Lab by Titus Majeza

VXLAN BGP EVPN (CLI)

CONFIGURATION AND VERIFICATION

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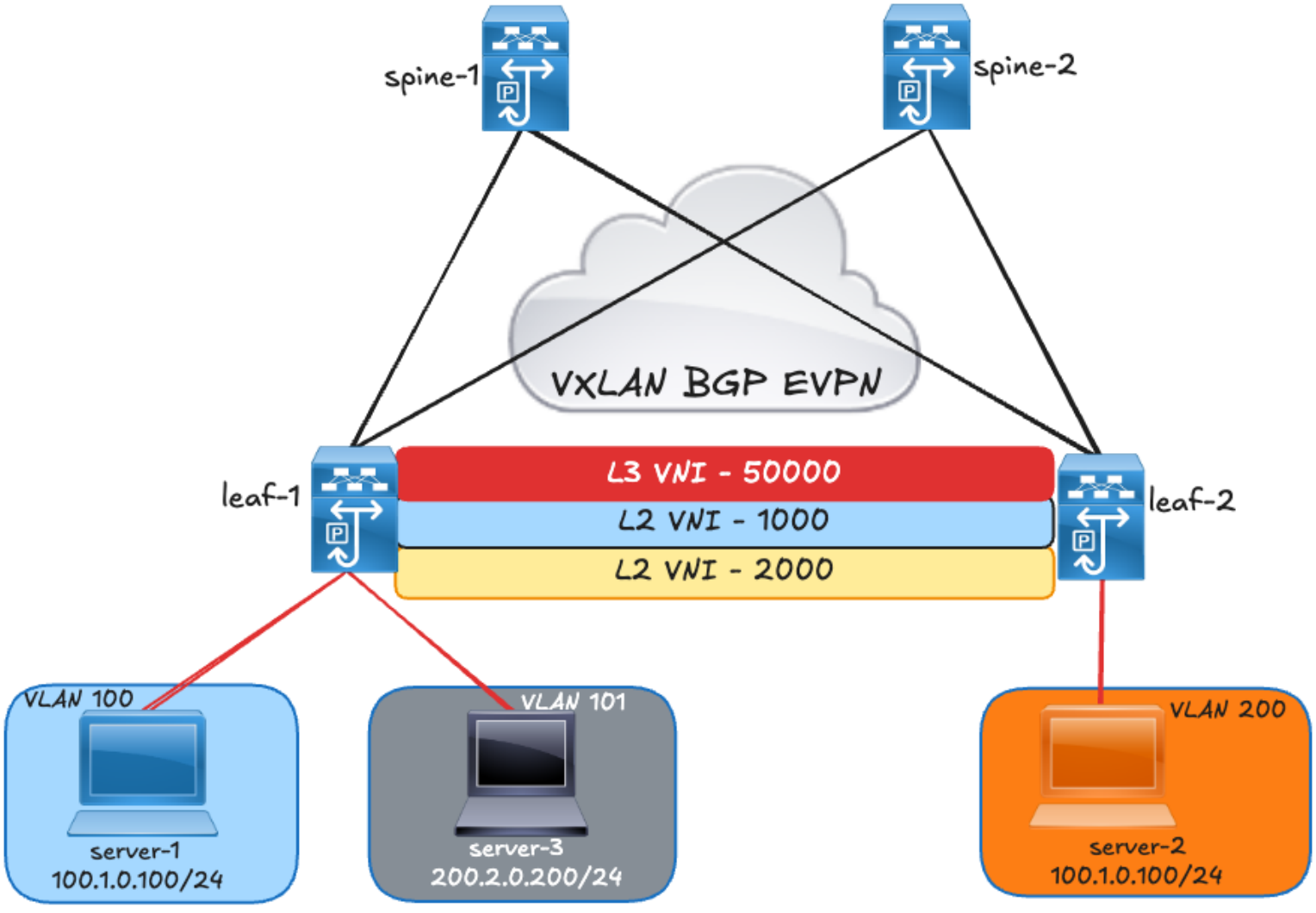


For more labs visit my GitHub repo: https://github.com/TitusM/Cisco-Data-Center

Note

This lab was conducted in a controlled environment. Any configurations in a production network should be implemented during a designated maintenance window. Additionally, always refer to official Cisco documentation relevant to your specific hardware and software.

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

Introduction

Virtual Extensible LAN (VXLAN) provides a mechanism to extend Layer 2 networks across a Layer 3 infrastructure using MAC-in-UDP encapsulation and tunnelling. This technology enables the creation of virtualized and multitenant data center fabrics over a shared physical infrastructure. VXLAN enhances workload mobility and flexibility by extending Layer 2 segments across the Layer 3 underlay network.

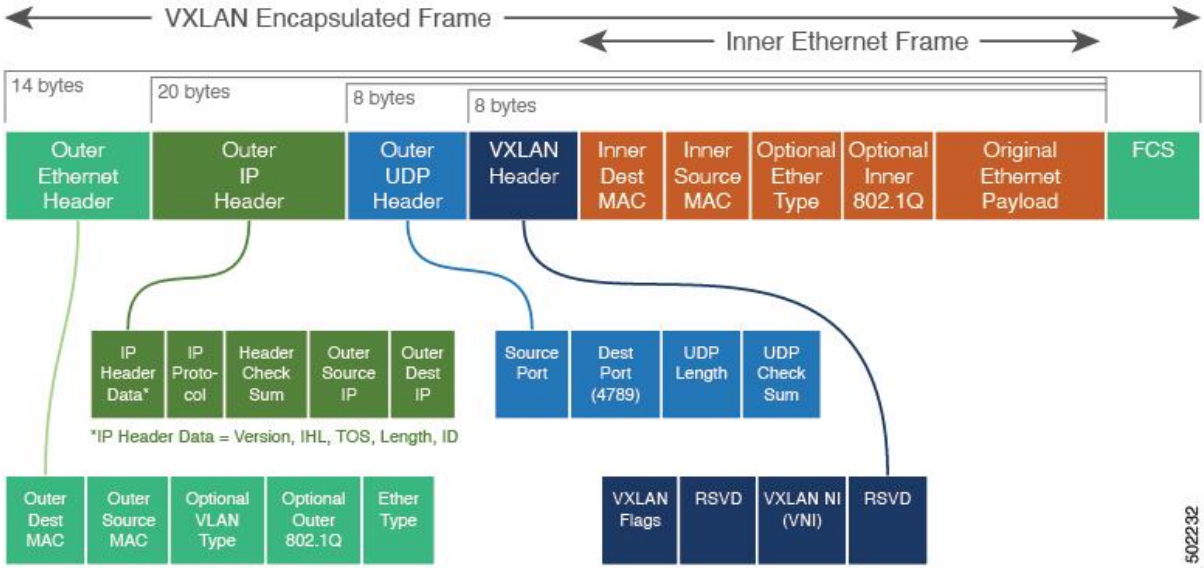
This lab demonstrates the complete configuration workflow for building a VXLAN fabric underlay and overlay, including the setup required for intra-VNI (Layer 2) and inter-VNI (Layer 3) communication using an L3 VNI. The lab also includes detailed verification steps at each stage of configuration. Additionally, a Wireshark capture is provided to illustrate how a packet from a local endpoint is encapsulated and transported through the VXLAN fabric to reach a remote endpoint.

VXLAN Encapsulation and Packet Format

VXLAN defines a MAC-in-UDP encapsulation scheme where the original Layer 2 frame has a VXLAN header added and is then placed in a UDP-IP packet. With this MAC-in-UDP encapsulation, VXLAN tunnels Layer 2 network over Layer 3 network.

The images below show an Ethernet frame that has been encapsulated with a VXLAN header.

Exhibit 1.



VXLAN uses an 8-byte VXLAN header that consists of a 24-bit VNID and a few reserved bits. The VXLAN header, together with the original Ethernet frame, go inside the UDP payload. The 24-bit VNID is used to identify Layer 2 segments and to maintain Layer 2 isolation between the segments. With all 24 bits in the VNID, VXLAN can support 16 million LAN segments.

I liked all three images showcasing a VXLAN packet hence I put all of them as I could not decide on a single image ☺

Exhibit 2.

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

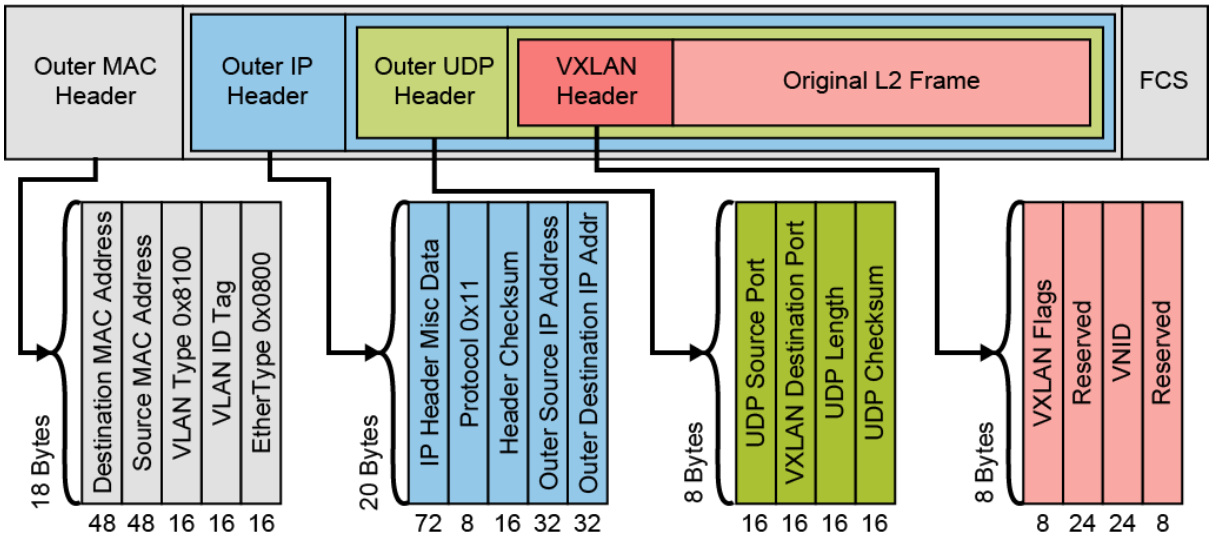
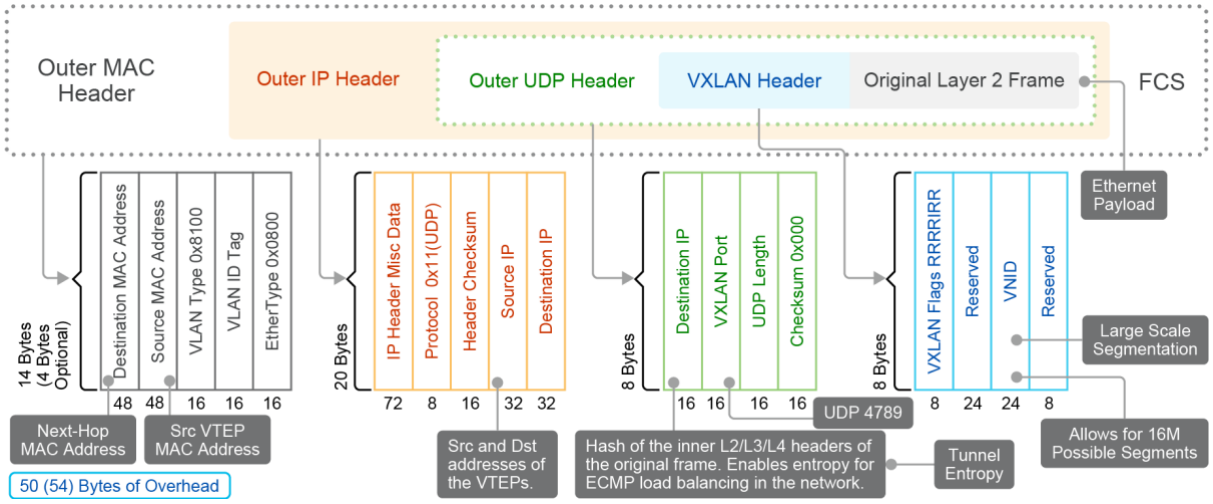
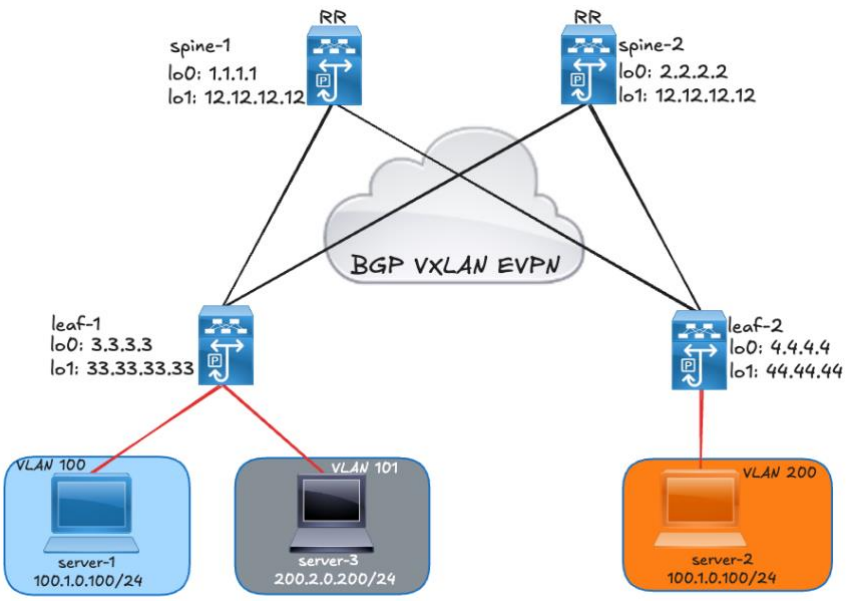


Exhibit 3.



