Mellanox Networking for Nutanix Backup and Disaster Recovery Solution

Rev 2.0

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Mellanox Technologies
350 Oakmead Parkway Suite 100
Sunnyvale, CA 94085
U.S.A.
www.mellanox.com
Tel: (408) 970-3400
Fax: (408) 970-3403

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1 Overview

More and more businesses relay on storing and sharing digital data for internal and external purposes. Today, this data is exposed to an unprecedented number of threats, from cyber threats to environmental events and natural disasters, and as companies are moving their business applications and data to a cloud-based solution, especially into a hybrid cloud solution, the risks increase and become more challenging to solve.

The main concern for any CIO is to manage these risks and devise an elaborate business continuity plan which includes a clear strategy on which backup method to use and what disaster recovery plan to follow.

There are many backup methods currently being deployed in the market which vary in data flow volume within data centers and the required processing power to deliver the desired performance.

The following are a few of the backup methods popular among businesses:

- Private Cloud – Back up VMs running in production
- Hybrid Cloud Solution – Back up VMs on both a private and public cloud interchangeably
- Cloud Storage – Both the data and the system are replicated off-site.
  This method enables uninterrupted access to systems and data, even after a disaster.

2 Effective Disaster Recovery Plan Requirements

The disaster recovery strategy is well defined in the RPO (recovery point objective) and RTO (recovery time objective) sections of a business continuity plan. The core of these objectives is to define which data to restore first and how fast.

The frequency and severity of weather-related events is increasing and the reliance on a complex network of technology and supply chains is expanding. Both trends leave businesses susceptible to a variety of existing and emerging risks. Managing these risks by developing a business continuity strategy is key to the survival of any organization.

An efficient backup system can recover data at fast speeds. In case of data center failure, the lower the interruption period of data access, the better the data backup and recovery system is.

3 Implementation

3.1 Introduction

This document describes the implementation of DCI as shown in the setup diagram below where Mellanox Spectrum switches were utilized as the host's gateways. There are other implementations of VXLAN/EVPN involving centralized or distributed gateways, routers, firewalls and more which are not covered in this document.

Mellanox DCI/VXLAN solution has virtualization integration with VMware NSX-V/MH, Midokura MidoNet and OpenStack. With this integration, Mellanox SN2000 switch series running Cumulus Linux can function as hardware VTEP gateways while the controller provides consistent provisioning across virtual and physical server infrastructures. For more information read "Virtualization Integrations of Hardware VTEPs "

3.2 Use Cases

Backup from the main site to a disaster recovery site was previously done by changing the DNS entry from an old DNS entry to a new one pointing the client to a new location. However, this method is not efficient as changing each DNS entry takes a lot of time and the network should be designed in a way that it can take care of any workload down situation.

With the cloud evolution, the network has also evolved and can now provide multiple designs on how the cloud network can manage the workload in the cloud instead of locally or on-premise data center. With these innovations comes EVPN, which provides a neat solution for DCI (Data Center Interconnect).

By using an EVPN based DCI, businesses can stretch a layer2 network between data centers, and VMs can move easily with the same IP and gateway in the event of a disaster. The EVPN based control plane will automatically update the location of the VM (the host on which it is sitting) while the client accessing the data from this VM will not be affected and will not notice the change. The MAC move community takes care of moving the mac address to the right host.

EVPN on the network enables high speeds (up to 100Gb/s), low latency (required for most business applications), better buffer and tuning for big data, Artificial Inelegance (AI) and Machine Learning (ML) applications.

While EVPN is pure software implementation the rest of the mentioned attributes come from the network switching ASIC.

3.3 Mellanox DCI Solution

Mellanox SN2000 series of switches are the industry leader in ESF (Ethernet Storage Fabric), as these switches were designed for storage and have the right combination of performance, form factor, power consumption, buffers, automation hooks, integrated management and price point.

At the core of the ESF solution for Nutanix is the Mellanox Spectrum SN2010 switch, which is the ideal Top-of-Rack (ToR) switch for this use case.

Mellanox Spectrum SN2010 switch is the industry's best cost-to-performance solution which allows Nutanix customers to easily deploy a highly scalable, fully transparent networking cloud by utilizing the systems 18 ports of 25GbE and 4 ports of 100GbE. With EVPN enabled these switches support the DCI solution and have a clean data backup and recovery solution integrated within Nutanix.

Mellanox also provides a centralized network management application called NEO™ which is a powerful platform for data-center network orchestration, designed to simplify network provisioning, monitoring and operation for the modern data-center. NEO™ offers robust automation capabilities that extend the existing tools features set, from network staging and bring-up, to day-to-day operations. It allows to easily automate network configuration using various configuration templates for Mellanox Onyx and Cumulus Linux as well as custom made templates.

The integration of NEO™ with Nutanix Prism Central provided a seamless DCI/VXLAN L2 stretch from host perspective. When a user creates a network and a VM from Prism Central, The API triggers Mellanox NEO to configure the network switches for VLAN to VXLAN mapping to stretch L2 across the data-center interconnect infrastructure, so data backup and recovery can be realized.

NOTE:

Mellanox NEO can be installed on any host (bare-metal/virtual machine) in the network and the NEO virtual applianceis integrated with Nutanix AHV and validated as Nutanix Ready for Networking. To install NEO on Nutanix AHV, follow installation guide in Mellanox NEO User Manual.

The configuration is based on EVPN DCI where VXLAN is stretched from primary data location to the backup data location.

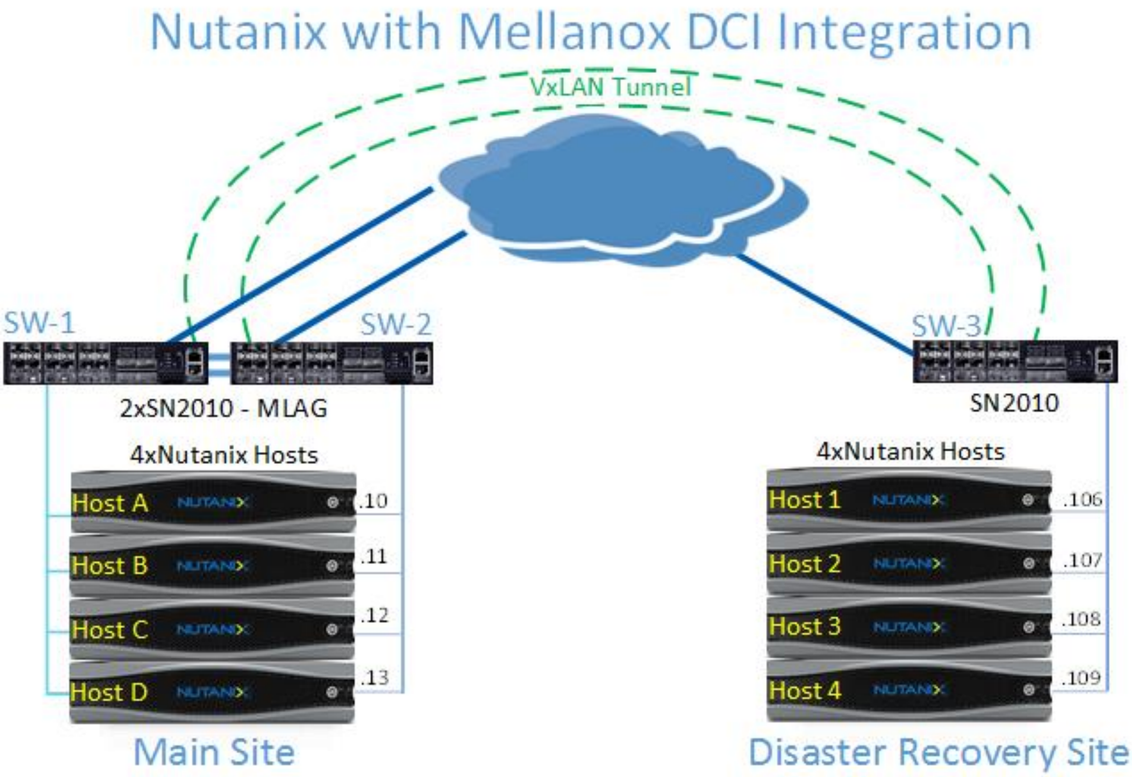
3.4 Supported Software

Below is a list of DCI solution supported software:

- NEO, ver. 2.3 and above
- CL, ver. 3.6.2 and above
- Nutanix AOS, ver. 5.5 and above
- Nutanix Prism Central, ver. 5.7.1 and above

3.5 Nutanix and Mellanox Spectrum SN2010 DCI Setup Diagram

The below diagram shows the logical connections of the Mellanox and Nutanix DCI/VXLAN solution.



The following chapter will guide you through the steps to configure the above solution using Nutanix Prism Central, NEO and SN2010 switches running Cumulus Linux.

3.5.1 Setup overview:

- Main Site – 4x Nutanix nodes and 2x Mellanox SN2010 switches (connected as MLAG peers)
- Disaster Recovery Site – 4x Nutanix nodes and 1x Mellanox SN2010 switch

Main Site	
VM A	192.168.1.10/24
VM B	192.168.2.11/24
VM C	192.168.3.12/24
VM D	192.168.4.13/24
SW-1 VLAN10	192.168.1.251/24
SW-1 VLAN20	192.168.2.251/24
SW-1 VLAN30	192.168.3.251/24
SW-1 VLAN40	192.168.4.251/24
SW-1 VTEP (Loopback)	10.10.10.1/32
SW-2 VTEP (Loopback)	10.10.10.2/32
SW-2 VLAN10	192.168.1.252/24
SW-2 VLAN20	192.168.2.252/24
SW-2 VLAN30	192.168.3.252/24
SW-2 VLAN40	192.168.4.252/24
CLAG VRR VLAN10 (GW)	192.168.1.254/24
CLAG VRR VLAN20 (GW)	192.168.2.254/24
CLAG VRR VLAN30 (GW)	192.168.3.254/24
CLAG VRR VLAN40 (GW)	192.168.4.254/24
CLAG Anycast IP	10.10.10.10/32

Disaster Recovery Site	
VM 1	192.168.1.106/24
VM 2	192.168.2.107/24
VM 3	192.168.3.108/24
VM 4	192.168.4.109/24
SW-3 VTEP (Loopback)	100.100.100.100/32
SW-3 VLAN10 (GW)	192.168.1.254/24
SW-3 VLAN20 (GW)	192.168.2.254/24
SW-3 VLAN30 (GW)	192.168.3.254/24
SW-3 VLAN40 (GW)	192.168.4.254/24

NOTE:

In this solution, we assume that the LAN gateways are Mellanox Spectrum switches (ToR). ToR switches may not act as LAN gateway in other deployments.

NOTE:

In deployments where there are more VMs in the same L2 domain (VLAN) as Nutanix Host (on site), L3 VLAN interfaces with trunks should be configured on the ToR's uplinks instead of L3 Router Port interfaces.

Mellanox DCI solution for Nutanix multi-cloud was accomplished by using a small number of network technologies: MLAG, underlay connectivity using any protocol, overlay BGP-EVPN control plane and VXLAN encapsulation for the data.

MLAG should be enabled and configured in the main site before configuring the underlay network as hosts in the main site have network high-availability (HA) provided by the MLAG protocol in the ToR switches to allow hosts to stay connected even when one of the ToR switches fail.

3.5.2 MLAG configuration on Cumulus Linux

Mellanox NEO offers a built in simplified MLAG configuration method on Cumulus Linux but an initial installation of the software is required. to install Mellanox NEO, follow the installation guide in Mellanox NEO User Manual.

There are two methods to configure MLAG on Cumulus Linux:

1. Automated MLAG configuration

   To configure MLAG using the automated method, run the following template in NEO:

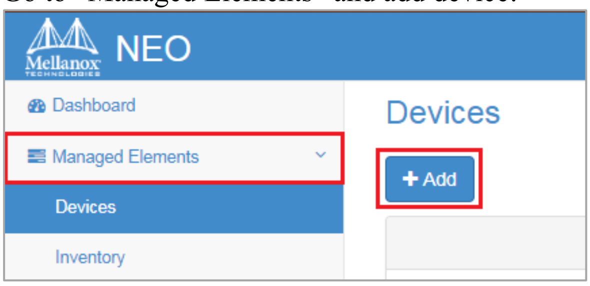
```
net add bond <bond_name> bond slaves <<interface_list>>
net add interface <bond_name>.<vlan_id> ip address
<<ipl_ip>>/<<netmask_length>>
net add interface <bond_name>.<vlan_id> clag peer-ip <<peer_ip>>
net add interface <bond_name>.<vlan_id> clag backup-ip <<backup_ip>>
net add interface <bond_name>.<vlan_id> clag sys-mac <virtual_mac>
net add bond <LAG_name> clag id <CLAG_ID>
net commit
```

2. Manual MLAG configuration

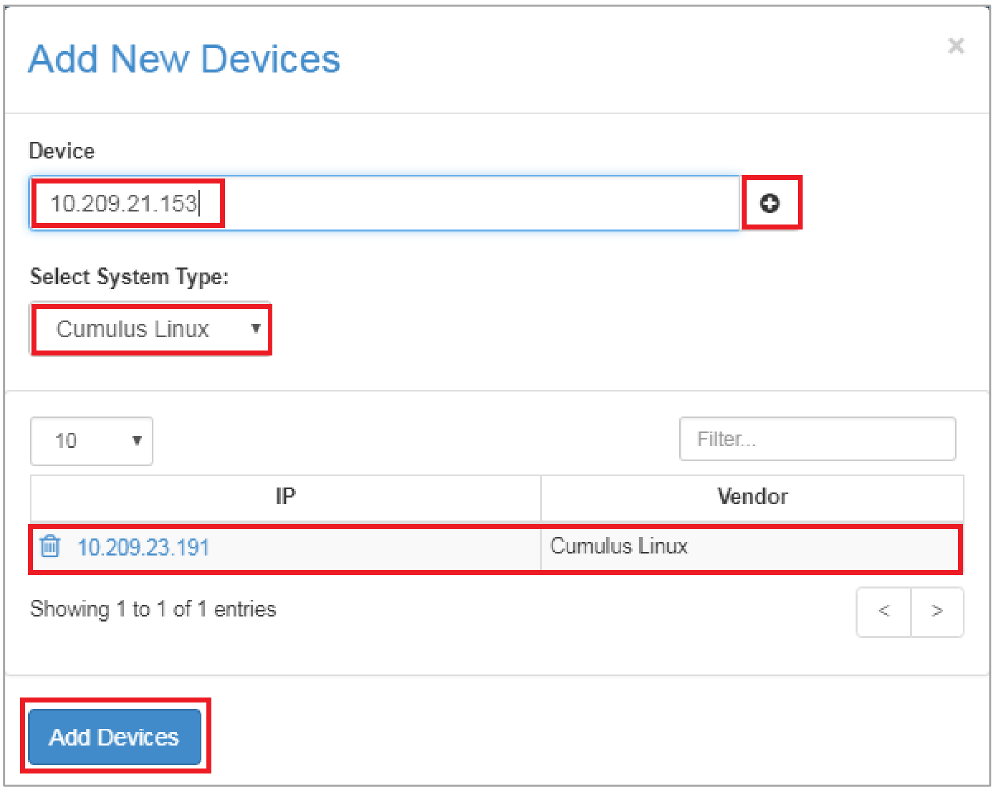
   To manually configure MLAG using NEO, both switches must be added to the management software.

