BGP EVPN in Enterprise Campus with Catalyst 9000 Switching Platforms

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Agenda

- Introduction
- BGP EVPN Overview & Fundamentals
- Underlay Design Options
- Overlay Types & Topologies
- BGP EVPN Fabric Architecture
- Overlay Multicast Services with TRM
- Fabric Border Design Options
- Fabric Design Options

Traditional Network Transition

EVPN Evolution

- Product transition drives architecture transitions
- Convergence of traditional L2 overlay to simplified and scalable fabric
- Transition classic L3 overlays to enterprise-grade scalable fabric
- Unified end-to-end common fabric architecture reducing cost and complexity

2010
Introduced in IETF

2011
PBB-EVPN
EVPN-VPWS
EVPN-Overlay
EVPN-ETREE

2013
EVPN IRB
EVPN DCI

2015
Virtual ES
IR Enhancement
IGMP Agg
…

2016+
L3VPN MH
EVPN IRB
DF Algorithm
…

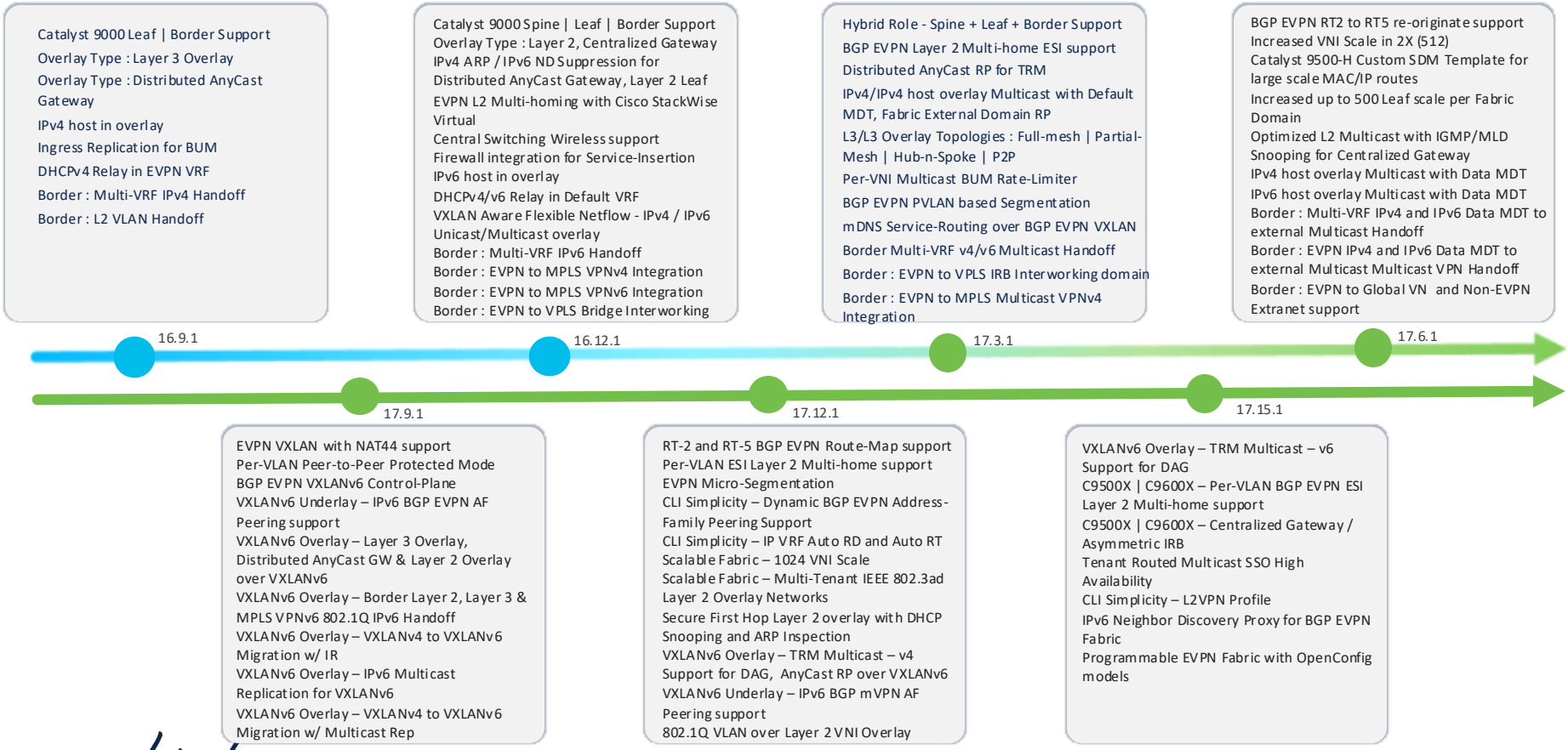
DRAFT	RFC	Authors
137	15	37

Cisco
Patent

Filed	Issued
400+	150+

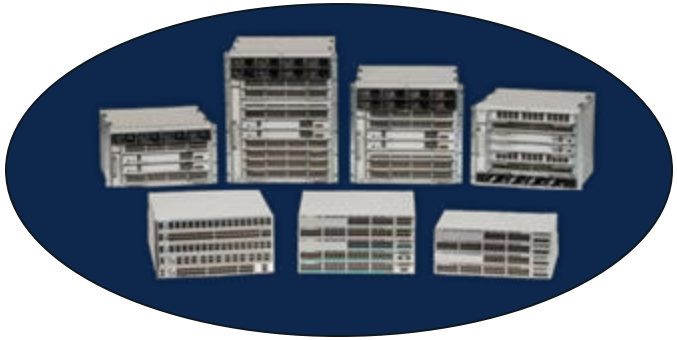
Source
https://www.arkko.com/tools/stats.html

Robust BGP EVPN–VXLAN Solution on Catalyst Switching



Cisco Catalyst 9000

BGP EVPN VXLAN Fabric



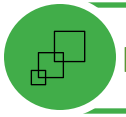
Enterprise | Healthcare | Education | Financial | Public Sector | Manufacturing | Hospitality | Media | Transportation | Retail

Enterprise Campus BGP EVPN Drivers

Industry Standard

One Fabric Architecture

Proven and Scalable



Hierarchical Fabric Domain

Flexible Overlay

Multi-vendor IT strategy

Unified operation across – Campus | DC | WAN

BGP Protocol History. Minimum new learning curve

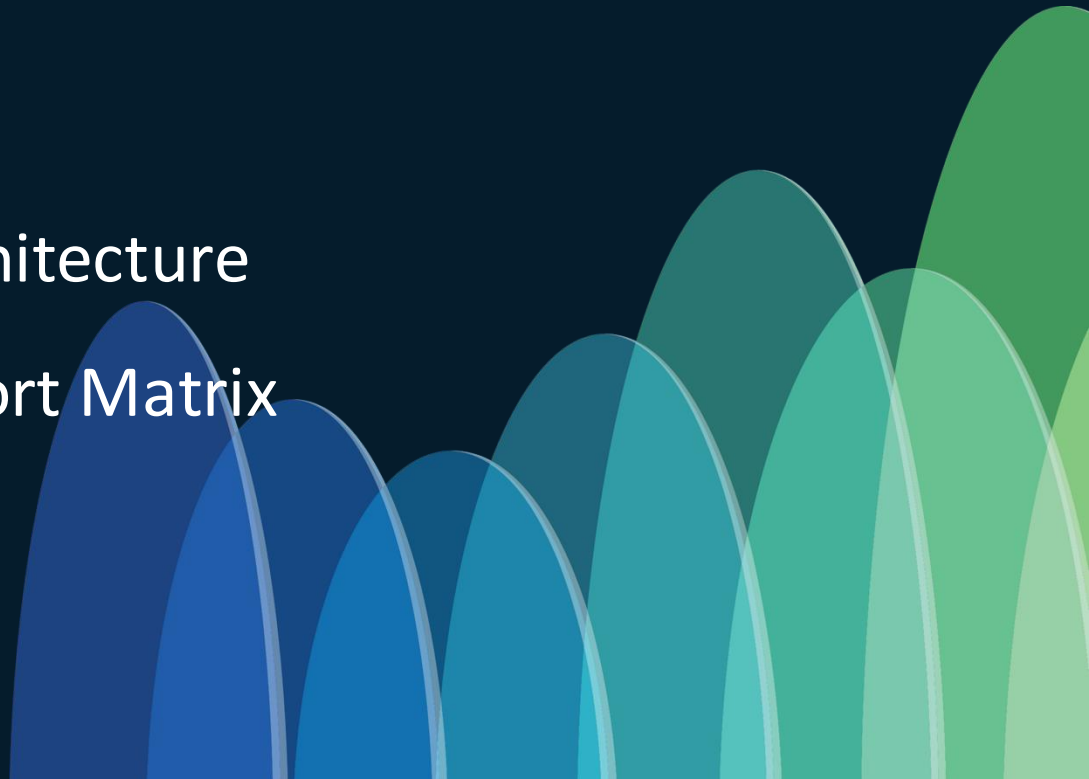
Multi-tier Overlay network architecture

Use-case driven customize Overlay networks Types and Topologies

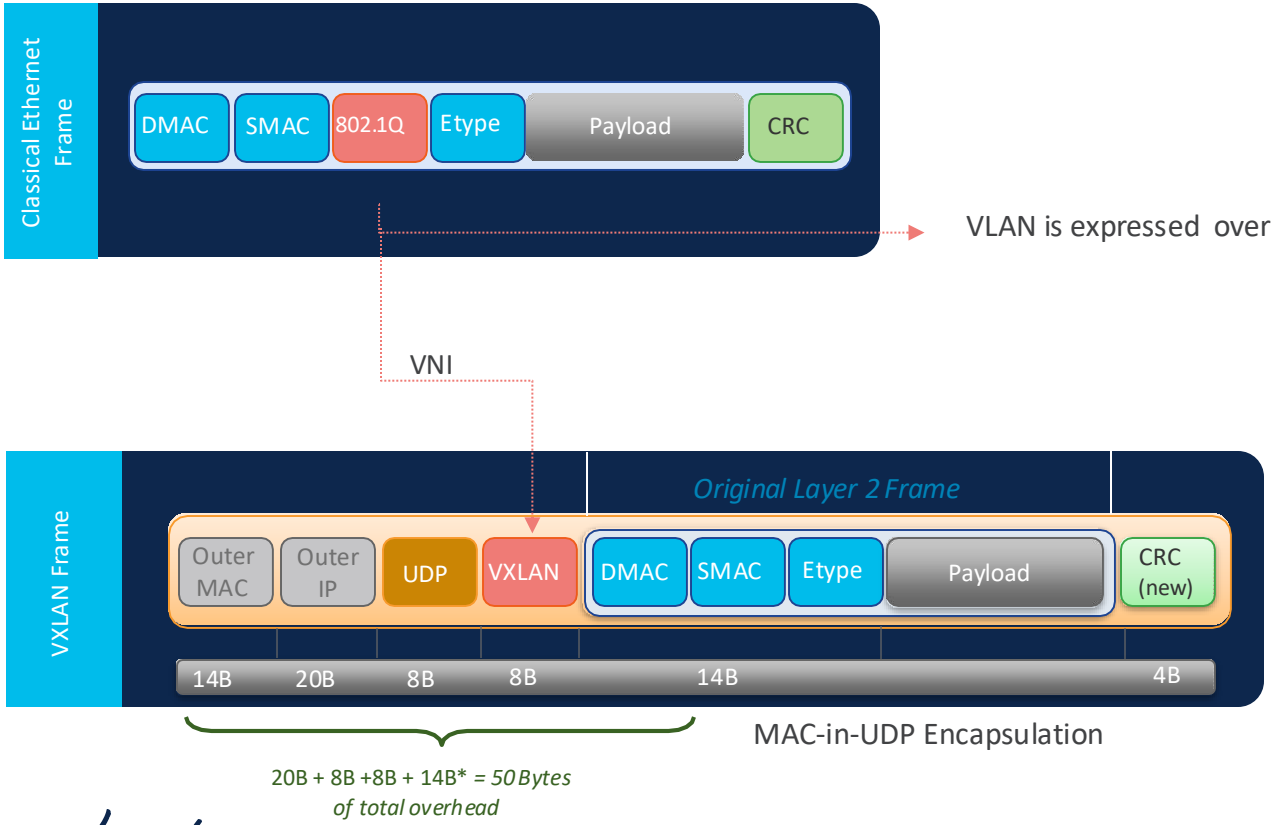
BGP EVPN Overview

Reference Network Architecture

System Roles and Support Matrix



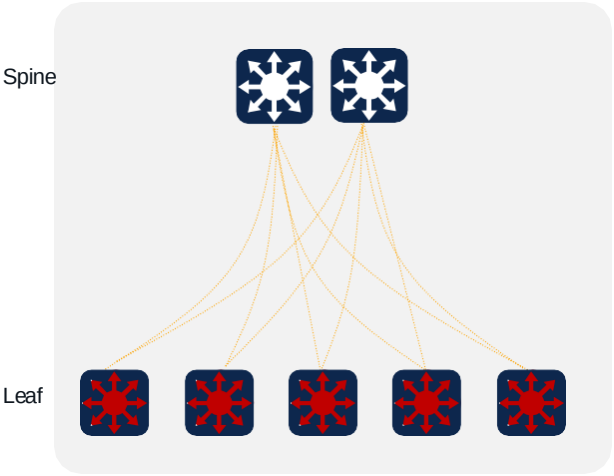
VXLAN Overview



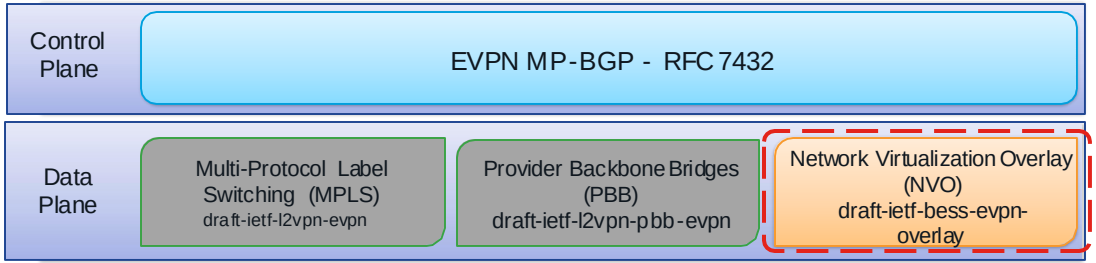
VXLAN leverages the VNI field with a total address space of 24 bits

The VXLAN Network Identifier (VNI/VNID) is part of the VXLAN Header

VXLAN with BGP EVPN



- Standards based Overlay (VXLAN) with Standards based Control-Plane (BGP)
- Layer-2 MAC and Layer-3 IP information distribution by Control-Plane (BGP)
- Forwarding decision based on Control-Plane (minimizes flooding)
- Integrated Routing/Bridging (IRB) for Optimized Forwarding in the Overlay
- Multi-Tenancy At Scale



EVPN over NVO Tunnels (VXLAN)

Provides Layer-2 and Layer-3 Overlays over simple IP Networks

BGP EVPN System Role

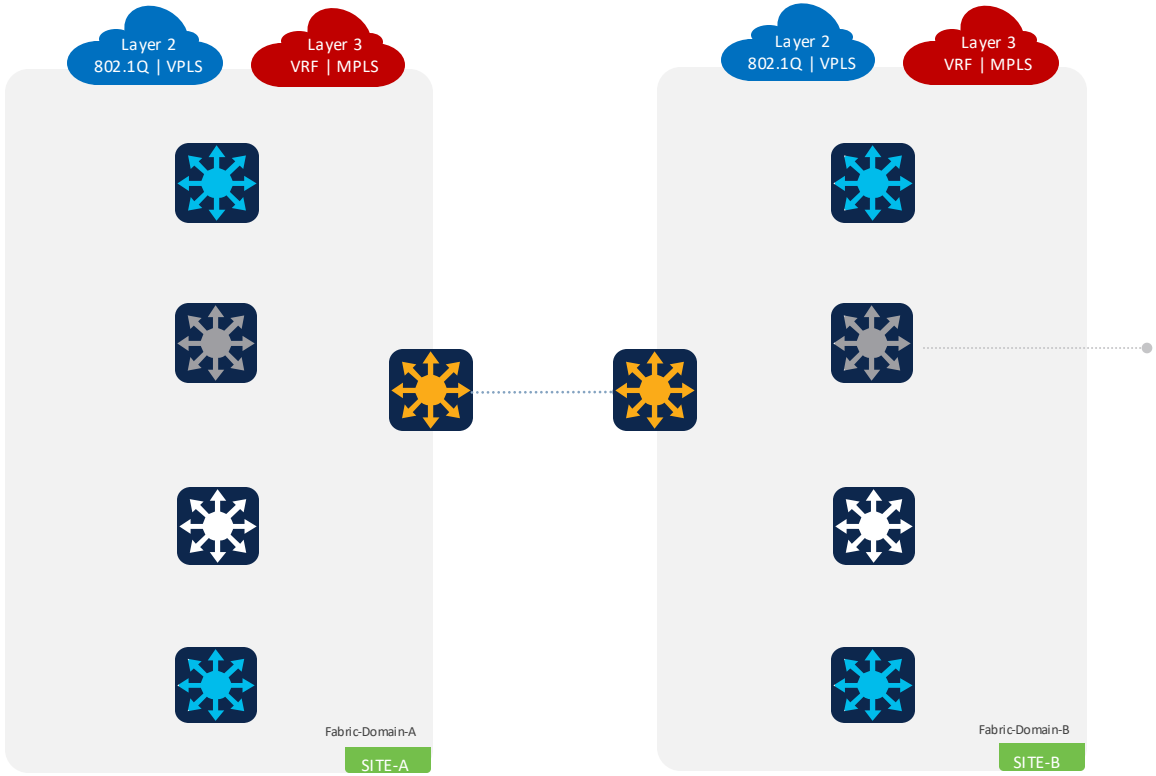
BORDER-GATEWAY:
A gateway point of between two or more BGP EVPN administrative domain boundary.

BORDER :
A gateway point of between EVPN fabric and external network domain.

INTERMEDIATE :
A Layer 2 or Layer 3 (IP/MPLS) Underlay network system providing basic transport and forwarding plane.

SPINE :
An BGP EVPN reflects the L2/L3 VPN prefixes providing hierarchical neighbor peering, learning and distribution point.

VTEP (LEAF) :
An origination and termination point of VXLAN enabled overlay network.