Lab Topology



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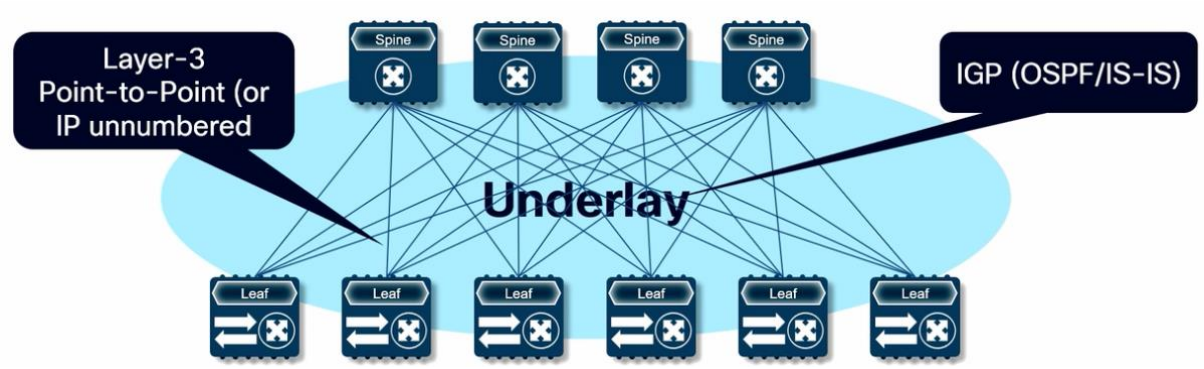
VXLAN BGP EVPN Underlay Unicast Routing

The underlay network in a VXLAN BGP EVPN fabric is a routed IP network that provides Layer 3 connectivity between the VTEPs (VXLAN Tunnel Endpoints). It is responsible for forwarding unicast traffic between VTEPs through VXLAN tunnels.

In this design, VXLAN encapsulated packets are transported across the underlay based on the outer IP header. The source IP address in the outer header represents the initiating VTEP's loopback interface, while the destination IP address corresponds to the terminating VTEP's loopback interface. The underlay therefore ensures efficient IP-based transport of VXLAN traffic across the fabric, independent of the tenant's Layer 2 or Layer 3 topology.



This lab uses OSPF as the underlay routing protocol.

SPINE-1

```
feature ospf
!
interface Ethernet1/3
  description to leaf-2
  mtu 9216
  ip address 10.14.14.1/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
 no shutdown
!
interface Ethernet1/4
  description to leaf-1
  mtu 9216
  ip address 10.13.13.1/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
 no shutdown
!
interface loopback0
  description for-vtep-reachability
  ip address 1.1.1.1/32
  ip router ospf UNDERLAY area 0.0.0.0
!
interface loopback1
  description for-mcast
  ip address 12.12.12.12/32
  ip router ospf UNDERLAY area 0.0.0.0
```

SPINE-2

```
feature ospf
!
interface Ethernet1/3
  description to leaf-1
  mtu 9216
  ip address 10.23.23.1/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  no shutdown
!
interface Ethernet1/4
  description to leaf-2
  mtu 9216
  ip address 10.24.24.1/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  no shutdown
!
interface loopback0
  description for-vtep-reachability
  ip address 2.2.2.2/32
  ip router ospf UNDERLAY area 0.0.0.0
!
interface loopback1
  description for-mcast
  ip address 12.12.12.12/32
  ip router ospf UNDERLAY area 0.0.0.0
```

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

LEAF-1

```
feature ospf
!
interface Ethernet1/3
  description to spine-2
  mtu 9216
  ip address 10.23.23.2/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
 no shutdown
!
interface Ethernet1/4
  description to spine-1
  mtu 9216
  ip address 10.13.13.2/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  no shutdown
!
interface loopback0
  description for-vtep-reachability
  ip address 3.3.3.3/32
  ip router ospf UNDERLAY area 0.0.0.0
!
interface loopback1
  description for-vni-peering
  ip address 33.33.33.33/32
  ip router ospf UNDERLAY area 0.0.0.0
```

LEAF2

```
feature ospf
!
interface Ethernet1/3
  description to spine-1
  mtu 9216
  ip address 10.14.14.2/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  no shutdown
!
interface Ethernet1/4
  description to spine-2
  mtu 9216
  ip address 10.24.24.2/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
 no shutdown
!
interface loopback0
  description for-vtep-reachability
  ip address 4.4.4.4/32
  ip router ospf UNDERLAY area 0.0.0.0
!
interface loopback1
  description for-vni-peering
  ip address 44.44.44.44/32
  ip router ospf UNDERLAY area 0.0.0.0
```

Verify OSPF routing adjacency (underlay).

Spine-1

```
spine-1# show ip ospf neighbors
 OSPF Process ID UNDERLAY VRF default
 Total number of neighbors: 2
 Neighbor ID     Pri State            Up Time  Address         Interface
 4.4.4.4           1 FULL/ -          3d13h    10.14.14.2      Eth1/3
 3.3.3.3           1 FULL/ -          3d13h    10.13.13.2      Eth1/4
```

Spine-2

```
spine-2# show ip ospf neighbors
 OSPF Process ID UNDERLAY VRF default
 Total number of neighbors: 2
 Neighbor ID     Pri State            Up Time  Address         Interface
 3.3.3.3           1 FULL/ -          3d13h    10.23.23.2      Eth1/3
 4.4.4.4           1 FULL/ -          3d13h    10.24.24.2      Eth1/4
```

Leaf-1

```
leaf-1# show ip ospf neighbors
 OSPF Process ID UNDERLAY VRF default
 Total number of neighbors: 2
 Neighbor ID     Pri State            Up Time  Address         Interface
 2.2.2.2           1 FULL/ -          3d13h    10.23.23.1      Eth1/3
 1.1.1.1           1 FULL/ -          3d13h    10.13.13.1      Eth1/4
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

Leaf-2

```
leaf-2# show ip ospf neighbors
 OSPF Process ID UNDERLAY VRF default
 Total number of neighbors: 2
 Neighbor ID     Pri State            Up Time  Address         Interface
 1.1.1.1           1 FULL/ -          3d13h    10.14.14.1      Eth1/3
 2.2.2.2           1 FULL/ -          3d13h    10.24.24.1      Eth1/4
```

VXLAN BGP EVPN Underlay Multicast Routing

Underlay multicast routing is used to handle Broadcast, Unknown unicast, and multicast (BUM) traffic. In this lab PIM ASM Sparse Mode is used. PIM Sparse mode creates one source tree per VTEP per multicast group. The PIM Sparse Mode uses PIM Anycast RP (RFC 4610) for RP redundancy. In a VXLAN fabric, the spine serves as RPs for the underlay.

SPINE-1

```
feature pim
!
ip pim rp-address 12.12.12.12 group-list 239.0.0.0/24
ip pim anycast-rp 12.12.12.12 1.1.1.1 <spine-1 lo0>
ip pim anycast-rp 12.12.12.12 2.2.2.2 <spine-2 lo0>
!
interface Ethernet1/3
  ip pim sparse-mode
!
interface Ethernet1/4
  ip pim sparse-mode
!
interface loopback0
  ip pim sparse-mode
!
interface loopback1
  ip pim sparse-mode
```

SPINE-2

```
feature pim
!
ip pim rp-address 12.12.12.12 group-list 239.0.0.0/24
ip pim anycast-rp 12.12.12.12 1.1.1.1 <lo1 - spine-1&2>
ip pim anycast-rp 12.12.12.12 2.2.2.2
!
interface Ethernet1/3
  ip pim sparse-mode
!
interface Ethernet1/4
  ip pim sparse-mode
!
interface loopback0
  ip pim sparse-mode
!
interface loopback1
  ip pim sparse-mode
```

LEAF-1

```
feature pim
!
ip pim rp-address 12.12.12.12 group-list 239.0.0.0/24
!
interface Ethernet1/3
  ip pim sparse-mode
!
interface Ethernet1/4
  ip pim sparse-mode
!
interface loopback0
  ip pim sparse-mode
!
interface loopback1
  ip pim sparse-mode
```

LEAF2

```
feature pim
!
ip pim rp-address 12.12.12.12 group-list 239.0.0.0/24
!
interface Ethernet1/3
  ip pim sparse-mode
!
interface Ethernet1/4
  ip pim sparse-mode
!
interface loopback0
  ip pim sparse-mode
!
interface loopback1
  ip pim sparse-mode
```

Multicast Validation: check the PIM neighbors

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Spine-1

```
spine-1# show ip pim neighbor
PIM Neighbor Status for VRF "default"
Neighbor        Interface            Uptime    Expires   DR       Bidir-  BFD    ECMP Redirect
                                                         Priority Capable State     Capable
10.14.14.2      Ethernet1/3          3d15h     00:01:34  1        yes     n/a     no
10.13.13.2      Ethernet1/4          3d15h     00:01:31  1        yes     n/a     no
```

Spine-2

```
spine-2# show ip pim neighbor
PIM Neighbor Status for VRF "default"
Neighbor        Interface            Uptime    Expires   DR       Bidir-  BFD    ECMP Redirect
                                                         Priority Capable State     Capable
10.23.23.2      Ethernet1/3          3d15h     00:01:20  1        yes     n/a     no
10.24.24.2      Ethernet1/4          3d15h     00:01:33  1        yes     n/a     no
```

Leaf-1

```
leaf-1# show ip pim neighbor
PIM Neighbor Status for VRF "default"
Neighbor        Interface            Uptime    Expires   DR       Bidir-  BFD    ECMP Redirect
                                                         Priority Capable State     Capable
10.23.23.1      Ethernet1/3          3d15h     00:01:18  1        yes     n/a     no
10.13.13.1      Ethernet1/4          3d15h     00:01:28  1        yes     n/a     no
```

Leaf-2

```
leaf-2# show ip pim neighbor
PIM Neighbor Status for VRF "default"
Neighbor        Interface            Uptime    Expires   DR       Bidir-  BFD    ECMP Redirect
                                                         Priority Capable State     Capable
10.14.14.1      Ethernet1/3          3d15h     00:01:41  1        yes     n/a     no
10.24.24.1      Ethernet1/4          3d15h     00:01:40  1        yes     n/a     no
```

Verify the RP status.

SPINE-1

```
spine-1# show ip pim rp
PIM RP Status Information for VRF "default"
BSR disabled
Auto-RP disabled
BSR RP Candidate policy: None
BSR RP policy: None
Auto-RP Announce policy: None
Auto-RP Discovery policy: None

Anycast-RP 12.12.12.12 members:
  1.1.1.1*  2.2.2.2

RP: 12.12.12.12*, (0),
 uptime: 3d17h   priority: 255,
 RP-source: (local),
 group ranges:
 239.0.0.0/24
```

SPINE-2

```
spine-2# show ip pim rp
PIM RP Status Information for VRF "default"
BSR disabled
Auto-RP disabled
BSR RP Candidate policy: None
BSR RP policy: None
Auto-RP Announce policy: None
Auto-RP Discovery policy: None

Anycast-RP 12.12.12.12 members:
  1.1.1.1  2.2.2.2*

RP: 12.12.12.12*, (0),
 uptime: 3d03h   priority: 255,
 RP-source: (local),
 group ranges:
 239.0.0.0/24
```

LEAF-1

```
leaf-1# show ip pim rp
PIM RP Status Information for VRF "default"
BSR disabled
Auto-RP disabled
```

LEAF2

```
leaf-2# show ip pim rp
PIM RP Status Information for VRF "default"
BSR disabled
Auto-RP disabled
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

```
BSR RP Candidate policy: None
BSR RP policy: None
Auto-RP Announce policy: None
Auto-RP Discovery policy: None

RP: 12.12.12.12, (0),
 uptime: 3d03h   priority: 255,
 RP-source: (local),
 group ranges:
 239.0.0.0/24
```

```
BSR RP Candidate policy: None
BSR RP policy: None
Auto-RP Announce policy: None
Auto-RP Discovery policy: None

RP: 12.12.12.12, (0),
 uptime: 3d03h   priority: 255,
 RP-source: (local),
 group ranges:
 239.0.0.0/24
```

Check the multicast routing table.