   To add them to the NEO management software, follow the below steps:

   1. Go to “Managed Elements” and add device:



2. Add both switches in the main site:

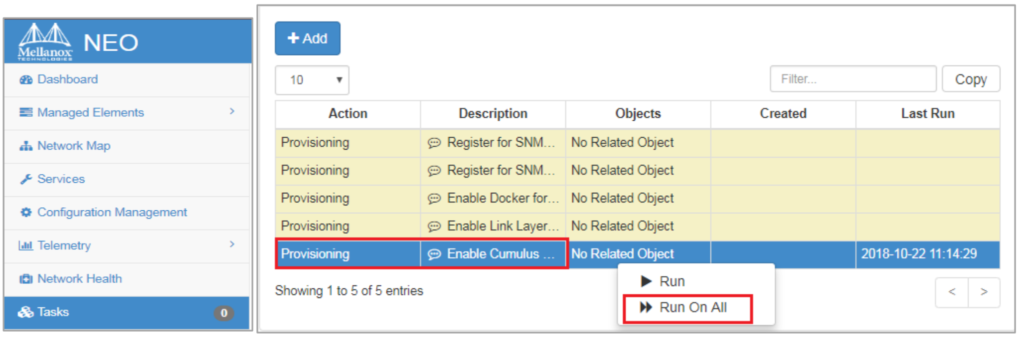


3. After the switches are successfully added to NEO, the following window will appear:

4. LLDP and SNMP protocols must be enabled on the switches for NEO to discover all the switch information, such as ports' connection information needed for the MLAG Wizard.
   There are 3 ways to enable the LLDP and SNMP protocols:

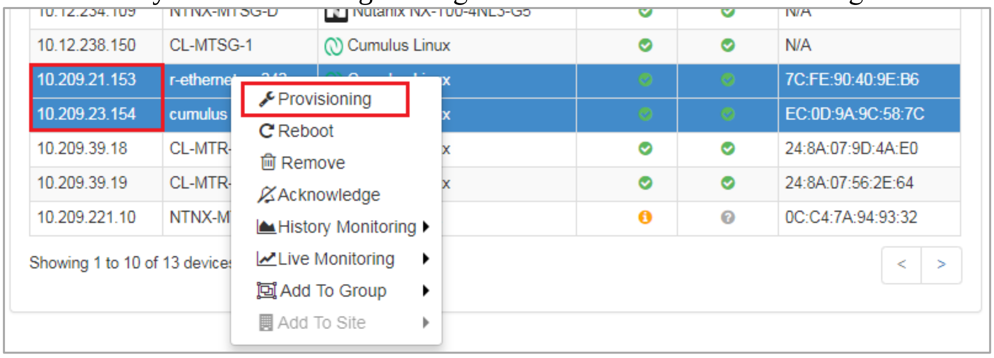
i. Predefined task

To configure using the Task, go “Tasks” and “Run”:

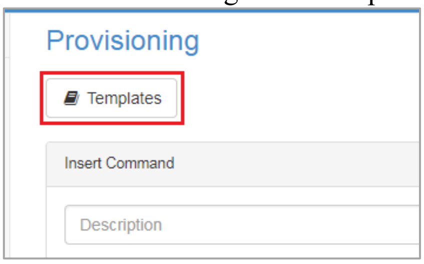


ii. Predefined template

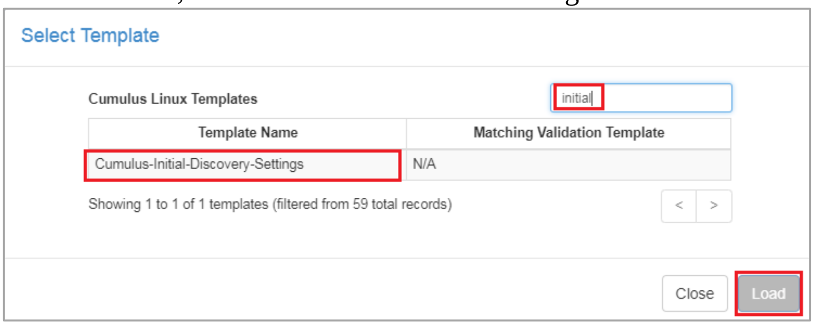
To configure using a predefined template, go to “Managed Elements” and select the switches you want to configure. Right click and choose “Provisioning”:



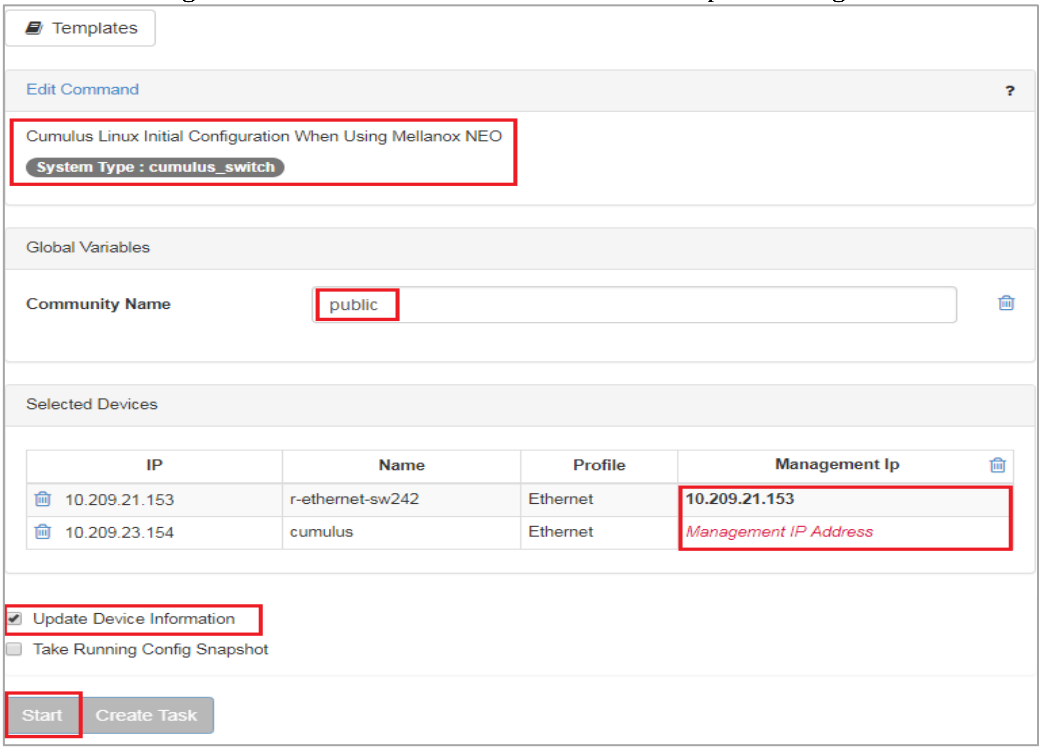
In the “Provisioning” tab that opened, press “Templates”:



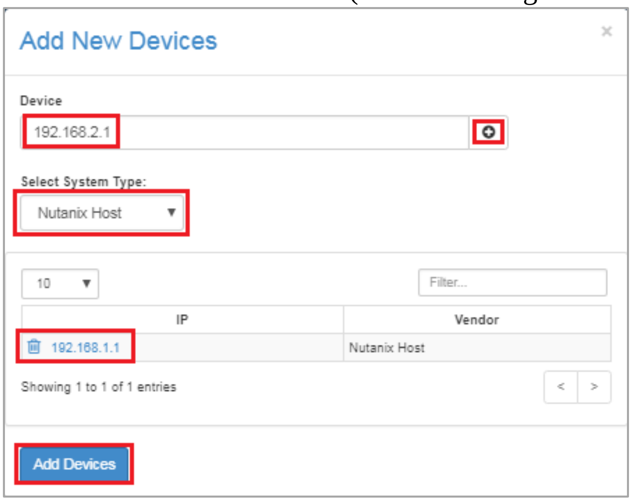
In this window, search for initial Cumulus configuration and load it:



Enter the Management IPs for the switches and start the template configuration:

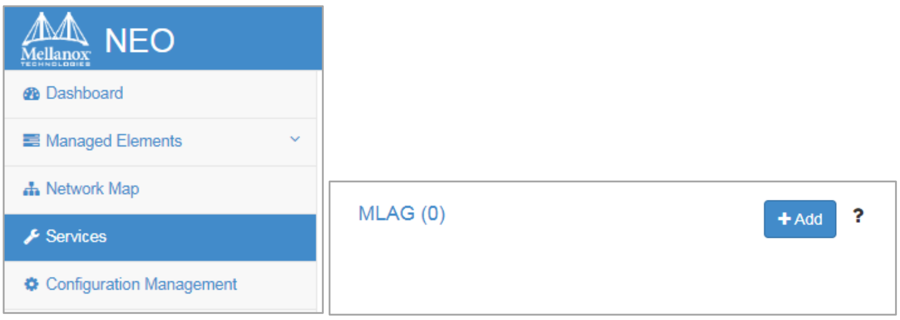


Add Nutanix servers to NEO (same as adding a switch):



After LLDP and SNMP are enabled on all switches and the servers added:

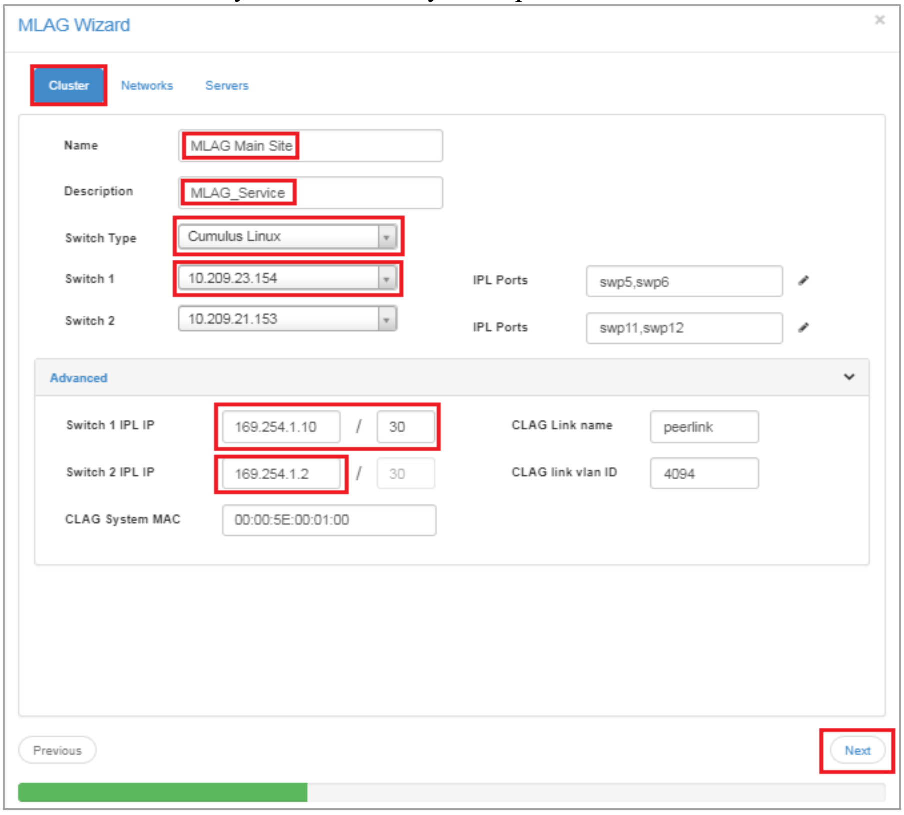
5. Go to "Services" and click on "+Add" button to open MLAG Wizard and add the MLAG service:



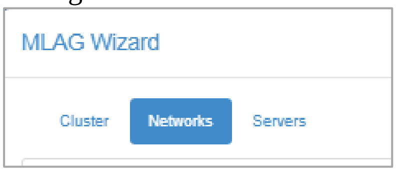
6. Add MLAG cluster parameters through the following:

a. Set name, description, select OS type and choose one of the added switches (the rest will be auto filled – ports and 2nd switch).

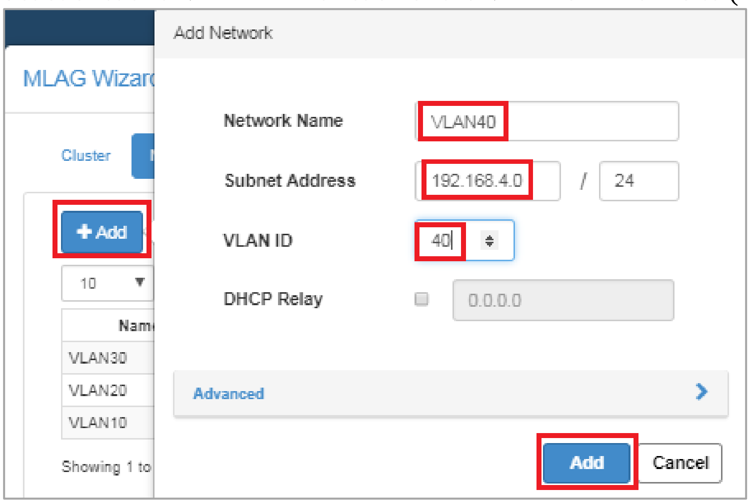
b. Under “Advanced” you can manually enter peerlink IP addresses for the cluster.



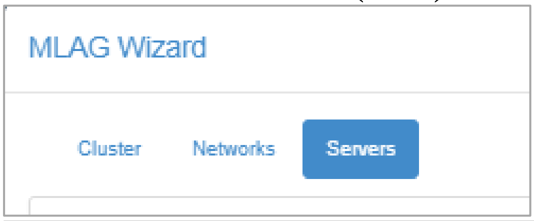
7. Configure MLAG networks:

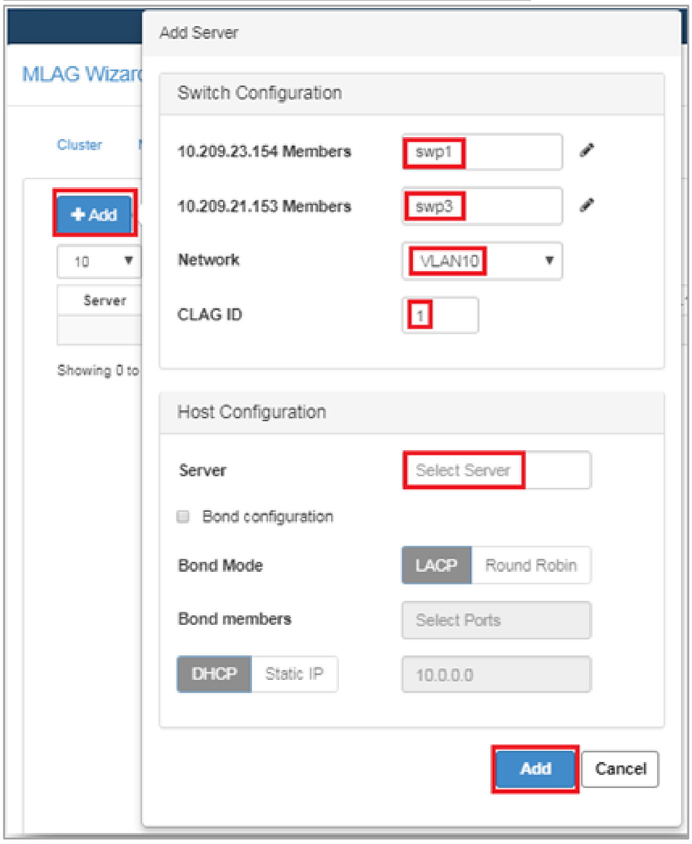


8. Set subnet and VLAN ID for each of the VLANs in main site (10, 20, 30, and 40):



9. Create MLAG Port-Channels (bonds) for downlinks:

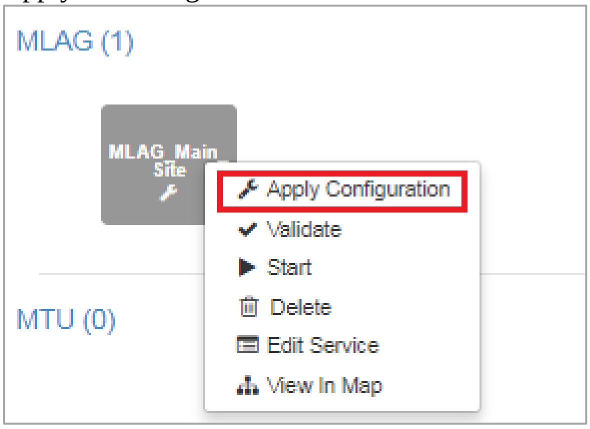




10. Repeat for the rest of the VLANs and VMs.
Note: For this configuration, previously added Nutanix servers are mandatory.

11. Press “Finish” to save MLAG service.

12. Apply the configuration on the switches:



i. MLAG is now configured with all the parameters on the switches.
CLI (see Appendix A).
Appendix A shows manual MLAG configuration using Cumulus Linux CLI.

3.6 Underlay Network Configuration

Underlay network reachability needs to be configured on the setup so that each ToR switch will have L3 connectivity to other switches (both physical and loopback interfaces-VTEPs).

The configuration method depends on the cross-site connection or the routing configuration already in use:

- OSPF Routing protocol
- BGP Routing protocol
- Static Routing

In our solution with Nutanix, BGP routing protocol underlay is used, but any of the above protocols are supported.

To create a ToR to remote ToR underlay network connectivity, BGP IPv4 neighborships must be established from each ToR to its next hop switch (there is an option to establish only BGP EVPN neighborship straight to the remote ToR in case of a different underlay protocol).

In the diagram above, only ToR switches are shown. The uplink interfaces will be used to connect to the exit point of the data center (generally with ECMP).

NOTE:

In case there is more than one rack on site, all racks should be connected using Spine switches. to connect the racks, an IP (including the undelay routing protocols) must be configured to enable intra and inter-site underlay L3 (IP) reachability between all leafs (Racks). any dynamic or static routing protocol can be used (here we cover BGP IPv4 address-family) for establishing IP connectivity. VTEP (Loopback) and MLAG Anycast-IP addresses (if exist) must be advertised via underlay routing protocol or set with static routing for further building the overlay VXLAN tunnel.

3.6.1 Underlay Network Configuration using BGP

We will demonstrate this process using 2 spine switches on each site. Each ToR is connected to both spines for ECMP.

Setup Overview:

- Main Site – spine1 and spine2.
- Disaster Recovery Site – spine3 and spine4.

