cumulus@leaf01:mgmt:~$ nv show vrf default router bgp neighbor brief

AS - Remote Autonomous System, PeerEstablishedTime - Peer established time in
UTC format, UpTime - Last connection reset time in days,hours:min:sec, Afi-Safi
- Address family, PfxSent - Transmitted prefix counter, PfxRcvd - Recieved
prefix counter

Neighbor  AS     State        PeerEstablishedTime   UpTime   MsgRcvd  MsgSent  Afi-Safi      PfxSent  PfxRcvd
--------  -----  -----------  --------------------  -------  -------  -------  ------------  -------  -------
swp51     65201  established  2025-05-09T11:26:38Z  1:05:24  1313     1314     ipv4-unicast  5        3
```

```
cumulus@leaf02:mgmt:~$ nv show vrf default router bgp neighbor brief

AS - Remote Autonomous System, PeerEstablishedTime - Peer established time in
UTC format, UpTime - Last connection reset time in days,hours:min:sec, Afi-Safi
- Address family, PfxSent - Transmitted prefix counter, PfxRcvd - Recieved
prefix counter

Neighbor  AS     State        PeerEstablishedTime   UpTime   MsgRcvd  MsgSent  Afi-Safi      PfxSent  PfxRcvd
--------  -----  -----------  --------------------  -------  -------  -------  ------------  -------  -------
swp51     65201  established  2025-05-09T11:26:39Z  1:07:03  1346     1347     ipv4-unicast  5        3
```

Important things to observe:
- The BGP neighbor shows the hostname of the BGP peer
- Only the peer is up, no routes are being advertised yet
- The BGP router identifier uses the loopback address
- Show commands can be a mix of “nv show” and legacy “vtysh show”. Here we are using “vtysh show” commands

Advertise Loopback and SVI subnets from leaf01, leaf02 and spine01 into fabric

Routing Advertisement Configuration			
Routes↓ \ Switch→	leaf01	leaf02	spine01
Subnets to be advertised	10.255.255.1/32 10.0.10.0/24	10.255.255.2/32 10.0.20.0/24	10.255.255.101/32

10. On spine01: Advertise loopback address into BGP.

```
cumulus@spine01:mgmt:~$ nv set vrf default router bgp address-family ipv4-unicast network 10.255.255.101/32
cumulus@spine01:mgmt:~$ nv config apply
```

11. On leaf01: Advertise loopback address into BGP.

```
cumulus@leaf01:mgmt:~$ nv set vrf default router bgp address-family ipv4-unicast network 10.255.255.1/32
```

12. On leaf01: Advertise subnet for VLAN10.

```
cumulus@leaf01:mgmt:~$ nv set vrf default router bgp address-family ipv4-unicast network 10.0.10.0/24
```

13. On leaf01: Commit the changes.

```
cumulus@leaf01:mgmt:~$ nv config apply
```

14. On leaf02: Repeat steps xx-xx. Notice the different loopback IP and subnet that is advertised.

```
cumulus@leaf02:mgmt:~$ nv set vrf default router bgp address-family ipv4-unicast network 10.255.255.2/32
cumulus@leaf02:mgmt:~$ nv set vrf default router bgp address-family ipv4-unicast network 10.0.20.0/24
cumulus@leaf02:mgmt:~$ nv config apply
```

```
nv set vrf default router bgp address-family ipv4-unicast network 10.255.255.2/32
nv set vrf default router bgp address-family ipv4-unicast network 10.0.20.0/24
nv config apply
```

Verify that BGP is advertising the routes

15. On spine01: Check that routes are being learned.

```
cumulus@spine01:mgmt:~$ sudo vtysh -c "show ip bgp ipv4 unicast"

BGP table version is 5, local router ID is 10.255.255.101, vrf id 0
Default local pref 100, local AS 65201
Status codes:  s suppressed, d damped, h history, u unsorted, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop            Metric LocPrf Weight Path
*> 10.0.10.0/24     swp1                     0             0 65101 i
*> 10.0.20.0/24     swp2                     0             0 65102 i
*> 10.255.255.1/32  swp1                     0             0 65101 i
*> 10.255.255.2/32  swp2                     0             0 65102 i
*> 10.255.255.101/32
                    0.0.0.0(spine01)
                                             0         32768 i

Displayed  5 routes and 5 total paths
```

Or

```
cumulus@cumulus:mgmt:~$ nv show vrf default router bgp address-family ipv4-unicast route

PathCount - Number of paths present for the prefix, MultipathCount - Number of
paths that are part of the ECMP, DestFlags - * - bestpath-exists, w - fib-wait-
for-install, s - fib-suppress, i - fib-installed, x - fib-install-failed

Prefix            PathCount  MultipathCount  DestFlags
----------------  ---------  --------------  ---------
10.0.10.0/24      1          1               *
10.0.20.0/24      1          1               *
10.255.255.1/32   1          1               *
10.255.255.2/32   1          1               *
10.255.255.101/32 1          1               *
```

Important things to observe:
- AS PATH identifies where routes are originating
- NEXT HOP is the interface and not an IP address because of BGP unnumbered Where the next hop is equal to 0.0.0.0, that route is originated locally.

Verify connectivity and path between server01 and server02

16. On Server01, ping to Server02 (10.0.20.102)

```
ubuntu@server01:~$ ping 10.0.20.102
PING 10.0.20.102 (10.0.20.102) 56(84) bytes of data.
64 bytes from 10.0.20.102: icmp_seq=1 ttl=61 time=9.86 ms
64 bytes from 10.0.20.102: icmp_seq=2 ttl=61 time=5.96 ms
64 bytes from 10.0.20.102: icmp_seq=3 ttl=61 time=5.80 ms
^C
--- 10.0.20.102 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 5.806/7.211/9.864/1.877 ms
```

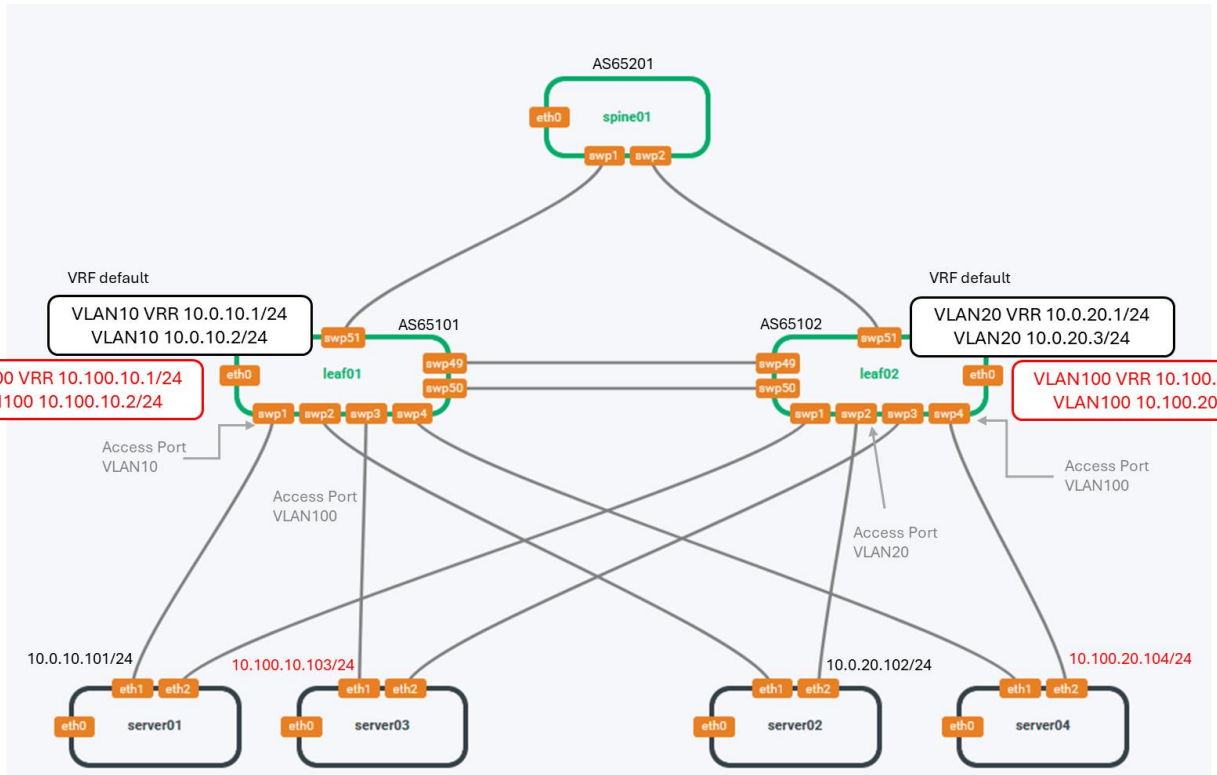
17. On Server01, traceroute to Server02. Identify all of the hops.

```
ubuntu@server01:~$ traceroute 10.0.20.102
traceroute to 10.0.20.102 (10.0.20.102), 30 hops max, 60 byte packets
 1  10.0.10.1 (10.0.10.1)  1.280 ms  1.389 ms  1.553 ms
 2  10.255.255.101 (10.255.255.101)  4.702 ms  4.679 ms  4.789 ms
 3  10.255.255.2 (10.255.255.2)  8.438 ms  8.877 ms  9.476 ms
 4  10.0.20.102 (10.0.20.102)  9.541 ms  9.766 ms  13.549 ms
cumulus@server01:~$
```

Important things to observe:
- With Unnumbered interfaces, traceroute (ICMP source interface) packets come from the loopback ipv4 address of the node.

Start configuring VRF and member interfaces

We will add our changes on top of the BGP configuration we have done in the previous section of this lab. This part is a continuation of lab3, therefore configuring BGP in previous steps [1-17] is a prerequisite to continue with this section of the lab.
By the end of this section, we will be configuring the following topology:



18. To start VRF-lite section of the lab, first create a VRF named ‘RED’, create a separate VLAN and SVI that will be mapped to this VRF and configure interfaces. We will use server03 and server04 to verify the connectivity inside vrf RED.
    Leaf01:

```
cumulus@leaf01:mgmt:~$ nv set vrf RED table auto
cumulus@leaf01:mgmt:~$ nv set bridge domain br_default vlan 100
cumulus@leaf01:mgmt:~$ nv set interface swp3 bridge domain br_default access 100
cumulus@leaf01:mgmt:~$ nv set interface vlan100 ip vrr enable on
cumulus@leaf01:mgmt:~$ nv set interface vlan100 ip vrr state up
cumulus@leaf01:mgmt:~$ nv set interface vlan100 type svi
cumulus@leaf01:mgmt:~$ nv set interface vlan100 ip address 10.100.10.2/24
cumulus@leaf01:mgmt:~$ nv set interface vlan100 ip vrr address 10.100.10.1/24
cumulus@leaf01:mgmt:~$ nv set interface vlan100 ip vrr mac-address 00:00:00:00:2a:10
cumulus@leaf01:mgmt:~$ nv set interface swp51.100,vlan100 ip vrf RED
cumulus@leaf01:mgmt:~$ nv set interface swp51.100,vlan100 vlan 100
```

    Leaf02:

```
cumulus@leaf02:mgmt:~$ nv set vrf RED table auto
cumulus@leaf02:mgmt:~$ nv set bridge domain br_default vlan 100
cumulus@leaf02:mgmt:~$ nv set interface swp4 bridge domain br_default access 100
cumulus@leaf02:mgmt:~$ nv set interface vlan100 ip vrr enable on
cumulus@leaf02:mgmt:~$ nv set interface vlan100 ip vrr state up
cumulus@leaf02:mgmt:~$ nv set interface vlan100 type svi
cumulus@leaf02:mgmt:~$ nv set interface vlan100 ip address 10.100.20.2/24
cumulus@leaf02:mgmt:~$ nv set interface vlan100 ip vrr address 10.100.20.1/24
cumulus@leaf02:mgmt:~$ nv set interface vlan100 ip vrr mac-address 00:00:00:00:2a:20
cumulus@leaf02:mgmt:~$ nv set interface swp51.100,vlan100 ip vrf RED
cumulus@leaf02:mgmt:~$ nv set interface swp51.100,vlan100 vlan 100
```

    Spine01:

```
cumulus@spine01:mgmt:~$ nv set vrf RED table auto
cumulus@spine01:mgmt:~$ nv set interface swp1.100 base-interface swp1
cumulus@spine01:mgmt:~$ nv set interface swp1.100,swp2.100 ip vrf RED
cumulus@spine01:mgmt:~$ nv set interface swp1.100,swp2.100 type sub
cumulus@spine01:mgmt:~$ nv set interface swp1.100,swp2.100 vlan 100
cumulus@spine01:mgmt:~$ nv set interface swp2.100 base-interface swp2
```

Configure BGP routing for VRF-lite

19. Then configure BGP unnumbered peering for vrf RED, advertise vlan100 SVI interface prefix on both leaf switches:
    Leaf01:

```
cumulus@leaf01:mgmt:~$ nv set vrf RED router bgp address-family ipv4-unicast enable on
cumulus@leaf01:mgmt:~$ nv set vrf RED router bgp address-family ipv4-unicast network 10.100.10.0/24
cumulus@leaf01:mgmt:~$ nv set vrf RED router bgp autonomous-system 65101
cumulus@leaf01:mgmt:~$ nv set vrf RED router bgp enable on
cumulus@leaf01:mgmt:~$ nv set vrf RED router bgp neighbor swp51.100 remote-as external
cumulus@leaf01:mgmt:~$ nv set vrf RED router bgp neighbor swp51.100 type unnumbered
cumulus@leaf01:mgmt:~$ nv set vrf RED router bgp path-selection multipath aspath-ignore on
```

Leaf02:

```
cumulus@leaf02:mgmt:~$ nv set vrf RED router bgp address-family ipv4-unicast enable on
cumulus@leaf02:mgmt:~$ nv set vrf RED router bgp address-family ipv4-unicast network 10.100.20.0/24
cumulus@leaf02:mgmt:~$ nv set vrf RED router bgp autonomous-system 65102
cumulus@leaf02:mgmt:~$ nv set vrf RED router bgp enable on
cumulus@leaf02:mgmt:~$ nv set vrf RED router bgp neighbor swp51.100 remote-as external
cumulus@leaf02:mgmt:~$ nv set vrf RED router bgp neighbor swp51.100 type unnumbered
cumulus@leaf02:mgmt:~$ nv set vrf RED router bgp path-selection multipath aspath-ignore on
```

Spine01:

```
cumulus@spine01:mgmt:~$ nv set vrf RED router bgp autonomous-system 65201
cumulus@spine01:mgmt:~$ nv set vrf RED router bgp enable on
cumulus@spine01:mgmt:~$ nv set vrf RED router bgp neighbor swp1.100 remote-as external
cumulus@spine01:mgmt:~$ nv set vrf RED router bgp neighbor swp1.100 type unnumbered
cumulus@spine01:mgmt:~$ nv set vrf RED router bgp neighbor swp2.100 remote-as external
cumulus@spine01:mgmt:~$ nv set vrf RED router bgp neighbor swp2.100 type unnumbered
cumulus@spine01:mgmt:~$ nv set vrf RED router bgp path-selection multipath aspath-ignore on
```

Verify routing table for each VRF

20. **Check default and RED vrf routing tables and verify whether prefixes are in the correct vrf routing tables.**

Leaf01:

```
cumulus@leaf01:mgmt:~$ nv show vrf default router rib ipv4 route

Flags - * - selected, q - queued, o - offloaded, i - installed, S - fib-
selected, x - failed

Route              Protocol   Distance  Uptime               NHGId  Metric  Flags
-----------------  ---------  --------  -------------------  -----  ------  -----
10.0.10.0/24       connected  0         2025-08-20T00:33:49Z  36     1024    i
                   connected  0         2025-08-20T00:33:49Z  37     0       *Si
10.0.10.1/32       local      0         2025-08-20T00:33:49Z  36     0       *Si
10.0.10.2/32       local      0         2025-08-20T00:33:49Z  37     0       *Si
10.0.20.0/24       bgp        20        2025-08-20T07:31:23Z  47     0       *Si
10.255.255.1/32    connected  0         2025-08-20T00:33:48Z  17     0       *Si
                   local      0         2025-08-20T00:33:48Z  17     0       i
10.255.255.2/32    bgp        20        2025-08-20T07:31:23Z  47     0       *Si
10.255.255.101/32  bgp        20        2025-08-20T07:31:23Z  47     0       *Si
cumulus@leaf01:mgmt:~$



cumulus@leaf01:mgmt:~$ nv show vrf RED router rib ipv4 route

Flags - * - selected, q - queued, o - offloaded, i - installed, S - fib-
selected, x - failed

Route           Protocol   Distance  Uptime               NHGId  Metric  Flags
--------------  ---------  --------  -------------------  -----  ------  -----
0.0.0.0/0       kernel     255       2025-08-20T08:50:59Z  22     8192    *Si
10.100.10.0/24  connected  0         2025-08-20T08:51:00Z  36     1024    i
                connected  0         2025-08-20T08:51:00Z  37     0       *Si
10.100.10.1/32  local      0         2025-08-20T08:51:00Z  36     0       *Si
10.100.10.2/32  local      0         2025-08-20T08:51:00Z  37     0       *Si
10.100.20.0/24  bgp        20        2025-08-20T08:55:35Z  52     0       *Si
```

Leaf02:

```
cumulus@leaf02:mgmt:~$ nv show vrf default router rib ipv4 route

Flags - * - selected, q - queued, o - offloaded, i - installed, S - fib-
selected, x - failed

Route              Protocol   Distance  Uptime               NHGId  Metric  Flags
-----------------  ---------  --------  -------------------  -----  ------  -----
10.0.10.0/24       bgp        20        2025-08-20T07:31:22Z  45     0       *Si
10.0.20.0/24       connected  0         2025-08-20T00:33:48Z  36     1024    i
                   connected  0         2025-08-20T00:33:48Z  37     0       *Si
```

```
10.0.20.1/32       local      0         2025-08-20T00:33:48Z  36     0       *Si
10.0.20.3/32       local      0         2025-08-20T00:33:48Z  37     0       *Si
10.255.255.1/32    bgp        20        2025-08-20T07:31:22Z  45     0       *Si
10.255.255.2/32    connected  0         2025-08-20T00:33:47Z  17     0       *Si
                   local      0         2025-08-20T00:33:47Z  17     0       i
10.255.255.101/32  bgp        20        2025-08-20T07:31:22Z  45     0       *Si
cumulus@leaf02:mgmt:~$
cumulus@leaf02:mgmt:~$ nv show vrf RED router rib ipv4 route

Flags - * - selected, q - queued, o - offloaded, i - installed, S - fib-
selected, x - failed

Route           Protocol   Distance  Uptime               NHGId  Metric  Flags
--------------  ---------  --------  -------------------  -----  ------  -----
0.0.0.0/0       kernel     255       2025-08-20T08:50:59Z  22     8192    *Si
10.100.10.0/24  bgp        20        2025-08-20T08:55:35Z  48     0       *Si
10.100.20.0/24  connected  0         2025-08-20T08:51:00Z  34     1024    i
                connected  0         2025-08-20T08:51:00Z  35     0       *Si
10.100.20.1/32  local      0         2025-08-20T08:51:00Z  34     0       *Si
10.100.20.2/32  local      0         2025-08-20T08:51:00Z  35     0       *Si
cumulus@leaf02:mgmt:~$
```

Spine01:

```
cumulus@leaf01:mgmt:~$ nv show vrf default router rib ipv4 route

Flags - * - selected, q - queued, o - offloaded, i - installed, S - fib-
selected, x - failed

Route              Protocol   Distance  Uptime               NHGId  Metric  Flags
-----------------  ---------  --------  -------------------  -----  ------  -----
10.0.10.0/24       connected  0         2025-08-20T00:33:49Z  36     1024    i
                   connected  0         2025-08-20T00:33:49Z  37     0       *Si
10.0.10.1/32       local      0         2025-08-20T00:33:49Z  36     0       *Si
10.0.10.2/32       local      0         2025-08-20T00:33:49Z  37     0       *Si
10.0.20.0/24       bgp        20        2025-08-20T07:31:23Z  47     0       *Si
10.255.255.1/32    connected  0         2025-08-20T00:33:48Z  17     0       *Si
                   local      0         2025-08-20T00:33:48Z  17     0       i
10.255.255.2/32    bgp        20        2025-08-20T07:31:23Z  47     0       *Si
10.255.255.101/32  bgp        20        2025-08-20T07:31:23Z  47     0       *Si
cumulus@leaf01:mgmt:~$
cumulus@spine01:mgmt:~$ nv show vrf RED router rib ipv4 route

Flags - * - selected, q - queued, o - offloaded, i - installed, S - fib-
selected, x - failed

Route           Protocol  Distance  Uptime               NHGId  Metric  Flags
--------------  --------  --------  -------------------  -----  ------  -----
0.0.0.0/0       kernel    255       2025-08-20T08:50:59Z  24     8192    *Si
10.100.10.0/24  bgp       20        2025-08-20T08:55:34Z  41     0       *Si
10.100.20.0/24  bgp       20        2025-08-20T08:55:34Z  40     0       *Si
```

Verify connectivity

21. Verify end to end connectivity from servers for the VRF they belong to (intra-VRF):

```
ubuntu@server01:~$ ping 10.0.20.102 -c 3
PING 10.0.20.102 (10.0.20.102) 56(84) bytes of data.
64 bytes from 10.0.20.102: icmp_seq=1 ttl=61 time=1.84 ms
64 bytes from 10.0.20.102: icmp_seq=2 ttl=61 time=1.97 ms
64 bytes from 10.0.20.102: icmp_seq=3 ttl=61 time=2.06 ms

--- 10.0.20.102 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 1.837/1.956/2.060/0.091 ms
ubuntu@server01:~$


ubuntu@server02:~$ ping 10.0.10.101 -c 3
PING 10.0.10.101 (10.0.10.101) 56(84) bytes of data.
64 bytes from 10.0.10.101: icmp_seq=1 ttl=61 time=1.56 ms
64 bytes from 10.0.10.101: icmp_seq=2 ttl=61 time=1.64 ms
64 bytes from 10.0.10.101: icmp_seq=3 ttl=61 time=1.64 ms

--- 10.0.10.101 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 1998ms
rtt min/avg/max/mdev = 1.562/1.612/1.638/0.035 ms
ubuntu@server02:~$

ubuntu@server03:~$ ping 10.100.20.104 -c 3
PING 10.100.20.104 (10.100.20.104) 56(84) bytes of data.
64 bytes from 10.100.20.104: icmp_seq=1 ttl=61 time=1.99 ms
64 bytes from 10.100.20.104: icmp_seq=2 ttl=61 time=1.87 ms
64 bytes from 10.100.20.104: icmp_seq=3 ttl=61 time=1.76 ms