Leaf-1

```
leaf-1# show ip mroute
IP Multicast Routing Table for VRF "default"

(*, 232.0.0.0/8), uptime: 3d14h, pim ip
  Incoming interface: Null, RPF nbr: 0.0.0.0
  Outgoing interface list: (count: 0)


(*, 239.0.0.1/32), uptime: 3d14h, nve pim ip
  Incoming interface: Ethernet1/3, RPF nbr: 10.23.23.1
  Outgoing interface list: (count: 1)
    nve1, uptime: 3d14h, nve


(33.33.33.33/32, 239.0.0.1/32), uptime: 3d14h, nve mrib pim ip
  Incoming interface: loopback1, RPF nbr: 33.33.33.33
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 3d14h, pim
```

Leaf-2

```
leaf-2# show ip mroute
IP Multicast Routing Table for VRF "default"

(*, 232.0.0.0/8), uptime: 3d14h, pim ip
  Incoming interface: Null, RPF nbr: 0.0.0.0
  Outgoing interface list: (count: 0)


(*, 239.0.0.1/32), uptime: 3d14h, nve pim ip
  Incoming interface: Ethernet1/3, RPF nbr: 10.14.14.1
  Outgoing interface list: (count: 1)
    nve1, uptime: 3d14h, nve

(44.44.44.44/32, 239.0.0.1/32), uptime: 3d14h, nve mrib pim ip
  Incoming interface: loopback1, RPF nbr: 44.44.44.44
  Outgoing interface list: (count: 1)
    Ethernet1/4, uptime: 2d15h, pim
```

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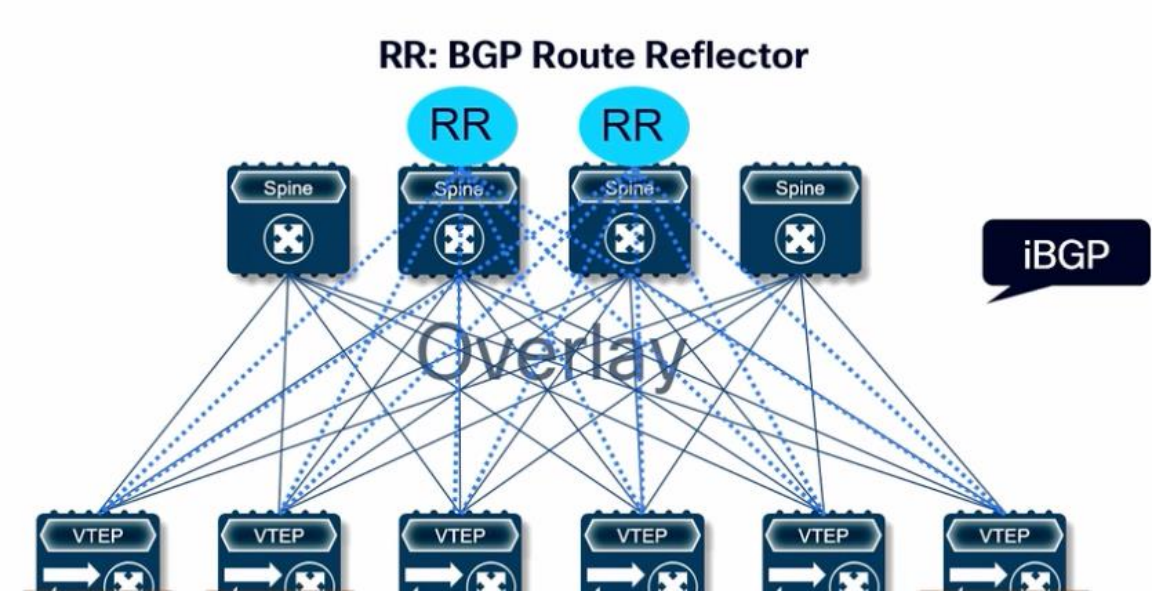
VXLAN BGP EVPN Overlay Unicast Routing (Control Plane)

In this lab, iBGP is configured between the spines and switches, i.e. the leafs and spines are part of the same autonomous system. The spines are configured as BGP route-reflectors. The spine's role in the EVPN overlay is to take the routes learned from each leaf and propagate them to the other leaves in the fabric. Using BGP EVPN as the control plane in the fabric allows for route learning, route distribution and VXLAN peer discovery.



BGP Configurations on Spines.

SPINE-1

```
nv overlay evpn
!
router bgp 65000
  address-family l2vpn evpn
  neighbor 3.3.3.3
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
      route-reflector-client
  neighbor 4.4.4.4
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
      route-reflector-client
```

SPINE-2

```
nv overlay evpn
!
router bgp 65000
  address-family l2vpn evpn
  neighbor 3.3.3.3
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
      route-reflector-client
  neighbor 4.4.4.4
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
      route-reflector-client
```

BGP Configurations on Leaf Switches.

LEAF-1

```
feature bgp
feature nv overlay
!
route-map PERMIT-ALL
!route map to redistribute directly connected routes in
the BGP instance>
!
```

LEAF2

```
feature bgp
feature nv overlay
!
route-map PERMIT-ALL
!route map to redistribute directly connected routes in
the BGP instance>
!
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

```
router bgp 65000
  address-family l2vpn evpn
  neighbor 1.1.1.1
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
  neighbor 2.2.2.2
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
  vrf tenant-1
    address-family ipv4 unicast
      redistribute direct route-map PERMIT-ALL
```

```
router bgp 65000
  address-family l2vpn evpn
  neighbor 1.1.1.1
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
  neighbor 2.2.2.2
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
  vrf tenant-1
    address-family ipv4 unicast
      redistribute direct route-map PERMIT-ALL
```

Validate BGP

Spine-1

```
spine-1# show bgp l2vpn evpn summary
BGP summary information for VRF default, address family L2VPN EVPN
BGP router identifier 1.1.1.1, local AS number 65000
BGP table version is 39, L2VPN EVPN config peers 2, capable peers 2
6 network entries and 6 paths using 1536 bytes of memory
BGP attribute entries [5/920], BGP AS path entries [0/0]
BGP community entries [0/0], BGP clusterlist entries [0/0]

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3         4 65000    5154    5166       39    0    0    3d01h 0
4.4.4.4         4 65000    5151    5164       39    0    0    3d01h 0
```

Spine-2

```
spine-2# show bgp l2vpn evpn summary
BGP summary information for VRF default, address family L2VPN EVPN
BGP router identifier 2.2.2.2, local AS number 65000
BGP table version is 35, L2VPN EVPN config peers 2, capable peers 2
6 network entries and 6 paths using 1752 bytes of memory
BGP attribute entries [5/1800], BGP AS path entries [0/0]
BGP community entries [0/0], BGP clusterlist entries [0/0]

Neighbor        V    AS    MsgRcvd    MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3         4 65000       5155       5164       35    0    0    3d01h 4
4.4.4.4         4 65000       5154       5164       35    0    0    3d01h 2

Neighbor        T    AS PfxRcd     Type-2     Type-3     Type-4     Type-5
3.3.3.3         I 65000 0          0          0          0          0
4.4.4.4         I 65000 0          0          0          0          0
```

Leaf-1

```
leaf-1# show bgp l2vpn evpn summary
BGP summary information for VRF default, address family L2VPN EVPN
BGP router identifier 3.3.3.3, local AS number 65000
BGP table version is 28, L2VPN EVPN config peers 2, capable peers 2
9 network entries and 11 paths using 2532 bytes of memory
BGP attribute entries [11/4048], BGP AS path entries [0/0]
BGP community entries [0/0], BGP clusterlist entries [2/8]
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

```
Neighbor        V    AS    MsgRcvd    MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
1.1.1.1         4 65000       5118       5099       28    0    0    3d01h 2
2.2.2.2         4 65000       5114       5101       28    0    0    3d01h 2

Neighbor        T    AS PfxRcd     Type-2     Type-3     Type-4     Type-5     Type-12
1.1.1.1         I 65000 0          0          0          0          0          0
2.2.2.2         I 65000 0          0          0          0          0          0
```

Leaf-2

```
leaf-2# show bgp l2vpn evpn summary
BGP summary information for VRF default, address family L2VPN EVPN
BGP router identifier 4.4.4.4, local AS number 65000
BGP table version is 27, L2VPN EVPN config peers 2, capable peers 2
9 network entries and 12 paths using 2532 bytes of memory
BGP attribute entries [12/4416], BGP AS path entries [0/0]
BGP community entries [0/0], BGP clusterlist entries [2/8]

Neighbor        V    AS    MsgRcvd    MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
1.1.1.1         4 65000       5121       5100       27    0    0    3d01h 0
2.2.2.2         4 65000       5117       5103       27    0    0    3d01h 0

Neighbor        T    AS PfxRcd     Type-2     Type-3     Type-4     Type-5     Type-12
1.1.1.1         I 65000 0          0          0          0          0          0
2.2.2.2         I 65000 0          0          0          0          0          0
```

VLAN to VNI Mapping

LEAF-1

```
feature vn-segment-vlan-based
!
vlan 100
  vn-segment 1000
!
interface nve1
  no shutdown
  host-reachability protocol bgp
  source-interface loopback1
  member vni 1000
    mcast-group 239.0.0.1
```

LEAF2

```
feature vn-segment-vlan-based
!
vlan 200
  vn-segment 1000
!
interface nve1
  no shutdown
  host-reachability protocol bgp
  source-interface loopback1
  member vni 1000
    mcast-group 239.0.0.1
```

Note: The `vn-segment` command maps a VLAN to a specific VNI. This mapping is locally significant, which means that you can have different VLAN IDs on the other switches. The VNI ID is the only parameter that is globally significant.

The configured segments are associated to a multicast group for multi-destination traffic.

Verify the nve interface status.

LEAF-1

```
leaf-1# show interface nve1
nve1 is up
admin state is up,  Hardware: NVE
  MTU 9216 bytes
  Encapsulation VXLAN
```

LEAF2

```
leaf-2# show interface nve1
nve1 is up
admin state is up,  Hardware: NVE
  MTU 9216 bytes
  Encapsulation VXLAN
```

Verify the nve interface components:

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

VNIs associated in the NVE.