To configure the underlay network follow the below steps:

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add bgp autonomous-system 65002
cumulus@SW-1:~$ net add bgp router-id 10.10.10.1
cumulus@SW-1:~$ net add bgp bestpath as-path multipath-relax
cumulus@SW-1:~$ net add bgp maximum-paths 2
cumulus@SW-1:~$ net add bgp neighbor [Spine1 interface IP] remote-as
[Spine1 AS]**
cumulus@SW-1:~$ net add bgp neighbor [Spine2 interface IP] remote-as
[Spine2 AS]**
**On Spines switches, use leaf’s IP address/AS numbers for BGP
neighborship (SW-1 uplinks IP addresses).
cumulus@SW-1:~$ net add bgp ipv4 unicast network 10.10.10.1/32
cumulus@SW-1:~$ net add bgp ipv4 unicast network 10.10.10.10/32
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-1:~$ net add bgp autonomous-system 65002
cumulus@SW-1:~$ net add bgp router-id 10.10.10.2
cumulus@SW-1:~$ net add bgp bestpath as-path multipath-relax
cumulus@SW-1:~$ net add bgp maximum-paths 2
cumulus@SW-1:~$ net add bgp neighbor [Spine1 interface IP] remote-as
[Spine1 AS]**
cumulus@SW-1:~$ net add bgp neighbor [Spine2 interface IP] remote-as
[Spine2 AS]**
**On Spines switches, use leaf’s IP address/AS numbers for BGP
neighborship (SW-2 uplinks IP addresses).
cumulus@SW-1:~$ net add bgp ipv4 unicast network 10.10.10.2/32
cumulus@SW-1:~$ net add bgp ipv4 unicast network 10.10.10.10/32
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-3:

```
cumulus@SW-3:~$ net add bgp autonomous-system 65003
cumulus@SW-3:~$ net add bgp router-id 100.100.100.100
cumulus@SW-3:~$ net add bgp bestpath as-path multipath-relax
cumulus@SW-1:~$ net add bgp maximum-paths 2
cumulus@SW-3:~$ net add bgp neighbor [Spine3 interface IP] remote-as
[Spine3 AS]**
cumulus@SW-3:~$ net add bgp neighbor [Spine4 interface IP] remote-as
[Spine4 AS]**
**On Spines switches, use leaf’s IP address/AS numbers for BGP
neighborship (SW-3 uplinks IP addresses).
cumulus@SW-3:~$ net add bgp ipv4 unicast network 100.100.100.100/32
cumulus@SW-3:~$ net pending
cumulus@SW-3:~$ net commit
```

If the BGP IPv4 connectivity is configured correctly, IP reachability should be successful between SW-1 and 2 loopbacks addresses in the main site and the SW-3 loopback on Disaster Recovery Site.

BGP EVPN control plane is used to “stretch” L2 network over the L3 underlay physical environment. Each leaf switch is used as VXLAN Tunnel End-Point (VTEP) that translates VLAN to VXLAN encapsulation and vice versa. As we have established undelay IP connectivity, BGP EVPN neighborship must be established between the sites and VTEP IP addresses must be advertised using BGP IPv4.

3.6.2 Overlay Network Configuration Using VXLAN with BGP EVPN

VTEPs Configuration:

To configure Loopback interface that will be used as VTEP tunnel IP address for VXLAN encapsulation follow the below steps:

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add loopback lo ip address 10.10.10.1/32
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add loopback lo ip address 10.10.10.2/32
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

- Run the following commands on SW-3:

```
cumulus@SW-3:~$ net add loopback lo ip address 100.100.100.100/32
cumulus@SW-3:~$ net pending
cumulus@SW-3:~$ net commit
```

In our case MLAG deployment exist on the main site, so both peers should be considered as “single” device from the VXLAN perspective and “Anycast-IP” should be configured.

To configure Anycast-IP follow the below steps:

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add loopback lo clag VXLAN -anycast-ip 10.10.10.10
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add loopback lo clag VXLAN -anycast-ip 10.10.10.10
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

BGP IPv4 neighbors are now established but both sites need to establish BGP EVPN neighborships.

For that, BGP EVPN address-family should be configured and neighbors activated within it. Each leaf will then be able to advertise L2 (MAC+IP) advertisements of VM’s LAN networks to other site. To do that, follow the below steps:

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add bgp neighbor 100.100.100.100 remote-as 65005
cumulus@SW-1:~$ net add bgp neighbor 100.100.100.100 update-source lo
cumulus@SW-1:~$ net add bgp l2vpn evpn neighbor 100.100.100.100 activate
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add bgp neighbor 100.100.100.100 remote-as 65005
cumulus@SW-2:~$ net add bgp neighbor 100.100.100.100 update-source lo
cumulus@SW-2:~$ net add bgp l2vpn evpn neighbor 100.100.100.100 activate
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

- Run the following commands on SW-3:

```
cumulus@SW-3:~$ net add bgp neighbor 10.10.10.1 remote-as 65002
cumulus@SW-3:~$ net add bgp neighbor 10.10.10.1 update-source lo
cumulus@SW-3:~$ net add bgp l2vpn evpn neighbor 10.10.10.1 activate
cumulus@SW-3:~$ net add bgp neighbor 10.10.10.2 remote-as 65002
cumulus@SW-3:~$ net add bgp neighbor 10.10.10.2 update-source lo
cumulus@SW-3:~$ net add bgp l2vpn evpn neighbor 10.10.10.2 activate
cumulus@SW-3:~$ net pending
cumulus@SW-3:~$ net commit
```

In case the cross-site has routing enabled, eBGP multihop must be used. For Dark fibre connection between sites, eBGP multihop is not required.

The following configuration is made per neighbor.

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add bgp neighbor 100.100.100.100 ebgp-multihop 255
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add bgp neighbor 100.100.100.100 ebgp-multihop 255
cumulus@SW-2:~$ net add bgp neighbor 100.100.100.100 ebgp-multihop 255
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

- Run the following commands on SW-3:

```
cumulus@SW-3:~$ net add bgp neighbor 10.10.10.1 ebgp-multihop 255
cumulus@SW-3:~$ net add bgp neighbor 10.10.10.2 ebgp-multihop 255
cumulus@SW-3:~$ net pending
cumulus@SW-3:~$ net commit
```

In addition, EVPN control plane should be able to advertise all VLAN→VNI mappings where NEO configures VLAN → VNI mapping automatically as per cluster networking in Prism Central.

To enable this functionality, run the following commands to configure under EVPN address-family and each new mapping of VLAN-VNI will be automatically synced using EVPN.

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add bgp l2vpn evpn advertise-all-vni
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add bgp l2vpn evpn advertise-all-vni
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

- Run the following commands on SW-3:

```
cumulus@SW-3:~$ net add bgp l2vpn evpn advertise-all-vni
cumulus@SW-3:~$ net pending
cumulus@SW-3:~$ net commit
```

To cover various failure scenarios, BGP neighborship should be established between both MLAG peers on the peerlink interfaces IP addresses. This way in case of a failure, there will still be a way to transfer VXLAN traffic between peers.

To do that, BGP IPv4 and EVPN address-families neighborships must be established between the MLAG pair switches using the following commands:

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add bgp neighbor 169.254.1.2 remote-as 65002
cumulus@SW-1:~$ net add bgp l2vpn evpn neighbor 169.254.1.2 activate
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add bgp neighbor 169.254.1.1 remote-as 65002
cumulus@SW-2:~$ net add bgp l2vpn evpn neighbor 169.254.1.1 activate
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

After establishing IP reachability on the underlay and ensuring EVPN control plane is configured, now we need to create a VLAN per VM and assign it to a VXLAN interface (VNI).

3.6.3 VLAN to VNI mapping on Cumulus Linux

When a new VM is configured using Nutanix Prism, NEO gets the APIs and automates the interface to VLAN (VLAN to VNI mapping). When the mapping done, each VXLAN interface created per VNI will have all the parameters needed for it and the LAN gateway address is configured with Virtual IP for the VMs.

Below is the NEO™ VLAN to VXLAN configuration template:

```
net add vlan <vlan_id>
net add vlan <vlan_id> ip address <<vlan_addr>>
net add vlan <vlan_id> ip address-virtual <mac_addr> <gw_addr>
net add bridge bridge ports <vni_name>
net add bridge bridge vids <vlan_id>
net add VXLAN  <vni_name> VXLAN  id <vni_id>
net add VXLAN  <vni_name> bridge access <vlan_id>
net add VXLAN  <vni_name> bridge arp-nd-suppress on
net add VXLAN  <vni_name> bridge learning off
0net add VXLAN  <vni_name> stp bpduguard
net add VXLAN  <vni_name> stp portbpdufilter
net add VXLAN  <vni_name> VXLAN  local-tunnelip <<tunnel_ip>>
net add VXLAN  <vni_name> mtu <mtu>*
net add <interface_type> <interface_name> bridge vids <VLAN_range_list>
net pending
net commit
```

After the above configuration takes place in Nutanix Prism, all LAN addresses should be advertised to other sites via BGP EVPN control plane to ensure L2 network is “stretched” to the Disaster Recovery site.

This is an automated process as we already configured EVPN to advertise all VNIs using “`net add bgp l2vpn evpn advertise-all-vni`” command under EVPN address-family.

As the environment will use VXLAN encapsulation, Jumbo MTU (9216B) should be set to support VXLAN headers that adds 50B to each packet.

```
[NEO]
ip = [NEO Server IP Address]
username = admin
password = password
session_timeout = 86400
timeout = 10
auto_discovery = true
add_host_credentials = true
host_ssh_username = root
host_ssh_password = nutanix/4u
switch_ssh_username = cumulus
switch_ssh_password = CumulusLinux!
vtep_mapping = [SW-1 IP Address]:10.10.10.1 [SW-2 IP Address]:10.10.10.2 [SW-3 IP Address]:100.100.100.100
vlan_ip_order = end
vxlan_mtu = 9216

# Section: Nutanix PRISM Central info
# username:         (required) Nutanix prism central username
# ip:               (required) CVM IP or Virtual IP of Nutanix prism central
# password:         (required) Nutanix prism central user password
# requests_retries: (required) maximum API requests retries
[PRISM]
username = admin
ip = [PRISM IP Address]
password = adm@Nutanix2017
requests_retries = 40

# Section: Server where plugin installed
# ip:   (optional) IP of the server from the same subnet as the Nutanix Cluster.
#       if the ip left empty, then the plugin will obtain the server's interface
#       ip that is connected to same network as Nutanix cluster.
# port: (required) TCP port on server should be unused to receive events from
#       from Nutanix cluster.
#       if the port is used, then the plugin will kill the process that uses
#       the port and reclaim it.
[SERVER]
ip = [NEO Server IP Address]
port = 8080
```

NOTE:

Cross-site connection (ISP, dark fibre etc.) must support this MTU to enable VXLAN traffic to pass between sites.

3.7 Nutanix Prism Central Plug-in for Mellanox NEO

For Nutanix DCI solution, Nutanix Prism Central plugin needs to be installed on the NEO server to connect to Nutanix Prism Central.

The software plug-in is an add-on that offers enhanced functionality to Mellanox and Nutanix customers. Nutanix Prism Central offers enhanced network capabilities, including a set of APIs to use Prism Central's accumulated VM data. Mellanox uses these APIs to establish the integration solution between Prism Central and Mellanox, which adds network automation for Nutanix AHV. This integration addresses the most common use-cases of the Nutanix hyperconverged cloud: VLAN auto-provisioning on Mellanox switches for Nutanix VM creation, migration and deletion. By using this plug-in, customers can establish a connection to Nutanix AHV’s events and have the infrastructure VLAN and VLAN-VNI mapping provisioned transparently. The plug-in can be installed and run on any CentOS/RHEL server that has connectivity to both Nutanix Prism Central and the NEO server.

The following table details the APIs used in this solution:

Scope	URL	Version	URL	Method
Prism/Cluster	/PrismGateway/services/rest/	v1.0	hosts	GET
Prism	/PrismGateway/services/rest/	v1.0	Hosts/<uuid>	GET
Cluster	/PrismGateway/services/rest/	v1.0	switches	GET
Prism	/PrismGateway/services/rest/	v1.0	clusters	GET
Cluster	/PrismGateway/services/rest/	v2.0	vms/<uuid>/virtual_nics	GET
Cluster	/PrismGateway/services/rest/	v2.0	vms/<uuid>/nics	GET
Prism	/api/nutanix/	v3.0	vms/<uuid>	GET
Cluster	/api/nutanix/	v3.0	webhooks/list	POST
Cluster	/api/nutanix/	v3.0	webhooks	POST
Cluster	/api/nutanix/	v3.0	subnets/list	POST
Cluster	/api/nutanix/	v3.0	vms/list	POST

Before installing the plugin, make sure you are using Nutanix Prism Central 5.7.1 and NEO v2.2 or above, SNMP and LLDP configured on the switches, Nutanix nodes physical connectivity to the switch established and Prism Central to NEO VM IP connectivity is established.

Download the plug-in from MyMellanox portal and run the RPM installation using the command “yum install nutanix-neo-1.3.0-3.x86_64.rpm”

To configure the plugin, fill the required details in the plugin configuration file located in /opt/nutanix-neo/config/nutanix-neo-plugin.cfg

Since this solution connects to the Prism Central, the credentials are those of the PC in use.

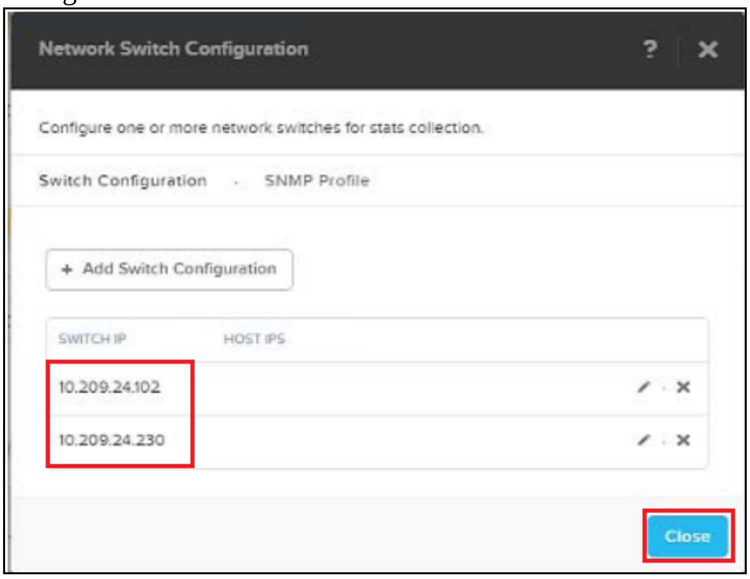
```
[NEO]
ip = [NEO Server IP Address]
username = admin
password = password
session_timeout = 86400
timeout = 10
auto_discovery = true
add_host_credentials = true
host_ssh_username = root
host_ssh_password = nutanix/4u
switch_ssh_username = cumulus
switch_ssh_password = CumulusLinux!
vtep_mapping = [SW-1 IP Address]:10.10.10.1 [SW-2 IP Address]:10.10.10.2 [SW-3 IP Address]:100.100.100.100
vlan_ip_order = end
vxlan_mtu = 9216

# Section: Nutanix PRISM Central info
# username:          (required) Nutanix prism central username
# ip:                (required) CVM IP or Virtual IP of Nutanix prism central
# password:          (required) Nutanix prism central user password
# requests_retries: (required) maximum API requests retries
[PRISM]
username = admin
ip = [PRISM IP Address]
password = adm@Nutanix2017
requests_retries = 40


# Section: Server where plugin installed
# ip:   (optional) IP of the server from the same subnet as the Nutanix Cluster.
#       if the ip left empty, then the plugin will obtain the server's interface
#       ip that is connected to same network as Nutanix cluster.
# port: (required) TCP port on server should be unused to receive events from
#       from Nutanix cluster.
#       if the port is used, then the plugin will kill the process that uses
#       the port and reclaim it.
[SERVER]
ip = [NEO Server IP Address]
port = 8080
```

Start the service using "`service nutanix-neo start`" command to enable the plugin.

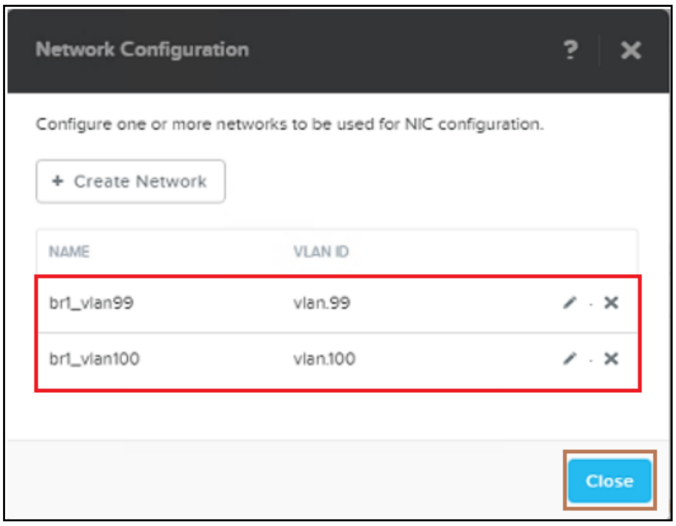
After plugin configuration file filled with the required information and the service started, we can start deploying the configuration using NEO™ automation.

Now we can create both clusters in Nutanix Prism. To do that follow the below:

1. Add the switches to the Nutanix Prism Element web UI. Click the wrench symbol on the right -> Network switch.



2. Create the Nutanix cluster network using Prism. Click the wrench symbol on the right -> Network Configuration. Make sure to edit the new network and identify the IP ranges if needed.