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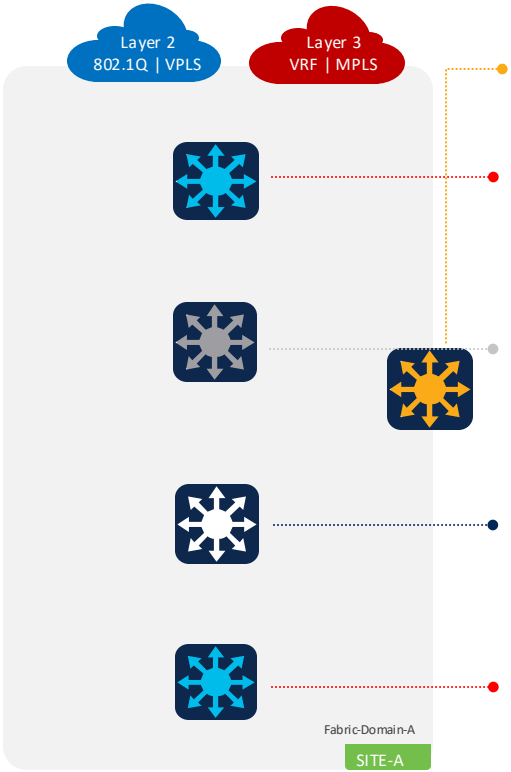
★- Recommended



Catalyst EVPN Scale and Performance Matrix

Cisco Catalyst BGP EVPN Configuration Guide
Scale and Performance Chapter

System Support	Mode
Nexus 9000	Standalone

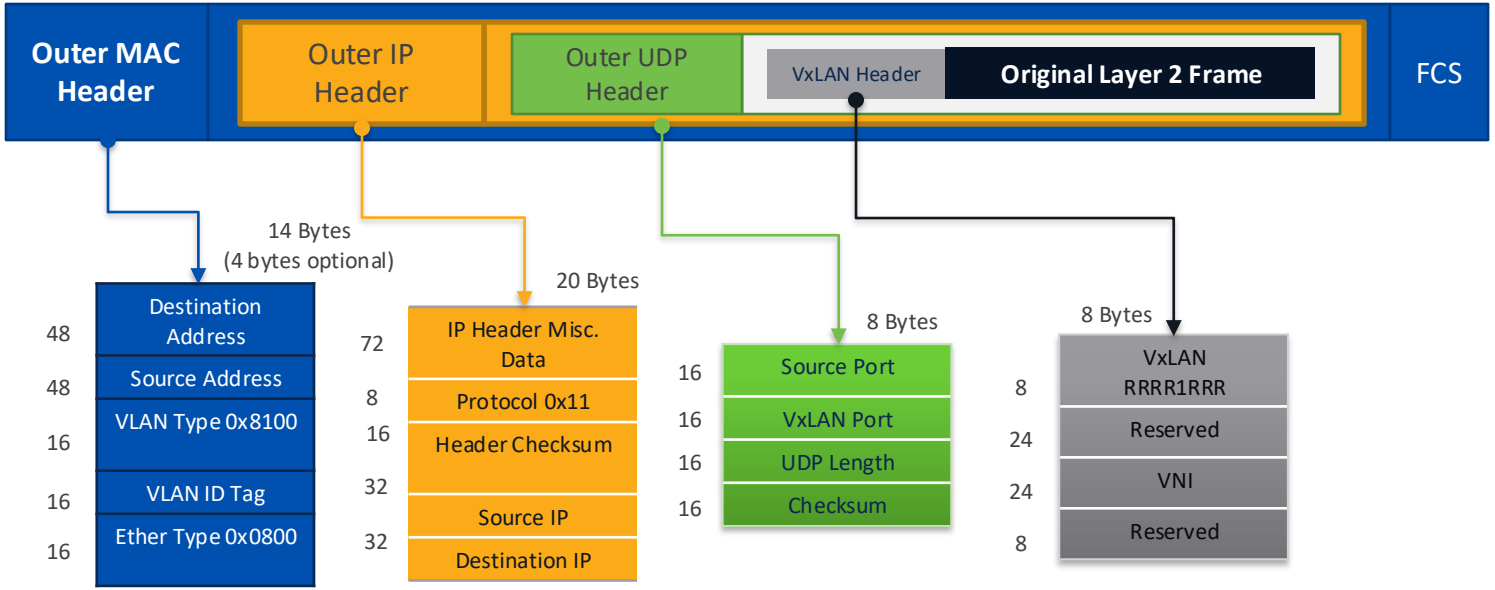
System Support	Mode
Catalyst 9300 – 9600 (9500-H/X/9600/X)	Standalone | Stack ★
Catalyst 8000 Edge | ASR 1000	Physical
Nexus 9000	Standalone
ASR 9000	Standalone

System Support	Mode
Any	Any

System Support	Mode
Catalyst 9300 – 9600 (9500-H/X & 9600/X)	Standalone | Stack
Catalyst 8000 Edge | ASR 1000	Physical | Virtual
Nexus 9000	Standalone
ASR 9000	Standalone

System Support	Mode
Catalyst 9300L | 9300 | 9300X Series	Standalone | StackWise ★
Catalyst 9400 | 9400X Series	Standalone | StackWise-Virtual ★
Catalyst 9500 | 9500X Series	Standalone | StackWise-Virtual ★
Catalyst 9600 | 9600X Series	Standalone | StackWise-Virtual ★

VxLAN Packet Structure



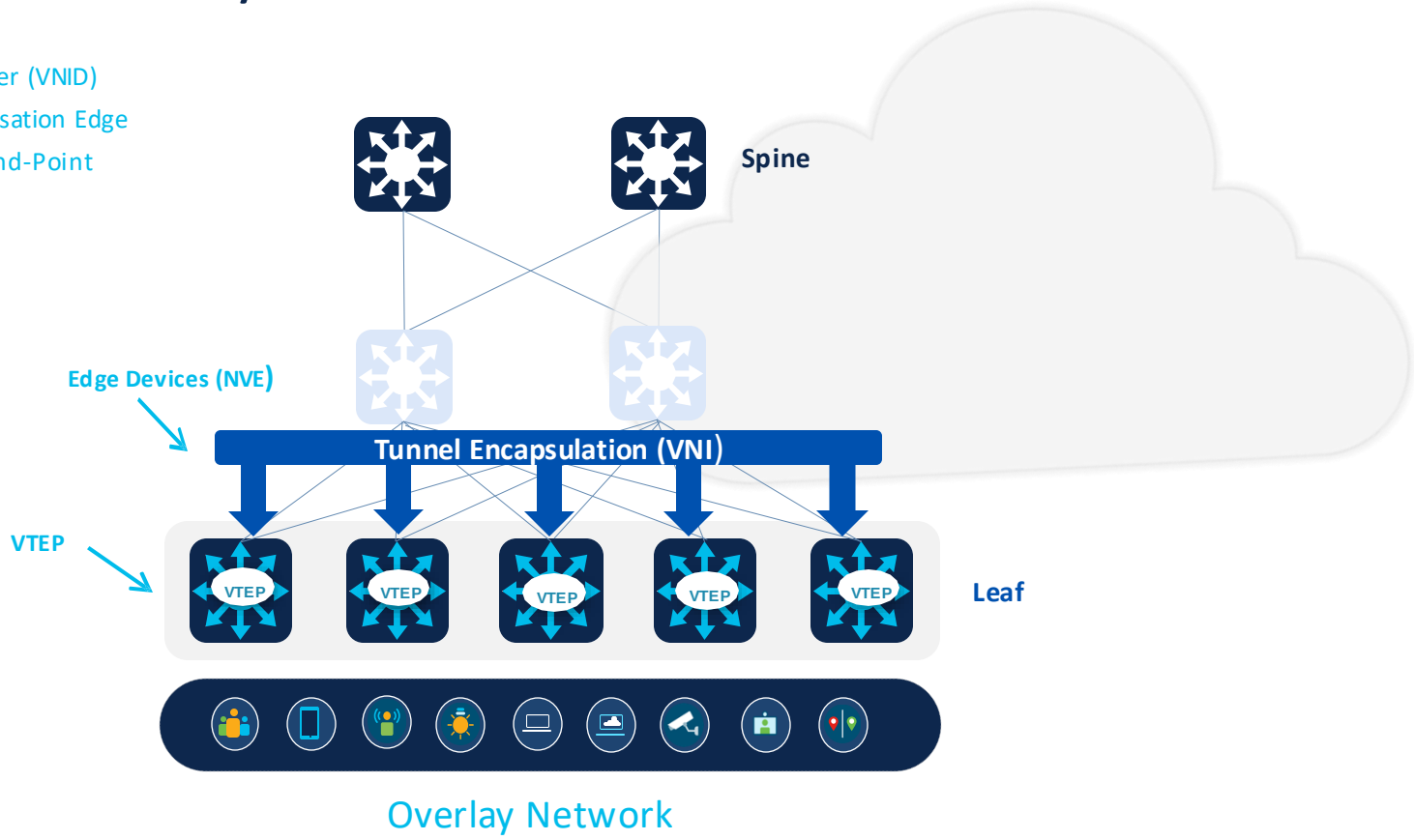
- VXLAN adds 50 Bytes (or 54 Bytes) to the Original Ethernet Frame
- Avoid Fragmentation by adjusting the IP Networks MTU
- Using a MTU of 9216* Bytes accommodates VXLAN Overhead plus other application MTU

Overlay Taxonomy

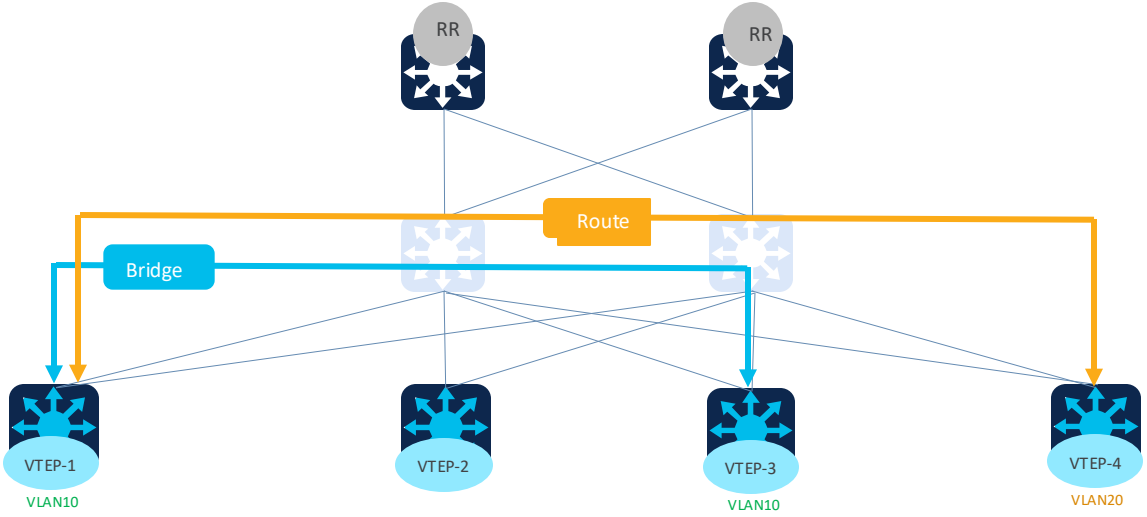
Identifier = VN Identifier (VNID)

NVE = Network Virtualisation Edge

VTEP = VXLAN Tunnel End-Point



Bridging and Routing



Host A
MAC: 0000.1111.1111
IP: 192.168.10.10

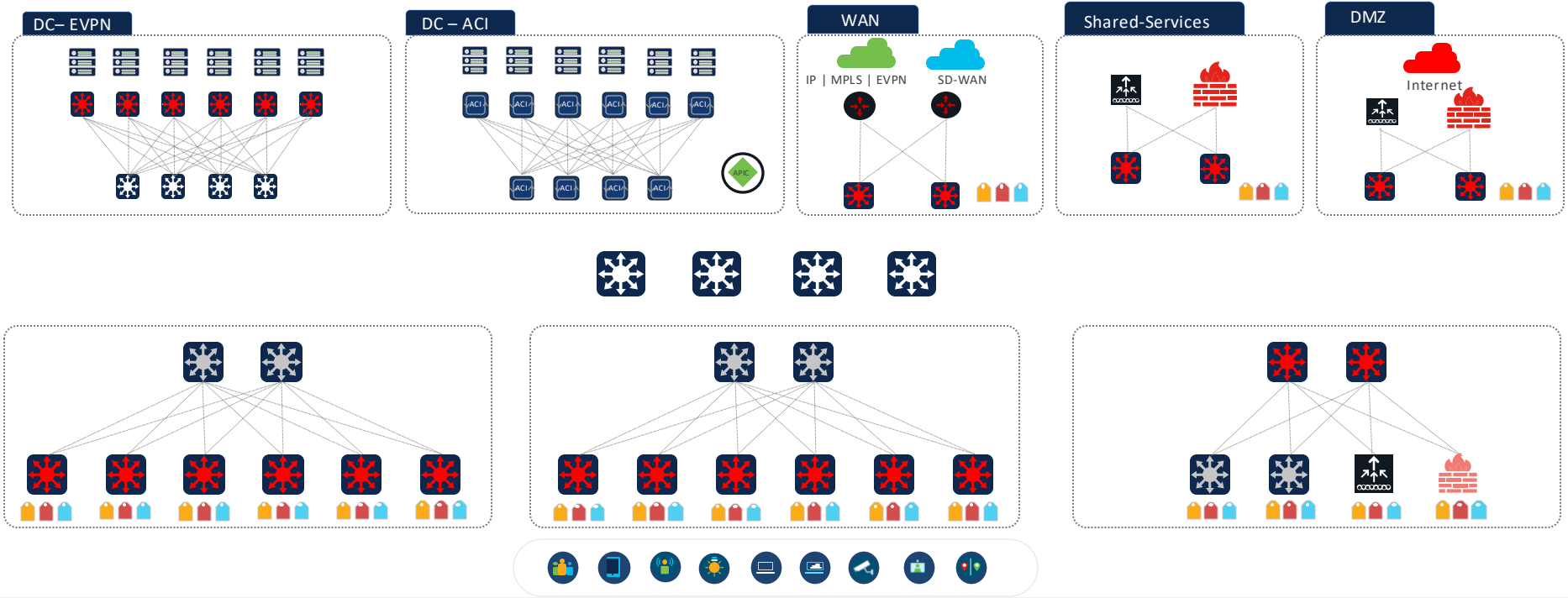
Host B
MAC: 0000.2222.2222
IP: 192.168.10.11

Host C
MAC: 0000.4444.4444
IP: 192.168.20.11

L3 VXLAN Tunnel

L2 VXLAN Tunnel

Enterprise BGP EVPN Reference Architecture



Industry Standard

- Standard-based Fabric
- Multi-vendor interoperable
- Broad innovation adoption

Unified Fabric

- Cross-PIN single fabric
- Extensible beyond site
- Simplified Management

Proven

- Reliable control-plane
- Multi-protocol capabilities
- Less new learning-curve

Hierarchical

- Non-blocking architecture
- Structured & Scalable fabric
- Hybrid system role support

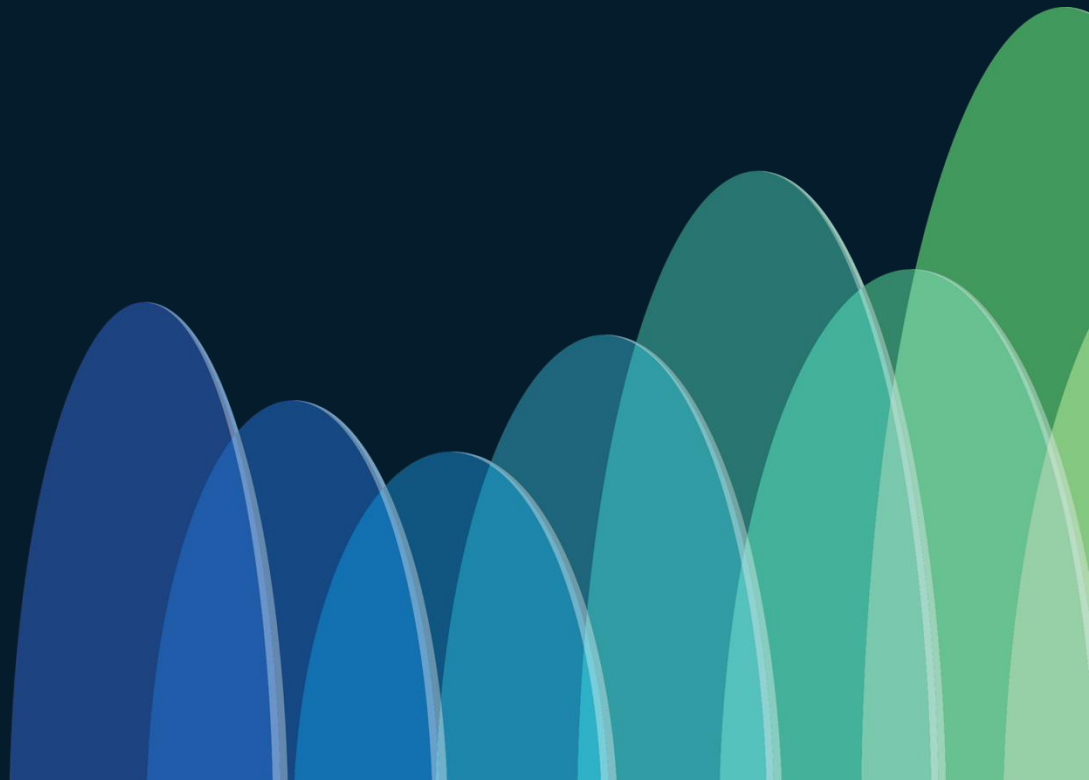
Flexible

- Complex network solution
- Tailored L2/L3 overlays
- Deep eco-system integration