Leaf-1

```
leaf-1#  show nve vni
Codes: CP - Control Plane        DP - Data Plane
       UC - Unconfigured         SA - Suppress ARP
       S-ND - Suppress ND
       SU - Suppress Unknown Unicast
       Xconn - Crossconnect
       MS-IR - Multisite Ingress Replication
       HYB - Hybrid IRB mode

Interface VNI      Multicast-group   State Mode Type [BD/VRF]      Flags
--------- -------- ----------------- ----- ---- ------------------ -----
nve1      1000     239.0.0.1         Up    CP   L2 [100]
```

Leaf-2

```
leaf-2# show nve vni
Codes: CP - Control Plane        DP - Data Plane
       UC - Unconfigured         SA - Suppress ARP
       S-ND - Suppress ND
       SU - Suppress Unknown Unicast
       Xconn - Crossconnect
       MS-IR - Multisite Ingress Replication
       HYB - Hybrid IRB mode

Interface VNI      Multicast-group   State Mode Type [BD/VRF]      Flags
--------- -------- ----------------- ----- ---- ------------------ -----
nve1      1000     239.0.0.1         Up    CP   L2 [200]
```

To verify the NVE peers on a VTEP, use the `show nve peers` command. Notice that the output below in the LearnType column indicates CP. CP stands for control plane learning, meaning the NVE peer was learned dynamically using BGP EVPN.

Leaf-1

```
leaf-1# show nve peers
Interface Peer-IP                                 State LearnType Uptime   Router-Mac
--------- --------------------------------------  ----- --------- -------- -----------------
nve1      44.44.44.44                             Up    CP        3d00h    3488.1815.5425
```

Leaf-2

```
leaf-2# show nve peers
Interface Peer-IP                                 State LearnType Uptime   Router-Mac
--------- --------------------------------------  ----- --------- -------- -----------------
nve1      33.33.33.33                             Up    CP        3d00h    3488.1815.561f
```

Verify the configured VLAN-to-VN-Segment mappings.

LEAF-1

```
leaf-1# show vlan id 100 vn-segment


VLAN Segment-id
---- -----------
100  1000
```

LEAF2

```
leaf-2#  show vlan id 200 vn-segment


VLAN Segment-id
---- -----------
200  1000
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

Layer 3 VNI Configuration

A Layer 3 VNI to route traffic between Layer 2 VNIs. The first step is to define the VRF (tenant) where the subnets will be members. The L3 VNI will be defined under the VRF context.

LEAF-1

```
vrf context tenant-1
  vni 50000 l3
  rd auto
  address-family ipv4 unicast
    route-target both auto
    route-target both auto evpn
```

LEAF2

```
vrf context tenant-1
  vni 50000 l3
  rd auto
  address-family ipv4 unicast
    route-target both auto
    route-target both auto evpn
```

Note
Beginning with Cisco NX-OS Release 10.2(3)F, the new L3VNI mode is supported on Cisco Nexus 9000 switches. The new CLI for L3 VNI does not require mapping a VLAN to L3VNI, which also removes the requirement to provision an SVI interface, saving on VLANs and increasing the scale of VNIs supported on a given leaf node

The L3 VNI is associated to the VRF.

LEAF-1

```
interface nve1
  no shutdown
  member vni 50000 associate-vrf
```

LEAF2

```
interface nve1
  no shutdown
  member vni 50000 associate-vrf
```

Displays VRFs and associated VNIs.

LEAF-1

```
leaf-1# show nve vrf
VRF-Name      VNI         Interface Gateway-MAC
------------ ---------- --------- -----------------
tenant-1      50000       nve1      3488.1815.561f
```

LEAF2

```
leaf-2# show nve vrf
VRF-Name      VNI         Interface Gateway-MAC
------------ ---------- --------- -----------------
tenant-1      50000       nve1      3488.1815.5425
```

Display the new L3VNI mode configuration information.

LEAF-1

```
leaf-1# show nve vni
Codes: CP - Control Plane        DP - Data Plane
       UC - Unconfigured         SA - Suppress ARP
       S-ND - Suppress ND
       SU - Suppress Unknown Unicast
       Xconn - Crossconnect
       MS-IR - Multisite Ingress Replication
       HYB - Hybrid IRB mode

Interface VNI      Multicast-group   State Mode Type [BD/VRF]
Flags
--------- -------- ----------------- ----- ---- ----------------
nve1      1000     239.0.0.1         Up    CP   L2 [100]
nve1      50000    n/a               Up    CP   L3 [tenant-1]
```

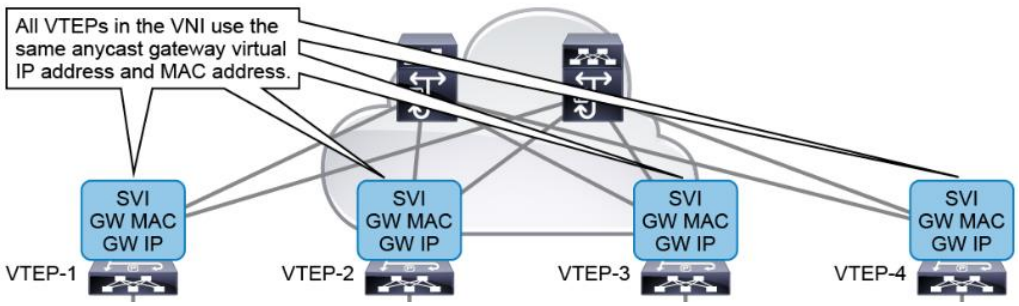
LEAF2

```
leaf-2# show nve vni
Codes: CP - Control Plane        DP - Data Plane
       UC - Unconfigured         SA - Suppress ARP
       S-ND - Suppress ND
       SU - Suppress Unknown Unicast
       Xconn - Crossconnect
       MS-IR - Multisite Ingress Replication
       HYB - Hybrid IRB mode

Interface VNI      Multicast-group   State Mode Type [BD/VRF]
Flags
--------- -------- ----------------- ----- ---- ----------------
nve1      1000     239.0.0.1         Up    CP   L2 [200]
nve1      50000    n/a               Up    CP   L3 [tenant-1]
```

Anycast Gateway Configuration

The Anycast Gateway feature is a default gateway-addressing mechanism that enables you to use the same gateway IP addresses across all the leaf switches that are part of a VXLAN network. Every VTEP is assigned the same anycast gateway MAC address for every L2 VNI SVI interface. This feature gives you flexibility to put a workload to any leaf switch. It allows host mobility and optimal traffic forwarding.

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe



LEAF-1

```
feature interface-vlan
!
fabric forwarding anycast-gateway-mac 0002.0002.0002
!
interface Vlan100
  no shutdown
  vrf member tenant-1
  ip address 100.1.0.254/24
  fabric forwarding mode anycast-gateway
```

LEAF2

```
feature interface-vlan
!
fabric forwarding anycast-gateway-mac 0002.0002.0002
!
interface Vlan200
  no shutdown
  vrf member tenant-1
  ip address 100.1.0.254/24
  fabric forwarding mode anycast-gateway
```

LEAF-1

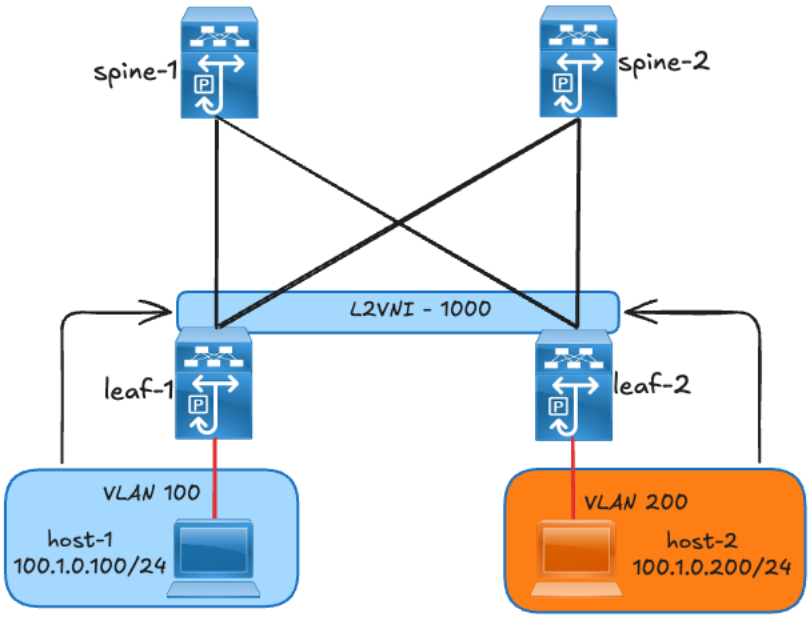
```
leaf-1# show ip interface brief vrf tenant-1

IP Interface Status for VRF "tenant-1"(4)
Interface          IP Address      Interface Status
Vlan100            100.1.0.254     protocol-up/link-up/admin-up
Vni50000           forward-enabled protocol-up/link-up/admin-up
```

LEAF-1

```
leaf-2# show ip interface brief vrf tenant-1

IP Interface Status for VRF "tenant-1"(4)
Interface          IP Address      Interface Status
Vlan200            100.1.0.254     protocol-up/link-up/admin-up
Vni50000           forward-enabled protocol-up/link-up/admin-up
```

Layer 2 Communication

This section will verify endpoint learning on each switch, verify endpoint communication across the fabric and the packet walk from the source endpoint to the destination endpoint across the fabric.



"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

Check the MAC address of each leaf.
The output shows that each leaf has MAC address information for its locally connected endpoints and MAC address information for the remote endpoint.

Leaf-1

```
leaf-1# show mac address-table dynamic
Legend:
        * - primary entry, G - Gateway MAC, (R) - Routed MAC, O - Overlay MAC
        age - seconds since last seen,+ - primary entry using vPC Peer-Link,
        (T) - True, (F) - False, C - ControlPlane MAC, ~ - vsan,
        (NA)- Not Applicable A - ESI Active Path, S - ESI Standby Path
   VLAN     MAC Address      Type      age     Secure NTFY Ports
---------+-----------------+--------+---------+------+----+------------------
C  100     00ee.abd0.9197   dynamic  NA         F      F    nve1(44.44.44.44)
*  100     10b3.d6cb.77e7   dynamic  NA         F      F    Eth1/33
```

Leaf-2

```
leaf-2# show mac address-table dynamic
Legend:
        * - primary entry, G - Gateway MAC, (R) - Routed MAC, O - Overlay MAC
        age - seconds since last seen,+ - primary entry using vPC Peer-Link,
        (T) - True, (F) - False, C - ControlPlane MAC, ~ - vsan,
        (NA)- Not Applicable A - ESI Active Path, S - ESI Standby Path
   VLAN     MAC Address      Type      age     Secure NTFY Ports
---------+-----------------+--------+---------+------+----+------------------
*  200     00ee.abd0.9197   dynamic  NA         F      F    Eth1/34
C  200     10b3.d6cb.77e7   dynamic  NA         F      F    nve1(33.33.33.33)
```

Check the routing table on each leaf.
The routing table on each leaf for the respective tenant shows the endpoints IP addresses that are learned from BGP.

Leaf-1

```
leaf-1#  show ip route vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

100.1.0.0/24, ubest/mbest: 1/0, attached
    *via 100.1.0.254, Vlan100, [0/0], 2d13h, direct
100.1.0.100/32, ubest/mbest: 1/0, attached
    *via 100.1.0.100, Vlan100, [190/0], 2d13h, hmm
100.1.0.200/32, ubest/mbest: 1/0
    *via 44.44.44.44%default, [200/0], 00:28:46, bgp-65000, internal, tag 65000, segid: 50000 tunnelid: 0x2c2c2c2c
encap: VXLAN <remote endpoint learned via BGP>

100.1.0.254/32, ubest/mbest: 1/0, attached
    *via 100.1.0.254, Vlan100, [0/0], 2d13h, local
```

```
leaf-2# show ip route vrf tenant-1
IP Route Table for VRF "tenant-1"
100.1.0.0/24, ubest/mbest: 1/0, attached
    *via 100.1.0.254, Vlan200, [0/0], 2d13h, direct
100.1.0.100/32, ubest/mbest: 1/0
```

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

```
    *via 33.33.33.33%default, [200/0], 00:26:35, bgp-65000, internal, tag 65000, segid: 50000 tunnelid: 0x21212121
encap: VXLAN <remote endpoint learned via BGP>