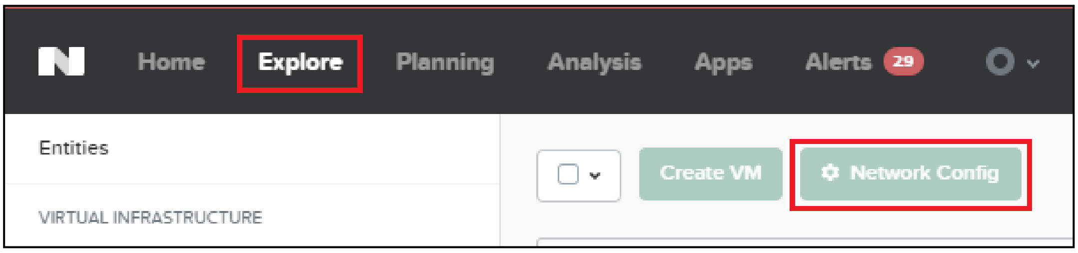


3. Repeat same steps to create the Disaster Recovery Site and add the switch to it.

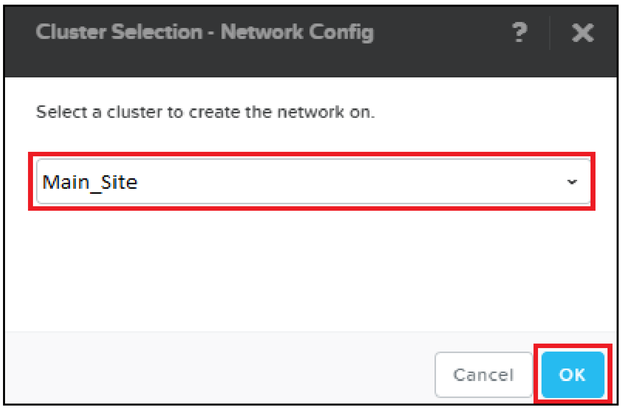
   For further information about Nutanix cluster network configuration, please refer to the Nutanix AHV Networking Best Practice Guide.

Now that the clusters were created, switches added to Prism Element and the plugin installed, let's see per tenant automation in-action:

1. Create Networks on the "Main Site" cluster:

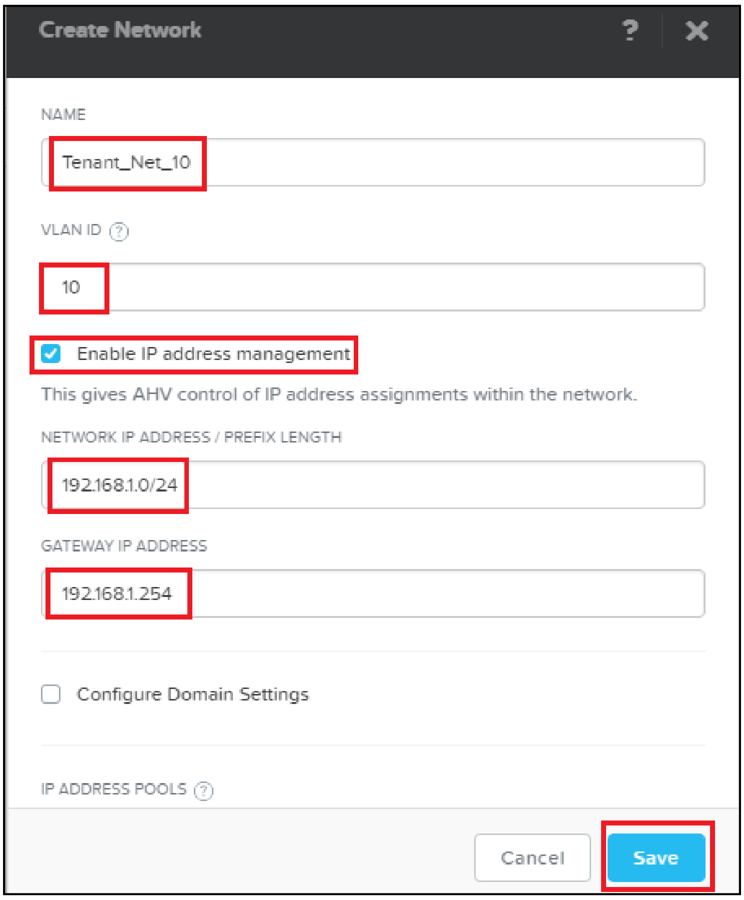


2. Select the cluster and create virtual network in it:

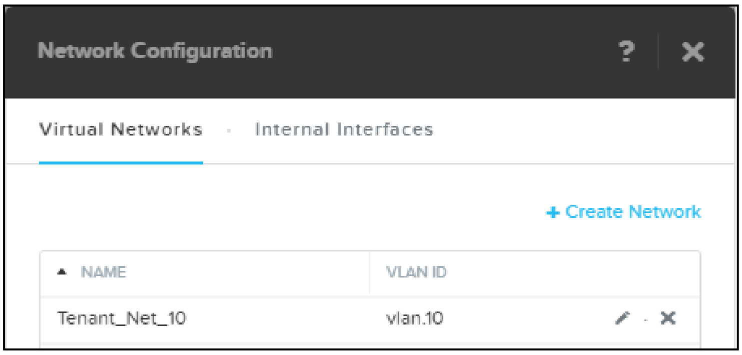


3. Define new network and set its VLAN and IP addressing for it (IP+Mask and default gateway):

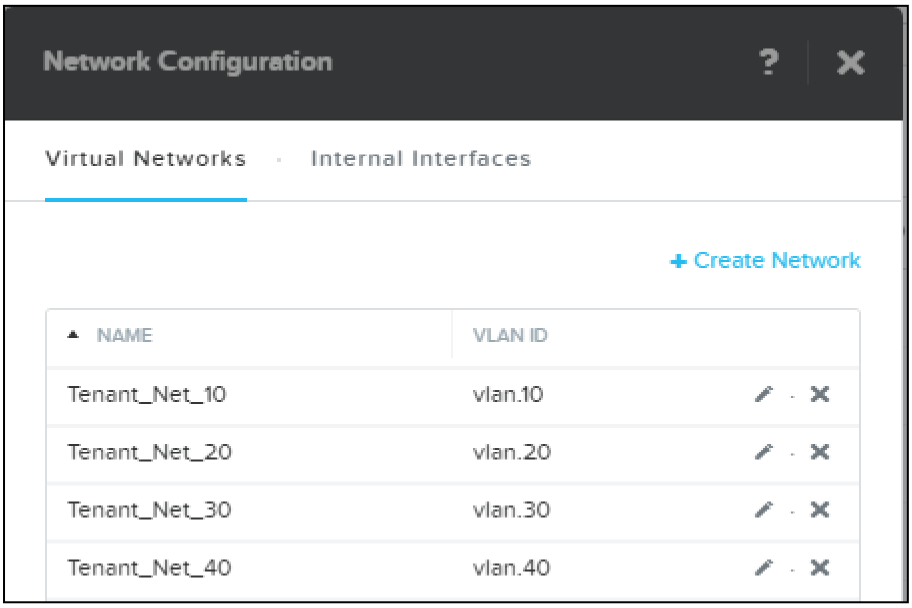
   In this example, each VM separated in different VLAN and has Network name of "Tenant_Net_[VLAN ID]".



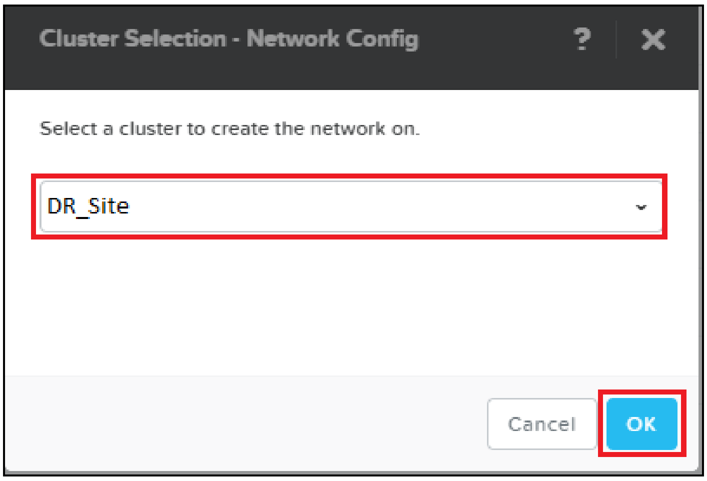
4. Network “Tenant_Net_10” created with VLAN 10:

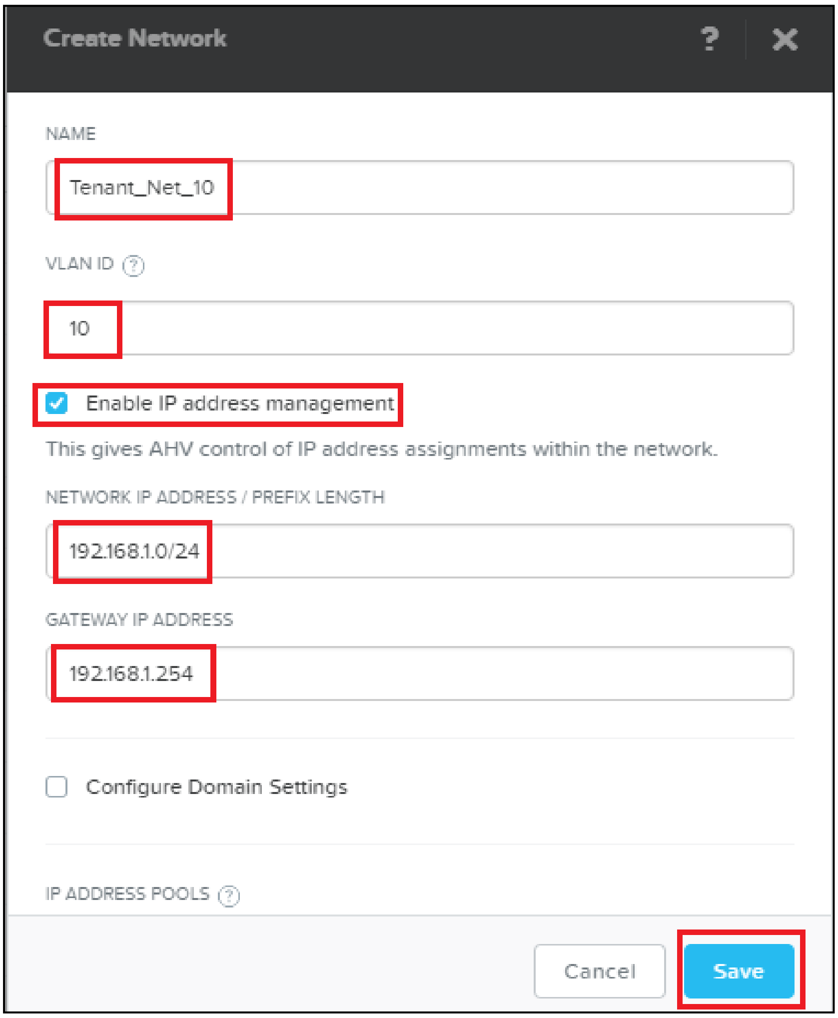


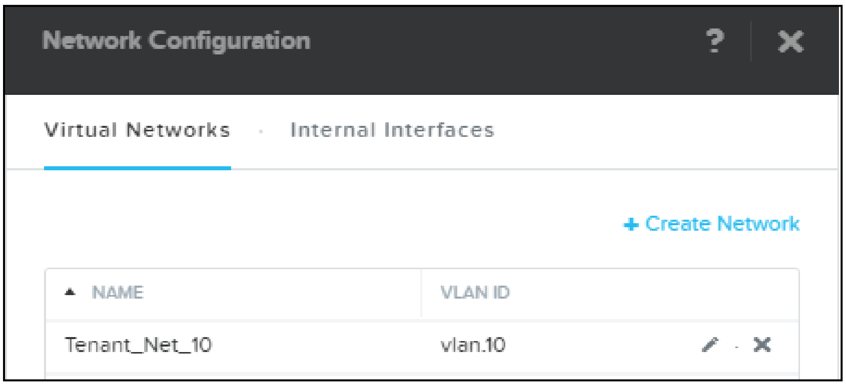
5. Repeat the steps above for each network in Main Site from the diagram:

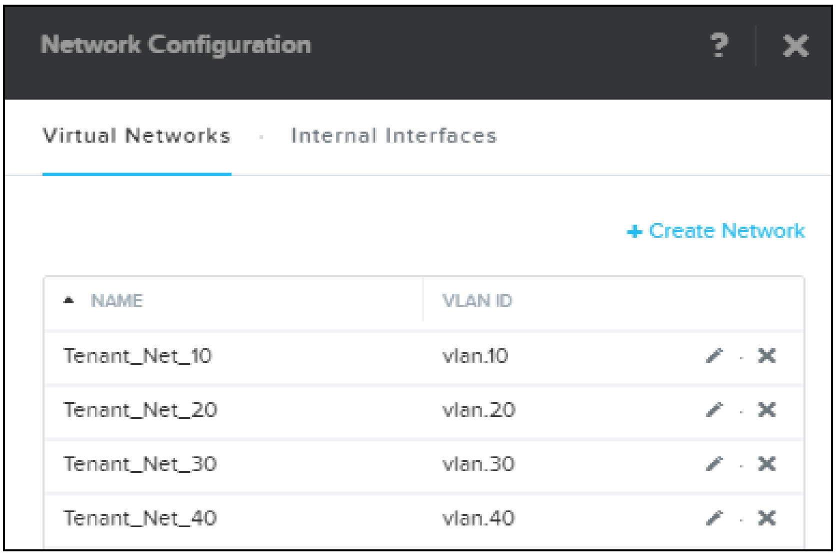


6. The same configuration will be made on “Disaster Recovery Site”. Same network names, VLANs and IP address assignments will be used here:



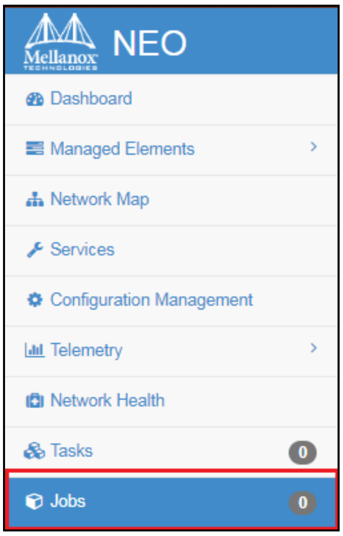

Create Network
NAME
Tenant_Net_10
VLAN ID
10
Enable IP address management
This gives AHV control of IP address assignments within the network.
NETWORK IP ADDRESS / PREFIX LENGTH
192.168.1.0/24
GATEWAY IP ADDRESS
192.168.1.254
Configure Domain Settings
IP ADDRESS POOLS
Cancel
Save


Network Configuration
Virtual Networks
Internal Interfaces
+ Create Network
NAME
VLAN ID
Tenant_Net_10
vlan.10

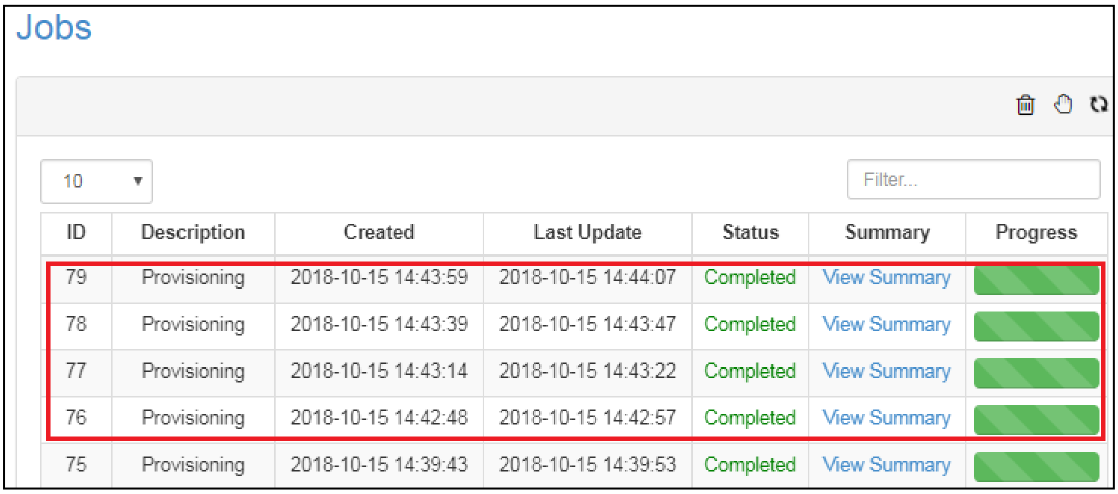


Now that the networks were created on both Nutanix clusters, NEO receives their respective network properties and configures the network switches accordingly.