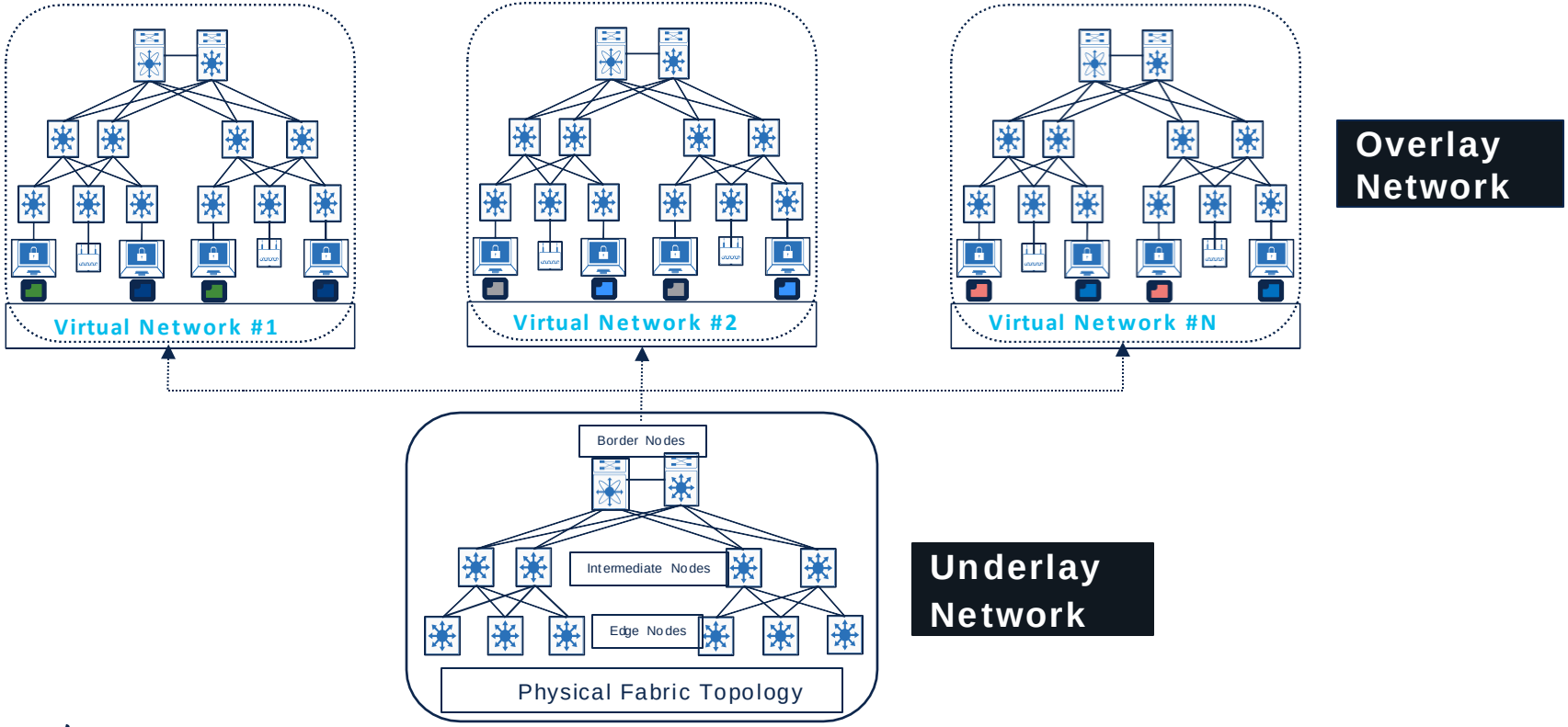
System Design Alternatives

Unicast Routing Design

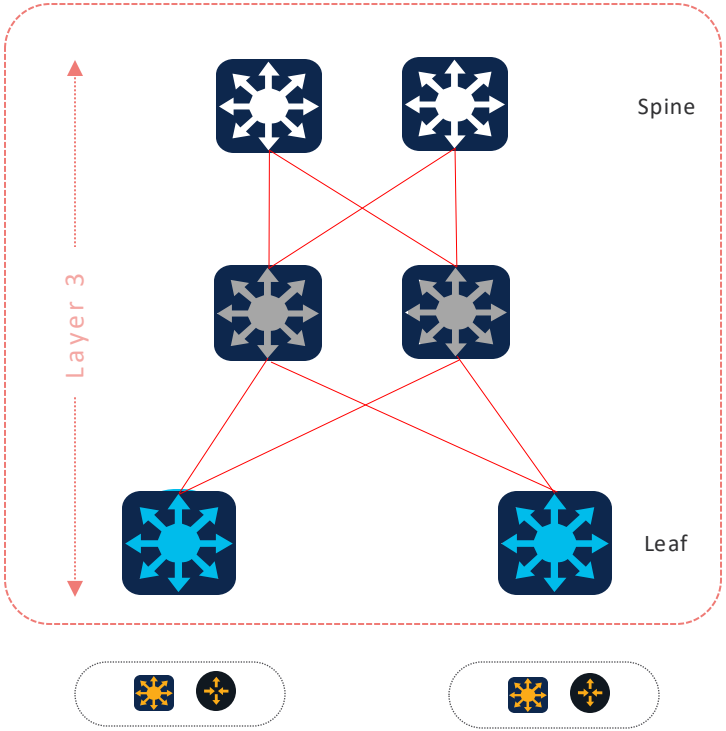
Multicast Routing Design



What is Underlay and Overlay?



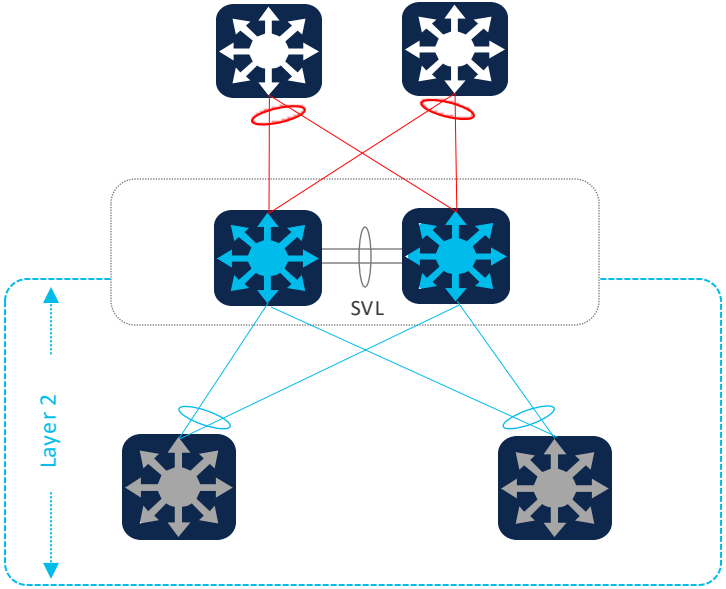
Layer 3 Routed Access Design



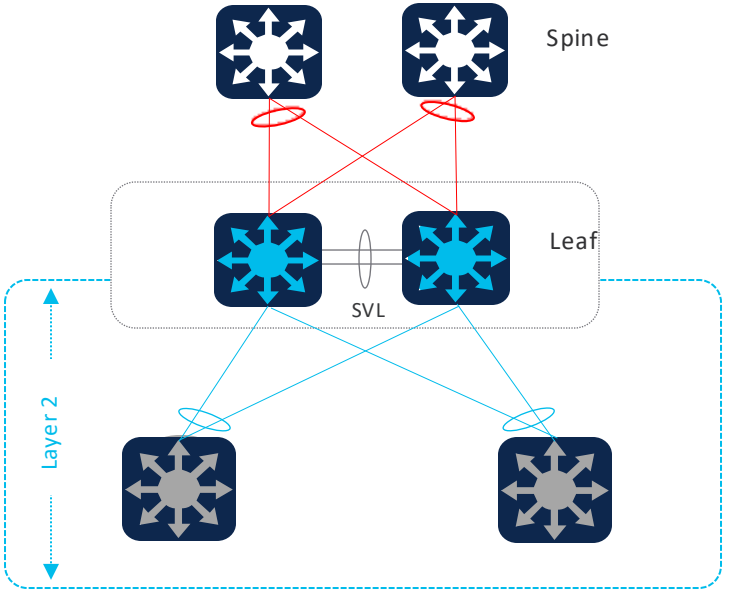
- Routed Access environment
- Leaf Layer – Routed Access
- Spine/RR – Direct | Multi-hop
- ECMP | Non-Blocking ports
- Underlay | Overlay IP Gateway
- L2 | L3 Overlay Support
- Multicast Support

Layer 3

Cisco StackWise-Virtual Design



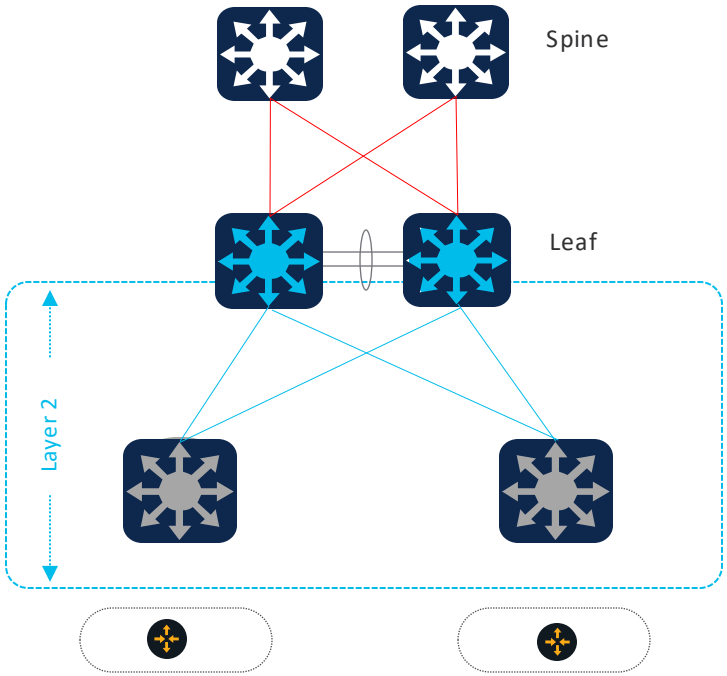
- Unified Experience
- Single Unified Management Plane
- Inter-Chassis Management Redundancy
- Single Control Pane | Distributed forwarding
- Inter-Chassis ISSU
- Unified L2/L3 Control Plane
- Loop-free L2 forwarding
- Per-Flow Load-sharing



- Access – Traditional Layer 2
- Leaf Layer – Distribution
- Simplified Control Plane with SVL Architecture
- Spine/RR – Direct | Multi-hop
- MEC | ECMP | Active/Active forwarding
- Underlay | Overlay IP Gateway
- L2 | L3 Overlay Support
- Multicast Support

Layer 2 Layer 3

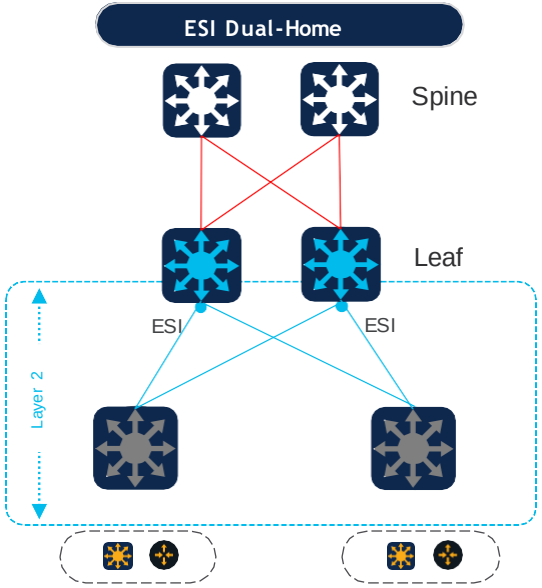
Layer 2 | 3 Distribution



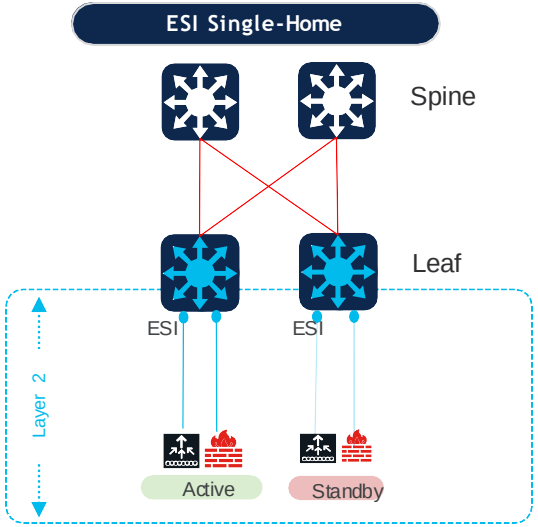
- Access – Traditional Layer 2
- Leaf Layer – Distribution
- Spine/RR – Direct | Multi-hop
- FHRP | ECMP | Multicast
- Underlay | Overlay IP Gateway
- L3 Overlay Support. No L2 Extension
- Multicast Support

Layer 2 Layer 3

EVPN ESI(Ethernet Segment Identifier)



- Access – Traditional Layer 2
- Leaf Layer – Distribution
- Spine/RR – Direct | Multi-hop
- Per-ESI Anycast Gateway
- Per-VLAN | FHRP | ECMP | Multicast
- Active / Standby load-balancing
- L2 | L3 Overlay support
- Multicast Support



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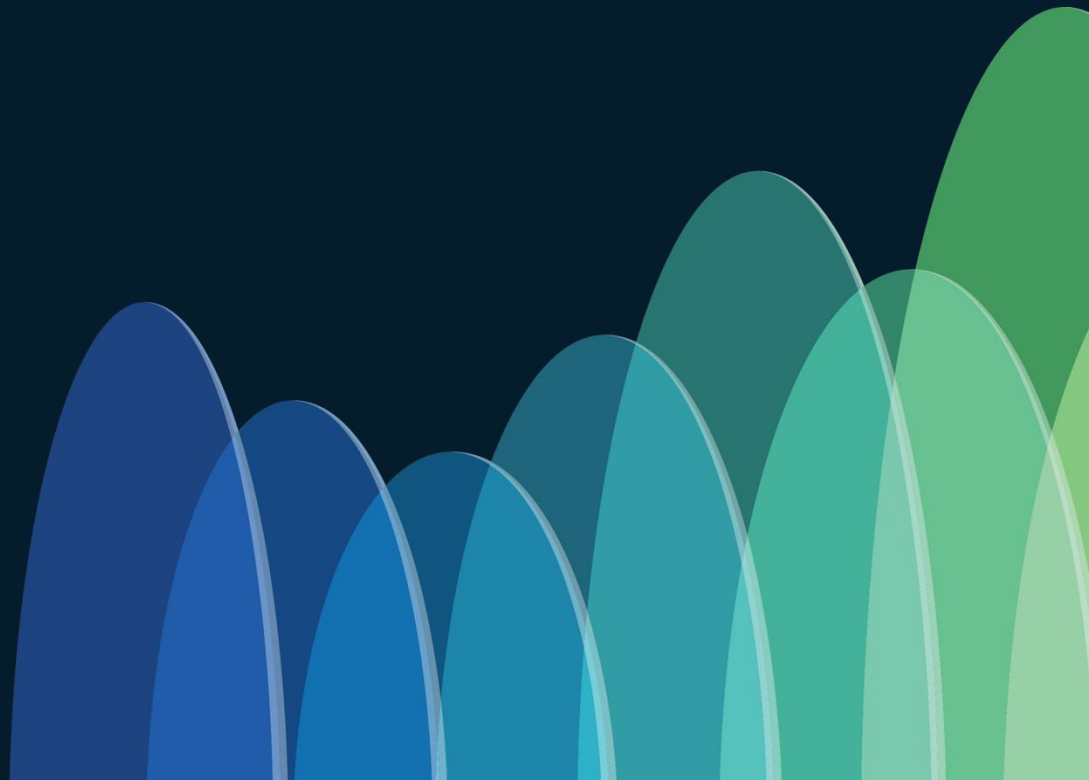
Layer 2 Layer 3

Underlay IP Routed Network Options



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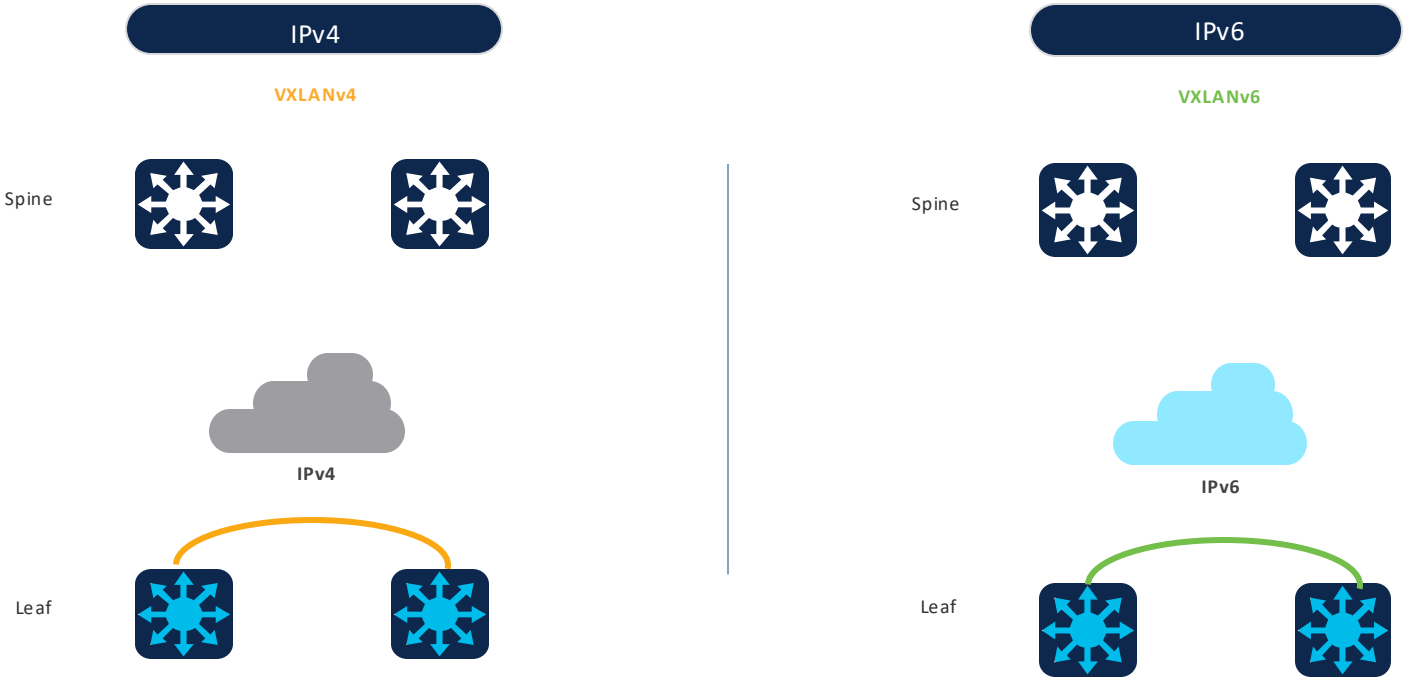
Underlay IP Routed Network Options



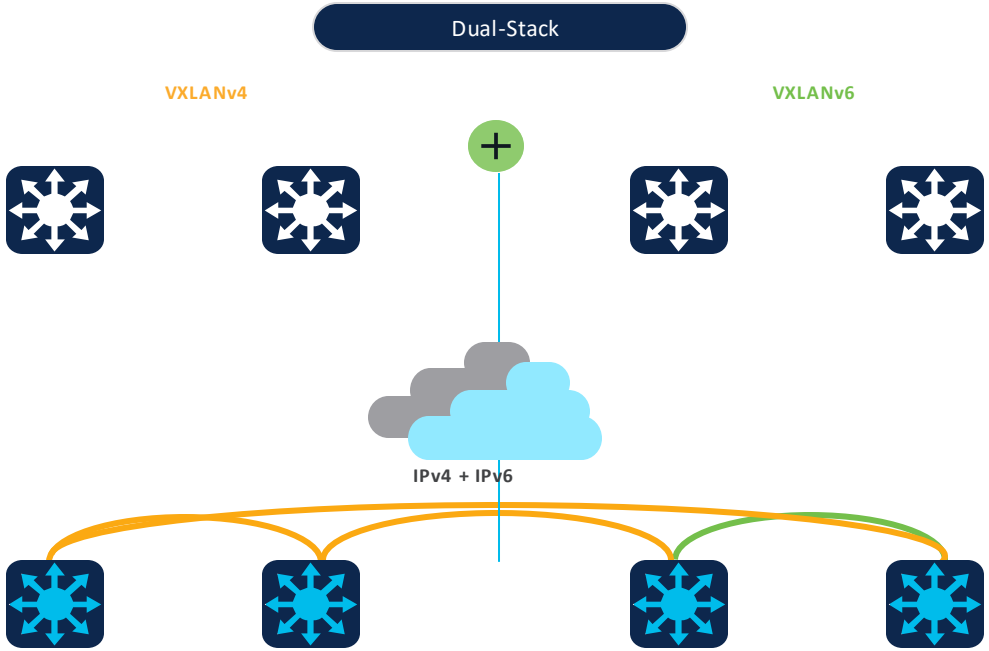
Flexible Underlay IP Routed network design alternatives