100.1.0.200/32, ubest/mbest: 1/0, attached
    *via 100.1.0.200, Vlan200, [190/0], 2d13h, hmm
100.1.0.254/32, ubest/mbest: 1/0, attached
    *via 100.1.0.254, Vlan200, [0/0], 2d13h, local
```

Check the BGP table on each leaf.
The BGP table of each leaf shows that each leaf successfully advertised and learned Type-2 (MAC/IP routes) and Type-5 (IP prefix routes) over the EVPN control plane.

Leaf-1

```
leaf-1# show bgp l2vpn evpn
BGP routing table information for VRF default, address family L2VPN EVPN
BGP table version is 30, Local Router ID is 3.3.3.3
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup, 2 - best2

   Network            Next Hop            Metric     LocPrf     Weight Path
Route Distinguisher: 3.3.3.3:32867    (L2VNI 1000)
*>i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[0]:[0.0.0.0]/216
                      44.44.44.44                       100          0 i
*>l[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[0]:[0.0.0.0]/216
                      33.33.33.33                       100      32768 i
*>i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                      44.44.44.44                       100          0 i <remote-endpoint from leaf-2>
*>l[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                      33.33.33.33                       100      32768 i <local endpoint>

Route Distinguisher: 4.4.4.4:32967
* i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[0]:[0.0.0.0]/216
                      44.44.44.44                       100          0 i
*>i                   44.44.44.44                       100          0 i
*>i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                      44.44.44.44                       100          0 i
* i                   44.44.44.44                       100          0 i
Route Distinguisher: 3.3.3.3:4    (L3VNI 50000)
*>i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                      44.44.44.44                       100          0 i <remote-endpoint from leaf-2>
*>l[5]:[0]:[0]:[24]:[100.1.0.0]/224
                      33.33.33.33              0        100      32768 ?
```

Leaf-2

```
leaf-2# show bgp l2vpn evpn
BGP routing table information for VRF default, address family L2VPN EVPN
BGP table version is 30, Local Router ID is 4.4.4.4
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup, 2 - best2

   Network            Next Hop            Metric     LocPrf     Weight Path
Route Distinguisher: 3.3.3.3:4
*>i[5]:[0]:[0]:[24]:[100.1.0.0]/224
                      33.33.33.33              0        100          0 ?
* i                   33.33.33.33              0        100          0 ?
*>i[5]:[0]:[0]:[24]:[200.2.0.0]/224
                      33.33.33.33              0        100          0 ?
```

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

```
* i                    33.33.33.33              0        100          0 ?

Route Distinguisher: 3.3.3.3:32867
* i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[0]:[0.0.0.0]/216
                       33.33.33.33                       100          0 i
*>i                    33.33.33.33                       100          0 i
*>i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                       33.33.33.33                       100          0 i
* i                    33.33.33.33                       100          0 i

Route Distinguisher: 4.4.4.4:32967    (L2VNI 1000)
*>l[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[0]:[0.0.0.0]/216
                       44.44.44.44                       100      32768 i
*>i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[0]:[0.0.0.0]/216
                       33.33.33.33                       100          0 i
*>l[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                       44.44.44.44                       100      32768 i
*>i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                       33.33.33.33                       100          0 i <remote-endpoint from leaf-1>
Route Distinguisher: 4.4.4.4:4    (L3VNI 50000)
*>i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                       33.33.33.33                       100          0 i
*>i[5]:[0]:[0]:[24]:[100.1.0.0]/224
                       33.33.33.33              0        100          0 ?
```

Verify the Layer 2 routing table for EVPN. The table displays how the MAC address of an endpoint was learned, the next-hop IP address, and the VNI tag.

Leaf-1

```
leaf-1# show l2route evpn mac all

Flags -(Rmac):Router MAC (Stt):Static (L):Local (R):Remote
(Dup):Duplicate (Spl):Split (Rcv):Recv (AD):Auto-Delete (D):Del Pending
(S):Stale (C):Clear, (Ps):Peer Sync (O):Re-Originated (Nho):NH-Override
(Asy):Asymmetric (Gw):Gateway
(Bh):Blackhole, (Dum):Dummy
(Pf):Permanently-Frozen, (Orp): Orphan

(PipOrp): Directly connected Orphan to PIP based vPC BGW
(PipPeerOrp): Orphan connected to peer of PIP based vPC BGW
Topology    Mac Address    Prod   Flags              Seq No     Next-Hops
----------- -------------- ------ ------------------ ---------- ------------------------------------------------
100         00ee.abd0.9197 BGP    SplRcv             0          44.44.44.44 (Label: 1000)
100         10b3.d6cb.77e7 Local  L,                 0          Eth1/33
8193        3488.1815.5425 VXLAN  Rmac,              0          44.44.44.44
```

Leaf-2

```
leaf-2# show l2route evpn mac all

Flags -(Rmac):Router MAC (Stt):Static (L):Local (R):Remote
(Dup):Duplicate (Spl):Split (Rcv):Recv (AD):Auto-Delete (D):Del Pending
(S):Stale (C):Clear, (Ps):Peer Sync (O):Re-Originated (Nho):NH-Override
(Asy):Asymmetric (Gw):Gateway
(Bh):Blackhole, (Dum):Dummy
(Pf):Permanently-Frozen, (Orp): Orphan

(PipOrp): Directly connected Orphan to PIP based vPC BGW
(PipPeerOrp): Orphan connected to peer of PIP based vPC BGW
Topology    Mac Address    Prod   Flags              Seq No     Next-Hops
----------- -------------- ------ ------------------ ---------- ------------------------------------------------
```

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

```
200          00ee.abd0.9197 Local  L,                 0          Eth1/34
200          10b3.d6cb.77e7 BGP    SplRcv              0          33.33.33.33 (Label: 1000)
8193         3488.1815.561f VXLAN  Rmac,               0          33.33.33.33
```

Display the VRF associated with an L2VNI.

LEAF-1

```
leaf-1# show bgp evi 1000
------------------------------------------------
  L2VNI ID                      : 1000 (L2-1000)
  RD                            : 3.3.3.3:32867
  Prefixes (local/total)        : 2/4
  Created                       : Oct  6 16:32:41.058384
  Last Oper Up/Down             : Oct  6 16:32:41.060408 / never
  Enabled                       : Yes
  Associated IP-VRF             : tenant-1
  Active Export RT list         :
        65000:1000
  Active Import RT list         :
        65000:1000
```

LEAF-2

```
leaf-2# show bgp evi 1000
------------------------------------------------
  L2VNI ID                      : 1000 (L2-1000)
  RD                            : 4.4.4.4:32967
  Prefixes (local/total)        : 2/4
  Created                       : Oct  6 16:28:48.924753
  Last Oper Up/Down             : Oct  6 16:28:48.956189 / never
  Enabled                       : Yes
  Associated IP-VRF             : tenant-1
  Active Export RT list         :
        65000:1000
  Active Import RT list         :
        65000:1000
```

The Hosts can successfully ping each other.

Server-1

```
PING 100.1.0.200 (100.1.0.200) from 100.1.0.100: 56 data bytes
64 bytes from 100.1.0.200: icmp_seq=0 ttl=254 time=1.351 ms
64 bytes from 100.1.0.200: icmp_seq=1 ttl=254 time=0.865 ms
64 bytes from 100.1.0.200: icmp_seq=2 ttl=254 time=0.85 ms
64 bytes from 100.1.0.200: icmp_seq=3 ttl=254 time=0.773 ms
64 bytes from 100.1.0.200: icmp_seq=4 ttl=254 time=0.977 ms

--- 100.1.0.200 ping statistics ---
5 packets transmitted, 5 packets received, 0.00% packet loss
round-trip min/avg/max = 0.773/0.963/1.351 ms
```

Server-2

```
PING 100.1.0.100 (100.1.0.100) from 100.1.0.200: 56 data bytes
64 bytes from 100.1.0.100: icmp_seq=0 ttl=254 time=1.24 ms
64 bytes from 100.1.0.100: icmp_seq=1 ttl=254 time=0.86 ms
64 bytes from 100.1.0.100: icmp_seq=2 ttl=254 time=0.866 ms
64 bytes from 100.1.0.100: icmp_seq=3 ttl=254 time=0.83 ms
64 bytes from 100.1.0.100: icmp_seq=4 ttl=254 time=0.834 ms

--- 100.1.0.100 ping statistics ---
5 packets transmitted, 5 packets received, 0.00% packet loss
round-trip min/avg/max = 0.83/0.926/1.24 ms
```

From a packet walk point of view:

1. Server-1 (100.1.0.100) initiated communication to Server-2 (100.1.0.200)

As this was the first time the servers were communication, Server-1 sent an ARP (request) which is Broadcast packet.

```
Cisco_cb:77:e7       Broadcast            ARP      42 Who has 100.1.0.200? Tell 100.1.0.100
Cisco_d0:91:97       Cisco_cb:77:e7       ARP      60 100.1.0.200 is at 00:ee:ab:d0:91:97
```

Packet on the Ethernet segment (between leaf and server-1):

```
Ethernet II, Src: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  Destination: Broadcast (ff:ff:ff:ff:ff:ff)
      .... ..1. .... .... .... .... = LG bit: Locally administered address (this is NOT the factory default)
      .... ...1 .... .... .... .... = IG bit: Group address (multicast/broadcast)
  Source: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: ARP (0x0806)
    [Stream index: 1]
Address Resolution Protocol (request)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: request (1)
    Sender MAC address: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7)
    Sender IP address: 100.1.0.100
    Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Target IP address: 100.1.0.200
```

This original Ethernet packet was the encapsulated with a VXLAN header, so that it can be sent to the other leaf switches with hosts in the same VNI segment.

From the packet there are additional headers:

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

1. VXLAN header showing the VXLAN network ID (VNI) – 1000
2. A UDP packet with a random source port and a known VXLAN destination port of 4789.
3. An outer IP header that enables a packet to traverse in the VXLAN fabric. This IPv4 packet has a source IP address (33.33.33.33) which is the nve1/loopback1 IP address of leaf-1 and the destination IP address is (239.0.0.1) which is the multicast group address that is associated with the VNI-1000. All multi-destination packets for a particular segment in a VXLAN fabric will be destined to the defined multicast group address.

```
> Ethernet II, Src: 52:60:48:6c:1b:08 (52:60:48:6c:1b:08), Dst: IPv4mcast_01 (01:00:5e:00:00:01)
v Internet Protocol Version 4, Src: 33.33.33.33, Dst: 239.0.0.1
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 78
    Identification: 0xf701 (63233)
  > 000. .... = Flags: 0x0
    ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 254
    Protocol: UDP (17)
    Header Checksum: 0x9459 [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 33.33.33.33
    Destination Address: 239.0.0.1
    [Stream index: 3]
> User Datagram Protocol, Src Port: 49343, Dst Port: 4789
v Virtual eXtensible Local Area Network
  > Flags: 0x0800, VXLAN Network ID (VNI)
    Group Policy ID: 0
    VXLAN Network Identifier (VNI): 1000
    Reserved: 0
> Ethernet II, Src: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
v Address Resolution Protocol (request)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: request (1)
    Sender MAC address: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7)
    Sender IP address: 100.1.0.100
    Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Target IP address: 100.1.0.200
```

When host-2 is identified to be located at leaf-2, leaf-2 encapsulates the packet with the outer headers (VLXAN, UDP, outer IP and outer MAC). In the outer IP header, the source IP is the nve/loopback1 IP address (44.44.44.44) of leaf-2 and destination IP address is the nve1/loopback1 IP address of the leaf-1 (33.33.33.33). This shows that a tunnel of communication is now between leaf-1 and leaf-2 since an ARP reply is a unicast packet.