1. To see the configuration, log into the NEO server and go to “Jobs”:

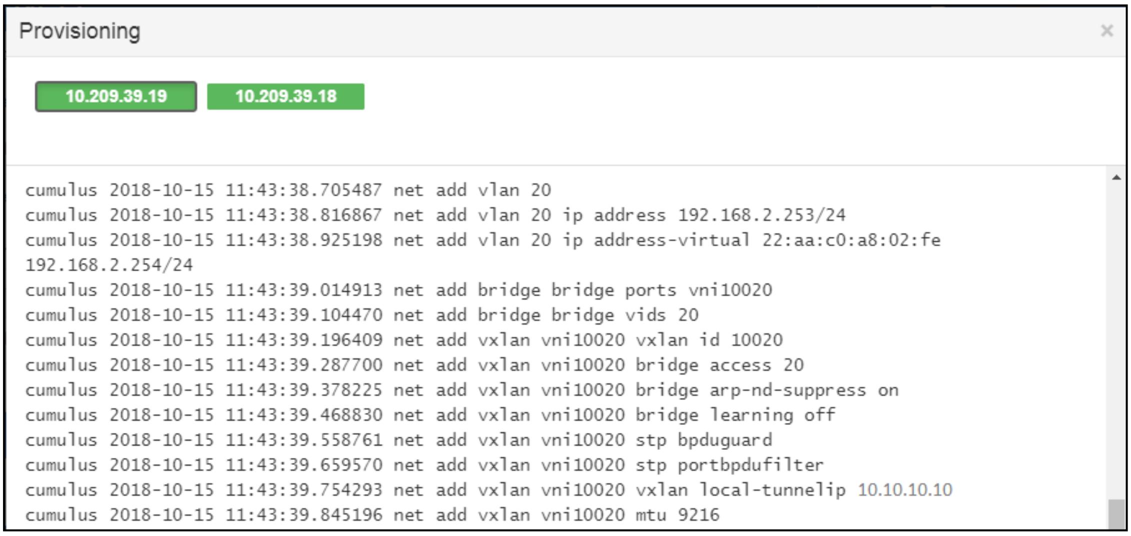


2. A job will be presented for each created network (on both clusters):

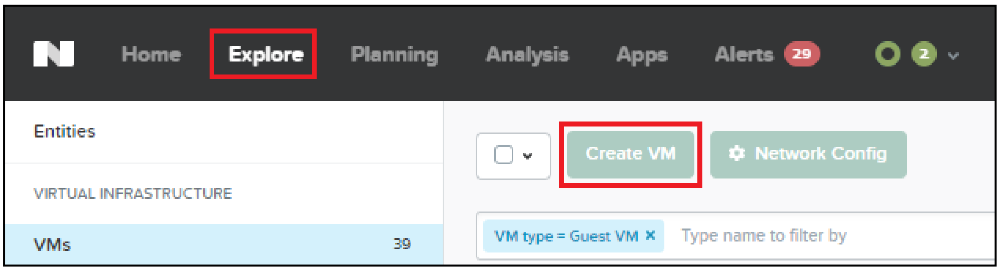


3. To see the configuration commands template NEO automatically executed you can press “View Summary”. After pressed, a window will appear with the switches we want to look at (in our case there is MLAG in Main Site, so the configuration will be made on two switches.

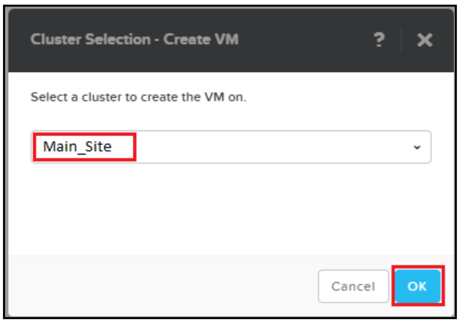
4. Select the switch you would like to review and configuration commands on the switch will be displayed.



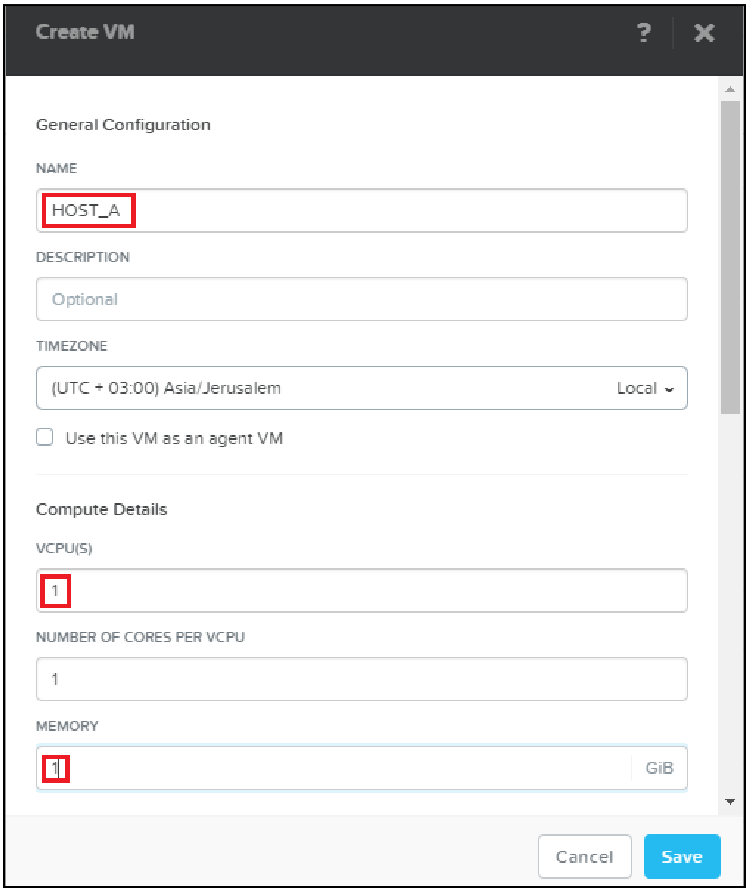
5. Now, we will create VMs in the respective networks.



6. Select the desired cluster to create the VM:

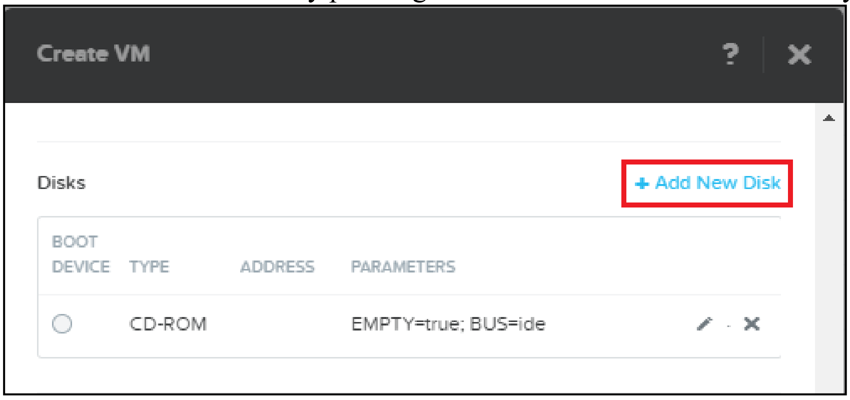


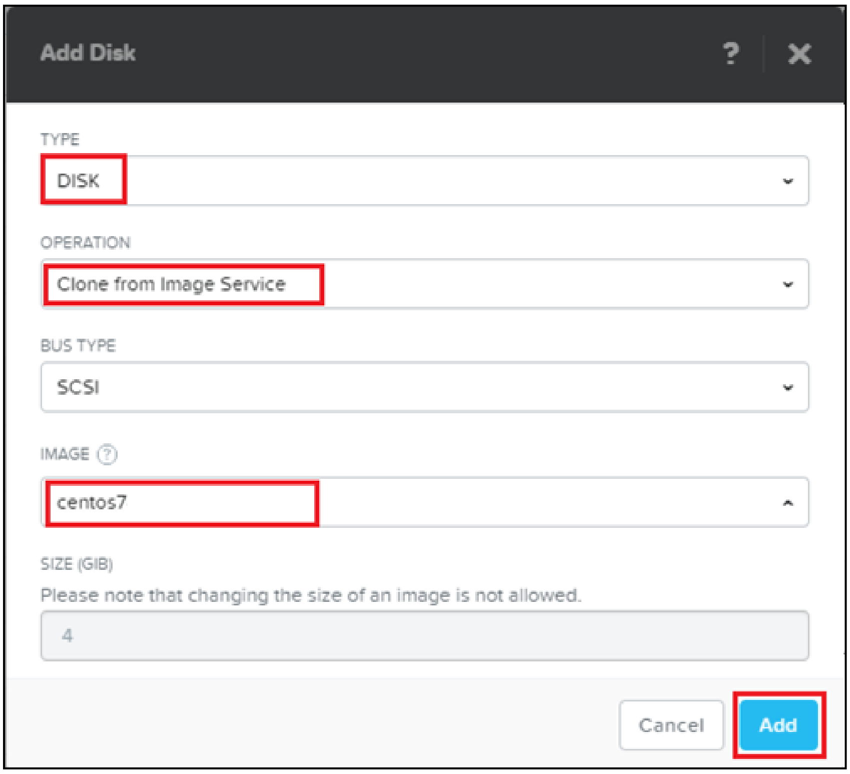
7. Configure the VM itself (name, compute details, NICs and disks):



You can scroll down for more parameters.

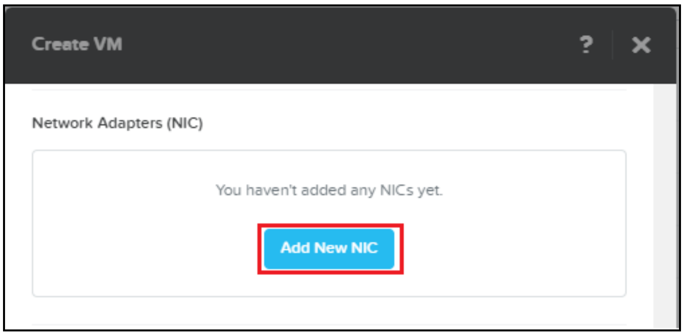
8. Now add HD to the VM by pressing “+Add New Disk” and choose its type:



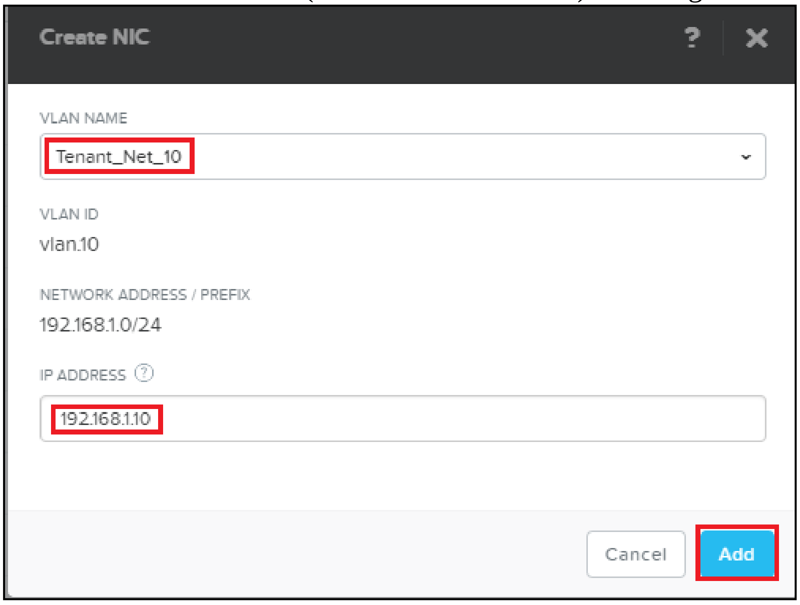


In this example we are using HD to clone an image of CentOS7

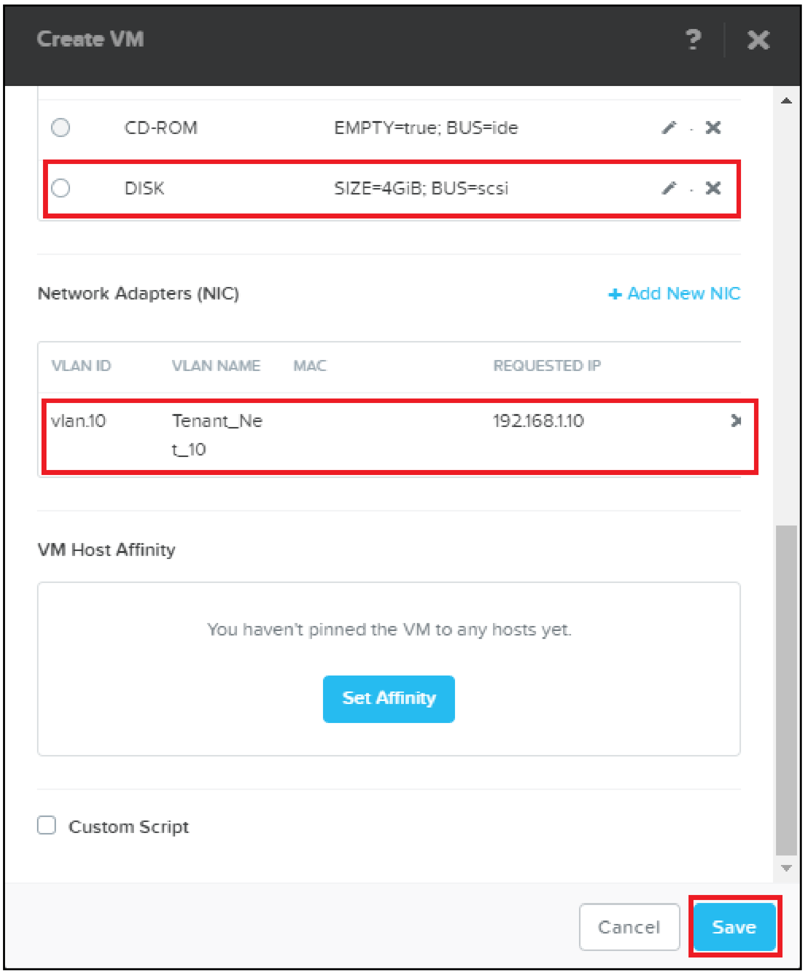
9. Create Network card for the VM (NIC):



10. Attach the VM to VLAN (from created networks) and assign IP address for the VM:



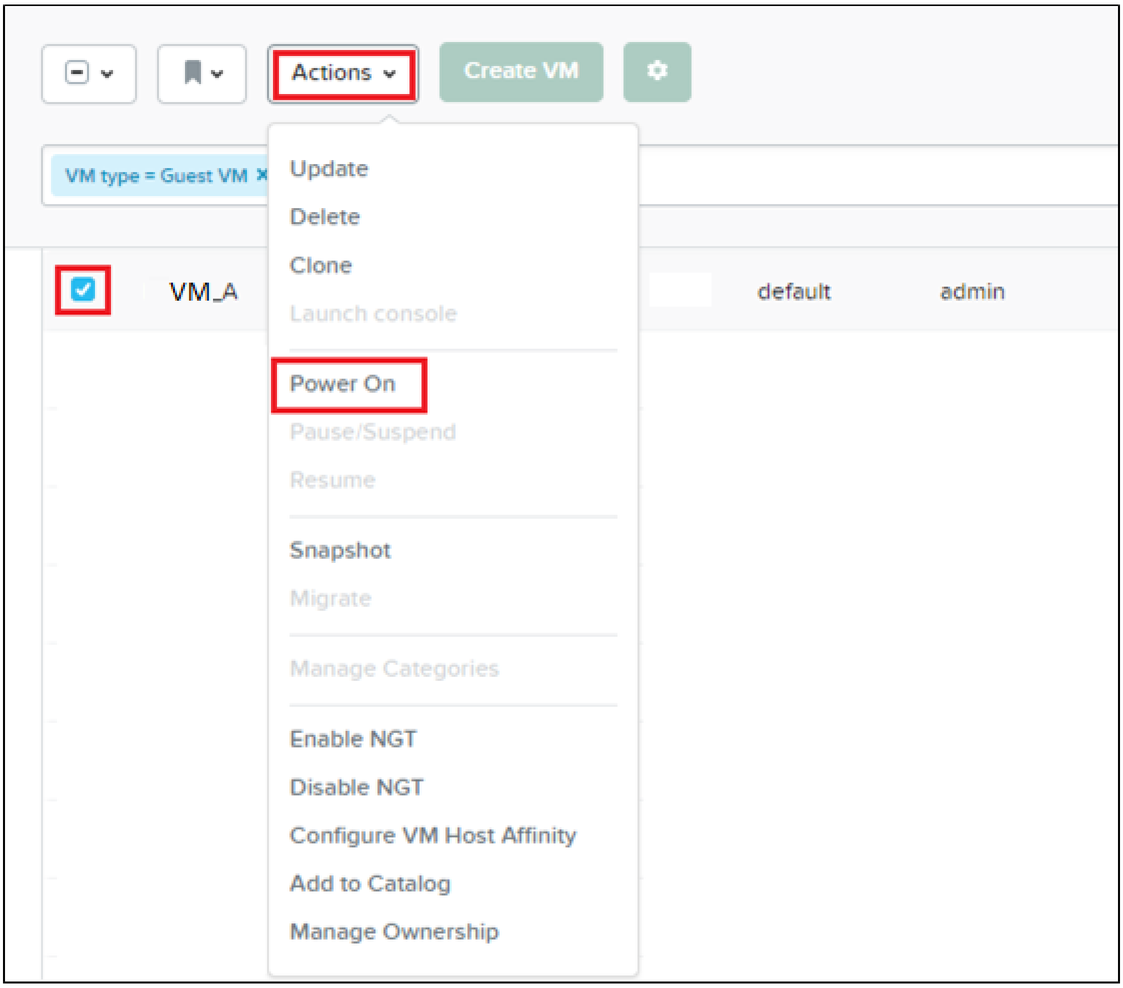
11. Check and save VM configuration:



Now, the VM appears in VM list:

12. Create VMs B, C and D on Main Site and VMs 1, 2, 3 and 4 on “DR_Site” using the same steps.

13. “Power on” all the VMs:



That’s it! You now have DCI between the VMs in Main site and the VMs in Disaster Recovery Site for the same subnets.