--- 10.100.20.104 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 1.764/1.875/1.989/0.091 ms
ubuntu@server03:~$

ubuntu@server04:~$ ping 10.100.10.103 -c 3
```

```
PING 10.100.10.103 (10.100.10.103) 56(84) bytes of data.
64 bytes from 10.100.10.103: icmp_seq=1 ttl=61 time=2.80 ms
64 bytes from 10.100.10.103: icmp_seq=2 ttl=61 time=2.08 ms
64 bytes from 10.100.10.103: icmp_seq=3 ttl=61 time=2.12 ms

--- 10.100.10.103 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 2.075/2.331/2.800/0.331 ms
ubuntu@server04:~$
```

22. Verify that prefixes are NOT leaked between VRFs (inter-VRF):

```
ubuntu@server01:~$ ping 10.100.20.104 -c 3
PING 10.100.20.104 (10.100.20.104) 56(84) bytes of data.
From 10.0.10.1 icmp_seq=1 Destination Net Unreachable
From 10.0.10.1 icmp_seq=2 Destination Net Unreachable
From 10.0.10.1 icmp_seq=3 Destination Net Unreachable

--- 10.100.20.104 ping statistics ---
3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 2048ms

ubuntu@server01:~$

ubuntu@server02:~$ ping 10.100.20.104 -c 3
PING 10.100.20.104 (10.100.20.104) 56(84) bytes of data.
From 10.0.20.1 icmp_seq=1 Destination Net Unreachable
From 10.0.20.1 icmp_seq=2 Destination Net Unreachable
From 10.0.20.1 icmp_seq=3 Destination Net Unreachable

--- 10.100.20.104 ping statistics ---
3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 2027ms

ubuntu@server02:~$

ubuntu@server03:~$ ping 10.0.10.101 -c 3
PING 10.0.10.101 (10.0.10.101) 56(84) bytes of data.
From 10.100.10.2 icmp_seq=1 Destination Host Unreachable
From 10.100.10.2 icmp_seq=2 Destination Host Unreachable
From 10.100.10.2 icmp_seq=3 Destination Host Unreachable

--- 10.0.10.101 ping statistics ---
3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 2025ms

ubuntu@server03:~$

ubuntu@server04:~$ ping 10.0.20.102 -c 3
PING 10.0.20.102 (10.0.20.102) 56(84) bytes of data.
From 10.100.20.2 icmp_seq=1 Destination Host Unreachable
From 10.100.20.2 icmp_seq=2 Destination Host Unreachable
From 10.100.20.2 icmp_seq=3 Destination Host Unreachable

--- 10.0.20.102 ping statistics ---
3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 2060ms