```
> Ethernet II, Src: 52:df:48:a9:1b:08 (52:df:48:a9:1b:08), Dst: 52:60:48:6c:1b:08 (52:60:48:6c:1b:08)
> Internet Protocol Version 4, Src: 44.44.44.44, Dst: 33.33.33.33
> User Datagram Protocol, Src Port: 56225, Dst Port: 4789
v Virtual eXtensible Local Area Network
  > Flags: 0x0800, VXLAN Network ID (VNI)
    Group Policy ID: 0
    VXLAN Network Identifier (VNI): 1000
    Reserved: 0
> Ethernet II, Src: Cisco_d0:91:97 (00:ee:ab:d0:91:97), Dst: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7)
v Address Resolution Protocol (reply)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: reply (2)
    Sender MAC address: Cisco_d0:91:97 (00:ee:ab:d0:91:97)
    Sender IP address: 100.1.0.200
    Target MAC address: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7)
    Target IP address: 100.1.0.100
```

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

The ARP payload indicates that the target MAC (MAC address of server-2 is resolved).

Expanded packet headers (below):

```
> Ethernet II, Src: 52:df:48:a9:1b:08 (52:df:48:a9:1b:08), Dst: 52:60:48:6c:1b:08 (52:60:48:6c:1b:08)
v Internet Protocol Version 4, Src: 44.44.44.44, Dst: 33.33.33.33
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 78
    Identification: 0x0000 (0)
  > 000. .... = Flags: 0x0
    ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 253
    Protocol: UDP (17)
    Header Checksum: 0x2305 [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 44.44.44.44
    Destination Address: 33.33.33.33
    [Stream index: 3]
> User Datagram Protocol, Src Port: 56225, Dst Port: 4789
v Virtual eXtensible Local Area Network
  > Flags: 0x0800, VXLAN Network ID (VNI)
    Group Policy ID: 0
    VXLAN Network Identifier (VNI): 1000
    Reserved: 0
v Ethernet II, Src: Cisco_d0:91:97 (00:ee:ab:d0:91:97), Dst: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7)
  v Destination: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
  v Source: Cisco_d0:91:97 (00:ee:ab:d0:91:97)
      .... ..0. .... .... .... .... = LG bit: Globally unique address (factory default)
      .... ...0 .... .... .... .... = IG bit: Individual address (unicast)
    Type: ARP (0x0806)
    [Stream index: 3]
v Address Resolution Protocol (reply)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: reply (2)
    Sender MAC address: Cisco_d0:91:97 (00:ee:ab:d0:91:97)
    Sender IP address: 100.1.0.200
    Target MAC address: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7)
    Target IP address: 100.1.0.100
```

ICMP between the 2 servers is achieved:

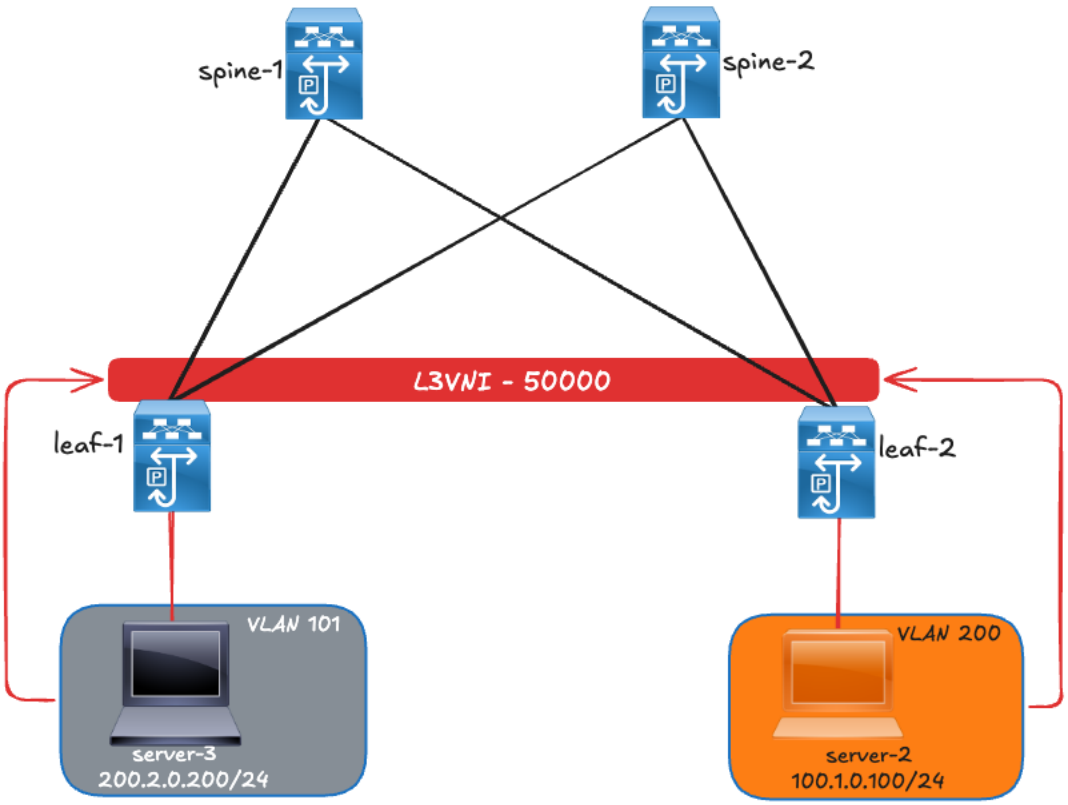
```
→    9 2.875668    100.1.0.100    100.1.0.200    ICMP    98 Echo (ping) request  id=0x0002, seq=2/512, ttl=64 (reply in 10)
←   10 2.882713    100.1.0.200    100.1.0.100    ICMP    98 Echo (ping) reply    id=0x0002, seq=2/512, ttl=64 (request in 9)
    11 3.875982    100.1.0.100    100.1.0.200    ICMP    98 Echo (ping) request  id=0x0002, seq=3/768, ttl=64 (reply in 12)
    12 3.885935    100.1.0.200    100.1.0.100    ICMP    98 Echo (ping) reply    id=0x0002, seq=3/768, ttl=64 (request in 11)

> Frame 9: Packet, 98 bytes on wire (784 bits), 98 bytes captured (784 bits)
> Ethernet II, Src: Cisco_cb:77:e7 (10:b3:d6:cb:77:e7), Dst: Cisco_d0:91:97 (00:ee:ab:d0:91:97)
> Internet Protocol Version 4, Src: 100.1.0.100, Dst: 100.1.0.200
> Internet Control Message Protocol
```

Overall, the packet capture confirms successful VXLAN encapsulation of Layer-2 traffic within an IP/UDP/VXLAN header. The inner ARP request from source 10b3.d6cb.77e7 (IP 100.1.0.100) to target 100.1.0.200 is encapsulated by the VTEP with source IP 33.33.33.33 and destination IP 44.44.44.44. The VXLAN header indicates VNI 1000, corresponding to the L2VNI used for the tenant segment. This verifies that the leaf switch is correctly encapsulating local Layer-2 frames into VXLAN packets for transport across the underlay network, enabling Layer-2 adjacency between remote endpoints.

Layer 3 Communication

To achieve Layer 3 communication, additional configurations will be added.

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe



An additional server (server-3) in a different L2 segment (VNI 2000) with a local VLAN 101 is added on leaf-1

Leaf-1

```
 vlan 101
  vn-segment 2000
!
interface Vlan101
  no shutdown
  vrf member tenant-1
  ip address 200.2.0.254/24
  fabric forwarding mode anycast-gateway
!
interface nve1
  no shutdown
  member vni 2000
    mcast-group 239.0.0.1
```

```
leaf-1# show ip interface brief vrf tenant-1

IP Interface Status for VRF "tenant-1"(4)
Interface            IP Address      Interface Status
Vlan100              100.1.0.254     protocol-up/link-up/admin-up
Vlan101              200.2.0.254     protocol-up/link-up/admin-up
Vni50000             forward-enabled protocol-up/link-up/admin-up
```

```
leaf-1# show nve vni
Codes: CP - Control Plane        DP - Data Plane
       UC - Unconfigured         SA - Suppress ARP
       S-ND - Suppress ND
       SU - Suppress Unknown Unicast
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

```
       Xconn - Crossconnect
       MS-IR - Multisite Ingress Replication
       HYB - Hybrid IRB mode

Interface VNI      Multicast-group   State Mode Type [BD/VRF]      Flags
--------- -------- ----------------- ----- ---- ------------------ -----
nve1      1000     239.0.0.1         Up    CP   L2 [100]
nve1      2000     239.0.0.1         Up    CP   L2 [101]
nve1      50000    n/a               Up    CP   L3 [tenant-1]
```

Display the VRF associated with an L2VNI.

LEAF-1

```
leaf-1# show bgp evi 1000
-------------------------------------------------
  L2VNI ID                      : 1000 (L2-1000)
  RD                            : 3.3.3.3:32867
  Prefixes (local/total)        : 2/4
  Created                       : Oct  6 16:32:41.058384
  Last Oper Up/Down             : Oct  6 16:32:41.060408 / never
  Enabled                       : Yes
  Associated IP-VRF             : tenant-1
  Active Export RT list         :
        65000:1000
  Active Import RT list         :
        65000:1000
leaf-1#
leaf-1# show bgp evi 2000
-------------------------------------------------
  L2VNI ID                      : 2000 (L2-2000)
  RD                            : 3.3.3.3:32868
  Prefixes (local/total)        : 2/2
  Created                       : Oct  6 16:32:41.060528
  Last Oper Up/Down             : Oct  6 16:32:41.060627 / never
  Enabled                       : Yes
  Associated IP-VRF             : tenant-1
  Active Export RT list         :
        65000:2000
  Active Import RT list         :
        65000:2000
```

LEAF-2

```
leaf-2# show bgp evi 1000
-------------------------------------------------
  L2VNI ID                      : 1000 (L2-1000)
  RD                            : 4.4.4.4:32967
  Prefixes (local/total)        : 2/4
  Created                       : Oct  6 16:28:48.924753
  Last Oper Up/Down             : Oct  6 16:28:48.956189 / never
  Enabled                       : Yes
  Associated IP-VRF             : tenant-1
  Active Export RT list         :
        65000:1000
  Active Import RT list         :
        65000:1000
```

Local endpoint MAC address

```
leaf-1# show mac address-table dynamic
Legend:
        * - primary entry, G - Gateway MAC, (R) - Routed MAC, O - Overlay MAC
        age - seconds since last seen,+ - primary entry using vPC Peer-Link,
        (T) - True, (F) - False, C - ControlPlane MAC, ~ - vsan
   VLAN     MAC Address      Type      age     Secure NTFY Ports
---------+-----------------+--------+---------+------+----+------------------
C  100      00ee.abd0.9197   dynamic  0         F      F    nve1(44.44.44.44)
*  100      10b3.d6cb.77e7   dynamic  0         F      F    Eth1/33
*  101      00ee.abd0.3333   dynamic  0         F      F    Eth1/34
```

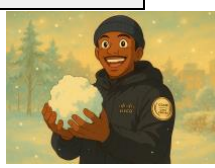
```
leaf-1# show ip route vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

100.1.0.0/24, ubest/mbest: 1/0, attached
    *via 100.1.0.254, Vlan100, [0/0], 2d17h, direct
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

```
100.1.0.100/32, ubest/mbest: 1/0, attached
    *via 100.1.0.100, Vlan100, [190/0], 2d17h, hmm
100.1.0.200/32, ubest/mbest: 1/0
    *via 44.44.44.44%default, [200/0], 04:17:36, bgp-65000, internal, tag 65000, segid: 50000 tunnelid: 0x2c2c2c2c
encap: VXLAN

100.1.0.254/32, ubest/mbest: 1/0, attached
    *via 100.1.0.254, Vlan100, [0/0], 2d17h, local
200.2.0.0/24, ubest/mbest: 1/0, attached.              <New subnet is now present in the routing table>
    *via 200.2.0.254, Vlan101, [0/0], 00:09:50, direct
200.2.0.200/32, ubest/mbest: 1/0, attached
    *via 200.2.0.200, Vlan101, [190/0], 00:03:32, hmm
200.2.0.254/32, ubest/mbest: 1/0, attached
    *via 200.2.0.254, Vlan101, [0/0], 00:09:50, local
```

```
leaf-2# show ip route vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

100.1.0.0/24, ubest/mbest: 1/0, attached
    *via 100.1.0.254, Vlan200, [0/0], 2d17h, direct
100.1.0.100/32, ubest/mbest: 1/0
    *via 33.33.33.33%default, [200/0], 04:18:10, bgp-65000, internal, tag 65000, segid: 50000 tunnelid: 0x21212121
encap: VXLAN