3.7.1 Verifying site-to-site connectivity using EVPN/VXLAN

To verify the site-to-site connectivity status:

Connectivity test from VM_A on Main site to VM_1 on Disaster Recovery Site (VLAN10←→VNI10010):

```
[root@localhost ~]# ping 192.168.1.106 -c 5
PING 192.168.1.106 (192.168.1.106) 56(84) bytes of data.
64 bytes from 192.168.1.106: icmp_seq=1 ttl=64 time=0.224 ms
64 bytes from 192.168.1.106: icmp_seq=2 ttl=64 time=0.116 ms
64 bytes from 192.168.1.106: icmp_seq=3 ttl=64 time=0.103 ms
64 bytes from 192.168.1.106: icmp_seq=4 ttl=64 time=0.136 ms
64 bytes from 192.168.1.106: icmp_seq=5 ttl=64 time=0.101 ms

--- 192.168.1.106 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 3999ms
rtt min/avg/max/mdev = 0.101/0.136/0.224/0.045 ms
```

Success!

Connectivity from VM_B on Main site to VM_2 on Disaster Recovery Site (VLAN20←→VNI10020):

```
[root@localhost ~]# ping 192.168.2.107 -c 5
PING 192.168.2.107 (192.168.2.107) 56(84) bytes of data.
64 bytes from 192.168.2.107: icmp_seq=1 ttl=64 time=0.416 ms
64 bytes from 192.168.2.107: icmp_seq=2 ttl=64 time=0.215 ms
64 bytes from 192.168.2.107: icmp_seq=3 ttl=64 time=0.271 ms
64 bytes from 192.168.2.107: icmp_seq=4 ttl=64 time=0.137 ms
64 bytes from 192.168.2.107: icmp_seq=5 ttl=64 time=0.215 ms

--- 192.168.2.107 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 3999ms
rtt min/avg/max/mdev = 0.137/0.250/0.416/0.095 ms
```

Success!

Connectivity from VM_C on Main site to VM_3 on Disaster Recovery Site (VLAN30←→VNI10030):

```
[root@localhost ~]# ping 192.168.3.108 -c 5
PING 192.168.3.108 (192.168.3.108) 56(84) bytes of data.
64 bytes from 192.168.3.108: icmp_seq=1 ttl=64 time=0.436 ms
64 bytes from 192.168.3.108: icmp_seq=2 ttl=64 time=0.215 ms
64 bytes from 192.168.3.108: icmp_seq=3 ttl=64 time=0.199 ms
64 bytes from 192.168.3.108: icmp_seq=4 ttl=64 time=0.235 ms
64 bytes from 192.168.3.108: icmp_seq=5 ttl=64 time=0.238 ms

--- 192.168.3.108 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4000ms
rtt min/avg/max/mdev = 0.199/0.264/0.436/0.088 ms
```

Success!

Connectivity from VM_D on Main site to VM_4 on Disaster Recovery Site (VLAN40←→VNI10040):

```
[root@localhost ~]# ping 192.168.4.109 -c 5
PING 192.168.4.109 (192.168.4.109) 56(84) bytes of data.
64 bytes from 192.168.4.109: icmp_seq=1 ttl=64 time=0.486 ms
64 bytes from 192.168.4.109: icmp_seq=2 ttl=64 time=0.224 ms
64 bytes from 192.168.4.109: icmp_seq=3 ttl=64 time=0.244 ms
64 bytes from 192.168.4.109: icmp_seq=4 ttl=64 time=0.220 ms
64 bytes from 192.168.4.109: icmp_seq=5 ttl=64 time=0.247 ms

--- 192.168.4.109 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4000ms
rtt min/avg/max/mdev = 0.220/0.284/0.486/0.102 ms
```

Success!

We can see that VMs on the same vlan have L2 connectivity across the sites. This indicates that L2 networks are “stretched” across the two sites connected over L3 networks.

Mellanox NEO allows for automated provisioning of switch MLAG, and VLAN and VNI creation per network. Appendix A shows how these steps can be manually configured through Cumulus Linux CLI, and how you can verify BGP EVPN control plane.

4 Appendix A: Manual DCI with VXLAN +EVPN and MLAG configuration using Cumulus Linux CLI

4.1 SNMP and LLDP configuration

Configure SNMP and LLDP on a Cumulus Linux switch to manage using NEO.

The following script is a prerequisite to the configuration process:

```
sudo service lldpd start
sudo systemctl start snmpd.service
sudo systemctl enable snmpd.service
net add snmp-server readonly-community public access any
net add snmp-server listening-address all
net commit
```

4.2 Manual MLAG configuration using Cumulus Linux CLI:

4.2.1 Configure Peerlink Interface

Peerlink interface, a port-channel (bond) between switches that maintains state information of MLAG and MLAG-ports.

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add bond peerlink bond slaves swp5-6
cumulus@SW-1:~$ net add interface peerlink.4094 ip address 169.254.1.10/30
cumulus@SW-1:~$ net add interface peerlink.4094 clag peer-ip 169.254.1.2
cumulus@SW-1:~$ net add interface peerlink.4094 clag backup-ip 192.0.2.50
cumulus@SW-1:~$ net add interface peerlink.4094 clag sys-mac
44:38:39:FF:40:94
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add bond peerlink bond slaves swp11-12
cumulus@SW-2:~$ net add interface peerlink.4094 ip address 169.254.1.2/30
cumulus@SW-2:~$ net add interface peerlink.4094 clag peer-ip 169.254.1.10
cumulus@SW-2:~$ net add interface peerlink.4094 clag backup-ip 192.0.2.50
cumulus@SW-2:~$ net add interface peerlink.4094 clag sys-mac
44:38:39:FF:40:94
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

Notes:

- MLAG backup-ip used for MLAG peerlink failure detection and should be an IP address reachable via leaf's management network
- Do not use 169.254.0.1 as the MLAG peerlink IP address. This address is used for BGP unnumbered in Cumulus Linux
- Same MAC address for different MLAG pairs cannot be used. Make sure you specify a different "clag sys-mac" setting for each MLAG pair in the network. To prevent MAC address conflicts with other interfaces in the same bridged network, use MAC address from MLAG specially reserved MAC range - 44:38:39:ff:00:00 to 44:38:39:ff:ff:ff.
- For high availability, we recommend having more than one physical link within this LAG
- All VLANs are open on the peerlink interface
- No need to add VLAN 4094 to the bridge VLAN list

To enable MLAG, peerlink must be added to bridge (or VLAN-aware bridge).

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add bridge bridge ports peerlink
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add bridge bridge ports peerlink
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

4.2.2 Configure MLAG Ports (Downlinks to hosts)

There are 4 MLAG ports—one for each host.

Host A is connected to MLAG-port (bond) 1, host B to MLAG-port 2, host C to MLAG-port 3 and host D to MLAG-port 4.

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add bond HostA bond slaves swp1
cumulus@SW-1:~$ net add clag port bond HostA interface swp1 clag-id 1
cumulus@SW-1:~$ net add bond HostB bond slaves swp2
cumulus@SW-1:~$ net add clag port bond HostB interface swp2 clag-id 2
cumulus@SW-1:~$ net add bond HostC bond slaves swp3
cumulus@SW-1:~$ net add clag port bond HostC interface swp3 clag-id 3
cumulus@SW-1:~$ net add bond HostD bond slaves swp4
cumulus@SW-1:~$ net add clag port bond HostD interface swp4 clag-id 4
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add bond HostA bond slaves swp1
cumulus@SW-2:~$ net add clag port bond HostA interface swp1 clag-id 1
cumulus@SW-2:~$ net add bond HostB bond slaves swp2
cumulus@SW-2:~$ net add clag port bond HostB interface swp2 clag-id 2
cumulus@SW-2:~$ net add bond HostC bond slaves swp3
cumulus@SW-2:~$ net add clag port bond HostC interface swp3 clag-id 3
cumulus@SW-2:~$ net add bond HostD bond slaves swp4
cumulus@SW-2:~$ net add clag port bond HostD interface swp4 clag-id 4
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

NOTE:

By default MLAG interfaces set to Active LACP mode, use "balance-xor" mode only if you cannot use LACP from some reason.

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add bond HostA bond mode balance-xor
cumulus@SW-1:~$ net add bond HostB bond mode balance-xor
cumulus@SW-1:~$ net add bond HostC bond mode balance-xor
cumulus@SW-1:~$ net add bond HostD bond mode balance-xor
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add bond HostA bond mode balance-xor
cumulus@SW-2:~$ net add bond HostB bond mode balance-xor
cumulus@SW-2:~$ net add bond HostC bond mode balance-xor
cumulus@SW-2:~$ net add bond HostD bond mode balance-xor
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

4.2.3 VNI and VLAN interfaces creation

- Run the following commands on SW-1:

```
cumulus@SW-1:~$ net add vlan 10 vlan-id 10
cumulus@SW-1:~$ net add vlan 20 vlan-id 20
cumulus@SW-1:~$ net add vlan 30 vlan-id 30
cumulus@SW-1:~$ net add vlan 40 vlan-id 40
cumulus@SW-1:~$ net add vlan 10 vlan-raw-device bridge
cumulus@SW-1:~$ net add vlan 20 vlan-raw-device bridge
cumulus@SW-1:~$ net add vlan 30 vlan-raw-device bridge
cumulus@SW-1:~$ net add vlan 40 vlan-raw-device bridge
cumulus@SW-1:~$ net add bridge bridge vids 10,20,30,40
cumulus@SW-1:~$ net add bond HostA bridge vids 10,20,30,40
cumulus@SW-1:~$ net add bond HostB bridge vids 10,20,30,40
cumulus@SW-1:~$ net add bond HostC bridge vids 10,20,30,40
cumulus@SW-1:~$ net add bond HostD bridge vids 10,20,30,40
cumulus@SW-1:~$ net add vlan 10 ip address 192.168.1.251/24
cumulus@SW-1:~$ net add vlan 10 ip address-virtual 00:00:00:11:22:33
192.168.1.254/24
cumulus@SW-1:~$ net add vlan 20 ip address 192.168.2.251/24
cumulus@SW-1:~$ net add vlan 20 ip address-virtual 00:00:00:11:22:33
192.168.2.254/24
cumulus@SW-1:~$ net add vlan 30 ip address 192.168.3.251/24
cumulus@SW-1:~$ net add vlan 30 ip address-virtual 00:00:00:11:22:33
192.168.3.254/24
cumulus@SW-1:~$ net add vlan 40 ip address 192.168.4.251/24
cumulus@SW-1:~$ net add vlan 40 ip address-virtual 00:00:00:11:22:33
192.168.4.254/24
cumulus@SW-1:~$ net add VXLAN  vni10 VXLAN  id 10010
cumulus@SW-1:~$ net add VXLAN  vni10 bridge access 10
cumulus@SW-1:~$ net add VXLAN  vni10 bridge arp-nd-suppress on
cumulus@SW-1:~$ net add VXLAN  vni10 bridge learning off
cumulus@SW-1:~$ net add VXLAN  vni10 stp bpduguard
cumulus@SW-1:~$ net add VXLAN  vni10 stp portbpdufilter
cumulus@SW-1:~$ net add VXLAN  vni10 VXLAN  local-tunnelip 10.10.10.1
cumulus@SW-1:~$ net add VXLAN  vni10 mtu 9216*
cumulus@SW-1:~$ net add VXLAN  vni20 VXLAN  id 10020
cumulus@SW-1:~$ net add VXLAN  vni20 bridge access 20
cumulus@SW-1:~$ net add VXLAN  vni20 bridge arp-nd-suppress on
```

```
cumulus@SW-1:~$ net add VXLAN  vni20 bridge learning off
cumulus@SW-1:~$ net add VXLAN  vni20 stp bpduguard
cumulus@SW-1:~$ net add VXLAN  vni20 stp portbpdufilter
cumulus@SW-1:~$ net add VXLAN  vni20 VXLAN  local-tunnelip 10.10.10.1
cumulus@SW-1:~$ net add VXLAN  vni20 mtu 9216*
cumulus@SW-1:~$ net add VXLAN  vni30 VXLAN  id 10030
cumulus@SW-1:~$ net add VXLAN  vni30 bridge access 30
cumulus@SW-1:~$ net add VXLAN  vni30 bridge arp-nd-suppress on
cumulus@SW-1:~$ net add VXLAN  vni30 bridge learning off
cumulus@SW-1:~$ net add VXLAN  vni30 stp bpduguard
cumulus@SW-1:~$ net add VXLAN  vni30 stp portbpdufilter
cumulus@SW-1:~$ net add VXLAN  vni30 VXLAN  local-tunnelip 10.10.10.1
cumulus@SW-1:~$ net add VXLAN  vni30 mtu 9216*
cumulus@SW-1:~$ net add VXLAN  vni40 VXLAN  id 10040
cumulus@SW-1:~$ net add VXLAN  vni40 bridge access 40
cumulus@SW-1:~$ net add VXLAN  vni40 bridge arp-nd-suppress on
cumulus@SW-1:~$ net add VXLAN  vni40 bridge learning off
cumulus@SW-1:~$ net add VXLAN  vni40 stp bpduguard
cumulus@SW-1:~$ net add VXLAN  vni40 stp portbpdufilter
cumulus@SW-1:~$ net add VXLAN  vni40 VXLAN  local-tunnelip 10.10.10.1
cumulus@SW-1:~$ net add VXLAN  vni40 mtu 9216*
cumulus@SW-1:~$ net add bridge bridge ports vni10,vni20,vni30,vni40
cumulus@SW-1:~$ net pending
cumulus@SW-1:~$ net commit
```

- Run the following commands on SW-2:

```
cumulus@SW-2:~$ net add vlan 10 vlan-id 10
cumulus@SW-2:~$ net add vlan 20 vlan-id 20
cumulus@SW-2:~$ net add vlan 30 vlan-id 30
cumulus@SW-2:~$ net add vlan 40 vlan-id 40
cumulus@SW-2:~$ net add vlan 10 vlan-raw-device bridge
cumulus@SW-2:~$ net add vlan 20 vlan-raw-device bridge
cumulus@SW-2:~$ net add vlan 30 vlan-raw-device bridge
cumulus@SW-2:~$ net add vlan 40 vlan-raw-device bridge
cumulus@SW-2:~$ net add bridge bridge vids 10,20,30,40
cumulus@SW-2:~$ net add bond HostA bridge vids 10,20,30,40
cumulus@SW-2:~$ net add bond HostB bridge vids 10,20,30,40
cumulus@SW-2:~$ net add bond HostC bridge vids 10,20,30,40
cumulus@SW-2:~$ net add bond HostD bridge vids 10,20,30,40
cumulus@SW-2:~$ net add vlan 10 ip address 192.168.1.252/24
cumulus@SW-2:~$ net add vlan 10 ip address-virtual 00:00:00:11:22:33
192.168.1.254/24
cumulus@SW-2:~$ net add vlan 20 ip address 192.168.2.252/24
cumulus@SW-2:~$ net add vlan 20 ip address-virtual 00:00:00:11:22:33
192.168.2.254/24
cumulus@SW-2:~$ net add vlan 30 ip address 192.168.3.252/24
cumulus@SW-2:~$ net add vlan 30 ip address-virtual 00:00:00:11:22:33
192.168.3.254/24
cumulus@SW-2:~$ net add vlan 40 ip address 192.168.4.252/24
cumulus@SW-2:~$ net add vlan 40 ip address-virtual 00:00:00:11:22:33
192.168.4.254/24
cumulus@SW-2:~$ net add VXLAN  vni10 VXLAN  id 10010
cumulus@SW-2:~$ net add VXLAN  vni10 bridge access 10
cumulus@SW-2:~$ net add VXLAN  vni10 bridge arp-nd-suppress on
cumulus@SW-2:~$ net add VXLAN  vni10 bridge learning off
cumulus@SW-2:~$ net add VXLAN  vni10 stp bpduguard
cumulus@SW-2:~$ net add VXLAN  vni10 stp portbpdufilter
cumulus@SW-2:~$ net add VXLAN  vni10 VXLAN  local-tunnelip 10.10.10.2
cumulus@SW-2:~$ net add VXLAN  vni10 mtu 9216*
cumulus@SW-2:~$ net add VXLAN  vni20 VXLAN  id 10020
cumulus@SW-2:~$ net add VXLAN  vni20 bridge access 20
cumulus@SW-2:~$ net add VXLAN  vni20 bridge arp-nd-suppress on
cumulus@SW-2:~$ net add VXLAN  vni20 bridge learning off
cumulus@SW-2:~$ net add VXLAN  vni20 stp bpduguard
cumulus@SW-2:~$ net add VXLAN  vni20 stp portbpdufilter
cumulus@SW-2:~$ net add VXLAN  vni20 VXLAN  local-tunnelip 10.10.10.2
```

```
cumulus@SW-2:~$ net add VXLAN  vni20 mtu 9216*
cumulus@SW-2:~$ net add VXLAN  vni30 VXLAN  id 10030
cumulus@SW-2:~$ net add VXLAN  vni30 bridge access 30
cumulus@SW-2:~$ net add VXLAN  vni30 bridge arp-nd-suppress on
cumulus@SW-2:~$ net add VXLAN  vni30 bridge learning off
cumulus@SW-2:~$ net add VXLAN  vni30 stp bpduguard
cumulus@SW-2:~$ net add VXLAN  vni30 stp portbpdufilter
cumulus@SW-2:~$ net add VXLAN  vni30 VXLAN  local-tunnelip 10.10.10.2
cumulus@SW-2:~$ net add VXLAN  vni30 mtu 9216*
cumulus@SW-2:~$ net add VXLAN  vni40 VXLAN  id 10040
cumulus@SW-2:~$ net add VXLAN  vni40 bridge access 40
cumulus@SW-2:~$ net add VXLAN  vni40 bridge arp-nd-suppress on
cumulus@SW-2:~$ net add VXLAN  vni40 bridge learning off
cumulus@SW-2:~$ net add VXLAN  vni40 stp bpduguard
cumulus@SW-2:~$ net add VXLAN  vni40 stp portbpdufilter
cumulus@SW-2:~$ net add VXLAN  vni40 VXLAN  local-tunnelip 10.10.10.2
cumulus@SW-2:~$ net add VXLAN  vni40 mtu 9216*
cumulus@SW-2:~$ net add bridge bridge ports vni10,vni20,vni30,vni40
cumulus@SW-2:~$ net pending
cumulus@SW-2:~$ net commit
```