ubuntu@server04:~$
```

Lab 4: NetQ Configuration

Objective:

This lab will guide you through Nvidia NetQ telemetry and monitoring product which will help customers to monitor data center fabric telemetry, and perform a comprehensive list of health checks and validations. NetQ is part of our Cumulus switch portfolio as a monitoring and telemetry tool and is an essential component of Spectrum-X AI fabric solution. It supports Open Telemetry and Grafana data export.
In this lab, we will go through some basic steps of telemetry and validation checks using NetQ

Dependencies on other Labs:

- None.

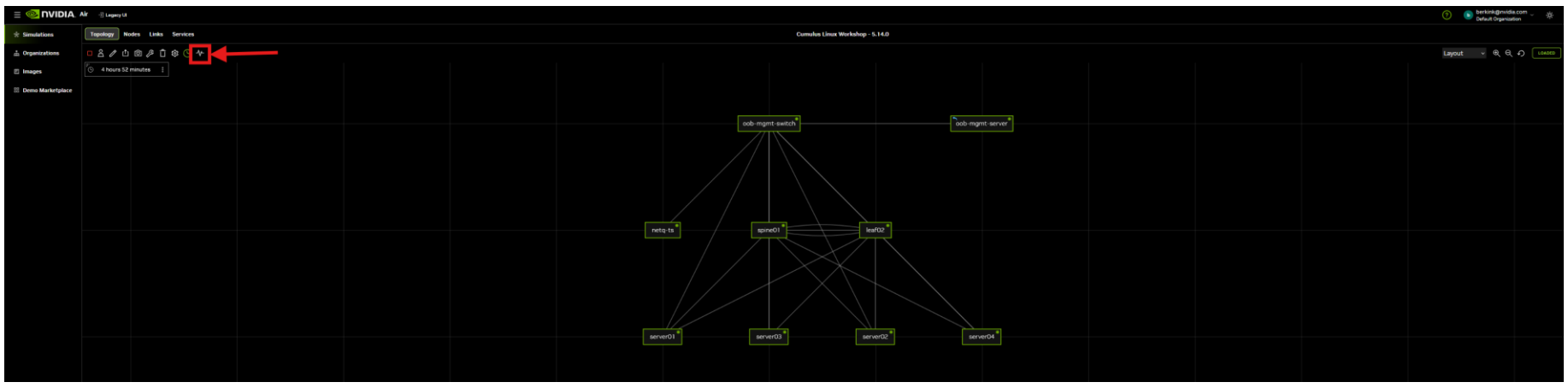
Goals:

- Login to NetQ SaaS solution and familiarize yourself with the dashboard
- Monitor interface counters
- Familiarize yourself with the fabric events, BGP events menu
- Create validations and view results

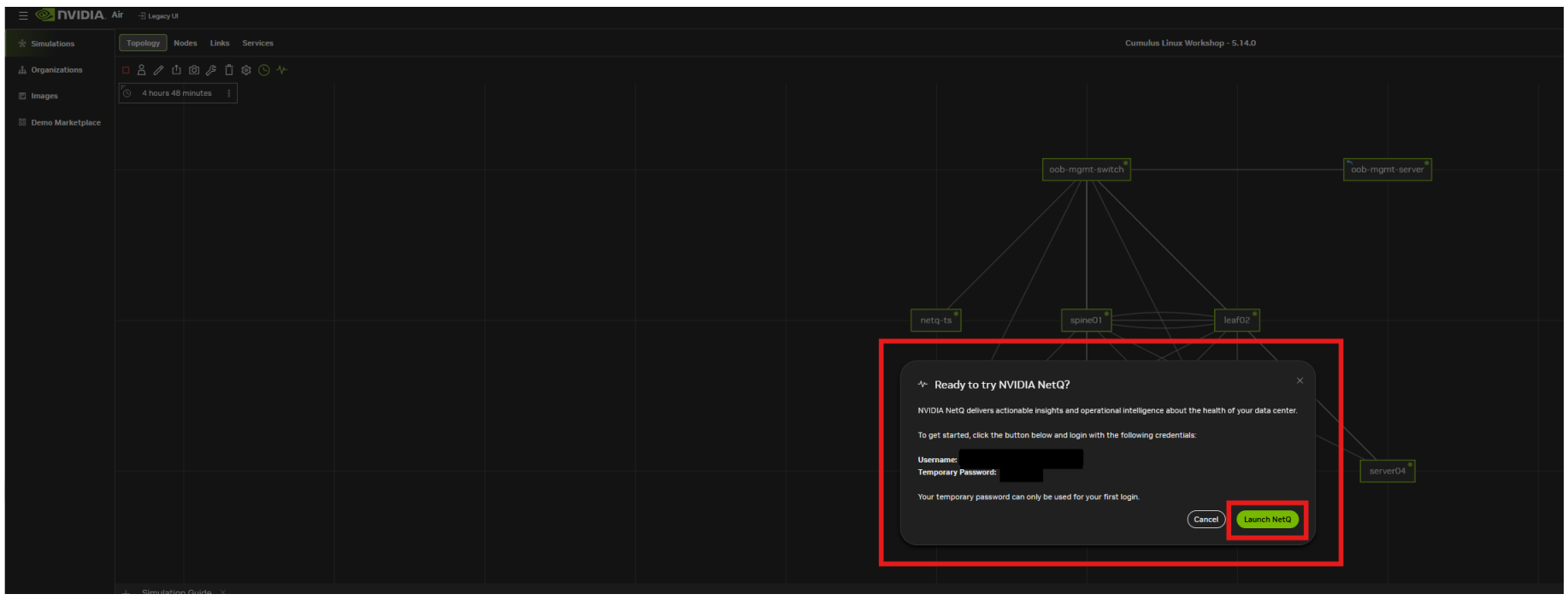
Procedure:

Login

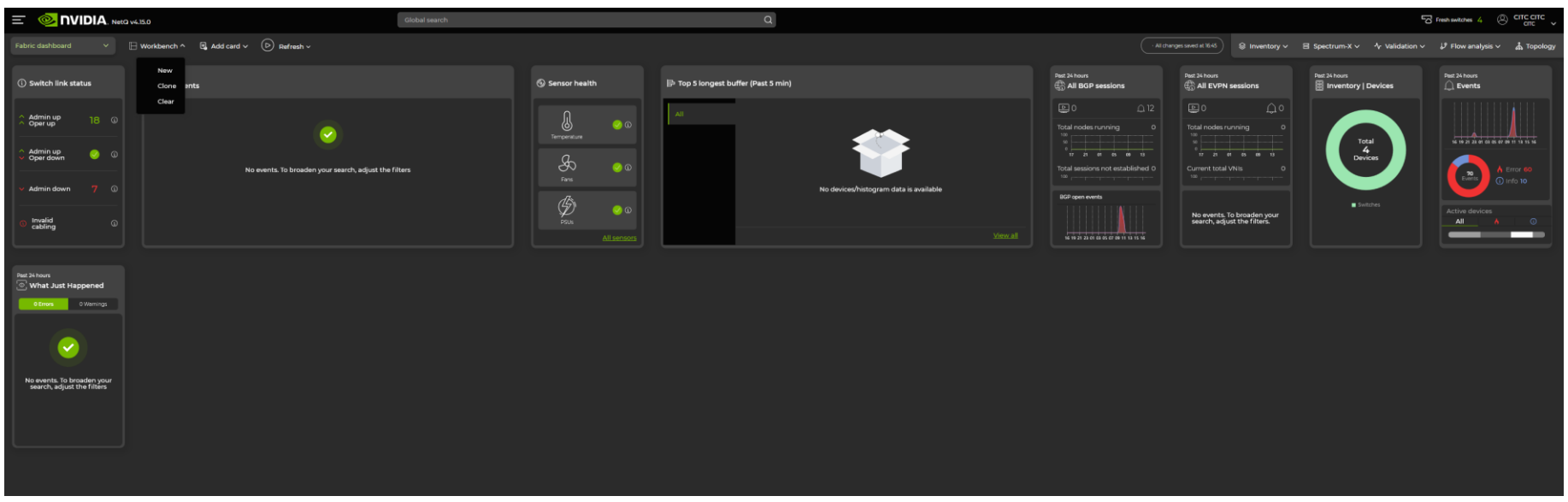
From AIR simulation window, click on the little hearth-beat shaped button to open launch NetQ pop-up.



From the popup, notice your individual Netq SaaS login Username and password and click on Launch NetQ button:

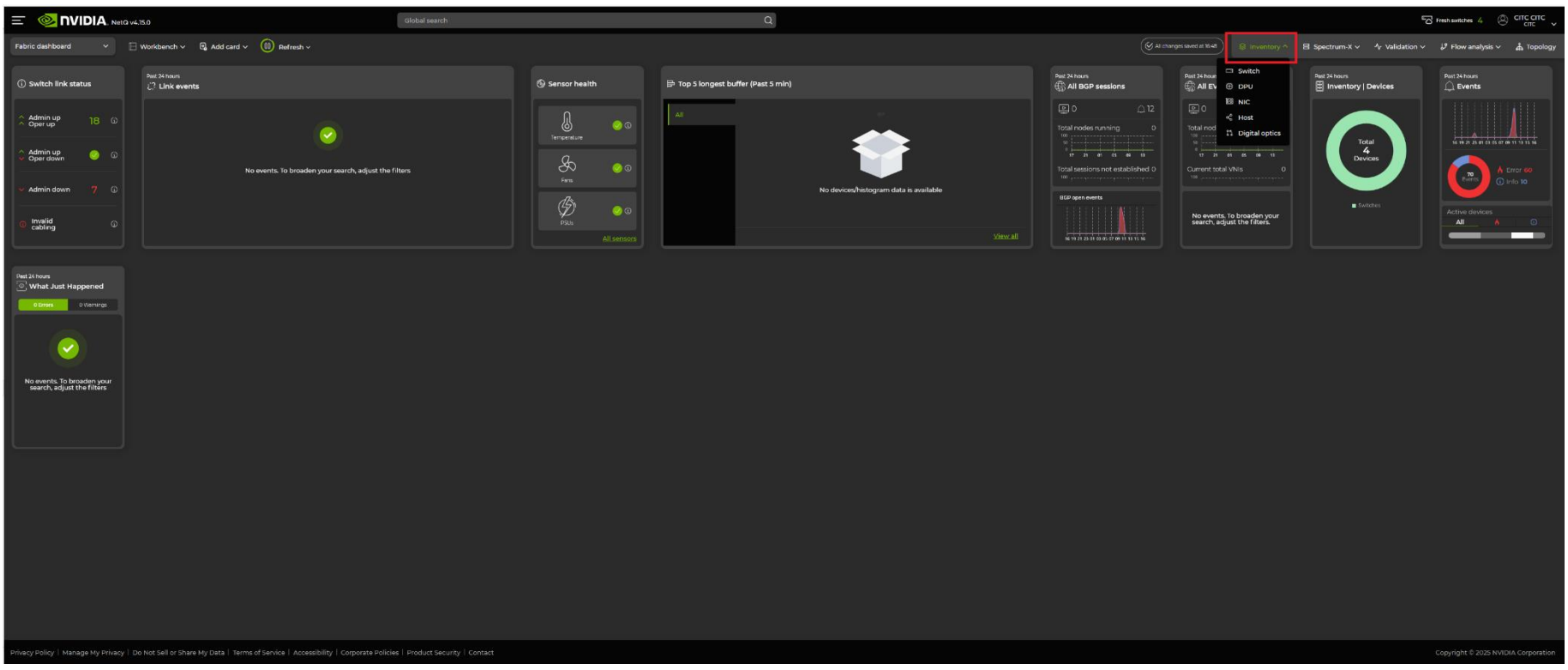


After changing your password and logging in, you will see the NetQ dashboard with all switches in the simulation, already populated in NetQ:



Please notice that NetQ comes with all switches in the simulation already configured. In real life deployments, you need to configure switches and add them into NetQ.