100.1.0.200/32, ubest/mbest: 1/0, attached
    *via 100.1.0.200, Vlan200, [190/0], 2d17h, hmm
100.1.0.254/32, ubest/mbest: 1/0, attached
    *via 100.1.0.254, Vlan200, [0/0], 2d17h, local
200.2.0.0/24, ubest/mbest: 1/0
    *via 33.33.33.33%default, [200/0], 00:09:47, bgp-65000, internal, tag 65000, segid: 50000 tunnelid: 0x21212121
encap: VXLAN

200.2.0.200/32, ubest/mbest: 1/0
    *via 33.33.33.33%default, [200/0], 1d01h, bgp-65000, internal, tag 65000, segid: 50000 tunnelid: 0x21212121
encap: VXLAN
```

```
leaf-1#  show bgp l2vpn evpn
BGP routing table information for VRF default, address family L2VPN EVPN
BGP table version is 38, Local Router ID is 3.3.3.3
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup, 2 - best2

   Network            Next Hop            Metric     LocPrf     Weight Path
Route Distinguisher: 3.3.3.3:32867    (L2VNI 1000)
*>i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[0]:[0.0.0.0]/216
                      44.44.44.44                           100          0 i
*>l[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[0]:[0.0.0.0]/216
                      33.33.33.33                           100      32768 i
*>i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                      44.44.44.44                           100          0 i
*>l[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                      33.33.33.33                           100      32768 i

Route Distinguisher: 3.3.3.3:32868    (L2VNI 2000)
*>l[2]:[0]:[0]:[48]:[00ee.abd0.3333]:[0]:[0.0.0.0]/216
                      33.33.33.33                           100      32768 i
*>l[2]:[0]:[0]:[48]:[00ee.abd0.3333]:[32]:[200.2.0.200]/272
                      33.33.33.33                           100      32768 i

Route Distinguisher: 4.4.4.4:32967
```



"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

```
* i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[0]:[0.0.0.0]/216
                      44.44.44.44                          100          0 i
*>i                   44.44.44.44                          100          0 i
*>i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                      44.44.44.44                          100          0 i
* i                   44.44.44.44                          100          0 i

Route Distinguisher: 3.3.3.3:4    (L3VNI 50000)
*>i[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                      44.44.44.44                          100          0 i
* i[5]:[0]:[0]:[24]:[100.1.0.0]/224
                      44.44.44.44              0           100          0 ?
*>l                   33.33.33.33              0           100      32768 ?
*>l[5]:[0]:[0]:[24]:[200.2.0.0]/224
                      33.33.33.33              0           100      32768 ?
```

```
leaf-2#  show bgp l2vpn evpn
BGP routing table information for VRF default, address family L2VPN EVPN
BGP table version is 56, Local Router ID is 4.4.4.4
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup, 2 - best2

   Network            Next Hop            Metric     LocPrf     Weight Path
Route Distinguisher: 3.3.3.3:4
*>i[5]:[0]:[0]:[24]:[100.1.0.0]/224
                      33.33.33.33              0           100          0 ?
* i                   33.33.33.33              0           100          0 ?
*>i[5]:[0]:[0]:[24]:[200.2.0.0]/224
                      33.33.33.33              0           100          0 ?
* i                   33.33.33.33              0           100          0 ?

Route Distinguisher: 3.3.3.3:32867
* i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[0]:[0.0.0.0]/216
                      33.33.33.33                          100          0 i
*>i                   33.33.33.33                          100          0 i
*>i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                      33.33.33.33                          100          0 i
* i                   33.33.33.33                          100          0 i

Route Distinguisher: 3.3.3.3:32868
*>i[2]:[0]:[0]:[48]:[00ee.abd0.3333]:[32]:[200.2.0.200]/272
                      33.33.33.33                          100          0 i
* i                   33.33.33.33                          100          0 i

Route Distinguisher: 4.4.4.4:32967    (L2VNI 1000)
*>l[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[0]:[0.0.0.0]/216
                      44.44.44.44                          100      32768 i
*>i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[0]:[0.0.0.0]/216
                      33.33.33.33                          100          0 i
*>l[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                      44.44.44.44                          100      32768 i
*>i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                      33.33.33.33                          100          0 i

Route Distinguisher: 4.4.4.4:4    (L3VNI 50000)
*>i[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                      33.33.33.33                          100          0 i
*>i[2]:[0]:[0]:[48]:[00ee.abd0.3333]:[32]:[200.2.0.200]/272
                      33.33.33.33                          100          0 i
*>l[5]:[0]:[0]:[24]:[100.1.0.0]/224
```

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

```
                      44.44.44.44              0        100      32768 ?
* i                   33.33.33.33              0        100          0 ?
*>i[5]:[0]:[0]:[24]:[200.2.0.0]/224
                      33.33.33.33              0        100          0 ?
```

Verify routes that are being advertised to the route reflectors by each leaf.

```
leaf-1# show bgp l2vpn evpn neig 1.1.1.1 advertised-routes

Peer 1.1.1.1 routes for address family L2VPN EVPN:
BGP table version is 42, Local Router ID is 3.3.3.3
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup, 2 - best2

   Network            Next Hop            Metric     LocPrf     Weight Path
Route Distinguisher: 3.3.3.3:32867    (L2VNI 1000)
*>l[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[0]:[0.0.0.0]/216
                      33.33.33.33                        100      32768 i
*>l[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                      33.33.33.33                        100      32768 i

Route Distinguisher: 3.3.3.3:32868    (L2VNI 2000)
*>l[2]:[0]:[0]:[48]:[00ee.abd0.3333]:[0]:[0.0.0.0]/216
                      33.33.33.33                        100      32768 i
*>l[2]:[0]:[0]:[48]:[00ee.abd0.3333]:[32]:[200.2.0.200]/272
                      33.33.33.33                        100      32768 i

Route Distinguisher: 4.4.4.4:4

Route Distinguisher: 4.4.4.4:32967

Route Distinguisher: 3.3.3.3:4    (L3VNI 50000)
*>l[5]:[0]:[0]:[24]:[100.1.0.0]/224
                      33.33.33.33              0        100      32768 ?
*>l[5]:[0]:[0]:[24]:[200.2.0.0]/224
                      33.33.33.33              0        100      32768 ?

leaf-1# show bgp l2vpn evpn neig 2.2.2.2 advertised-routes

Peer 2.2.2.2 routes for address family L2VPN EVPN:
BGP table version is 42, Local Router ID is 3.3.3.3
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup, 2 - best2

   Network            Next Hop            Metric     LocPrf     Weight Path
Route Distinguisher: 3.3.3.3:32867    (L2VNI 1000)
*>l[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[0]:[0.0.0.0]/216
                      33.33.33.33                        100      32768 i
*>l[2]:[0]:[0]:[48]:[10b3.d6cb.77e7]:[32]:[100.1.0.100]/272
                      33.33.33.33                        100      32768 i

Route Distinguisher: 3.3.3.3:32868    (L2VNI 2000)
*>l[2]:[0]:[0]:[48]:[00ee.abd0.3333]:[0]:[0.0.0.0]/216
                      33.33.33.33                        100      32768 i
*>l[2]:[0]:[0]:[48]:[00ee.abd0.3333]:[32]:[200.2.0.200]/272
                      33.33.33.33                        100      32768 i

Route Distinguisher: 4.4.4.4:4
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

```
Route Distinguisher: 4.4.4.4:32967

Route Distinguisher: 3.3.3.3:4    (L3VNI 50000)
*>l[5]:[0]:[0]:[24]:[100.1.0.0]/224
                     33.33.33.33              0        100      32768 ?
*>l[5]:[0]:[0]:[24]:[200.2.0.0]/224
                     33.33.33.33              0        100      32768 ?
```

```
leaf-2# show bgp l2vpn evpn neig 1.1.1.1 advertised-routes

Peer 1.1.1.1 routes for address family L2VPN EVPN:
BGP table version is 57, Local Router ID is 4.4.4.4
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup, 2 - best2

   Network            Next Hop            Metric     LocPrf     Weight Path
Route Distinguisher: 3.3.3.3:4

Route Distinguisher: 3.3.3.3:32867

Route Distinguisher: 3.3.3.3:32868

Route Distinguisher: 4.4.4.4:32967    (L2VNI 1000)
*>l[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[0]:[0.0.0.0]/216
                     44.44.44.44                           100      32768 i
*>l[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                     44.44.44.44                           100      32768 i

Route Distinguisher: 4.4.4.4:4    (L3VNI 50000)
*>l[5]:[0]:[0]:[24]:[100.1.0.0]/224
                     44.44.44.44              0        100      32768

leaf-2# show bgp l2vpn evpn neig 2.2.2.2 advertised-routes

Peer 2.2.2.2 routes for address family L2VPN EVPN:
BGP table version is 57, Local Router ID is 4.4.4.4
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup, 2 - best2

   Network            Next Hop            Metric     LocPrf     Weight Path
Route Distinguisher: 3.3.3.3:4

Route Distinguisher: 3.3.3.3:32867

Route Distinguisher: 3.3.3.3:32868

Route Distinguisher: 4.4.4.4:32967    (L2VNI 1000)
*>l[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[0]:[0.0.0.0]/216
                     44.44.44.44                           100      32768 i
*>l[2]:[0]:[0]:[48]:[00ee.abd0.9197]:[32]:[100.1.0.200]/272
                     44.44.44.44                           100      32768 i

Route Distinguisher: 4.4.4.4:4    (L3VNI 50000)
*>l[5]:[0]:[0]:[24]:[100.1.0.0]/224
                     44.44.44.44              0        100      32768 ?
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

Displays all MAC IP routes.

Leaf-1

```
leaf-1# show l2route evpn mac-ip all
Flags -(Rmac):Router MAC (Stt):Static (L):Local (R):Remote
(Dup):Duplicate (Spl):Split (Rcv):Recv(D):Del Pending (S):Stale (C):Clear
(Ps):Peer Sync (Ro):Re-Originated (Orp):Orphan (Asy):Asymmetric (Gw):Gateway
(Bh):Blackhole
(Piporp): Directly connected Orphan to PIP based vPC BGW
(Pipporp): Orphan connected to peer of PIP based vPC BGW
Topology    Mac Address    Host IP                                 Prod   Flags              Seq No     Next-Hops
----------- -------------- --------------------------------------- ------ ------------------ ---------- ------------------------------
100         10b3.d6cb.77e7 100.1.0.100                             HMM    L,                 0          Local
100         00ee.abd0.9197 100.1.0.200                             BGP    --                 0          44.44.44.44 (Label: 1000)
101         00ee.abd0.3333 200.2.0.200                             HMM    L,                 0          Local
!
leaf-1# show l2route evpn mac-ip all detail
Topology    Mac Address    Host IP                                 Prod   Flags              Seq No     Next-Hops
----------- -------------- --------------------------------------- ------ ------------------ ---------- ------------------------------
100         10b3.d6cb.77e7 100.1.0.100                             HMM    L,                 0          Local
            L3-Info: 50000
            Sent To: BGP
100         00ee.abd0.9197 100.1.0.200                             BGP    --                 0          44.44.44.44 (Label: 1000)
            encap-type:1
101         00ee.abd0.3333 200.2.0.200                             HMM    L,                 0          Local
            L3-Info: 50000
            Sent To: BGP
```

Leaf-2