- Run the following commands on SW-3:

```
cumulus@SW-3:~$ net add vlan 10 vlan-id 10
cumulus@SW-3:~$ net add vlan 20 vlan-id 20
cumulus@SW-3:~$ net add vlan 30 vlan-id 30
cumulus@SW-3:~$ net add vlan 40 vlan-id 40
cumulus@SW-3:~$ net add bridge bridge vids 10,20,30,40
cumulus@SW-3:~$ net add vlan 10 vlan-raw-device bridge
cumulus@SW-3:~$ net add vlan 20 vlan-raw-device bridge
cumulus@SW-3:~$ net add vlan 30 vlan-raw-device bridge
cumulus@SW-3:~$ net add vlan 40 vlan-raw-device bridge
cumulus@SW-3:~$ net add bond Host1 bridge vids 10,20,30,40
cumulus@SW-3:~$ net add bond Host2 bridge vids 10,20,30,40
cumulus@SW-3:~$ net add bond Host3 bridge vids 10,20,30,40
cumulus@SW-3:~$ net add bond Host4 bridge vids 10,20,30,40
cumulus@SW-3:~$ net add vlan 10 ip address-virtual 00:00:00:11:22:33
192.168.1.254/24
cumulus@SW-3:~$ net add vlan 20 ip address-virtual 00:00:00:11:22:33
192.168.2.254/24
cumulus@SW-3:~$ net add vlan 30 ip address-virtual 00:00:00:11:22:33
192.168.3.254/24
cumulus@SW-3:~$ net add vlan 40 ip address-virtual 00:00:00:11:22:33
192.168.4.254/24
cumulus@SW-3:~$ net add VXLAN  vni10 VXLAN  id 10010
cumulus@SW-3:~$ net add VXLAN  vni10 bridge access 10
cumulus@SW-3:~$ net add VXLAN  vni10 bridge arp-nd-suppress on
cumulus@SW-3:~$ net add VXLAN  vni10 bridge learning off
cumulus@SW-3:~$ net add VXLAN  vni10 stp bpduguard
cumulus@SW-3:~$ net add VXLAN  vni10 stp portbpdufilter
cumulus@SW-3:~$ net add VXLAN  vni10 VXLAN  local-tunnelip 100.100.100.100
cumulus@SW-3:~$ net add VXLAN  vni10 mtu 9216*
cumulus@SW-3:~$ net add VXLAN  vni20 VXLAN  id 10020
cumulus@SW-3:~$ net add VXLAN  vni20 bridge access 20
cumulus@SW-3:~$ net add VXLAN  vni20 bridge arp-nd-suppress on
cumulus@SW-3:~$ net add VXLAN  vni20 bridge learning off
cumulus@SW-3:~$ net add VXLAN  vni20 stp bpduguard
cumulus@SW-3:~$ net add VXLAN  vni20 stp portbpdufilter
cumulus@SW-3:~$ net add VXLAN  vni20 VXLAN  local-tunnelip 100.100.100.100
cumulus@SW-3:~$ net add VXLAN  vni20 mtu 9216*
cumulus@SW-3:~$ net add VXLAN  vni30 VXLAN  id 10030
cumulus@SW-3:~$ net add VXLAN  vni30 bridge access 30
cumulus@SW-3:~$ net add VXLAN  vni30 bridge arp-nd-suppress on
cumulus@SW-3:~$ net add VXLAN  vni30 bridge learning off
cumulus@SW-3:~$ net add VXLAN  vni30 stp bpduguard
cumulus@SW-3:~$ net add VXLAN  vni30 stp portbpdufilter
cumulus@SW-3:~$ net add VXLAN  vni30 VXLAN  local-tunnelip 100.100.100.100
```

```
cumulus@SW-3:~$ net add VXLAN  vni30 mtu 9216*
cumulus@SW-3:~$ net add VXLAN  vni40 VXLAN  id 10040
cumulus@SW-3:~$ net add VXLAN  vni40 bridge access 40
cumulus@SW-3:~$ net add VXLAN  vni40 bridge arp-nd-suppress on
cumulus@SW-3:~$ net add VXLAN  vni40 bridge learning off
cumulus@SW-3:~$ net add VXLAN  vni40 stp bpduguard
cumulus@SW-3:~$ net add VXLAN  vni40 stp portbpdufilter
cumulus@SW-3:~$ net add VXLAN  vni40 VXLAN  local-tunnelip 100.100.100.100
cumulus@SW-3:~$ net add VXLAN  vni40 mtu 9216*
cumulus@SW-3:~$ net add bridge bridge ports vni10,vni20,vni30,vni40
cumulus@SW-3:~$ net pending
cumulus@SW-3:~$ net commit
```

5 Configuration Verification

After all configuration configured correctly on the setup. Both sites will see each other as same L2 domain using BGP EVPN control plane.

Only SW-1 and SW-3 will be shown in the below outputs, SW-2 should have the same outputs as SW-1 (MLAG).

- BGP IPv4 and EVPN neighborships (for underlay and Overlay route advertisement)

```
cumulus@SW-1:~$ net show bgp summary

show bgp ipv4 unicast summary
=============================
BGP router identifier 10.10.10.1, local AS number 65002 vrf-id 0
BGP table version 19
RIB entries 7, using 1064 bytes of memory
Peers 4, using 77 KiB of memory

Neighbor        V         AS MsgRcvd MsgSent   TblVer  InQ OutQ  Up/Down
State/PfxRcd
1.1.1.2         4      65001  176052  176046        0    0    0 00:19:43
1
1.1.2.2         4      65004  201856  171989        0    0    0 00:19:43
1
169.254.1.2     4      65002  150152  150181        0    0    0 5d05h04m
3

Total number of neighbors 3


show bgp ipv6 unicast summary
=============================


show bgp l2vpn evpn summary
===========================
BGP router identifier 10.10.10.1, local AS number 65002 vrf-id 0
BGP table version 0
RIB entries 23, using 3496 bytes of memory
Peers 4, using 77 KiB of memory

Neighbor            V         AS MsgRcvd MsgSent   TblVer  InQ OutQ  Up/Down
State/PfxRcd
100.100.100.100     4      65005     131     140        0    0    0 00:02:43
12
169.254.1.2         4      65002  150152  150181        0    0    0 5d05h04m
12

Total number of neighbors 2
```

```
cumulus@SW-3:~$ net show bgp summary

show bgp ipv4 unicast summary
=============================
BGP router identifier 100.100.100.100, local AS number 65005 vrf-id 0
BGP table version 13
RIB entries 7, using 1064 bytes of memory
Peers 4, using 77 KiB of memory

Neighbo    V         AS MsgRcvd MsgSent   TblVer  InQ OutQ  Up/Down
State/PfxRcd
1.1.5.2    4      65006  150529  150433        0    0    0 00:24:41
3
1.1.6.2    4      65006  150534  150438        0    0    0 00:24:41
3

Total number of neighbors 2


show bgp ipv6 unicast summary
=============================
% No BGP neighbors found


show bgp l2vpn evpn summary
===========================
BGP router identifier 100.100.100.100, local AS number 65005 vrf-id 0
BGP table version 0
RIB entries 15, using 2280 bytes of memory
Peers 4, using 77 KiB of memory

Neighbor    V         AS MsgRcvd MsgSent   TblVer  InQ OutQ  Up/Down
State/PfxRcd
10.10.10.1  4      65002     215     209        0    0    0 00:06:46
12
10.10.10.2  4      65002     200     220        0    0    0 00:06:46
12

Total number of neighbors 2
```

All switches have BGP neighbors established with BGP IPv4 address-family to ensure underlay connectivity. EVPN address-family is also activated on the ToR switches to ensure MAC-IP route advertisements between sites.

- Underlay Routing Table to VTEPs (Loopbacks located on ToR switches)

```
cumulus@SW-1:~$ net show route

show ip route
=============
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, D - SHARP,
       F - PBR,
       > - selected route, * - FIB route

K>* 0.0.0.0/0 [0/0] via 10.209.20.1, eth0, 22:39:47
C>* 1.1.1.0/24 is directly connected, swp2, 22:39:47
C>* 1.1.2.0/24 is directly connected, swp3, 22:39:47
C>* 10.10.10.0/24 is directly connected, peerlink.4094, 19:28:39
C>* 10.10.10.1/32 is directly connected, lo, 22:39:47
B>* 10.10.10.2/32 [200/0] via 169.254.1.2, peerlink.4094, 01:07:44
C>* 10.10.10.10/32 is directly connected, lo, 19:28:28
C>* 10.209.20.0/22 is directly connected, eth0, 22:39:47
B>* 100.100.100.100/32 [20/0] via 1.1.1.2, swp2, 00:00:11
  *                           via 1.1.2.2, swp3, 00:00:11
C>* 169.254.1.0/30 is directly connected, peerlink.4094, 19:28:39
C * 192.168.1.0/24 is directly connected, vlan10-v1, 19:28:30
C * 192.168.1.0/24 is directly connected, vlan10-v0, 19:28:30
C>* 192.168.1.0/24 is directly connected, vlan10, 19:28:30
C * 192.168.2.0/24 is directly connected, vlan20-v1, 19:28:30
C * 192.168.2.0/24 is directly connected, vlan20-v0, 19:28:30
C>* 192.168.2.0/24 is directly connected, vlan20, 19:28:30
C * 192.168.3.0/24 is directly connected, vlan30-v1, 19:28:30
C * 192.168.3.0/24 is directly connected, vlan30-v0, 19:28:30
C>* 192.168.3.0/24 is directly connected, vlan30, 19:28:30
C * 192.168.4.0/24 is directly connected, vlan40-v1, 19:28:30
C * 192.168.4.0/24 is directly connected, vlan40-v0, 19:28:30
C>* 192.168.4.0/24 is directly connected, vlan40, 19:28:30
```

```
cumulus@SW-3:~$ net show route

show ip route
=============
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, D - SHARP,
       F - PBR,
       > - selected route, * - FIB route

K>* 0.0.0.0/0 [0/0] via 10.209.20.1, eth0, 01:44:24
C>* 1.1.5.0/24 is directly connected, swp5, 01:44:24
C>* 1.1.6.0/24 is directly connected, swp6, 01:44:24
B>* 10.10.10.1/32 [20/0] via 1.1.5.2, swp5, 01:04:22
  *                      via 1.1.6.2, swp6, 01:04:22
B>* 10.10.10.2/32 [20/0] via 1.1.5.2, swp5, 01:04:22
  *                      via 1.1.6.2, swp6, 01:04:22
B>* 10.10.10.10/32 [20/0] via 1.1.5.2, swp5, 01:04:22
  *                       via 1.1.6.2, swp6, 01:04:22
C>* 10.209.20.0/22 is directly connected, eth0, 01:44:24
C>* 100.100.100.100/32 is directly connected, lo, 01:44:24
C>* 192.168.1.0/24 is directly connected, vlan10-v0, 01:44:24
C>* 192.168.2.0/24 is directly connected, vlan20-v0, 01:44:24
C>* 192.168.3.0/24 is directly connected, vlan30-v0, 01:44:24
C>* 192.168.4.0/24 is directly connected, vlan40-v0, 01:44:24
```

As we can see, each ToR switch has L3 connectivity (routes) to the destination VTEP on remote site allowing VXLAN tunnel encapsulation and deliver the packets to a remote VTEP.