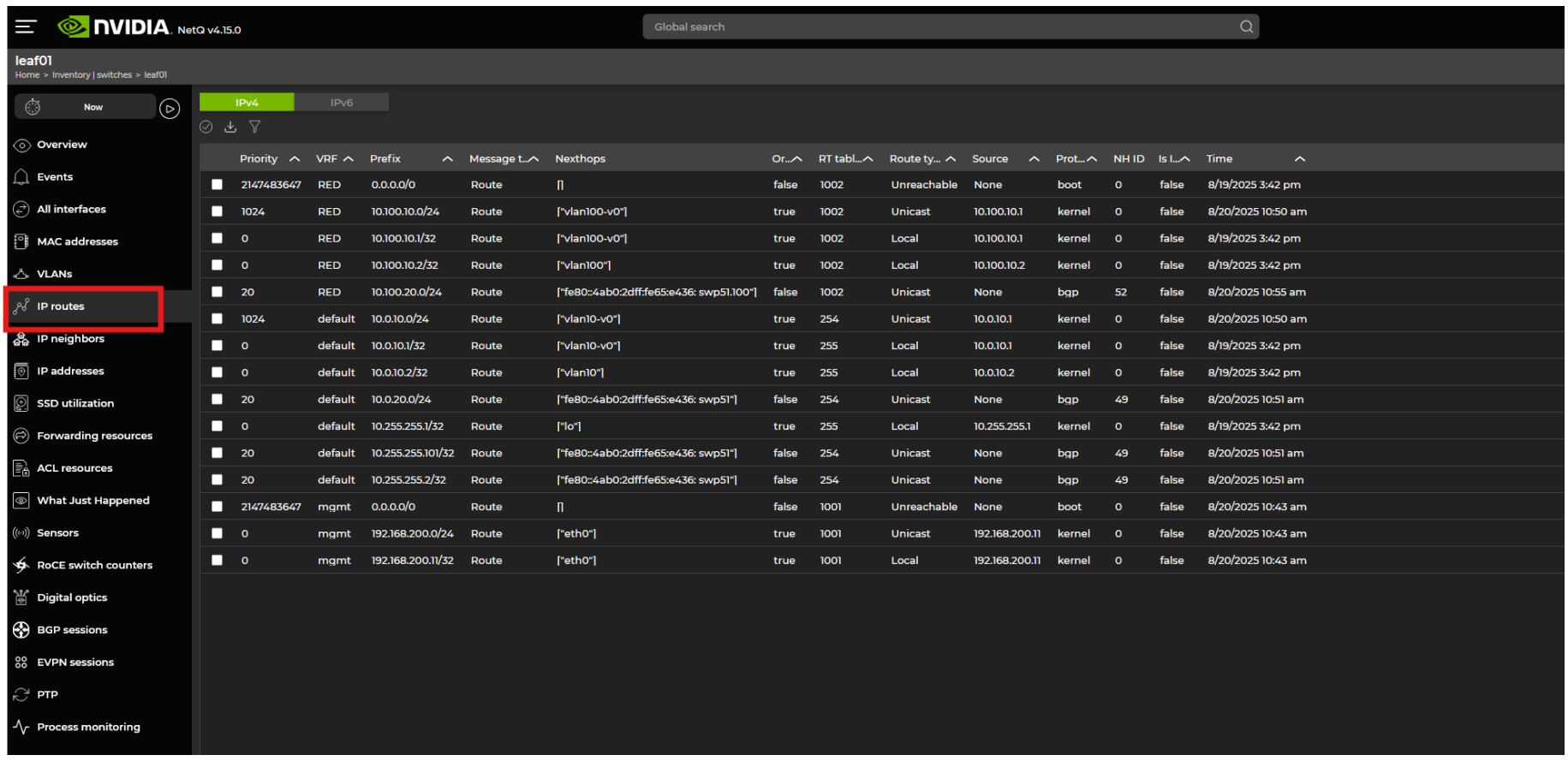
In order to the list of switches in your fabric, click on Inventory -> Switch



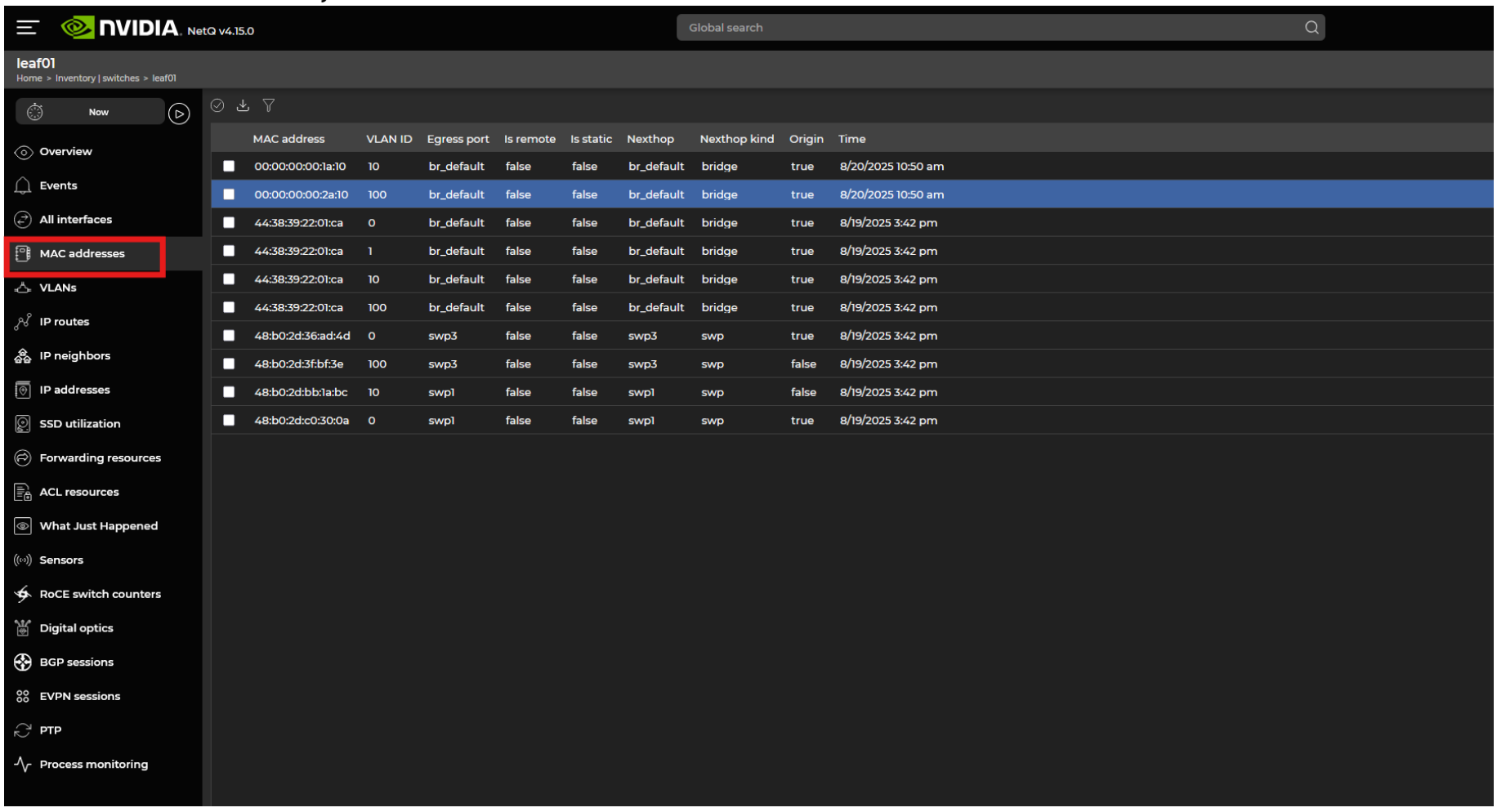
This will take you to Switch inventory list

When you click on one of the switches, you will navigate to the switch view, including a list of interfaces configured on the switch and the telemetry collected from the interfaces:

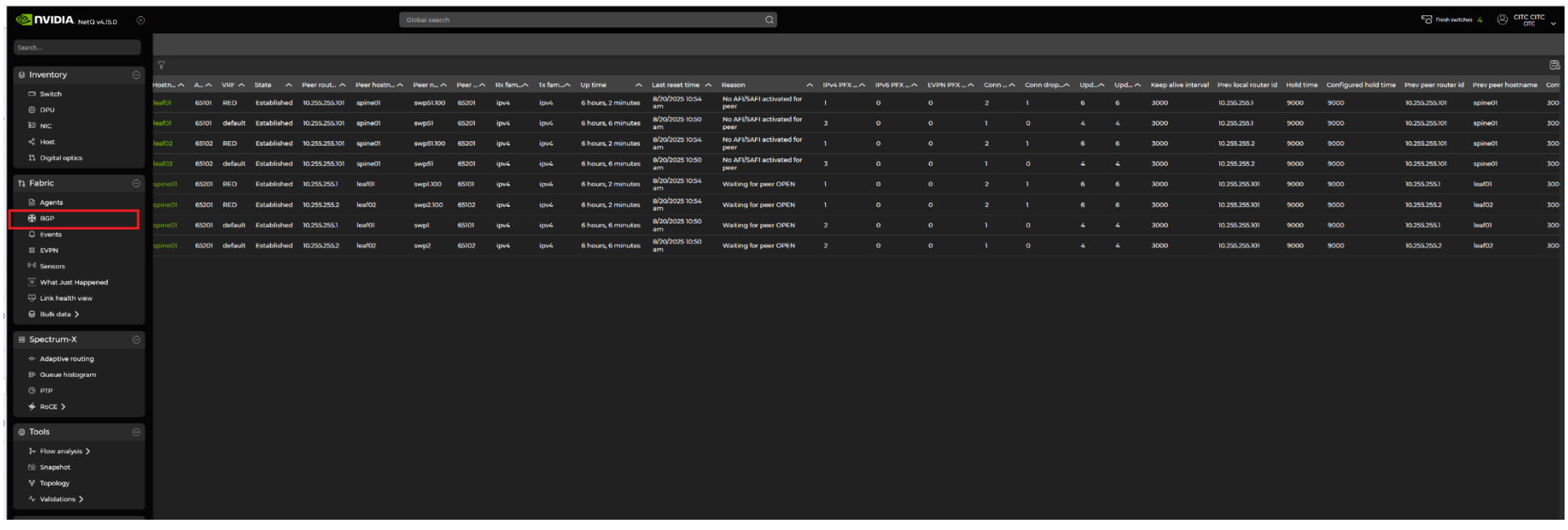
Click on “IP Routes” button to see the list of prefixes in each VRF:



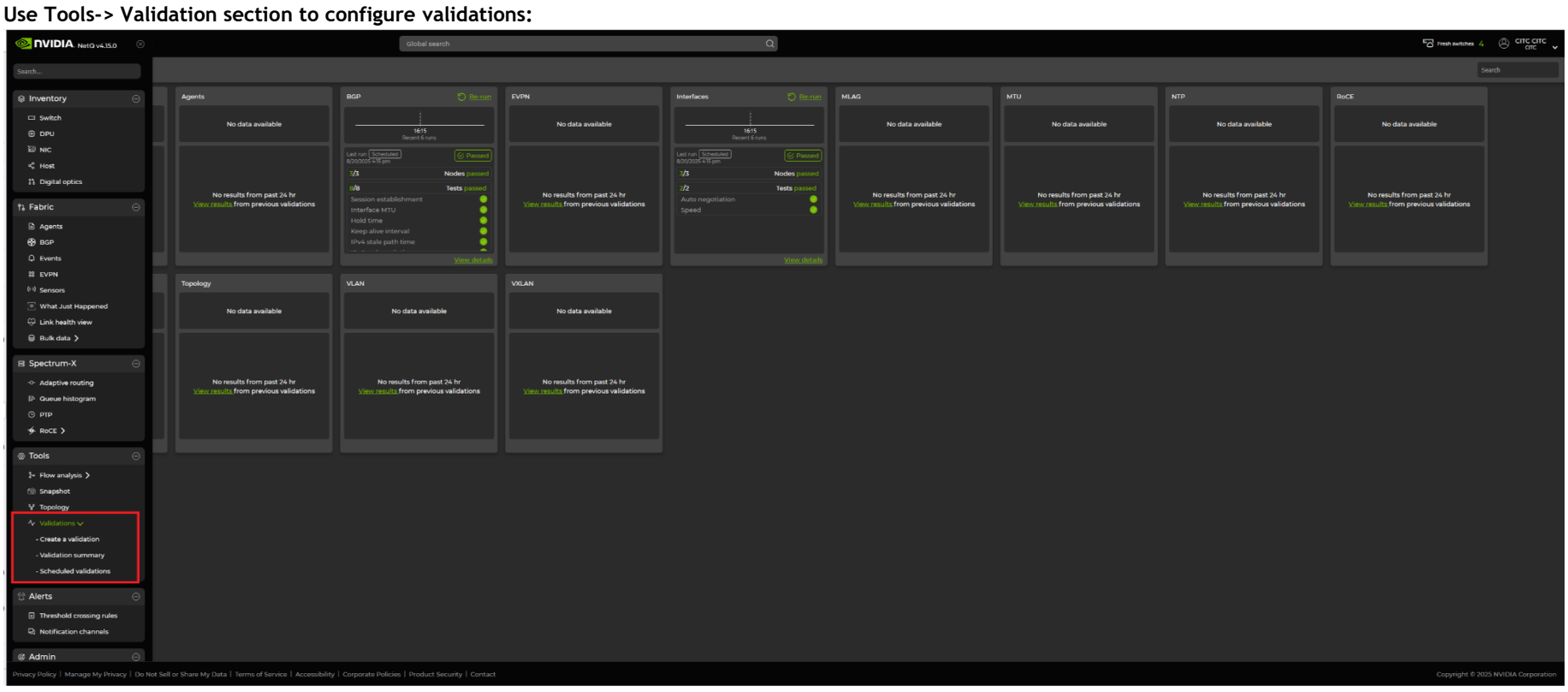
“Mac addresses” button will show you the list of MAC addresses learned on the switch:



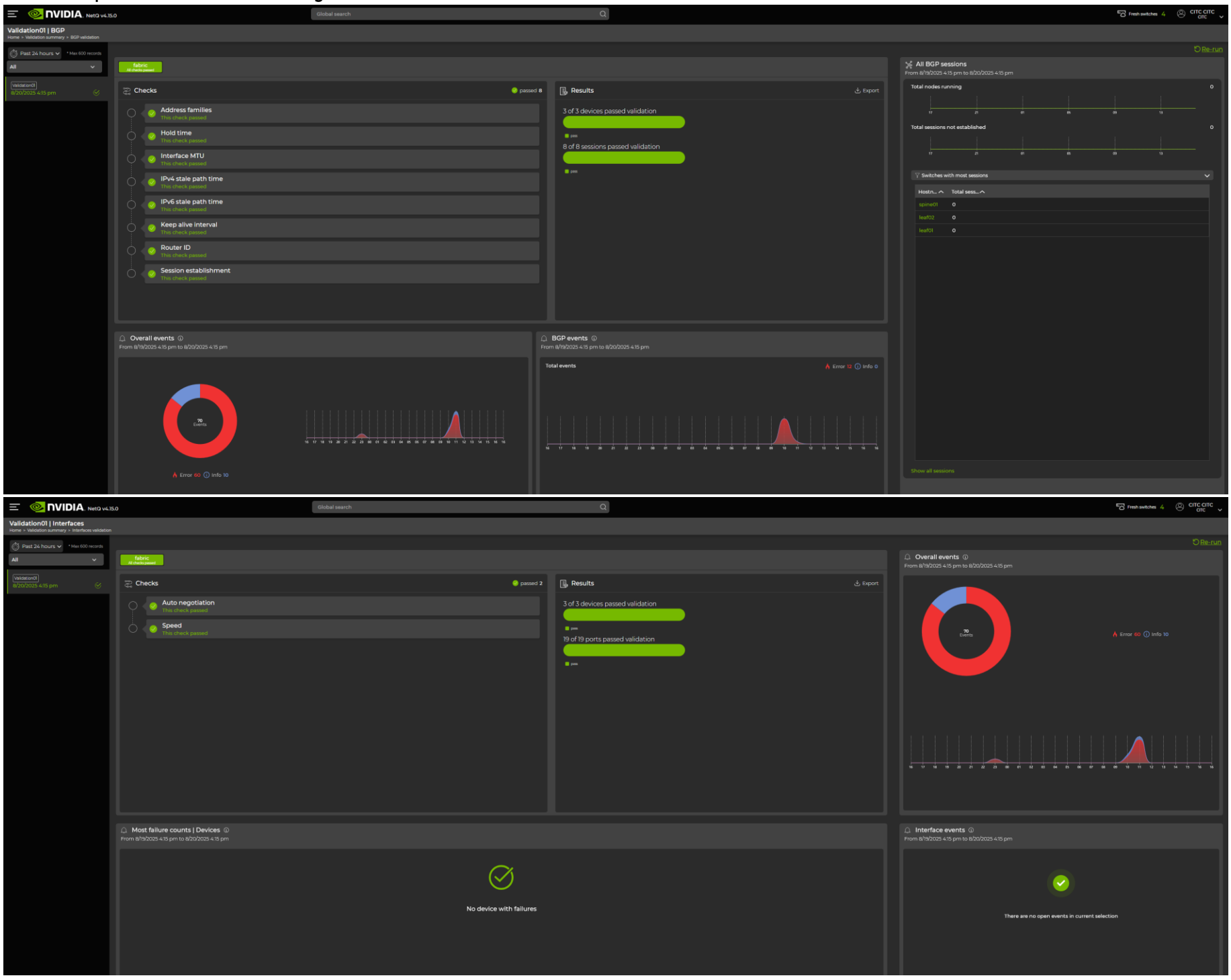
Fabric -> BGP view will take you to the list of all BGP sessions, here you can monitor all the BGP sessions in your fabric and see all up/down events from Events section:



Use Tools-> Validation section to configure validations:



In this example we have validations configured for BGP and Interfaces:



Create your own validations and schedule their running period and observe the results.

This concludes the NVIDIA Cumulus Linux Workshop.

Appendix A: How to use an SSH client to manually connect to the to the lab

SSH Key Prerequisite:
You must have an SSH public and private keypair. Generating one is simple. It is possible you may already have one generated on your box. For *nix users, you may already have a keypair created. Check in your home directory for a .ssh folder that contains id_rsa and id_rsa.pub files.