Native IPv4 underlay support to transport VXLANv4 over UDP

Native IPv4 or IPv6 underlay support VXLANv4 or transition VXLANv6 over UDP

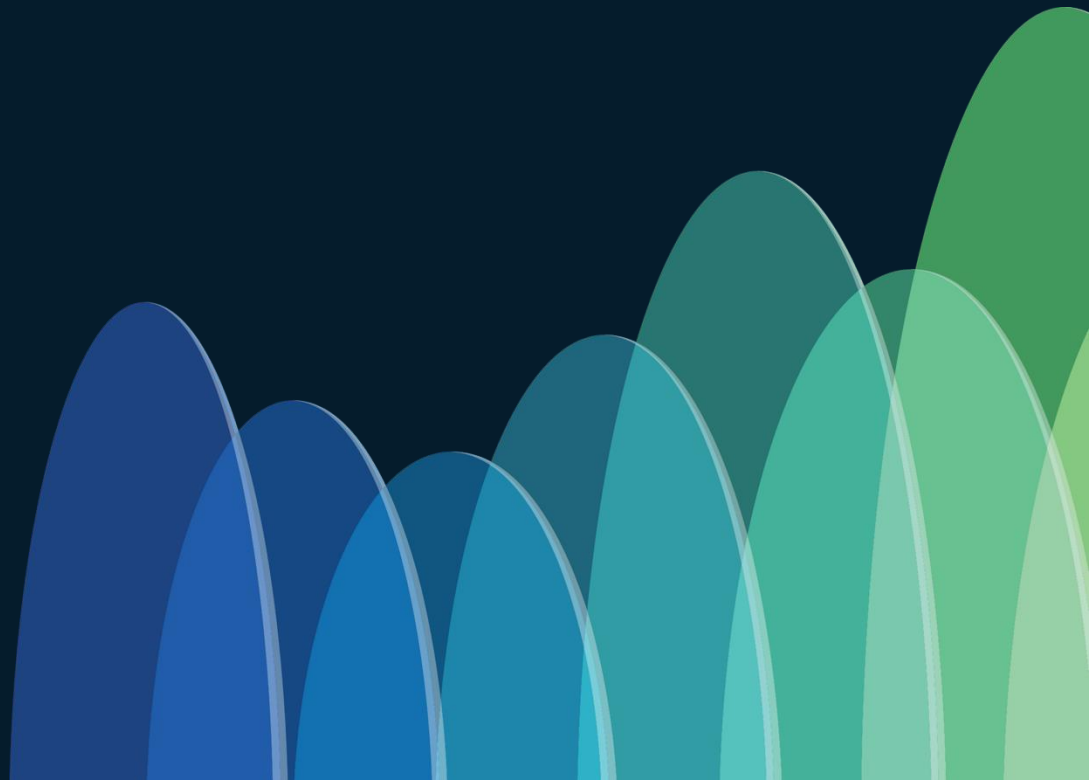
Dual-Stack IPv4 | IPv6 Underlay + VXLANv4 | v6 Overlay support for seamless migrations

Underlay IP Routed Network Options



- Native IPv4 or IPv6 underlay support VXLANv4 or transition VXLANv6 over UDP
- Dual-Stack IPv4 | IPv6 Underlay + VXLANv4 | v6 Overlay support for seamless migrations

Underlay Unicast Routing Design Alternatives



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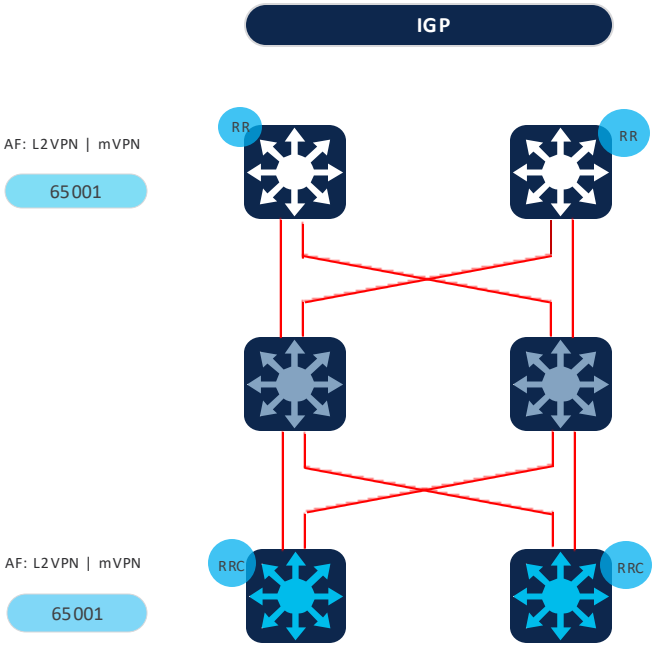
Underlay Unicast Routing Design Alternatives

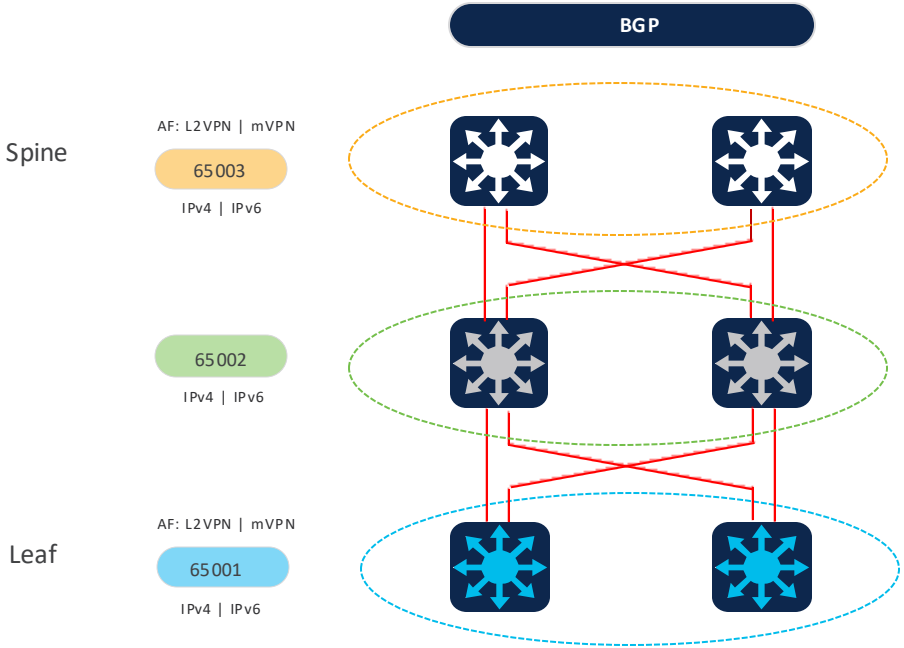


IPv4 | IPv6

EIGRP | OSPF | IS-IS

- Flexible Underlay Unicast alternatives – IGP (EIGRP/OSPF/IS-IS)
- Physical/Virtual Spine RR support – IOS-XE | NXOS | XR
- Secure link-layer underlay network encryption using MACSEC
- Underlay MTU size consideration. TCP MSS adjust supported.

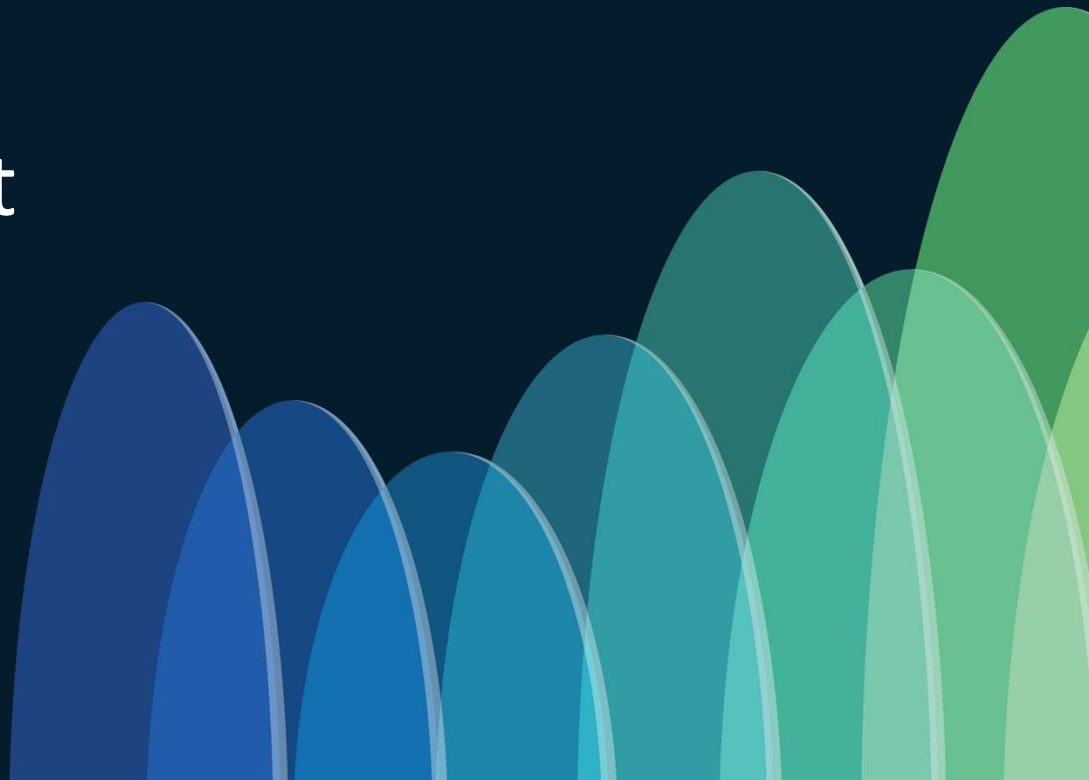
Underlay Unicast Routing Design Alternatives



- IGP free network
- Two-AS, One AS for Leaf's and one AS for Spines
- eBGP peering for Underlay-Routing based on physical interface
- Advertise all Infrastructure Loopbacks
- BGP peering for Overlay-Routing (EVPN)
- Loopback to Loopback Peering

- Requires some BGP config knobs
  - Disable BGP AS-Path check
  - Next-Hop needs to be Unchanged
  - Retain route-target on all spines

Underlay Multicast Routing Design



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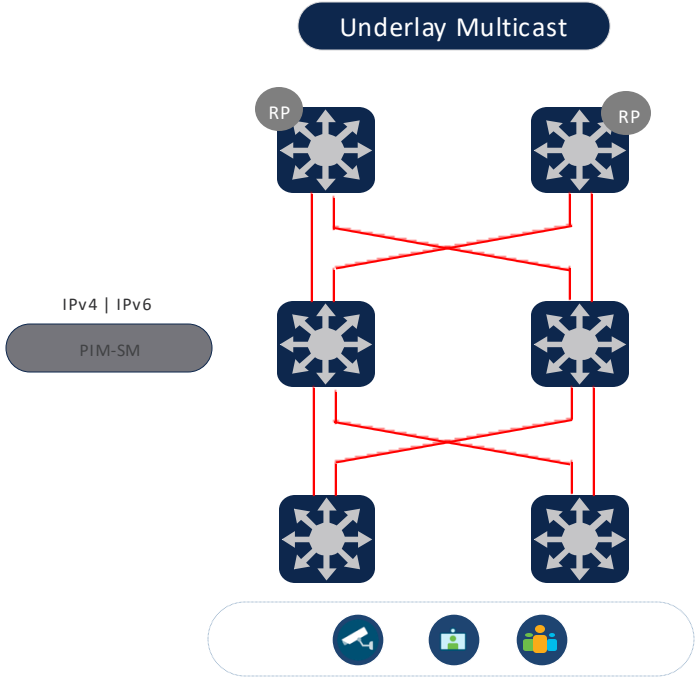
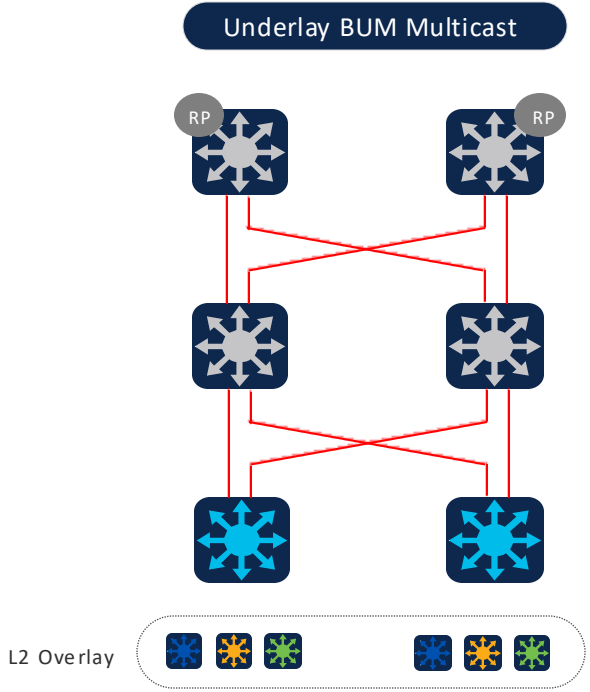
Unicast Multicast Routing Design



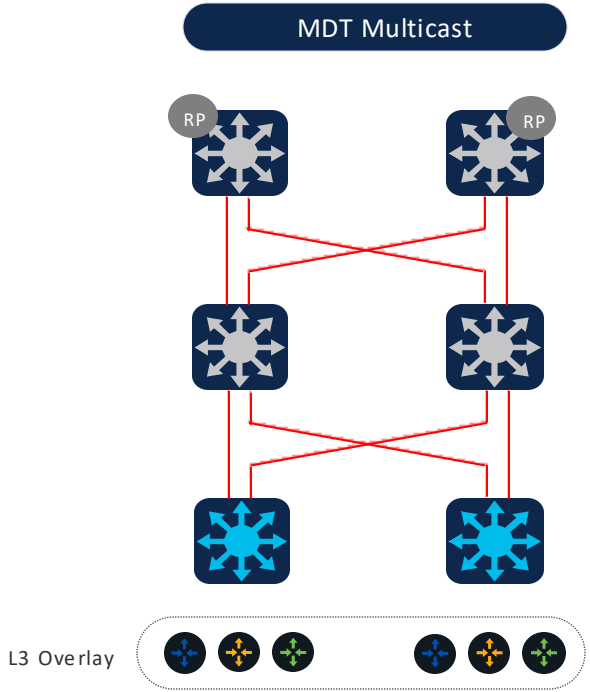
- Underlay Multicast
- Required for Multicast Replication
- Aggregation Switches make good Rendezvous-Point (RP) Locations in Topologies
- Any-Source Multicast | Source Specific Multicast

Unicast Multicast Routing Design



- Underlay BUM Multicast
- Required for Multicast Replication
- Co-existence with underlay Multicast network design
- Flexible BUM Multicast grouping – all L2VN, group-based L2VN to manage BUM boundary

Unicast Multicast Routing Design



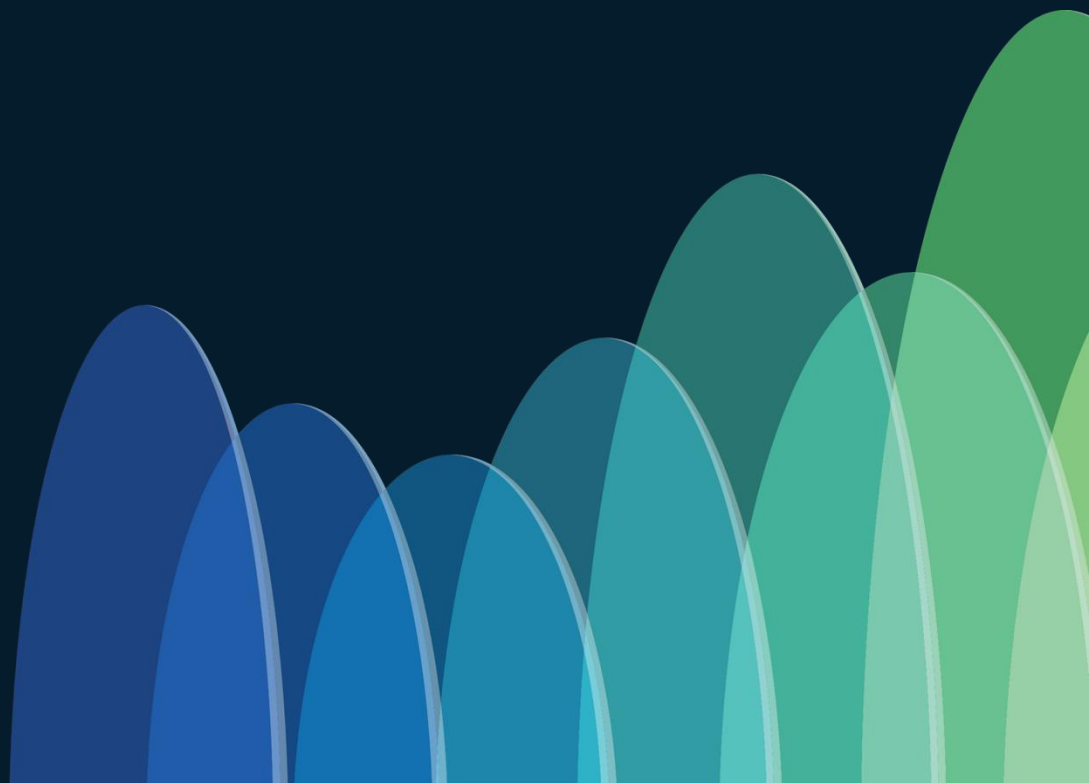
- Required for Multicast Replication
- Co-existence with underlay Multicast network design
- Enhanced overlay Multicast MDT for underlay load-sharing, redundancy and performance

Overlay Types

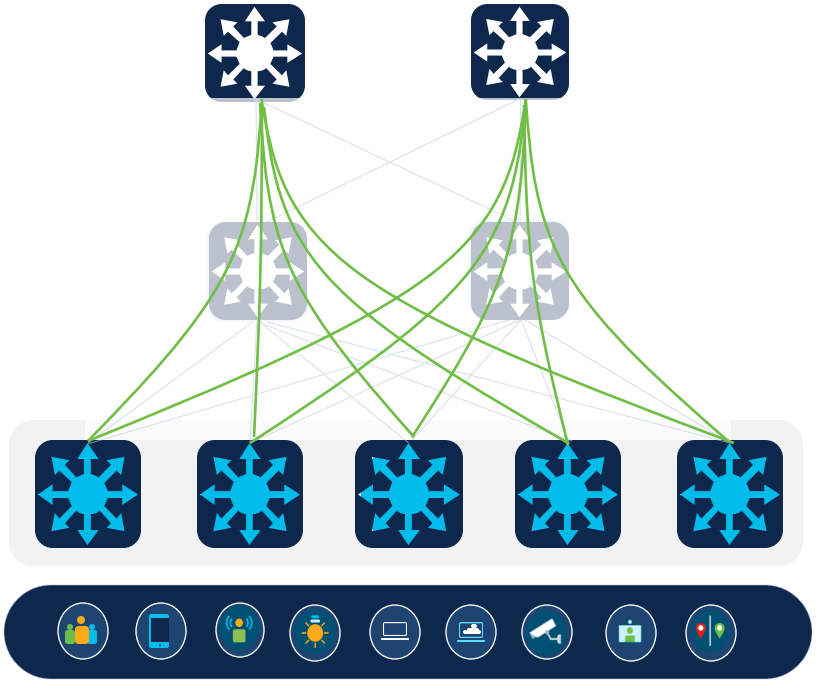
Overlay Configuration

Fabric Domain Design

Overlay Topologies

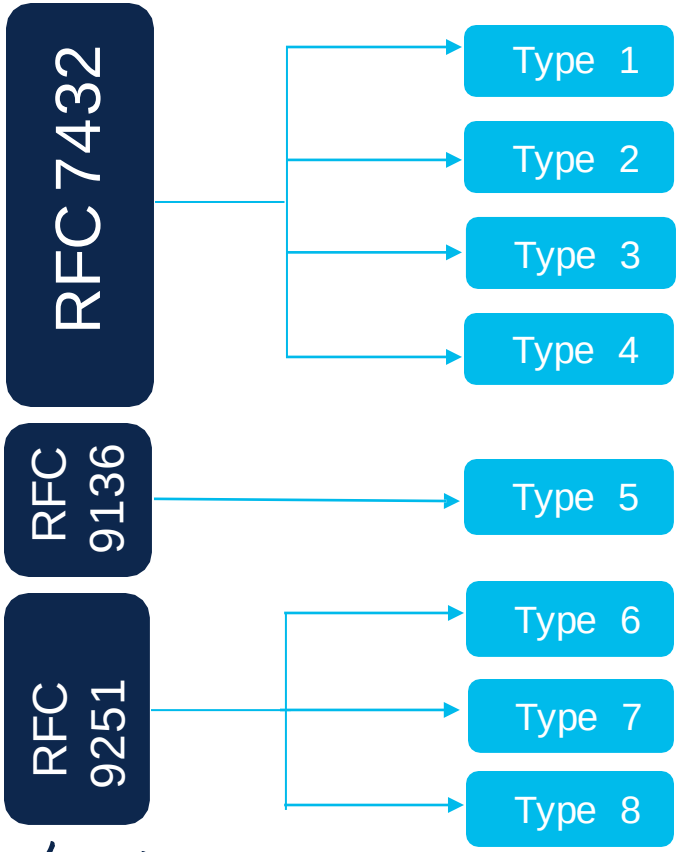


Multiprotocol BGP (MP-BGP)