```
leaf-2# show l2route evpn mac-ip all
Flags -(Rmac):Router MAC (Stt):Static (L):Local (R):Remote
(Dup):Duplicate (Spl):Split (Rcv):Recv(D):Del Pending (S):Stale (C):Clear
(Ps):Peer Sync (Ro):Re-Originated (Orp):Orphan (Asy):Asymmetric (Gw):Gateway
(Bh):Blackhole
(Piporp): Directly connected Orphan to PIP based vPC BGW
(Pipporp): Orphan connected to peer of PIP based vPC BGW
Topology    Mac Address    Host IP                                 Prod   Flags              Seq No     Next-Hops
----------- -------------- --------------------------------------- ------ ------------------ ---------- ------------------------------
200         10b3.d6cb.77e7 100.1.0.100                             BGP    --                 0          33.33.33.33 (Label: 1000)
200         00ee.abd0.9197 100.1.0.200                             HMM    L,                 0          Local
!
leaf-2# show l2route evpn mac-ip all detail
Flags -(Rmac):Router MAC (Stt):Static (L):Local (R):Remote
(Dup):Duplicate (Spl):Split (Rcv):Recv(D):Del Pending (S):Stale (C):Clear
(Ps):Peer Sync (Ro):Re-Originated (Orp):Orphan (Asy):Asymmetric (Gw):Gateway
(Bh):Blackhole
(Piporp): Directly connected Orphan to PIP based vPC BGW
(Pipporp): Orphan connected to peer of PIP based vPC BGW
Topology    Mac Address    Host IP                                 Prod   Flags              Seq No     Next-Hops
----------- -------------- --------------------------------------- ------ ------------------ ---------- ------------------------------
200         10b3.d6cb.77e7 100.1.0.100                             BGP    --                 0          33.33.33.33 (Label: 1000)
            encap-type:1
200         00ee.abd0.9197 100.1.0.200                             HMM    L,                 0          Local
            L3-Info: 50000
            Sent To: BGP
```

The Hosts can successfully ping each other.

Server-2

```
PING 200.2.0.200 (200.2.0.200) from 100.1.0.200: 56 data bytes
64 bytes from 200.2.0.200: icmp_seq=0 ttl=254 time=1.386 ms
64 bytes from 200.2.0.200: icmp_seq=1 ttl=254 time=0.861 ms
64 bytes from 200.2.0.200: icmp_seq=2 ttl=254 time=0.886 ms
```

Server-3

```
PING 100.1.0.200 (100.1.0.200) from 200.2.0.200: 56 data bytes
64 bytes from 100.1.0.200: icmp_seq=0 ttl=252 time=1.264 ms
64 bytes from 100.1.0.200: icmp_seq=1 ttl=252 time=1.084 ms
64 bytes from 100.1.0.200: icmp_seq=2 ttl=252 time=1.121 ms
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

```
64 bytes from 200.2.0.200: icmp_seq=3 ttl=254 time=0.913 ms
64 bytes from 200.2.0.200: icmp_seq=4 ttl=254 time=0.802 ms

--- 200.2.0.200 ping statistics ---
5 packets transmitted, 5 packets received, 0.00% packet loss
round-trip min/avg/max = 0.802/0.969/1.386 ms
```

```
64 bytes from 100.1.0.200: icmp_seq=3 ttl=252 time=0.97 ms
64 bytes from 100.1.0.200: icmp_seq=4 ttl=252 time=0.876 ms

--- 100.1.0.200 ping statistics ---
5 packets transmitted, 5 packets received, 0.00% packet loss
round-trip min/avg/max = 0.876/1.063/1.264 ms
```

From a packet encapsulation point of view, an important factor to note is that when 2 hosts residing in different L2 segments (VNIDs) need to communicate, the VXLAN Network Identifier used is the L3VNI, in this case 50000.

```
> Ethernet II, Src: 52:a8:60:51:1b:08 (52:a8:60:51:1b:08), Dst: 52:b2:74:d7:1b:08 (52:b2:74:d7:1b:08)
> Internet Protocol Version 4, Src: 33.33.33.33, Dst: 44.44.44.44
> User Datagram Protocol, Src Port: 57479, Dst Port: 4789
v Virtual eXtensible Local Area Network
  v Flags: 0x0800, VXLAN Network ID (VNI)
      0... .... .... .... = GBP Extension: Not defined
      .... 1... .... .... = VXLAN Network ID (VNI): True
      .... .... .0.. .... = Don't Learn: False
      .... .... .... 0... = Policy Applied: False
      .000 .000 0.00 .000 = Reserved(R): 0x0000
    Group Policy ID: 0
    VXLAN Network Identifier (VNI): 50000
    Reserved: 0
> Ethernet II, Src: 52:60:48:6c:1b:08 (52:60:48:6c:1b:08), Dst: 52:b2:74:d7:1b:08 (52:b2:74:d7:1b:08)
> Internet Protocol Version 4, Src: 200.2.0.200, Dst: 100.1.0.200
> Internet Control Message Protocol
```

Full Configurations

SPINE-1

```
hostname spine-1

nv overlay evpn
feature ospf
feature bgp
feature pim
feature lldp

ip pim rp-address 12.12.12.12 group-list 239.0.0.0/24
ip pim anycast-rp 12.12.12.12 1.1.1.1
ip pim anycast-rp 12.12.12.12 2.2.2.2

interface Ethernet1/3
  description to leaf-2
  mtu 9216
  ip address 10.14.14.1/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode
  no shutdown

interface Ethernet1/4
  description to leaf-1
  mtu 9216
  ip address 10.13.13.1/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode
```

SPINE-2

```
hostname spine-2

nv overlay evpn
feature ospf
feature bgp
feature pim
feature lldp

ip pim rp-address 12.12.12.12 group-list 239.0.0.0/24
ip pim anycast-rp 12.12.12.12 1.1.1.1
ip pim anycast-rp 12.12.12.12 2.2.2.2

interface Ethernet1/3
  description to leaf-1
  mtu 9216
  ip address 10.23.23.1/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode
  no shutdown

interface Ethernet1/4
  description to leaf-2
  mtu 9216
  ip address 10.24.24.1/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode
```

“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe

```
  no shutdown

interface loopback0
  description for-vtep-reachability
  ip address 1.1.1.1/32
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode

interface loopback1
  description for-mcast
  ip address 12.12.12.12/32
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode

router ospf UNDERLAY
router bgp 65000
  address-family l2vpn evpn
  neighbor 3.3.3.3
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
      route-reflector-client
  neighbor 4.4.4.4
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
      route-reflector-client
```

```
  no shutdown

interface loopback0
  description for-vtep-reachability
  ip address 2.2.2.2/32
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode

interface loopback1
  description for-mcast
  ip address 12.12.12.12/32
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode

router ospf UNDERLAY
router bgp 65000
  address-family l2vpn evpn
  neighbor 3.3.3.3
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
      route-reflector-client
  neighbor 4.4.4.4
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
      route-reflector-client
```

LEAF-1

```
hostname leaf-1

nv overlay evpn
feature ospf
feature bgp
feature pim
feature interface-vlan
feature vn-segment-vlan-based
feature lldp
feature nv overlay

fabric forwarding anycast-gateway-mac 0002.0002.0002
ip pim rp-address 12.12.12.12 group-list 239.0.0.0/24
vlan 1,100-101
vlan 100
  vn-segment 1000
vlan 101
  vn-segment 2000

route-map PERMIT-ALL permit 10

vrf context tenant-1
  vni 50000 l3
  rd auto
  address-family ipv4 unicast
```

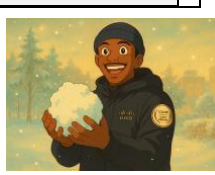
LEAF-2

```
hostname leaf-2

nv overlay evpn
feature ospf
feature bgp
feature pim
feature interface-vlan
feature vn-segment-vlan-based
feature lldp
feature nv overlay

fabric forwarding anycast-gateway-mac 0002.0002.0002
ip pim rp-address 12.12.12.12 group-list 239.0.0.0/24
vlan 1,200
vlan 200
  vn-segment 1000



route-map PERMIT-ALL permit 10

vrf context tenant-1
  vni 50000 l3
  rd auto
  address-family ipv4 unicast
```

"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

```
    route-target both auto
    route-target both auto evpn

interface Vlan100
  no shutdown
  vrf member tenant-1
  ip address 100.1.0.254/24
  fabric forwarding mode anycast-gateway

interface Vlan101
  no shutdown
  vrf member tenant-1
  ip address 200.2.0.254/24
  fabric forwarding mode anycast-gateway

interface nve1
  no shutdown
  host-reachability protocol bgp
  source-interface loopback1
  member vni 1000
    mcast-group 239.0.0.1
  member vni 2000
    mcast-group 239.0.0.1
  member vni 50000 associate-vrf

interface Ethernet1/3
  description to spine-2
  mtu 9216
  ip address 10.23.23.2/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode
  no shutdown

interface Ethernet1/4
  description to spine-1
  mtu 9216
  ip address 10.13.13.2/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode
  no shutdown

interface loopback0
  description for-vtep-reachability
  ip address 3.3.3.3/32
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode

interface loopback1
  description for-vni-peering
  ip address 33.33.33.33/32
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode

router ospf UNDERLAY
router bgp 65000
  address-family l2vpn evpn
  neighbor 1.1.1.1
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
```

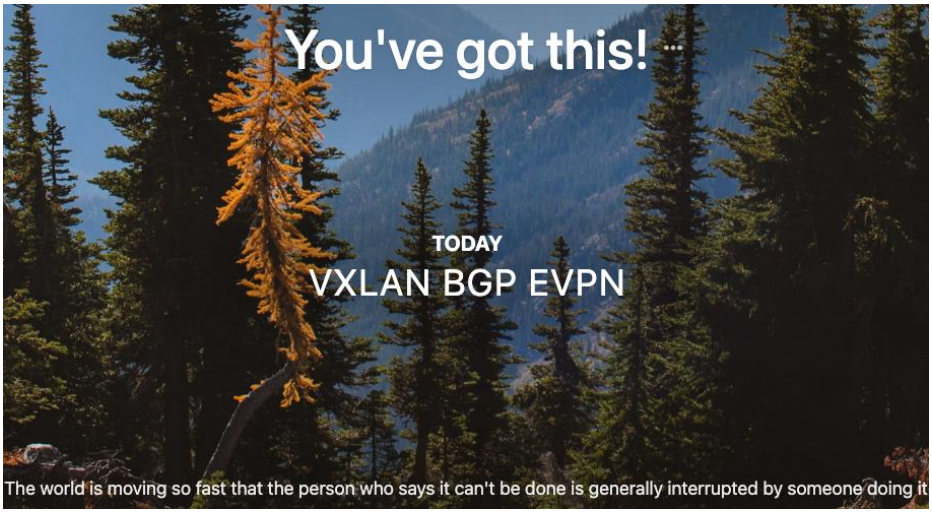
```
    route-target both auto
    route-target both auto evpn

interface Vlan200
  no shutdown
  vrf member tenant-1
  ip address 100.1.0.254/24
  fabric forwarding mode anycast-gateway

interface nve1
  no shutdown
  host-reachability protocol bgp
  source-interface loopback1
  member vni 1000
    mcast-group 239.0.0.1
  member vni 50000 associate-vrf

interface Ethernet1/3
  description to spine-1
  mtu 9216
  ip address 10.14.14.2/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode
  no shutdown

interface Ethernet1/4
  description to spine-2
  mtu 9216
  ip address 10.24.24.2/30
  ip ospf network point-to-point
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode
  no shutdown

interface loopback0
  description for-vtep-reachability
  ip address 4.4.4.4/32
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode

interface loopback1
  description for-vni-peering
  ip address 44.44.44.44/32
  ip router ospf UNDERLAY area 0.0.0.0
  ip pim sparse-mode

router ospf UNDERLAY
router bgp 65000
  address-family l2vpn evpn
  neighbor 1.1.1.1
    remote-as 65000
    update-source loopback0
    address-family l2vpn evpn
```



"Never doubt yourself. We are all capable of amazing things." - Rob Cristophe

```
    send-community
    send-community extended
neighbor 2.2.2.2
  remote-as 65000
  update-source loopback0
  address-family l2vpn evpn
    send-community
    send-community extended
vrf tenant-1
  address-family ipv4 unicast
    redistribute direct route-map PERMIT-ALL
```

```
    send-community
    send-community extended
neighbor 2.2.2.2
  remote-as 65000
  update-source loopback0
  address-family l2vpn evpn
    send-community
    send-community extended
vrf tenant-1
  address-family ipv4 unicast
    redistribute direct route-map PERMIT-ALL
```



For more labs visit my GitHub repo: https://github.com/TitusM/Cisco-Data-Center

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“Never doubt yourself. We are all capable of amazing things.” - Rob Cristophe