```
laptop:~ user$ cat ~/.ssh/id_rsa.pub
ssh-rsa
AAAAB3NzaC1yc2EAAAADAQABAAABAQC7feqSFSAUxpe2qTv77+pEk82C/i4AlXVcOQl5tWBCAq1tPWmZHJCPcElFTjeG2wMYMx2Kmb3kYwrLcwfTk06avziBhjMwIprFiupWCkykRPm4IOHkiW
DS/htpZfBdwuIFXV4MQtCiD9zUhLi0Uq0Is+lVtE1Q0/38N7sSa7FHaVNpDpJOQf3PYVdfhk/BG19WQlyKMUSjOaRrAHUIckiQs2H5Wm198ciKkgl4AxoDM9QB+flcCl3We52ei5tWqV8CgLeh
hrdjEXn+iXNdkcg+nGka1syUSYntotally+fake+key+MkEFwD9v16SmJYDK67w5RaHTjBS52UoRjnEEN user@hostname.local
```

> **Warning:** Please be careful. We can't know in advance if you have existing ssh keys and if you do, if they are used by anything on your machine or for any important to in your workflow or line of work. There is risk that ***regenerating default keys may break something*** you do or some other remote logins that depend on your default/existing keys. If you already have default keys, please use them and do not regenerate them.

These links are suggestions only for generating ssh keys. The information on these pages is not owned or controlled by NVIDIA. Use with caution.

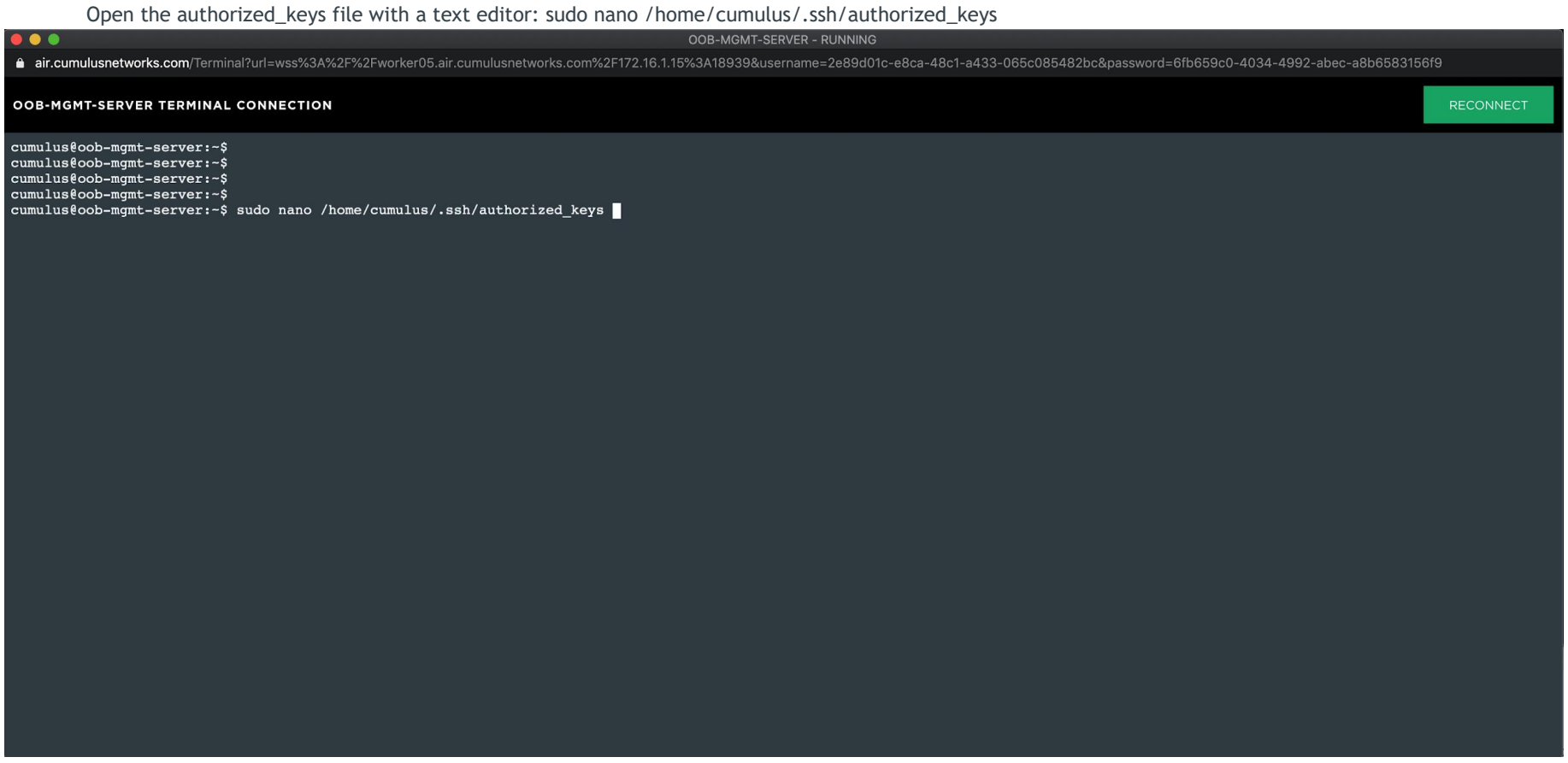
Windows (using putty): https://www.ssh.com/ssh/putty/windows/puttygen
Mac: https://docs.joyent.com/public-cloud/getting-started/ssh-keys/generating-an-ssh-key-manually/manually-generating-your-ssh-key-in-mac-os-x
Ubuntu/linux: https://help.ubuntu.com/community/SSH/OpenSSH/Keys

Your goal is to have an SSH keypair and access to your public key string that looks similar to the key string below. Often the ssh *private key* is password protected. You ought to know the password for your key. NVIDIA/Cumulus does not know the password/passphrase of your ssh private key. If you do not know or have forgotten, you may need to generate a new set of keys for access here.