- Multiprotocol BGP (MP-BGP)
- Extension to Border Gateway Protocol (BGP) - RFC 4760
- VPN Address-Family:
  - Allows different types of address families (e.g., VPNv4, VPNv6, L2VPN EVPN, MVPN) Information transported across single BGP peering
- MP-BGP with EVPN Address Family on leaf nodes to distribute internal host MAC/IP addresses, subnet routes and external reachability information

MP-BGP EVPN Route Type(s)



Ethernet Auto-Discovery (A-D) route

MAC/IP advertisement route

Inclusive Multicast Route

EVPN Ingress Replication (IR) (unicast mode for BUM)

Ethernet Segment Route

IP Prefix Route → Layer-3 VNI Route

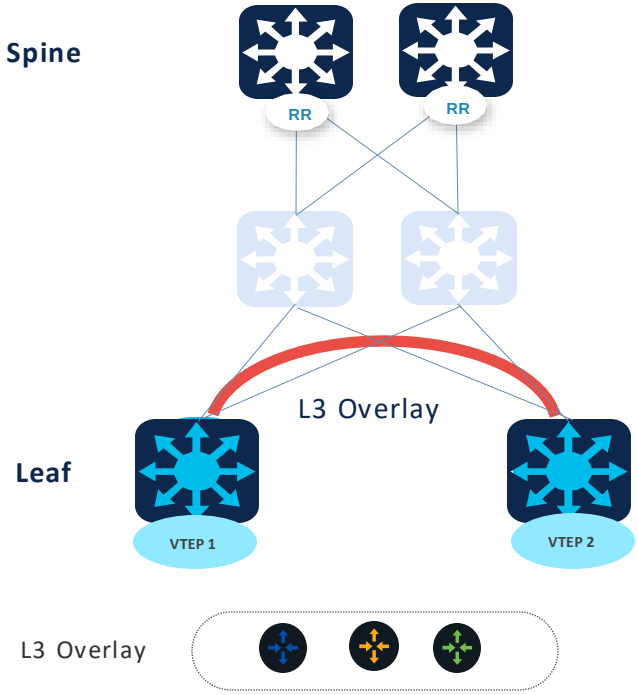
Selective Multicast Ethernet Tag Route

IGMP Join Sync routes (Join/Leave)

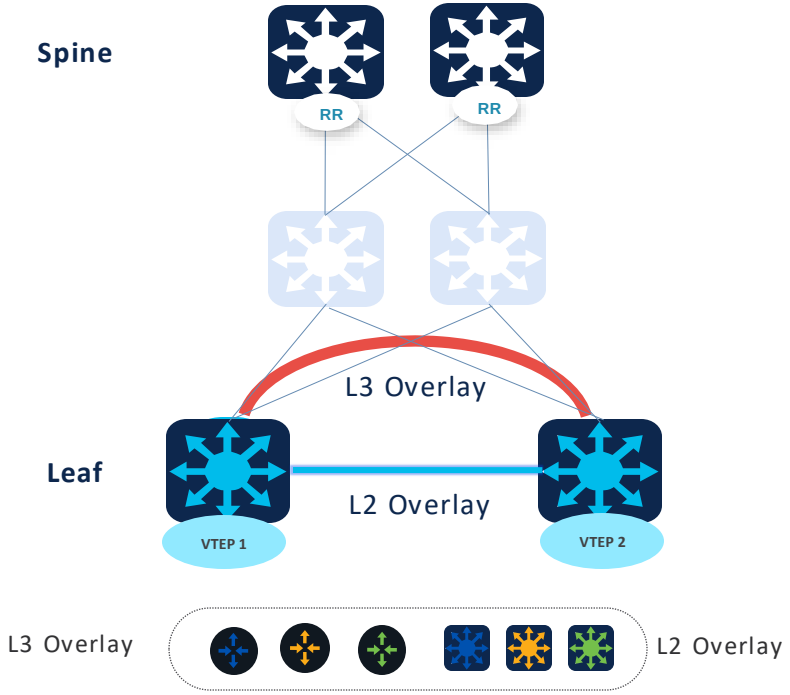
IGMP Leave Sync routes (Join/Leave)

Flexible Routing and Bridging Overlay Types

Layer 3 Overlay

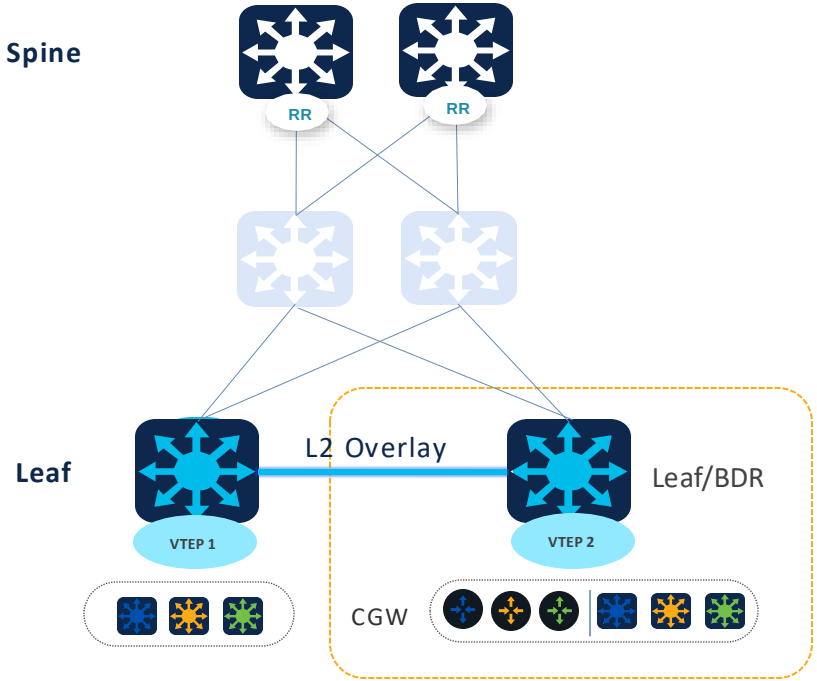


Distributed Anycast Gateway

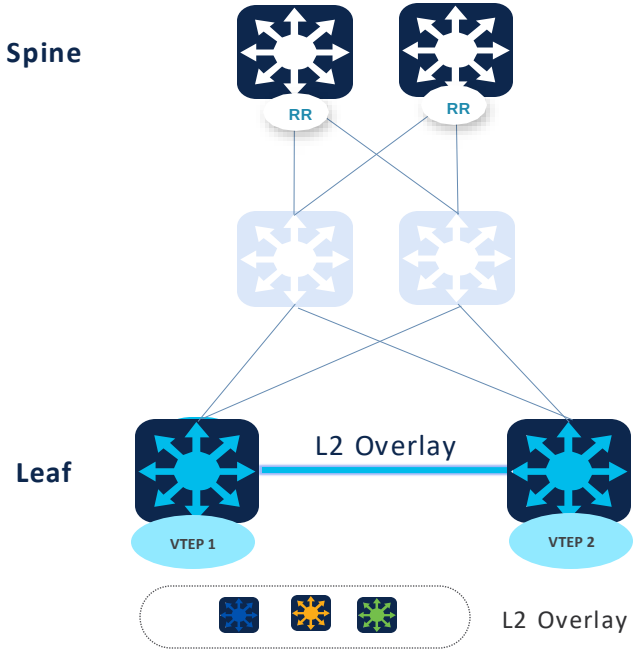


Flexible Routing and Bridging Overlay Types

Centralized Gateway



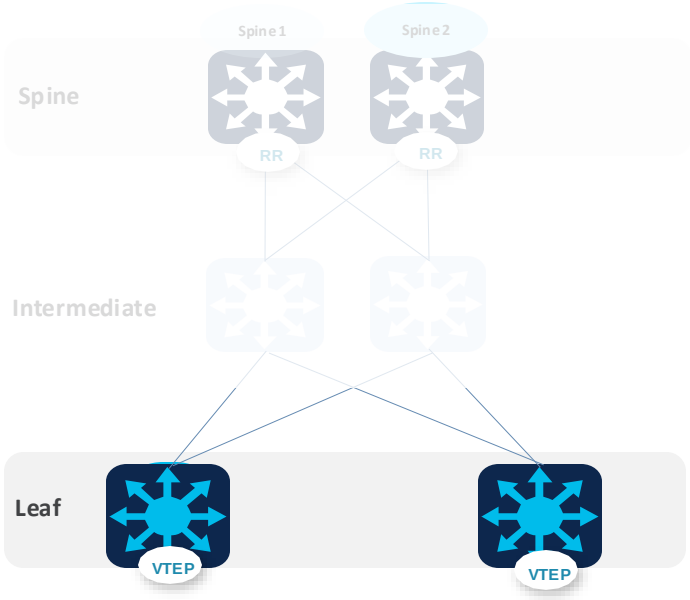
Layer 2 Overlay



Overlay Leaf Configuration – BGP EVPN Control Plane

Leaf-1

```
router bgp 65000
 neighbor 1.1.1.1 remote-as 65000
 neighbor 1.1.1.1 update-source Loopback0
 neighbor 2.2.2.2 remote-as 65000
 neighbor 2.2.2.2 update-source Loopback0
 !
 address-family l2vpn evpn
  neighbor 1.1.1.1 activate
  neighbor 1.1.1.1 send-community both
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community both
 exit-address-family
```



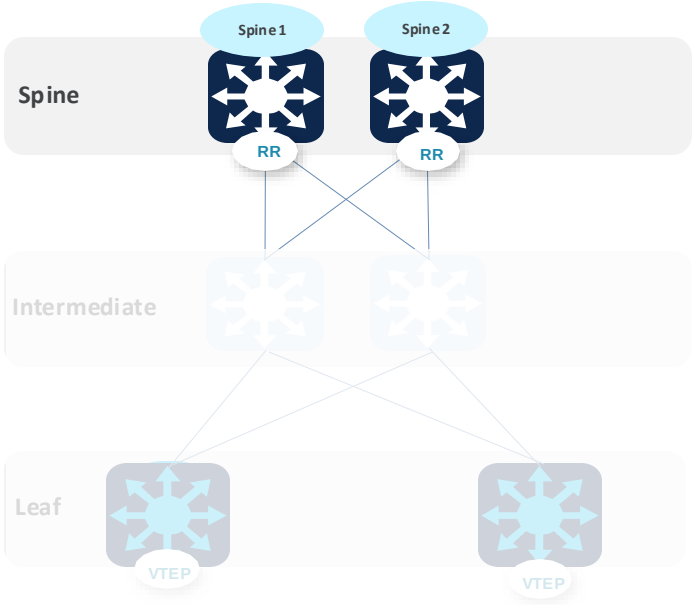
Leaf-2

```
router bgp 65000
 neighbor 1.1.1.1 remote-as 65000
 neighbor 1.1.1.1 update-source Loopback0
 neighbor 2.2.2.2 remote-as 65000
 neighbor 2.2.2.2 update-source Loopback0
 !
 address-family l2vpn evpn
  neighbor 1.1.1.1 activate
  neighbor 1.1.1.1 send-community both
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community both
 exit-address-family
```

Overlay Spine Configuration – BGP EVPN Control Plane

Spine-1

```
router bgp 65000
 neighbor 3.3.3.3 remote-as 65000
 neighbor 3.3.3.3 update-source Loopback0
 neighbor 4.4.4.4 remote-as 65000
 neighbor 4.4.4.4 update-source Loopback0
 !
 address-family l2vpn evpn
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community both
  neighbor 3.3.3.3 route-reflector-client
  neighbor 4.4.4.4 activate
  neighbor 4.4.4.4 send-community both
  neighbor 4.4.4.4 route-reflector-client
  maximum-paths 2
```



Spine-2

```
router bgp 65000
 neighbor 3.3.3.3 remote-as 65000
 neighbor 3.3.3.3 update-source Loopback0
 neighbor 4.4.4.4 remote-as 65000
 neighbor 4.4.4.4 update-source Loopback0
 !
 address-family l2vpn evpn
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community both
  neighbor 3.3.3.3 route-reflector-client
  neighbor 4.4.4.4 activate
  neighbor 4.4.4.4 send-community both
  neighbor 4.4.4.4 route-reflector-client
  maximum-paths 2
```

Overlay Control Plane Verification

```
spine1# show bgp l2vpn evpn summary
BGP summary information for VRF default, address family IPv4 Unicast BGP router identifier 1.1.1.1, local AS number 65000
13 network entries using 4992 bytes of memory
14 path entries using 3248 bytes of memory
6/6 BGP path/bestpath attribute entries using 1776 bytes of memory
6 BGP extended community entries using 664 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 10680 total bytes of memory
BGP activity 13/0 prefixes, 14/0 paths, scan interval 60 secs

Neighbor  V.    AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3   4 65000 2307    1997        3     0    0    1d04h           7
4.4.4.4   4 65000 16914   2185        3     0    0    1d04h           6
```

```
spine2# show bgp l2vpn evpn summary
BGP summary information for VRF default, address family IPv4 Unicast BGP router identifier 2.2.2.2, local AS number 65000
13 network entries using 4992 bytes of memory
14 path entries using 3248 bytes of memory
6/6 BGP path/bestpath attribute entries using 1776 bytes of memory
6 BGP extended community entries using 664 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 10680 total bytes of memory
BGP activity 13/0 prefixes, 14/0 paths, scan interval 60 secs

Neighbor  V.    AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3   4 65000 2307    1997        3     0    0    1d04h           7
4.4.4.4   4 65000 16914   2185        3     0    0    1d04h           6
```

Intermediate

```
leaf1# show bgp l2vpn evpn summary
BGP summary information for VRF default, address family IPv4 Unicast BGP router identifier 3.3.3.3, local AS number 65000
BGP table version is 3, IPv4 Unicast config peers 2, capable peers 2
16 network entries using 6144 bytes of memory
16 path entries using 3712 bytes of memory
7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
2 BGP rrinfo entries using 80 bytes of memory
5 BGP extended community entries using 624 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 12632 total bytes of memory
BGP activity 23/0 prefixes, 23/0 paths, scan interval 60 secs

Neighbor  V.    AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
1.1.1.1   4 65000 2306    1999        3     0    0    1d04h           6
2.2.2.2   4 65000 1691    2184        3     0    0    1d04h           10
```

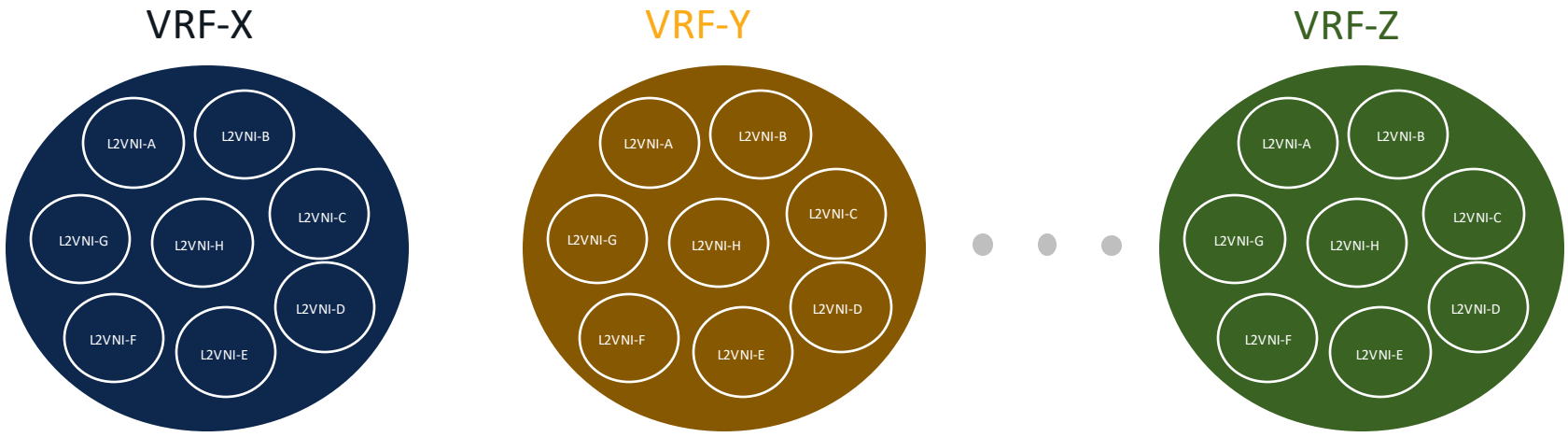
Vlan 10

```
leaf2# show bgp l2vpn evpn summary
BGP summary information for VRF default, address family IPv4 Unicast BGP router identifier 4.4.4.4, local AS number 65000
BGP table version is 3, IPv4 Unicast config peers 2, capable peers 2
16 network entries using 6144 bytes of memory
16 path entries using 3712 bytes of memory
7/7 BGP path/bestpath attribute entries using 2072 bytes of memory
2 BGP rrinfo entries using 80 bytes of memory
5 BGP extended community entries using 624 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 12632 total bytes of memory
BGP activity 23/0 prefixes, 23/0 paths, scan interval 60 secs

Neighbor  V.    AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
1.1.1.1   4 65000 2306    1999        3     0    0    1d04h           8
2.2.2.2   4 65000 1691    2184        3     0    0    1d04h           8
```