- BGP EVPN Routes

```
cumulus@SW-1:~$ net show bgp evpn route
BGP table version is 15, local router ID is 10.10.10.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal
Origin codes: i - IGP, e - EGP, ? - incomplete
EVPN type-2 prefix: [2]:[ESI]:[EthTag]:[MAClen]:[MAC]:[IPlen]:[IP]
EVPN type-3 prefix: [3]:[EthTag]:[IPlen]:[OrigIP]
EVPN type-5 prefix: [5]:[ESI]:[EthTag]:[IPlen]:[IP]

   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 10.10.10.1:2
*> [2]:[0]:[0]:[48]:[00:00:10:00:00:10]
                    10.10.10.10                        32768 i
*> [2]:[0]:[0]:[48]:[00:00:10:00:00:10]:[32]:[192.168.1.10]
                    10.10.10.10                        32768 i
*> [3]:[0]:[32]:[10.10.10.10]
                    10.10.10.10                        32768 i
Route Distinguisher: 10.10.10.1:3
*> [2]:[0]:[0]:[48]:[00:00:30:00:00:12]
                    10.10.10.10                        32768 i
*> [2]:[0]:[0]:[48]:[00:00:30:00:00:12]:[32]:[192.168.3.12]
                    10.10.10.10                        32768 i
*> [3]:[0]:[32]:[10.10.10.10]
                    10.10.10.10                        32768 i
Route Distinguisher: 10.10.10.1:4
*> [2]:[0]:[0]:[48]:[00:00:20:00:00:11]
                    10.10.10.10                        32768 i
*> [2]:[0]:[0]:[48]:[00:00:20:00:00:11]:[32]:[192.168.2.11]
                    10.10.10.10                        32768 i
*> [3]:[0]:[32]:[10.10.10.10]
                    10.10.10.10                        32768 i
Route Distinguisher: 10.10.10.1:5
*> [2]:[0]:[0]:[48]:[00:00:40:00:00:13]
                    10.10.10.10                        32768 i
*> [2]:[0]:[0]:[48]:[00:00:40:00:00:13]:[32]:[192.168.4.13]
                    10.10.10.10                        32768 i
*> [3]:[0]:[32]:[10.10.10.10]
                    10.10.10.10                        32768 i
Route Distinguisher: 100.100.100.100:7
* i[2]:[0]:[0]:[48]:[00:00:10:00:01:06]
                    100.100.100.100               100      0 65005 i
*> [2]:[0]:[0]:[48]:[00:00:10:00:01:06]
                    100.100.100.100                        0 65005 i
* i[2]:[0]:[0]:[48]:[00:00:10:00:01:06]:[32]:[192.168.1.106]
                    100.100.100.100               100      0 65005 i
*> [2]:[0]:[0]:[48]:[00:00:10:00:01:06]:[32]:[192.168.1.106]
                    100.100.100.100                        0 65005 i
* i[3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100               100      0 65005 i
*> [3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100                        0 65005 i
Route Distinguisher: 100.100.100.100:8
* i[2]:[0]:[0]:[48]:[00:00:30:00:01:08]
                    100.100.100.100               100      0 65005 i
*> [2]:[0]:[0]:[48]:[00:00:30:00:01:08]
                    100.100.100.100                        0 65005 i
* i[2]:[0]:[0]:[48]:[00:00:30:00:01:08]:[32]:[192.168.3.108]
                    100.100.100.100               100      0 65005 i
*> [2]:[0]:[0]:[48]:[00:00:30:00:01:08]:[32]:[192.168.3.108]
                    100.100.100.100                        0 65005 i
* i[3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100               100      0 65005 i
*> [3]:[0]:[32]:[100.100.100.100]
```

```
                    100.100.100.100                         0 65005 i
Route Distinguisher: 100.100.100.100:9
* i[2]:[0]:[0]:[48]:[00:00:20:00:01:07]
                    100.100.100.100               100       0 65005 i
*> [2]:[0]:[0]:[48]:[00:00:20:00:01:07]
                    100.100.100.100                         0 65005 i
* i[2]:[0]:[0]:[48]:[00:00:20:00:01:07]:[32]:[192.168.2.107]
                    100.100.100.100               100       0 65005 i
*> [2]:[0]:[0]:[48]:[00:00:20:00:01:07]:[32]:[192.168.2.107]
                    100.100.100.100                         0 65005 i
* i[3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100               100       0 65005 i
*> [3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100                         0 65005 i
Route Distinguisher: 100.100.100.100:10
* i[2]:[0]:[0]:[48]:[00:00:40:00:01:09]
                    100.100.100.100               100       0 65005 i
*> [2]:[0]:[0]:[48]:[00:00:40:00:01:09]
                    100.100.100.100                         0 65005 i
* i[2]:[0]:[0]:[48]:[00:00:40:00:01:09]:[32]:[192.168.4.109]
                    100.100.100.100               100       0 65005 i
*> [2]:[0]:[0]:[48]:[00:00:40:00:01:09]:[32]:[192.168.4.109]
                    100.100.100.100                         0 65005 i
* i[3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100               100       0 65005 i
*> [3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100                         0 65005 i

Displayed 24 prefixes (36 paths)
```

```
cumulus@SW-3:~$ net show bgp evpn route
BGP table version is 18, local router ID is 100.100.100.100
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal
Origin codes: i - IGP, e - EGP, ? - incomplete
EVPN type-2 prefix: [2]:[ESI]:[EthTag]:[MAClen]:[MAC]:[IPlen]:[IP]
EVPN type-3 prefix: [3]:[EthTag]:[IPlen]:[OrigIP]
EVPN type-5 prefix: [5]:[ESI]:[EthTag]:[IPlen]:[IP]

   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 10.10.10.1:2
*> [2]:[0]:[0]:[48]:[00:00:10:00:00:10]
                    10.10.10.10                            0 65002 i
*> [2]:[0]:[0]:[48]:[00:00:10:00:00:10]:[32]:[192.168.1.10]
                    10.10.10.10                            0 65002 i
*> [3]:[0]:[32]:[10.10.10.10]
                    10.10.10.10                            0 65002 i
Route Distinguisher: 10.10.10.1:3
*> [2]:[0]:[0]:[48]:[00:00:30:00:00:12]
                    10.10.10.10                            0 65002 i
*> [2]:[0]:[0]:[48]:[00:00:30:00:00:12]:[32]:[192.168.3.12]
                    10.10.10.10                            0 65002 i
*> [3]:[0]:[32]:[10.10.10.10]
                    10.10.10.10                            0 65002 i
Route Distinguisher: 10.10.10.1:4
*> [2]:[0]:[0]:[48]:[00:00:20:00:00:11]
                    10.10.10.10                            0 65002 i
*> [2]:[0]:[0]:[48]:[00:00:20:00:00:11]:[32]:[192.168.2.11]
                    10.10.10.10                            0 65002 i
*> [3]:[0]:[32]:[10.10.10.10]
                    10.10.10.10                            0 65002 i
Route Distinguisher: 10.10.10.1:5
*> [2]:[0]:[0]:[48]:[00:00:40:00:00:13]
                    10.10.10.10                            0 65002 i
*> [2]:[0]:[0]:[48]:[00:00:40:00:00:13]:[32]:[192.168.4.13]
                    10.10.10.10                            0 65002 i
*> [3]:[0]:[32]:[10.10.10.10]
                    10.10.10.10                            0 65002 i
Route Distinguisher: 100.100.100.100:7
*> [2]:[0]:[0]:[48]:[00:00:10:00:01:06]
                    100.100.100.100                    32768 i
*> [2]:[0]:[0]:[48]:[00:00:10:00:01:06]:[32]:[192.168.1.106]
                    100.100.100.100                    32768 i
*> [3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100                    32768 i
Route Distinguisher: 100.100.100.100:8
*> [2]:[0]:[0]:[48]:[00:00:30:00:01:08]
                    100.100.100.100                    32768 i
*> [2]:[0]:[0]:[48]:[00:00:30:00:01:08]:[32]:[192.168.3.108]
                    100.100.100.100                    32768 i
*> [3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100                    32768 i
Route Distinguisher: 100.100.100.100:9
*> [2]:[0]:[0]:[48]:[00:00:20:00:01:07]
                    100.100.100.100                    32768 i
*> [2]:[0]:[0]:[48]:[00:00:20:00:01:07]:[32]:[192.168.2.107]
                    100.100.100.100                    32768 i
*> [3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100                    32768 i
Route Distinguisher: 100.100.100.100:10
*> [2]:[0]:[0]:[48]:[00:00:40:00:01:09]
                    100.100.100.100                    32768 i
*> [2]:[0]:[0]:[48]:[00:00:40:00:01:09]:[32]:[192.168.4.109]
                    100.100.100.100                    32768 i
*> [3]:[0]:[32]:[100.100.100.100]
                    100.100.100.100                    32768 i
```

```
Displayed 24 prefixes (24 paths)
```

As we can see from output above, EVPN control plane is successfully converged and EVPN routes appear in BGP EVPN tables of each ToR. By this, each site will be able to forward encapsulated VXLAN packets to remote site hosts.

- VNI Information

```
cumulus@SW-1:~$ net show bgp evpn vni
Advertise Gateway Macip: Disabled
Advertise All VNI flag: Enabled
Number of L2 VNIs: 4
Number of L3 VNIs: 0
Flags: * - Kernel
  VNI        Type      RD          Import RT          Export RT
Tenant VRF
* 10030      L2   10.10.10.1:3   65002:10030       65002:10030   Default-IP-
Routing-Table
* 10010      L2   10.10.10.1:2   65002:10010       65002:10010   Default-IP-
Routing-Table
* 10040      L2   10.10.10.1:5   65002:10040       65002:10040   Default-IP-
Routing-Table
* 10020      L2   10.10.10.1:4   65002:10020       65002:10020   Default-IP-
Routing-Table
```

```
cumulus@SW-3:~$ net show bgp evpn vni
Advertise Gateway Macip: Disabled
Advertise All VNI flag: Enabled
Number of L2 VNIs: 4
Number of L3 VNIs: 0
Flags: * - Kernel
  VNI        Type       RD              Import RT          Export RT
Tenant VRF
* 10030      L2   100.100.100.100:8   65005:10030       65005:10030
Default-IP-Routing-Table
* 10010      L2   100.100.100.100:7   65005:10010       65005:10010
Default-IP-Routing-Table
* 10040      L2   100.100.100.100:10  65005:10040       65005:10040
Default-IP-Routing-Table
* 10020      L2   100.100.100.100:9   65005:10020       65005:10020
Default-IP-Routing-Table
```

Shows the configuration for VNI interfaces and route-targets used in BGP to exchange information.

- MAC addresses information

```
cumulus@SW-1:~$ net show evpn mac vni all

VNI 10030 #MACs (local and remote) 2

MAC               Type   Intf/Remote VTEP      VLAN
00:00:30:00:00:12 local  HostA                 30
ec:0d:9a:5f:9f:18 local  vlan30                30
00:00:00:11:22:33 local  vlan30-v0             30
00:00:30:00:01:08 remote 100.100.100.100

VNI 10010 #MACs (local and remote) 2

MAC               Type   Intf/Remote VTEP      VLAN
00:00:5e:00:01:01 local  vlan10-v1             10
00:00:10:00:01:06 remote 100.100.100.100
ec:0d:9a:5f:9f:18 local  vlan10                10
00:00:00:11:22:33 local  vlan10-v0             10
00:00:10:00:00:10 local  HostA                 10

VNI 10040 #MACs (local and remote) 2

MAC               Type   Intf/Remote VTEP      VLAN
00:00:40:00:01:09 remote 100.100.100.100
ec:0d:9a:5f:9f:18 local  vlan40                40
00:00:00:11:22:33 local  vlan40-v0             40
00:00:40:00:00:13 local  HostA                 40

VNI 10020 #MACs (local and remote) 2

MAC               Type   Intf/Remote VTEP      VLAN
00:00:20:00:01:07 remote 100.100.100.100
00:00:20:00:00:11 local  HostA                 20
ec:0d:9a:5f:9f:18 local  vlan20                20
00:00:00:11:22:33 local  vlan20-v0             20
```

```
cumulus@SW-1:~$ net show bridge macs

VLAN      Master  Interface  MAC                TunnelDest      State     Flags
LastSeen
----      ------  ---------  ---------------    --------------  --------  -----
------  --------
10         bridge  HostA     00:00:10:00:00:10
00:01:18
10         bridge  bridge    00:00:00:11:22:33                   permanent
00:33:57
10         bridge  bridge    ec:0d:9a:5f:9f:0c                   permanent
20:14:58
10         bridge  vni10     00:00:10:00:01:06
offload        00:33:56
20         bridge  HostA     00:00:20:00:00:11
00:00:18
20         bridge  bridge    00:00:00:11:22:33                   permanent
00:33:57
20         bridge  bridge    ec:0d:9a:5f:9f:0c                   permanent
20:14:58
20         bridge  vni20     00:00:20:00:01:07
offload        00:33:56
30         bridge  HostA     00:00:30:00:00:12
00:00:18
30         bridge  bridge    00:00:00:11:22:33                   permanent
00:33:57
30         bridge  bridge    ec:0d:9a:5f:9f:0c                   permanent
20:14:58
30         bridge  vni30     00:00:30:00:01:08
offload        00:33:56
40         bridge  HostA     00:00:40:00:00:13
00:00:18
40         bridge  bridge    00:00:00:11:22:33                   permanent
00:33:57
40         bridge  bridge    ec:0d:9a:5f:9f:0c                   permanent
20:14:58
40         bridge  vni40     00:00:40:00:01:09
offload        00:33:56
untagged           bridge    00:00:00:11:22:33                   permanent
self           never
untagged           bridge    00:00:5e:00:01:01                   permanent
self           never
untagged           bridge    00:00:5e:00:01:02                   permanent
self           never
untagged           bridge    00:00:5e:00:01:03                   permanent
self           never
untagged           bridge    00:00:5e:00:01:04                   permanent
self           never
untagged           bridge    ec:0d:9a:5f:9f:18                   permanent
self           never
untagged           vlan10    00:00:00:11:22:33                   permanent
self           never
untagged           vlan10    00:00:5e:00:01:01                   permanent
self           never
untagged           vlan20    00:00:00:11:22:33                   permanent
self           never
untagged           vlan20    00:00:5e:00:01:02                   permanent
self           never
untagged           vlan30    00:00:00:11:22:33                   permanent
self           never
untagged           vlan30    00:00:5e:00:01:03                   permanent
self           never
untagged           vlan40    00:00:00:11:22:33                   permanent
self           never
untagged           vlan40    00:00:5e:00:01:04                   permanent
self           never
```

```
untagged           vni10     00:00:00:00:00:00 100.100.100.100 permanent
self         01:36:37
untagged           vni10     00:00:10:00:01:06 100.100.100.100
self,offload 01:36:37
untagged           vni20     00:00:00:00:00:00 100.100.100.100 permanent
self         01:36:37
untagged           vni20     00:00:20:00:01:07 100.100.100.100
self,offload 01:36:37
untagged           vni30     00:00:00:00:00:00 100.100.100.100 permanent
self         01:36:37
untagged           vni30     00:00:30:00:01:08 100.100.100.100
self,offload 01:36:37
untagged           vni40     00:00:00:00:00:00 100.100.100.100 permanent
self         01:36:37
untagged           vni40     00:00:40:00:01:09 100.100.100.100
self,offload 01:36:37
untagged  bridge  HostA     ec:0d:9a:5f:9f:18                 permanent
20:12:21
untagged  bridge  peerlink  ec:0d:9a:5f:9f:0c                 permanent
20:59:36
untagged  bridge  vni10     2a:5d:51:e8:70:36                 permanent
23:13:37
untagged  bridge  vni20     4e:59:08:0f:70:2a                 permanent
23:13:37
untagged  bridge  vni30     fa:05:ea:f0:dd:cf                 permanent
23:13:37
untagged  bridge  vni40     52:d4:ec:23:fc:0d                 permanent
23:13:37
```

```
cumulus@SW-3:~$ net show evpn mac vni all

VNI 10030 #MACs (local and remote) 4

MAC               Type   Intf/Remote VTEP      VLAN
ec:0d:9a:fd:61:10 local  vlan30                30
00:00:30:00:00:12 remote 10.10.10.10
00:00:00:11:22:33 local  vlan30-v0             30
00:00:30:00:01:08 local  swp3                  30

VNI 10010 #MACs (local and remote) 4

MAC               Type   Intf/Remote VTEP      VLAN
00:00:10:00:01:06 local  swp3                  10
ec:0d:9a:fd:61:18 local  vlan10                10
00:00:00:11:22:33 local  vlan10-v0             10
00:00:10:00:00:10 remote 10.10.10.10

VNI 10040 #MACs (local and remote) 4

MAC               Type   Intf/Remote VTEP      VLAN
00:00:40:00:01:09 local  swp3                  40
ec:0d:9a:fd:61:10 local  vlan40                40
00:00:00:11:22:33 local  vlan40-v0             40
00:00:40:00:00:13 remote 10.10.10.10

VNI 10020 #MACs (local and remote) 4

MAC               Type   Intf/Remote VTEP      VLAN
00:00:20:00:01:07 local  swp3                  20
00:00:20:00:00:11 remote 10.10.10.10
ec:0d:9a:fd:61:10 local  vlan20                20
00:00:00:11:22:33 local  vlan20-v0             20
```

```
cumulus@SW-3:~$ net show bridge macs

VLAN      Master  Interface  MAC                TunnelDest     State     Flags
LastSeen
--------  ------  ---------  -----------------  -----------  ---------  ----
---------  ----------------
10        bridge  bridge     00:00:00:11:22:33               permanent
02:00:48
10        bridge  bridge     ec:0d:9a:fd:61:10               permanent
01:43:21
10        bridge  swp3       00:00:10:00:01:06
00:00:09
10        bridge  vni10      00:00:10:00:00:10
offload         01:47:11
20        bridge  bridge     00:00:00:11:22:33               permanent
02:00:48
20        bridge  bridge     ec:0d:9a:fd:61:10               permanent
01:26:40
20        bridge  swp3       00:00:20:00:01:07
00:00:39
20        bridge  vni20      00:00:20:00:00:11
offload         01:47:11
30        bridge  bridge     00:00:00:11:22:33               permanent
02:00:48
30        bridge  bridge     ec:0d:9a:fd:61:10               permanent
01:26:40
30        bridge  swp3       00:00:30:00:01:08
00:00:09
30        bridge  vni30      00:00:30:00:00:12
offload         01:47:11
40        bridge  bridge     00:00:00:11:22:33               permanent
02:00:48
40        bridge  bridge     ec:0d:9a:fd:61:10               permanent
01:26:39
40        bridge  swp3       00:00:40:00:01:09
00:01:39
40        bridge  vni40      00:00:40:00:00:13
offload         01:47:11
untagged          bridge     00:00:00:11:22:33               permanent  self
<1 sec
untagged          bridge     ec:0d:9a:fd:61:18               permanent  self
<1 sec
untagged          vlan10     00:00:00:11:22:33               permanent  self
<1 sec
untagged          vlan20     00:00:00:11:22:33               permanent  self
<1 sec
untagged          vlan30     00:00:00:11:22:33               permanent  self
<1 sec
untagged          vlan40     00:00:00:11:22:33               permanent  self
<1 sec
untagged          vni10      00:00:00:00:00:00  10.10.10.10  permanent  self
01:47:11
untagged          vni10      00:00:10:00:00:10  10.10.10.10             self,
offload  01:47:11
untagged          vni20      00:00:00:00:00:00  10.10.10.10  permanent  self
01:47:11
untagged          vni20      00:00:20:00:00:11  10.10.10.10             self,
offload  01:47:11
untagged          vni30      00:00:00:00:00:00  10.10.10.10  permanent  self
01:47:11
untagged          vni30      00:00:30:00:00:12  10.10.10.10             self,
offload  01:47:11
untagged          vni40      00:00:00:00:00:00  10.10.10.10  permanent  self
01:47:11
untagged          vni40      00:00:40:00:00:13  10.10.10.10             self,
offload  01:47:11
```

```
untagged  bridge  swp3     ec:0d:9a:fd:61:10                permanent
01:43:21
untagged  bridge  vni10    22:0c:55:21:fe:bb                permanent
01:44:53
untagged  bridge  vni20    7e:f8:cb:45:32:fd                permanent
01:26:40
untagged  bridge  vni30    02:0c:e2:d7:50:cd                permanent
01:26:40
untagged  bridge  vni40    d6:55:14:5f:7a:07                permanent
01:26:40
```

As we can see, both sites have remote MAC addresses stored locally in their MAC address-table (offload to FDB). That means L2 networks are “stretched” successfully and Virtual Machines can communicate over L3 networks between the sites.