```
ssh-rsa
AAAAB3NzaC1yc2EAAAADAQABAAABAQC7feqSFSAUxpe2qTv77+pEk82C/i4AlXVcOQl5tWBCAq1tPWmZHJCPcElFTjeG2wMYMx2Kmb3kYwrLcwfTk06avziBhjMwIprFiupWCkykRPm4IOHk
iWDS/htpZfBdwuIFXV4MQtCiD9zUhLi0Uq0Is+lVtE1Q0/38N7sSa7FHaVNpDpJOQf3PYVdfhk/BG19WQlyKMUSjOaRrAHUIckiQs2H5Wm198ciKkgl4AxoDM9QB+flcCl3We52ei5tWqV8C
gLehhrdjEXn+iXNdkcg+nGka1syUSYntotally+fake+key+MkEFwD9v16SmJYDK67w5RaHTjBS52UoRjnEEN user@hostname.local
```

1. **First, you must add your ssh pubkey to the oob-mgmt-server authorized_keys file for the cumulus user. Pop out the console window of the oob-mgmt-server.**

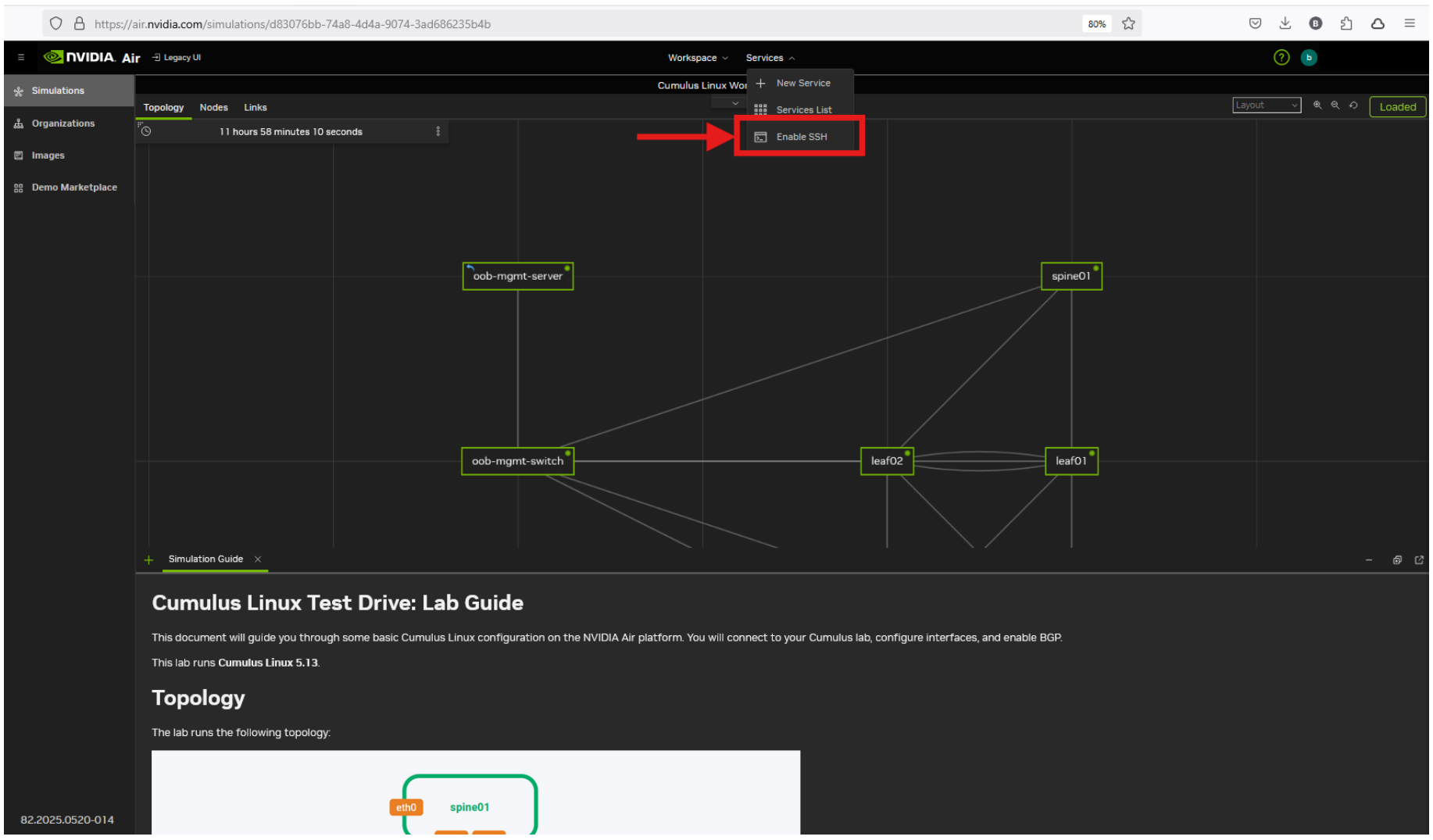
   Open the authorized_keys file with a text editor: sudo nano /home/cumulus/.ssh/authorized_keys



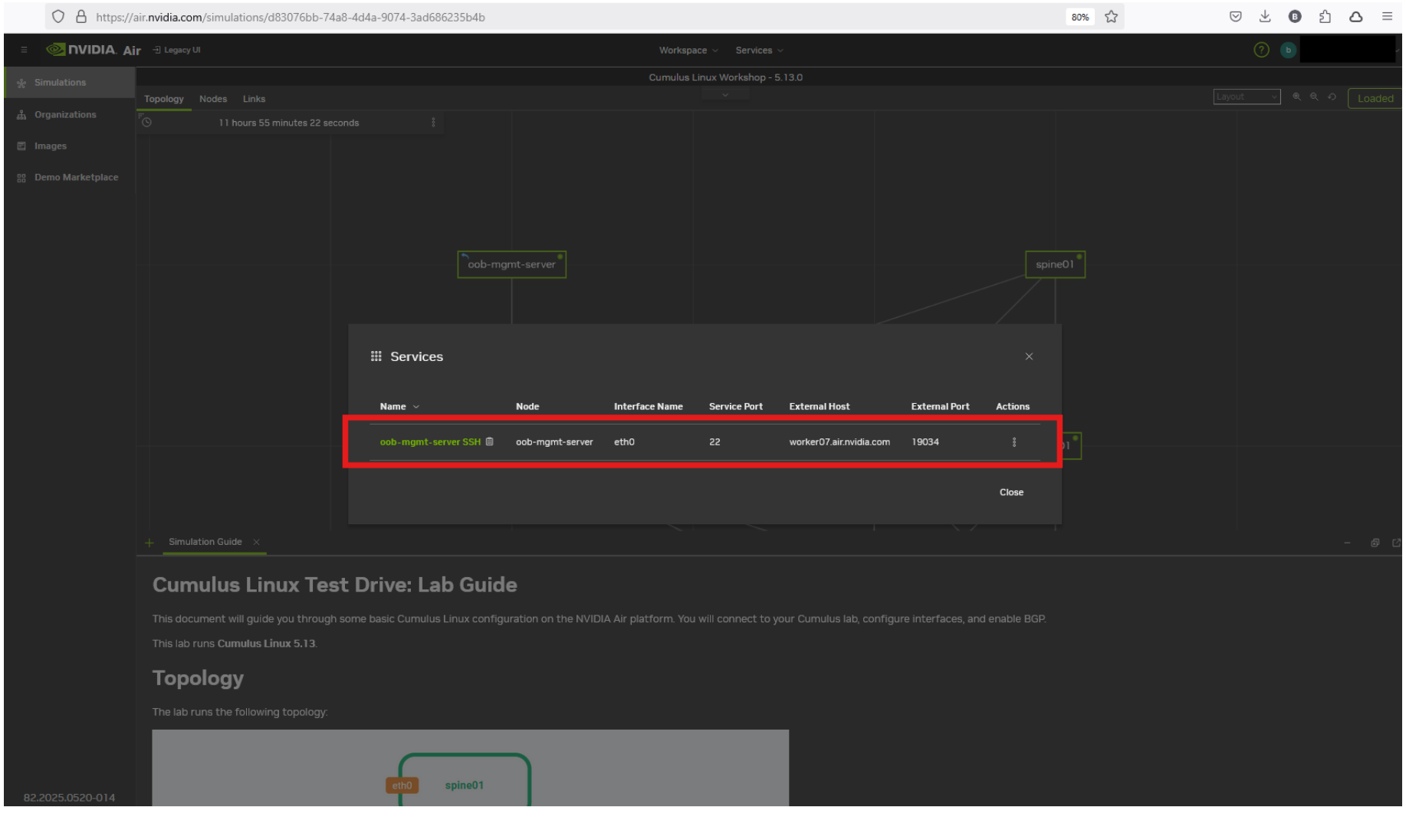
   Paste in your ssh pubkey string. It is a long single line string that doesn't wrap in nano.

Save and quit. In nano, save is [ctrl + o], then confirm the filename with [return]. Quit is [ctrl + x]

2. Next, click the “Enable SSH” button under the Services window to expose the SSH service on the oob-mgmt-server to the Internet.



This will cause the SSH service information to populate in the “Services” Panel



Next, click on the hyperlink for the SSH service. If your web browser is configured with an application to handle SSH URLs, then clicking on the link from your browser will automatically launch the application to handle the SSH connection and connect with the correct username, IP address, and port number.

If your browser is unable to handle the SSH URL to automatically launch a default program for SSH, follow the additional steps below to connect manually with your SSH client:

Manual SSH Connection Details	
Username	ubuntu
~~Password~~	If prompted for a password, you are being asked for the password/passphrase for *your ssh private key*
Server Hostname	*Use "External Host" in services box on UI ---------->*
SSH Port	*Use "External Port" in Services box on UI ---------->*

Service Port: 22
External Host: worker05.air.nvidia.com
External Port: 25230

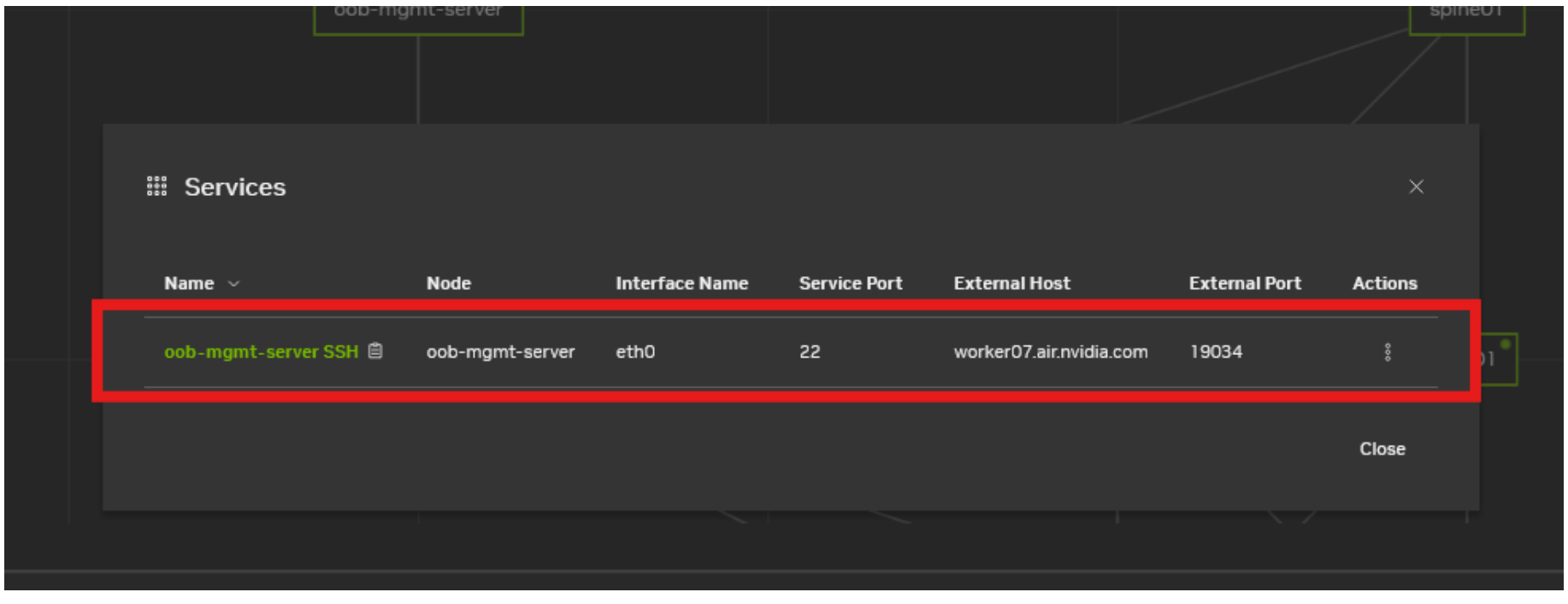
Note: This SSH connection ***does not use the default destination TCP port 22***. Ensure that the external port is specified in your SSH client.
Note: If you are prompted for a password, it is the password to access your SSH private key. This is not a password being requested from the server for authentication against the cumulus user.

To connect via SSH manually, you must have an SSH client installed.

- Windows users: Download PuTTY from https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html
- Mac users: Use the *Terminal* application.
- Linux users: Open a Bash shell.

Linux/Mac OS:

The SSH command will follow a format similar to: **`ssh ubuntu@workerXX.air.nvidia.com -p XXXXX`**
You just need to find your worker and the port number from the information in the AIR UI Services panel:



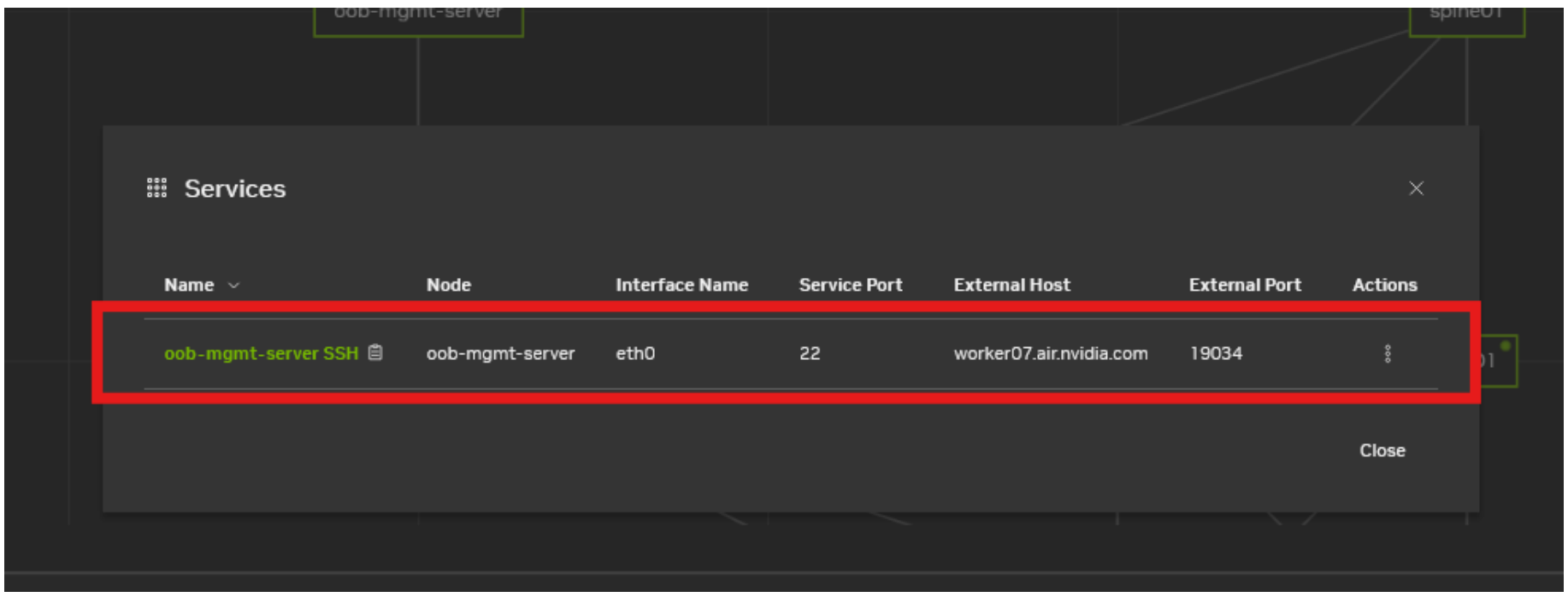
Example:

```
user@laptop$ ssh ubuntu@worker07.air.nvidia.com -p 19034
The authenticity of host '[worker07.air.nvidia.com]:19034 ([147.75.91.219]:19034)' can't be established.
ECDSA key fingerprint is SHA256:2gi+bqJHFCZw1IefBtUdXuAIp7XERPuJ4vyom+CsZhg.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '[worker07.air.nvidia.com]:19034,[147.75.91.219]:19034 (ECDSA) to the list of
known hosts.
Enter passphrase for key '/Users/user/.ssh/id_rsa': <your ssh private key passphrase>
Welcome to Ubuntu 18.04.5 LTS (GNU/Linux 4.15.0-124-generic x86_64)

     <banner omitted for brevity>

Last login: Thu Feb 11 20:32:29 2021
ubuntu@oob-mgmt-server ~
```

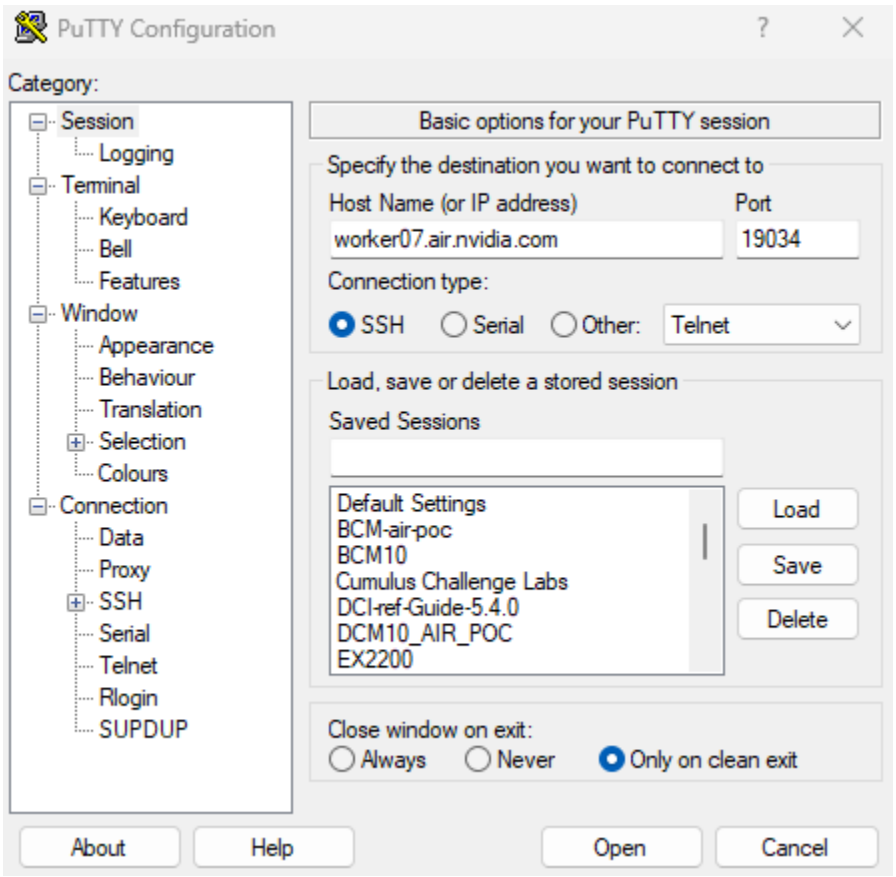
Windows using PuTTY:

You must tell PuTTY the SSH private key to use for this connection. The public key should be on the oob-mgmt-server in the authorized_keys file. Now your client must use your SSH private key. Here is an example: https://devops.ionos.com/tutorials/use-ssh-keys-with-putty-on-windows/#connect-to-server-with-private-key

The SSH session will be found in the Services Pane of the AIR UI



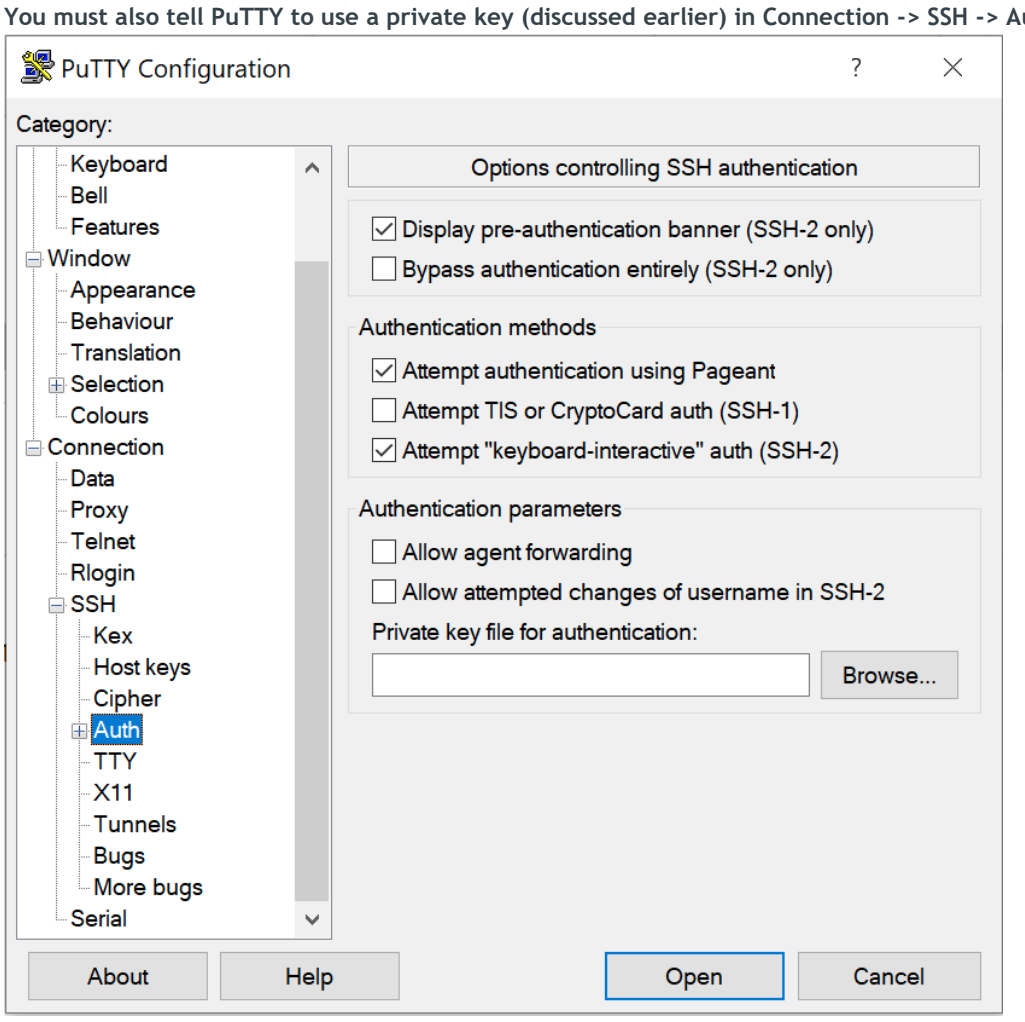
In your PuTTY Connection Info:



Hostname: workerXX.air.nvidia.com [“External Host” in Services pane on AIR UI]

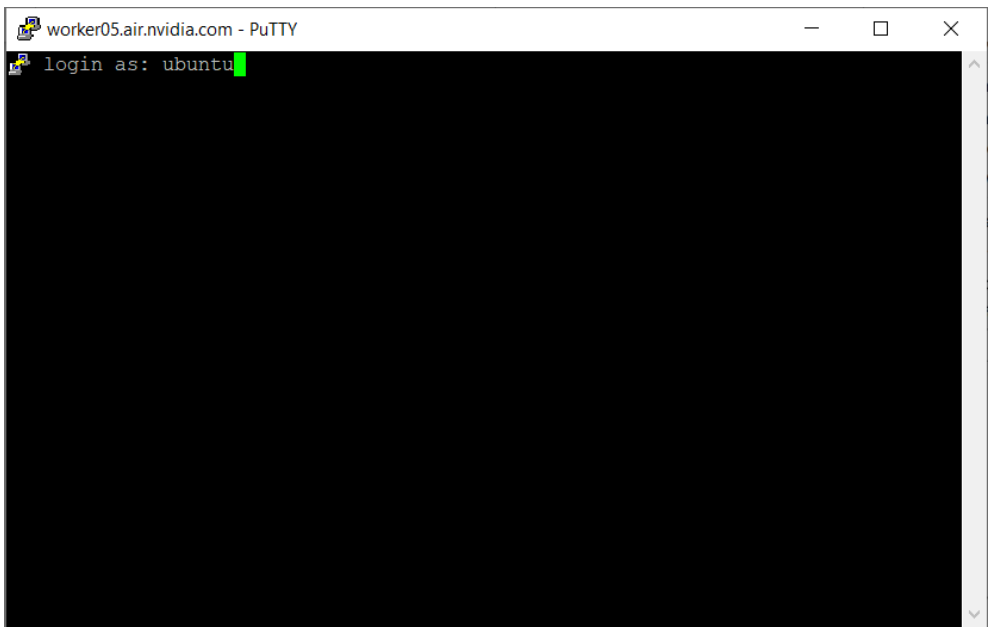
Port: [“External Port” in Services pane on AIR UI]

You must also tell PuTTY to use a private key (discussed earlier) in Connection -> SSH -> Auth Click the Browse button to pop out a box to point to the private key file.

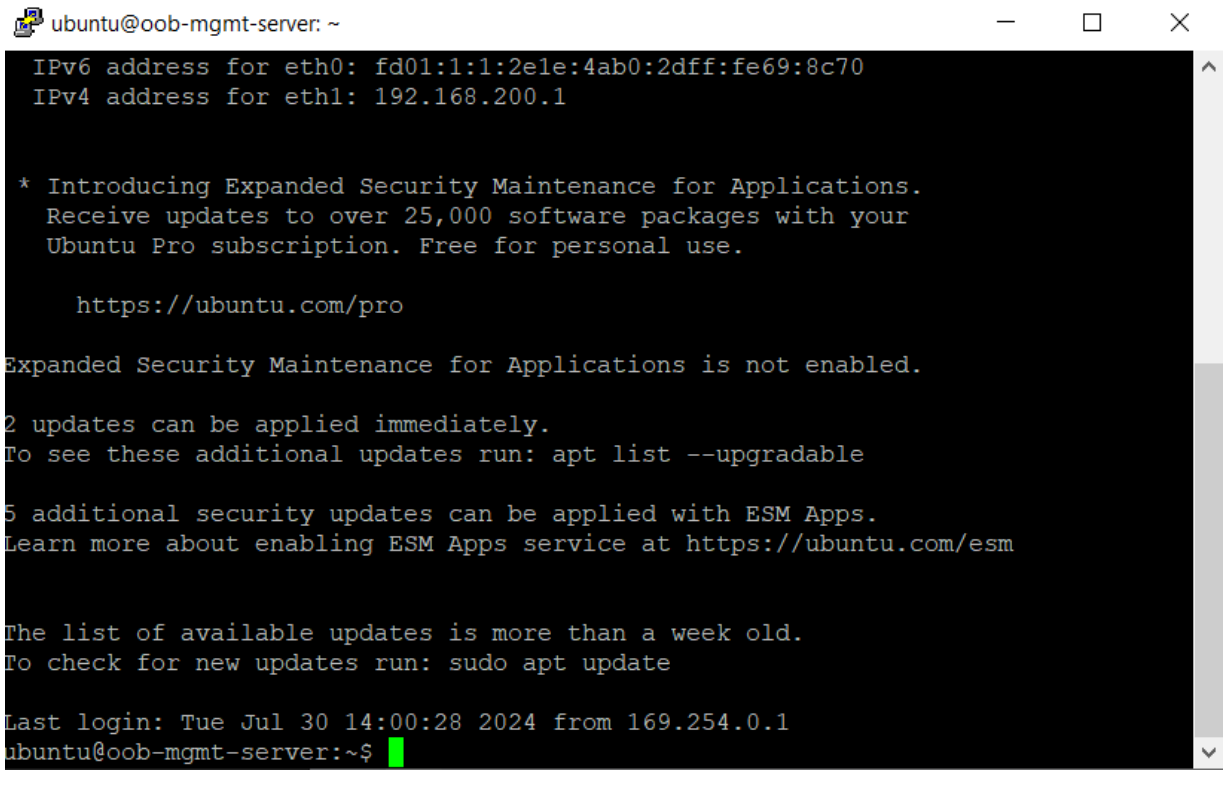


Click Open.

When prompted, login as user ubuntu



You will be authenticated using your ssh key and may have to provide a password/passphrase if one was used to save the private key



You now have an SSH session to your workbench, and you will be at the BASH prompt on the oob-mgmt-server.

Last updated: May 22nd 2025