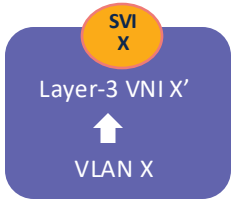
Vlan 20

Virtual Network Overview

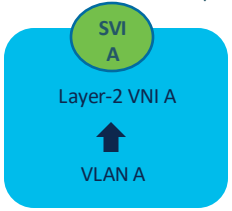


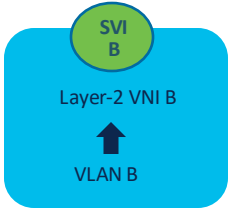
VNI – Virtual Network Identifier

Virtual Network Overview

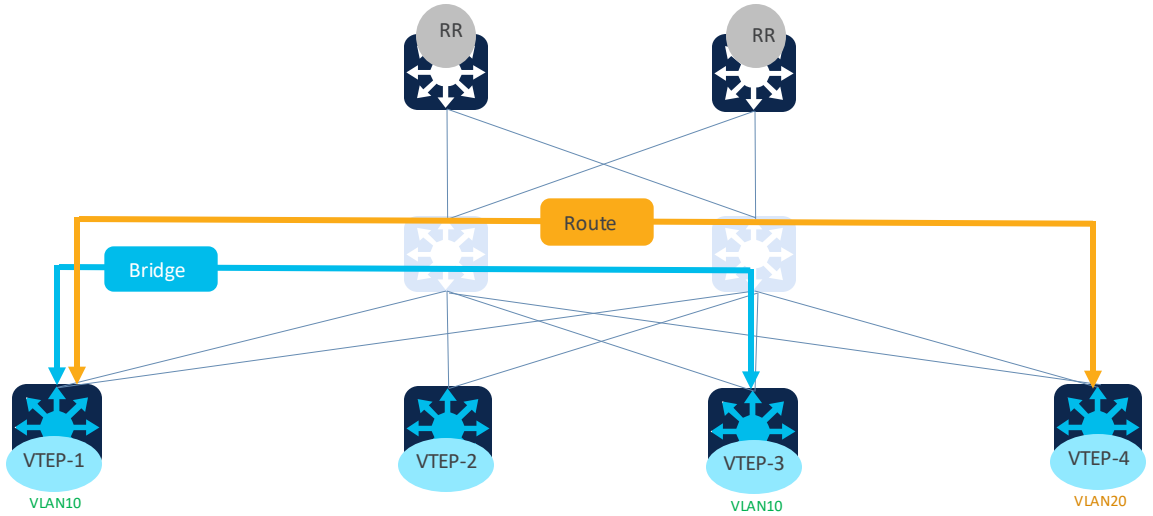


- 1 Layer-3 VNI per Tenant (VRF) for routing
- VNI X' is used for routed packets





- 1 Layer-2 VNI per Layer-2 segment
- Multiple Layer-2 VNIs per tenant
- VNI A' and B' are used for bridged packets



Host A
MAC: 0000.1111.1111
IP: 192.168.10.10

Host B
MAC: 0000.2222.2222
IP: 192.168.10.11

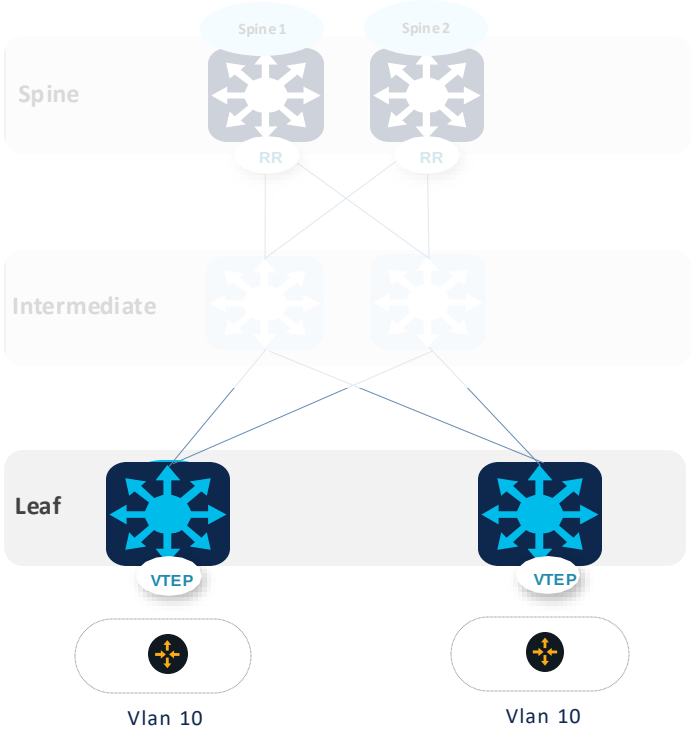
Host D
MAC: 0000.4444.4444
IP: 192.168.20.11

L3 VXLAN Tunnel
L2 VXLAN Tunnel

VRF Configuration

Leaf-1

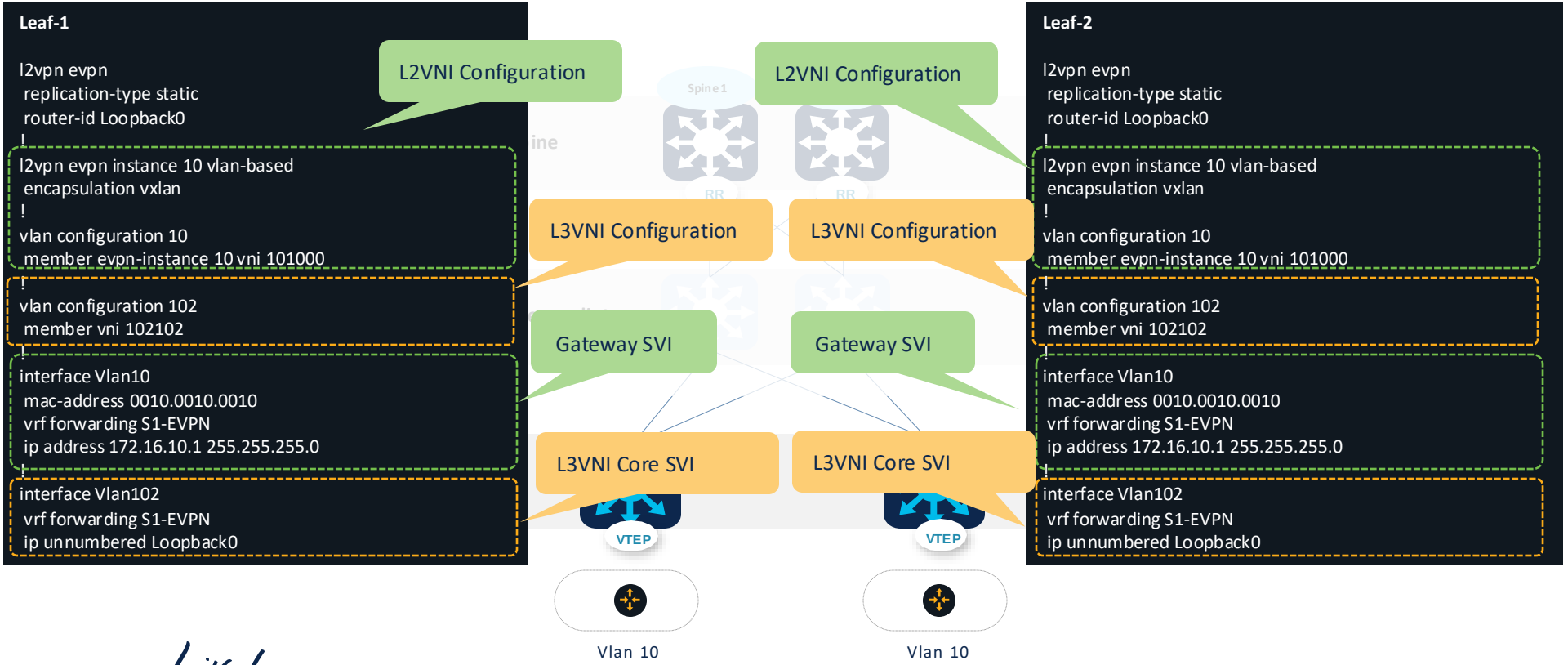
```
vrf definition S1-EVPN
 rd 1:1
 !
 address-family ipv4
  route-target 1:1 stitching
exit-address-family
!
router bgp 64500
!
 address-family ipv4 vrf S1-EVPN
  advertise l2vpn evpn
  redistribute connected
 exit-address-family
```



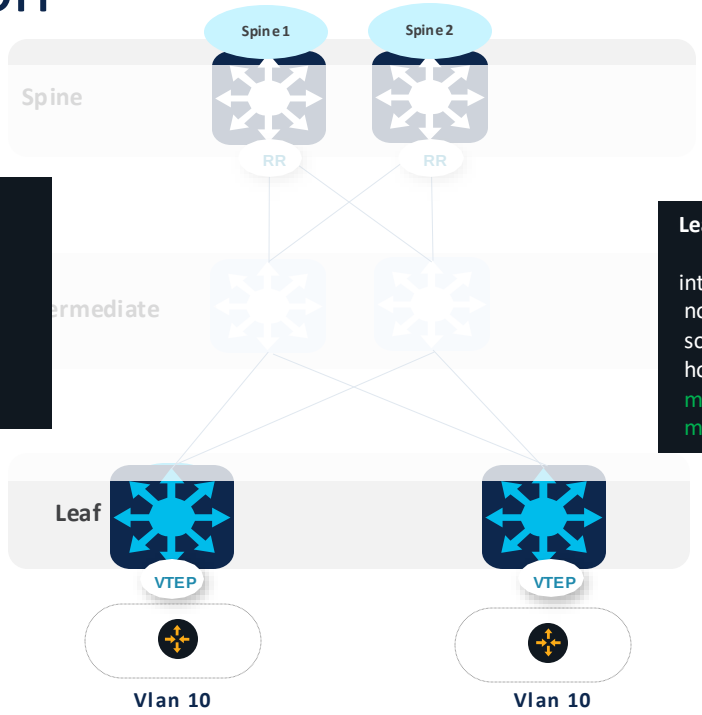
Leaf-2

```
vrf definition S1-EVPN
 rd 1:1
 !
 address-family ipv4
  route-target 1:1 stitching
exit-address-family
!
router bgp 64500
!
 address-family ipv4 vrf S1-EVPN
  advertise l2vpn evpn
  redistribute connected
 exit-address-family
```

VNI Configuration



NVE Configuration



Leaf-1

```
interface nve1
 no ip address
 source-interface Loopback0
 host-reachability protocol bgp
 member vni 102102 vrf S1-EVPN
 member vni 101000 ingress-replication
```

Leaf-1

```
interface nve1
 no ip address
 source-interface Loopback0
 host-reachability protocol bgp
 member vni 102102 vrf S1-EVPN
 member vni 101000 ingress-replication
```

Leaf-1

```
S1-ACCESS-LEAF-1# sh nve peers
Interface  VNI     Type Peer-IP         RMAC/Num_RTs   eVNI     state flags UP time
nve1       110110  L3CP 172.168.1.2     00a3.d145.0dcd 110110   UP  A/M/4 10:46:22 L3VNI
nve1       111110  L2CP 172.168.1.2     4              101000   UP  N/A 10:49:19 L2VNI
```

Leaf-2

```
S1-ACCESS-LEAF-2# sh nve peers
Interface  VNI     Type Peer-IP         RMAC/Num_RTs   eVNI     state flags UP time
nve1       110110  L3CP 172.168.1.1     00a3.d145.0acb 110110   UP  A/M/4 10:46:22 L3VNI
nve1       111110  L2CP 172.168.1.1     4              101000   UP  N/A 10:49:19 L2VNI
```

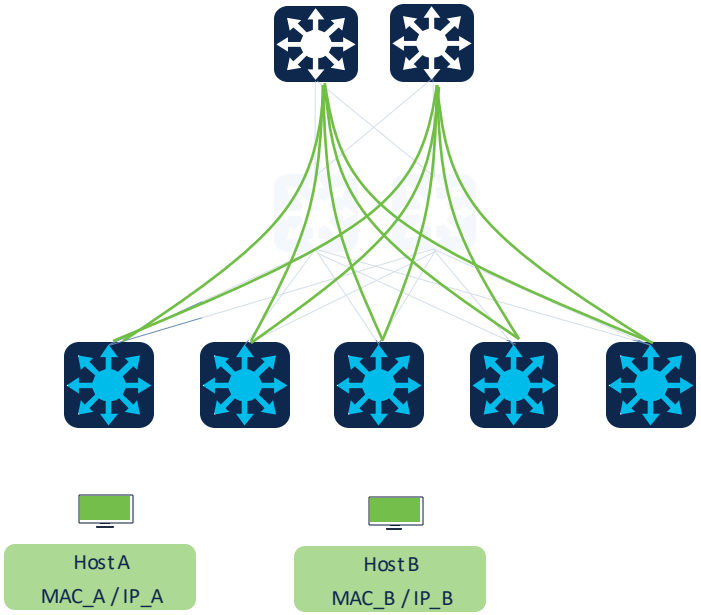
Efficient Layer 2 Broadcast domain

- 2 mechanics to handle **B**roadcast, **U**nknown Unicast and Link-Local **M**ulticast (BUM):
  - Ingress-Replication – Convert each BUM packet to multiple Unicast packets and transmit to each remote VTEP
  - Multicast-Replication – Convert each BUM packet to single Multicast packets and transmit in Underlay network
- Multicast replication offers significant system, network and end-user level performance benefits

MAC/IP Advertisement route
Route-Type 2

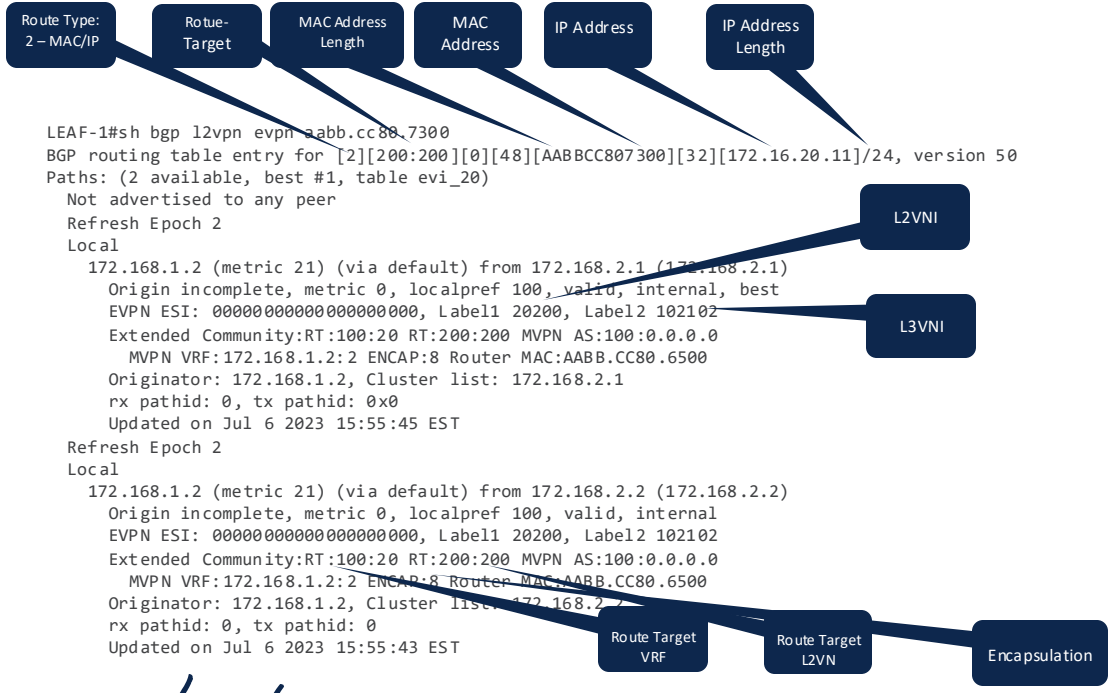
- Host “A” attaches to Edge Device (VTEP)
- VTEP V1 advertises Host “A” reachability information
  - MAC and L2VNI [mandatory]
  - IP and L3VNI [optional]
  - depending on ARP
- Additional Attributes advertised
  - MPLS Label 1 (Layer-2 VNI)
  - MPLS Label 2 (Layer-3 VNI)
  - Extended Communities

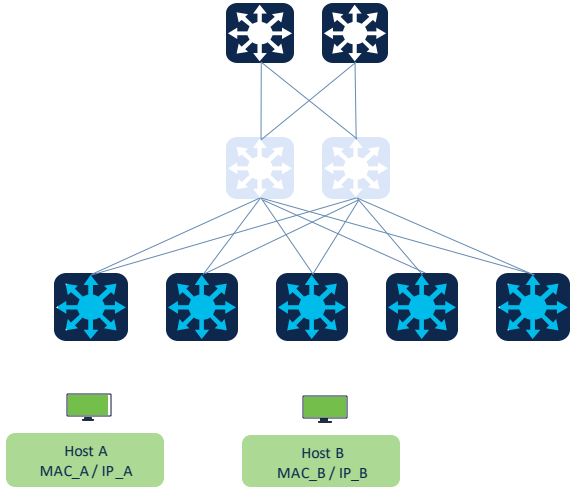
Route Type	MAC, IP	L2VNI	Layer-3 VNI (“VRF”)	NH	Encap	Seq
2	MAC_A, IP_A	30001	50001	IP_L1	8:VXLAN	0



EVPN BGP Route Type 2 Fields

- Ethernet Tag ID, MAC Address Length, MAC Address, IP Address Length, and IP Address fields are considered to be part of the prefix in the NLRI.
- Ethernet Segment Identifier, MPLS Label1, and MPLS Label2 are treated as route attributes, not part of the "route". Both the IP and MAC address lengths are in bits.



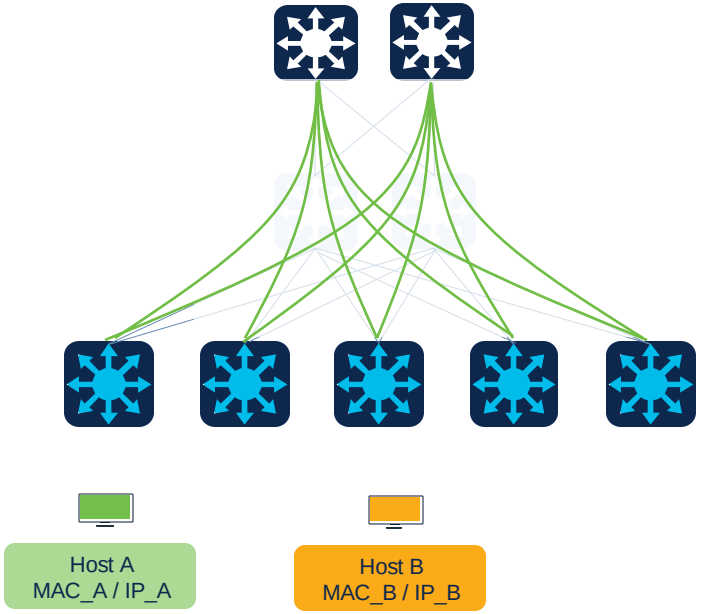


Protocol Learning & Distribution

“Subnet Route Advertisement (Route-Type 5)”

- IP Prefix Redistribution
  - From “Direct” (connected), Static or dynamically learned Routes
- VTEP V1 advertises local Subnet through redistribution of “Direct” (connected) routes
  - IP Prefix, IP Prefix Length, and Layer-3 VNI
- Additional route attributes advertised
  - MPLS Label (Layer-3 VNI)
  - Extended Communities
- Multiple VTEPs can announce same IP Prefix

Route Type	MAC, IP	Layer-3 VNI (“VRF”)	NH	Encap
5	Subnet_A/24	50001	IP_L1	8:VXLAN

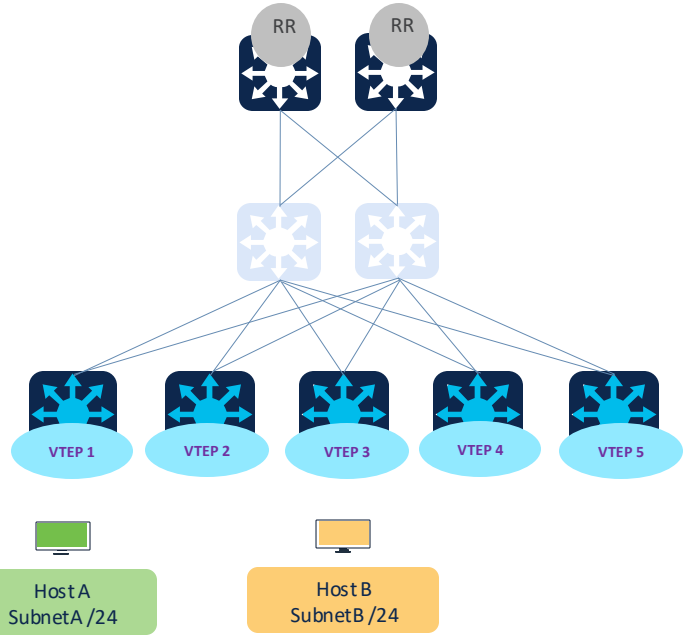


Protocol Learning & Distribution

“Subnet Route Advertisement (Route-Type 5)”

```
LEAF-1#sh bgp l2vpn evpn 172.16.22.0/24
BGP routing table entry for [5][2:2][0][24][172.16.22.0]/17, version 36
Paths: (2 available, best #2, table EVPN-BGP-Table)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    172.168.1.2 (metric 21) (via default) from 172.168.2.1 (172.168.2.1)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      EVPN ESI: 00000000000000000000, Gateway Address: 0.0.0.0, VNI Label 102102, MPLS VPN Label 0
      Extended Community: RT:2:2 MVPN AS:100:0.0.0.0 MVPN VRF:172.168.1.2:2
       ENCAP:8 Router MAC:AABB.CC80.6500
      Originator: 172.168.1.2, Cluster list: 172.168.2.1
      rx pathid: 0, tx pathid: 0x0
      Updated on Jul 7 2023 01:48:53 EST
```

Route Type	MAC, IP	Layer-3 VNI (“VRF”)	NH	Encap
5	Subnet_A/24	50001	IP_L1	8:VXLAN

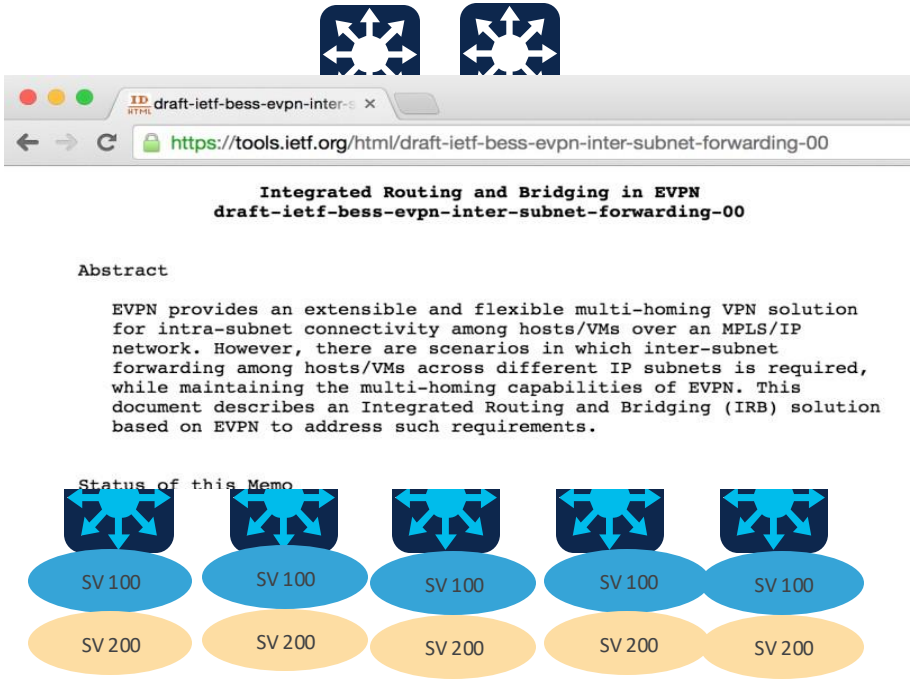


- Route Distinguisher – 8 byte
- Ethernet Segment ID – 10 byte
- Ethernet Tag ID – 4 byte
- IP Address Length – 1 byte
- IP Prefix – 4 or 16 byte
- GW IP address – 4 or 16 byte
- MPLS Label “3 byte, L3VNI

Integrated Routing and Bridging (IRB)

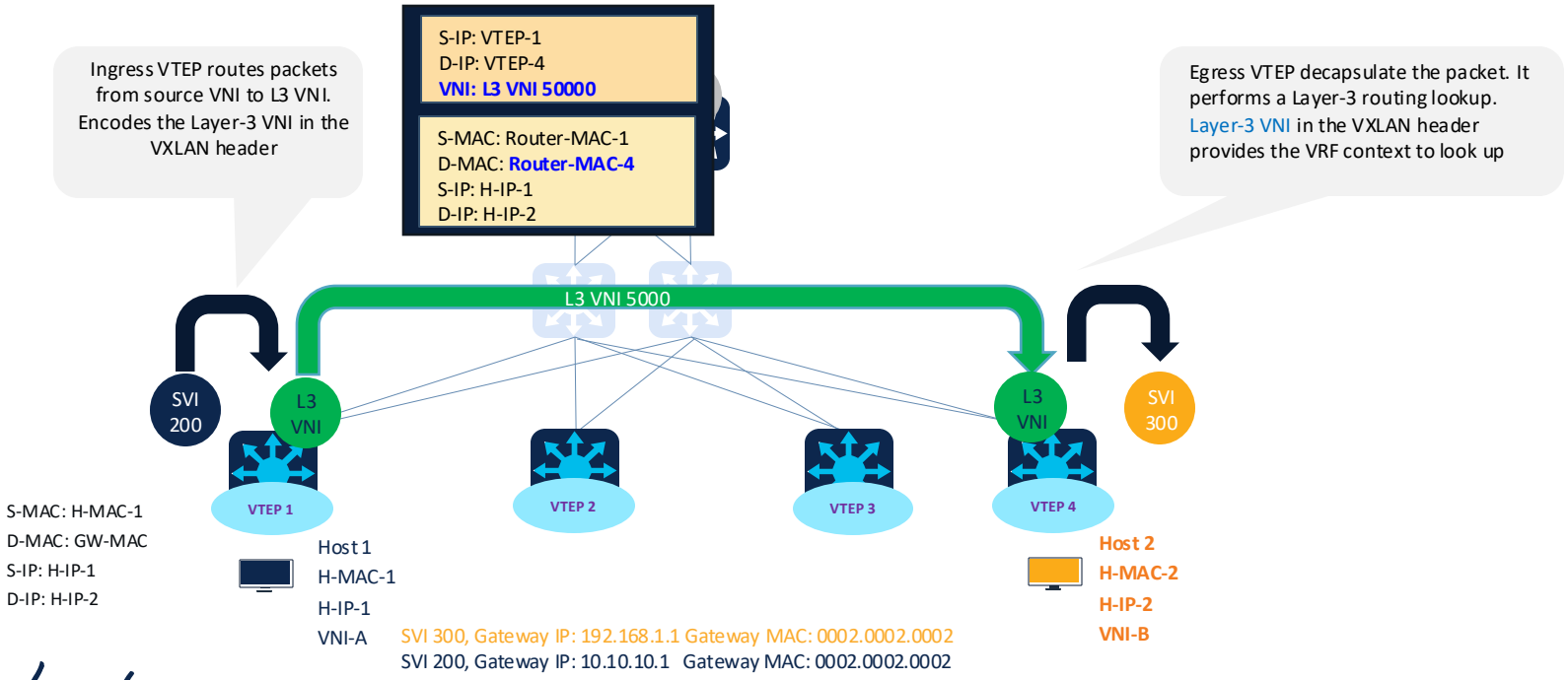
VXLAN/EVPN based overlays follow two slightly different Integrated Routing and Bridging (IRB) semantics

- Asymmetric
  - Uses an “asymmetric path” from the Host towards the egressing port of the VTEP vs. the way back
- Symmetric
  - Uses an “symmetric path” from the Host towards the egressing port of the VTEP vs. the way back

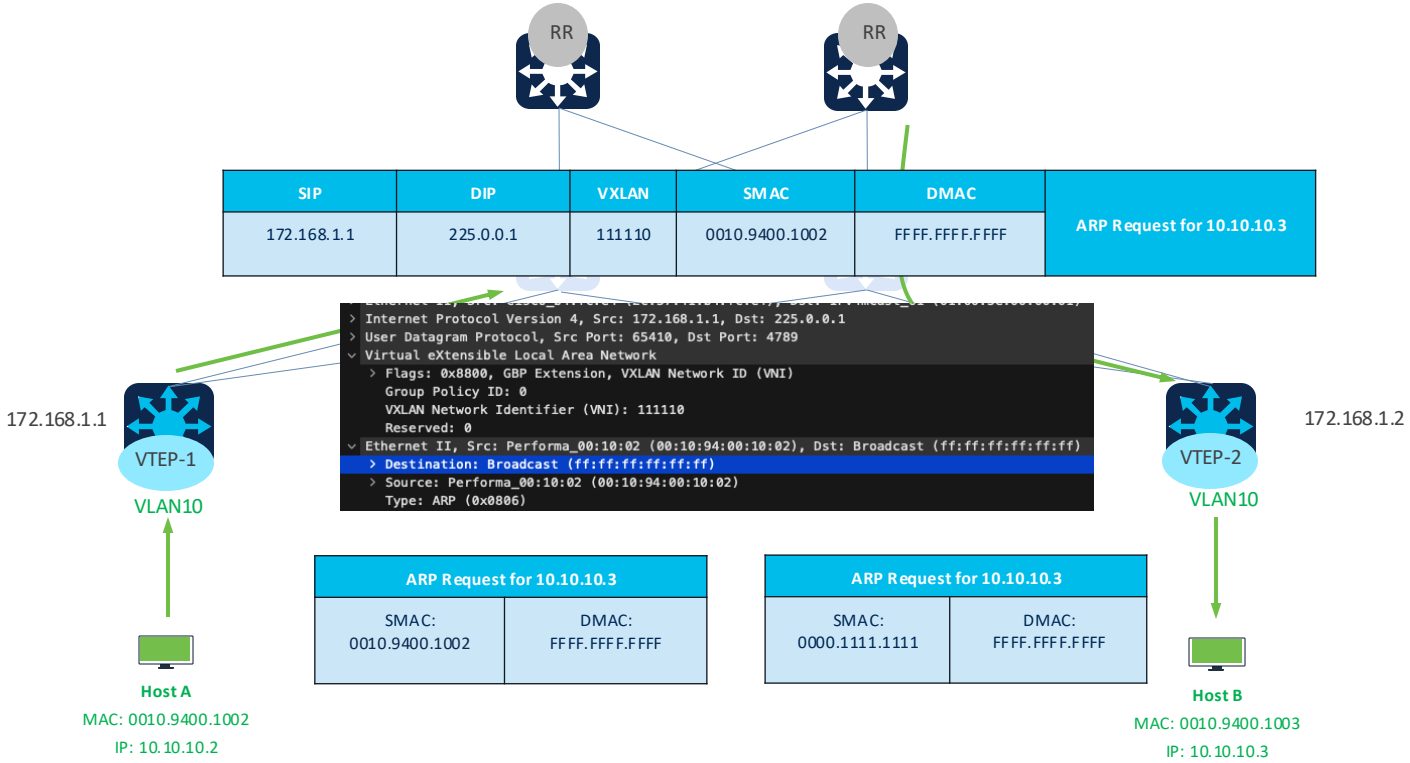


Symmetric IRB

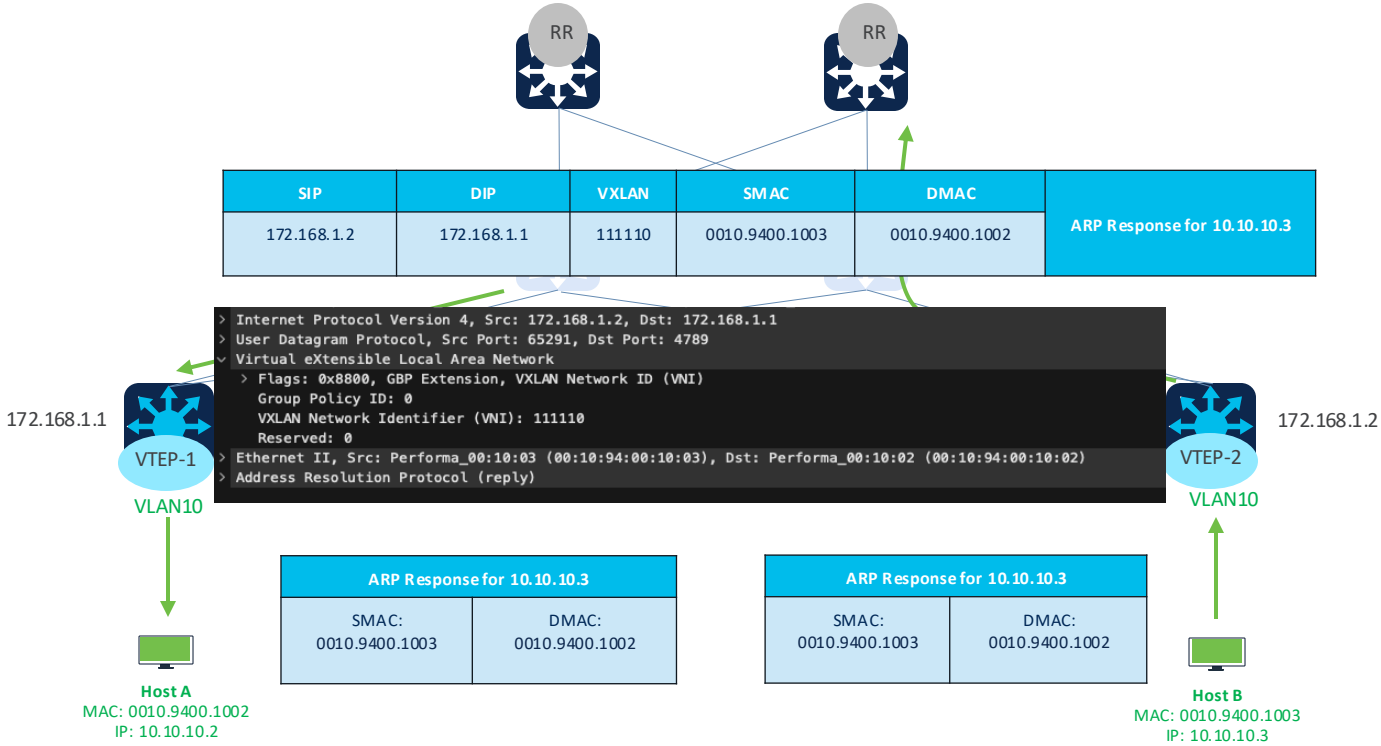
- Allows Scoped Configuration of VLAN/Layer-2 VNI (L2VNI) ; L2VNI only required where End-Points reside
- VNI (Layer-3 VNI) introduced per virtual routing and forwarding (VRF) context
- Routed traffic uses transit VNI (Layer-3 VNI)



Packet Walk – ARP Request



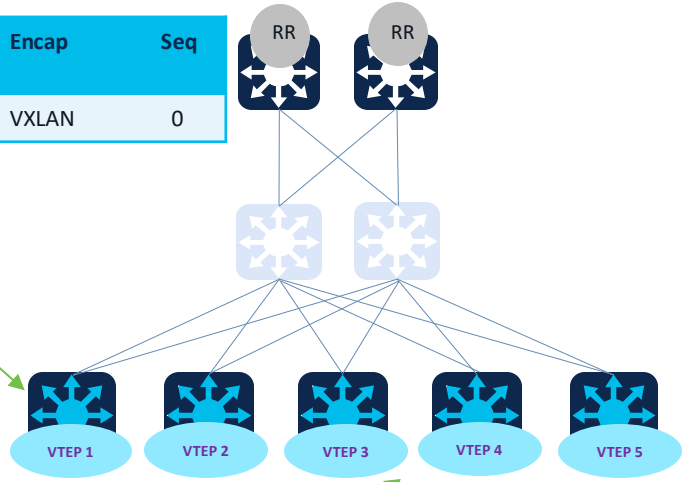
Packet Walk – ARP Response



EVPN Control Plane - ARP Suppression

Minimize Flood-&-learn behavior for host learning via ARP/ND Relay

Route Type	MAC, IP	VNI	NH	Encap	Seq
2	MAC_A, IP_A	30001	IP_L1	VXLAN	0



2

VTEP-1 receives and intercepts the ARP Request. Checks in its own host table.

If it has a match for IP-B, It will change the ethernet header broadcast address to the destination unicast address and will forward to the destination

3

VTEP-3 receives and intercepts the ARP Request. Checked in its own host table.

If it has an match for IP-B, It will respond with ARP reply by updating the mac-address in the ARP header

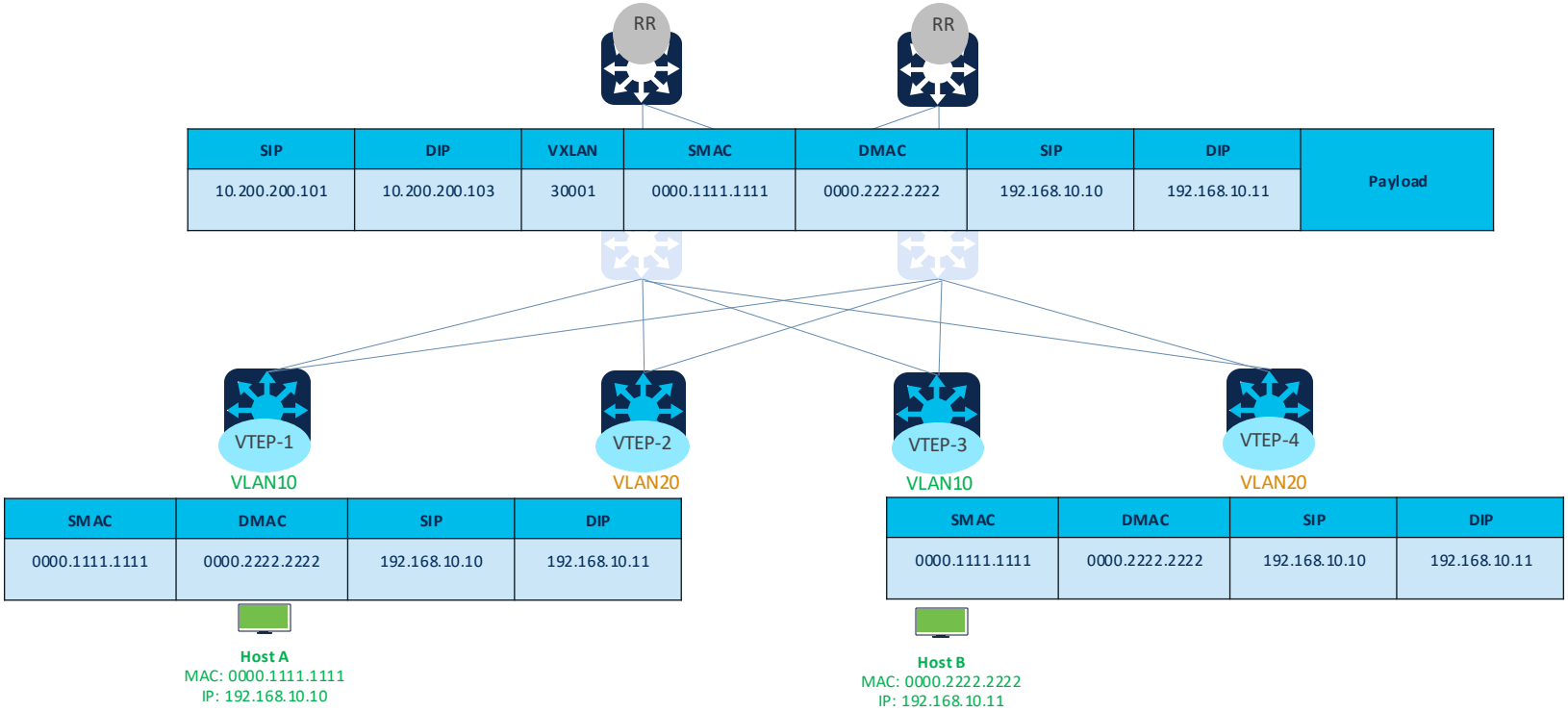
1

Host-A sends ARP request for IP-B

4

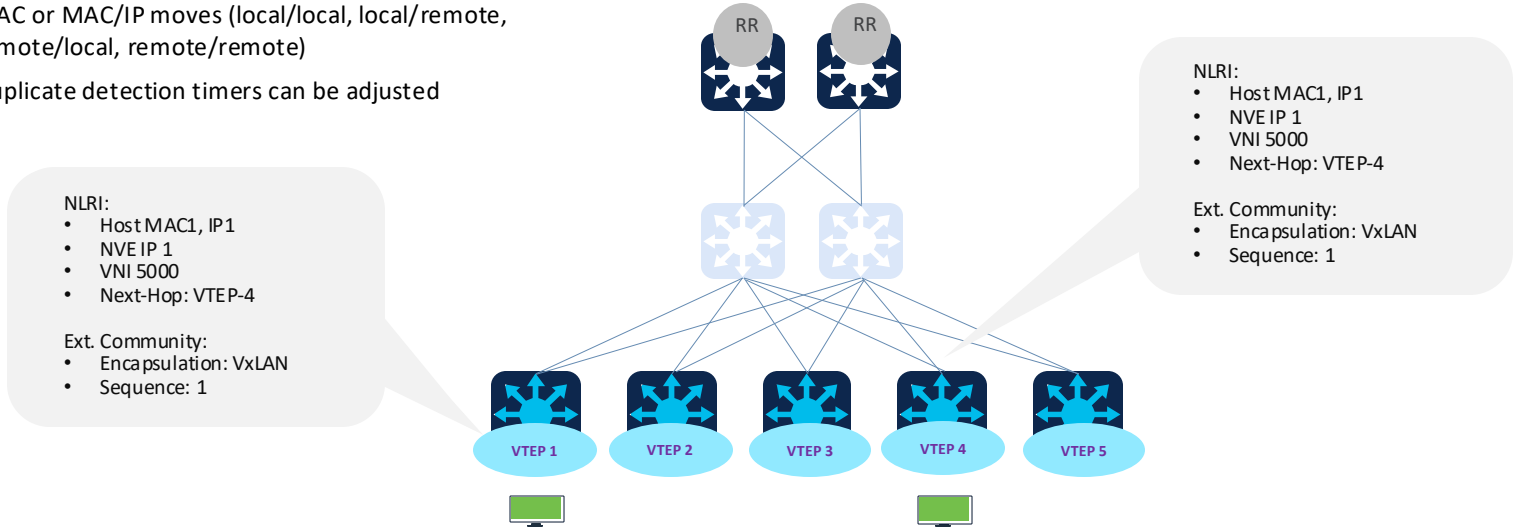
ARP response is received at the source and then traffic will be forwarded

Packet Walk – Bridging



EVPN Control Plane – Host Movement

- MAC or MAC/IP moves (local/local, local/remote, remote/local, remote/remote)
- Duplicate detection timers can be adjusted

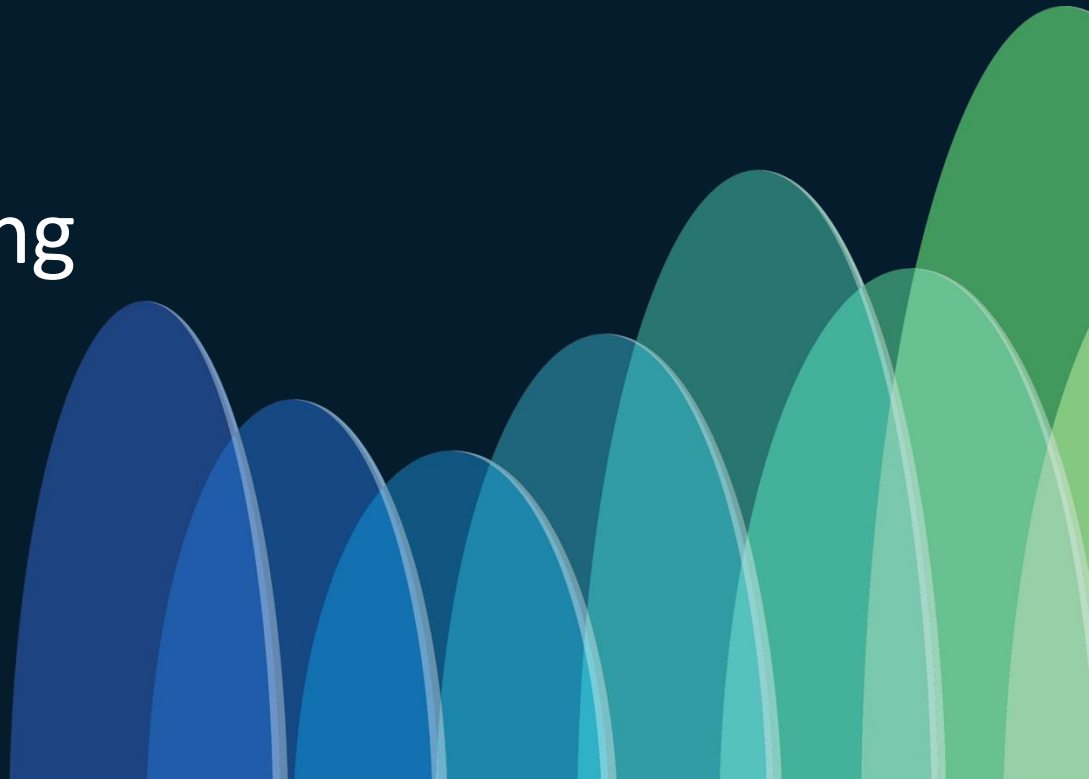


MAC	IP	VNI	Nex-Hop	Encap	Seq
MAC1	IP-1	5000	VTEP-4	VxLan	1

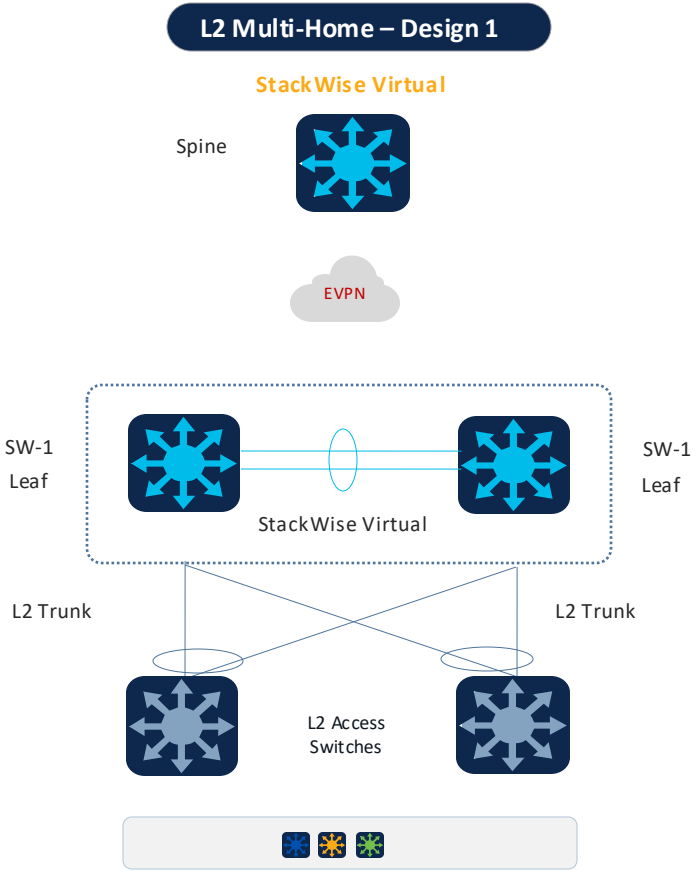
MAC	IP	VNI	Nex-Hop	Encap	Seq
MAC1	IP-1	5000	VTEP-4	VxLan	1

1. VTEP-1 detects Host1 and advertise an EVPN route for Host1 with Seq# 0
2. Host1 Moves behind VTEP-4
3. VTEP-4 detects Host1 and advertises an EVPN route for Host1 with Seq #1
4. VTEP-1 sees more recent route and withdraws its advertisement

EVPN Multi-Homing



EVPN Multi-Homing




```
SV-1(config)#stackwise-virtual
SV-1(config-stackwise-virtual)#domain 100
SV-1(config)#interface range fortyGigabitEthernet 1/0/23-24
SV-1(config-if-range)#stackwise-virtual link 1
SV-1(config)#interface fortyGigabitEthernet 1/0/12
SV-1(config-if)#stackwise-virtual dual-active-detection
```

Recommended

Industry's Best in Class Layer 2 Multi-Homing Solution

Active/Active per flow load-balancing

Simplified , Resilient and Proven

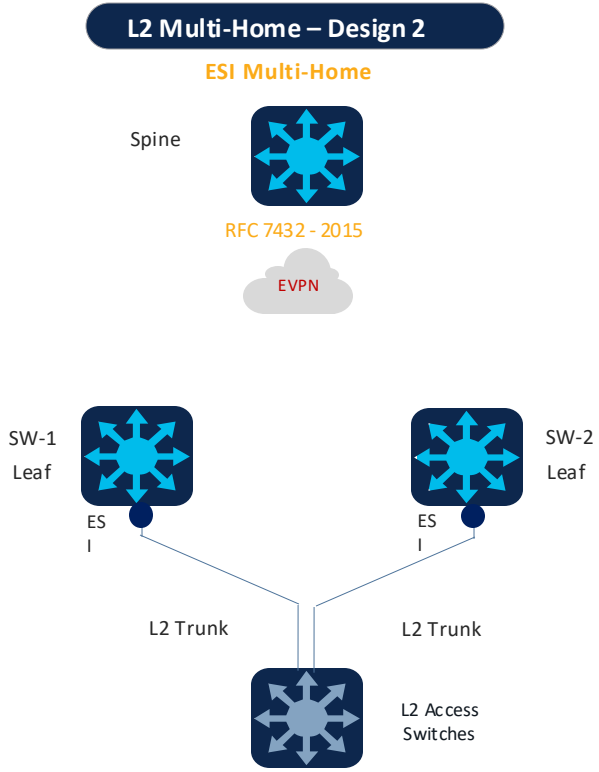
Single Control Pane | Distributed forwarding

Unified L2/L3 Control Plane

Inter-Chassis ISSU

EVPN Multi-Homing

Standards-based L2 Multi-homing



Alternative

Standards Based. No Ether-Channel Required

Single Active Redundancy

Per Vlan Auto Load-balancing (17.11)

Auto DF forwarder Selection

Co-existence with non EVPN Vlan’s

MP-BGP EVPN Route Type 4 – Ethernet Segment Route

- Ethernet Segment Routes are needed in multi-homing

```
Path Attribute - MP_REACH_NLRI
    Flags: 0x90, Optional, Length: Optional, Non-transitive, Complete, Extended Length
      1... .... = Optional: Optional
      .0.. .... = Transitive: Non-transitive
      ..0. .... = Partial: Complete
      ...1 .... = Length: Extended length
    Type Code: MP_REACH_NLRI (14)
    Length: 34
    Address family identifier (AFI): Layer-2 VPN (25)
    Subsequent address family identifier (SAFI): EVPN (70)
    Next hop network address (4 bytes)
    Number of Subnetwork points of attachment (SNPA): 0
    Network layer reachability information (25 bytes)
      EVPN NLRI: Ethernet Segment Route
        AFI: Ethernet Segment Route (4)
        Length: 23
        Route Distinguisher: 0001780002050000 (120.0.2.5:0)
        ESI: 00 00 00 00 00 00 10 00 00 05
          ESI Type: ESI 9 bytes value (0)
          ESI 9 bytes value: 00 00 00 00 00 00 10 00 00 05
        IP Address Length: 32
        IPv4 address: 120.0.2.5
```

NLRI = Network Layer Reachability Information

Route Distinguisher (8 octets)

Ethernet Segment Identifier (10 octets)

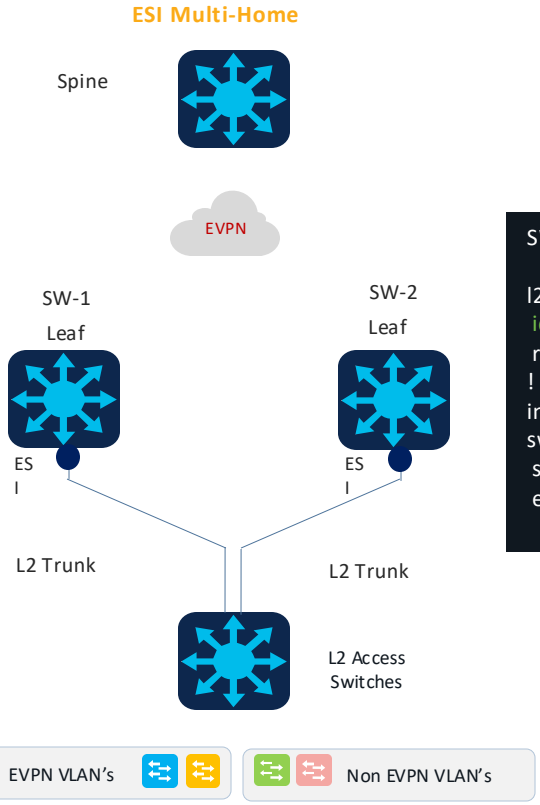
IP Address Length (1 octet)

Originating Device's IP Address (4 or 16 octets)

EVPN Multi-Homing

SW-1:

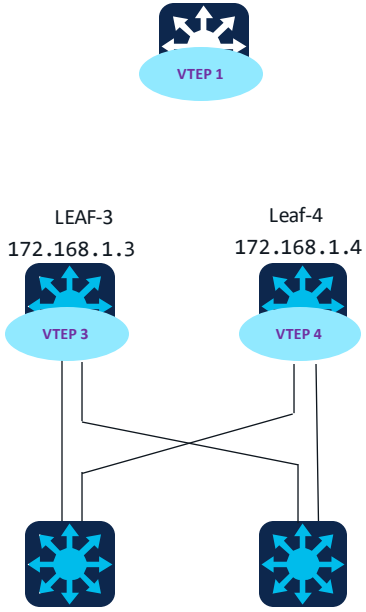
```
l2vpn evpn ethernet-segment 1
 identifier type 0 00.00.00.00.00.00.00.00.01
 redundancy single-active
!
interface GigabitEthernet1/0
switchport trunk allowed vlan 11,12
 switchport mode trunk
 evpn ethernet-segment 1
```



SW-2:

```
l2vpn evpn ethernet-segment 1
 identifier type 0 00.00.00.00.00.00.00.00.01
 redundancy single-active
!
interface GigabitEthernet1/0
switchport trunk allowed vlan 11,12
 switchport mode trunk
 evpn ethernet-segment 1
```

EVPN Multi-Homing - ESI




```
LEAF-3#show l2vpn evpn ethernet-segment detail
EVPN Ethernet Segment ID: 0000.0000.0000.0000.0001
  Interface:                Gi1/0/10
  Redundancy mode:          single-active
  DF election wait time:    1 seconds
  Split Horizon label:      0
  State:                    Ready
  Encapsulation:            vxlan
  Ordinal:                  0
  Core Isolation:           No
  RD:                       172.168.1.3:3
    Export-RTs:             100:20 100:21 100:30 200:200 210:210
                            300:300
  Forwarder List:           172.168.1.3 172.168.1.4
```

L2 Extension & L3 Segmentation Overlay Designs

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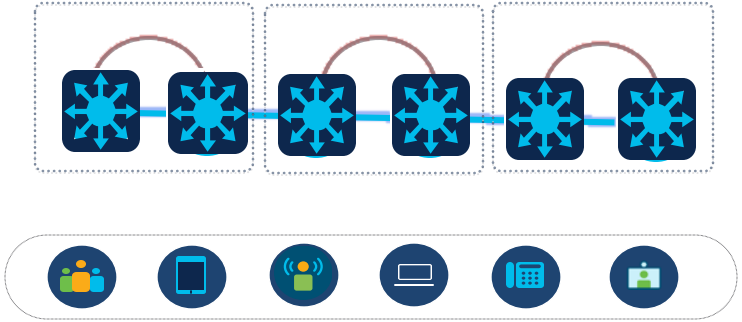
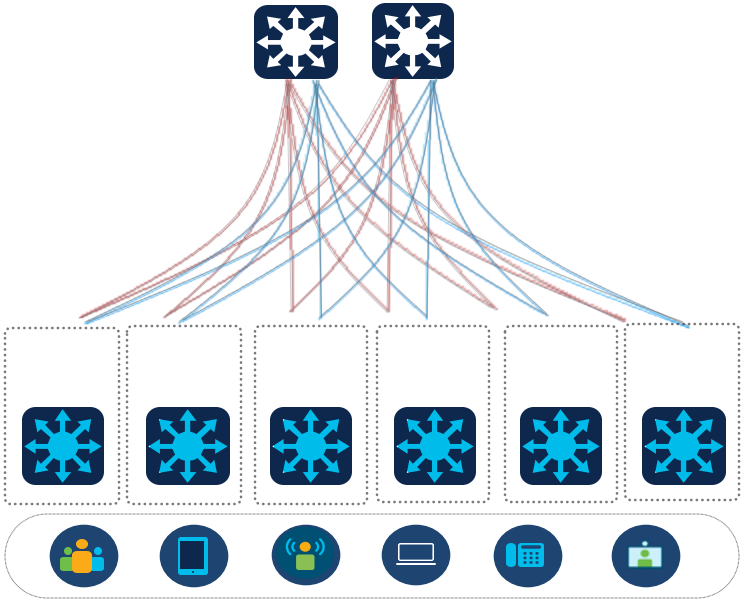
Flexible Routing and Bridging Overlay Topologies

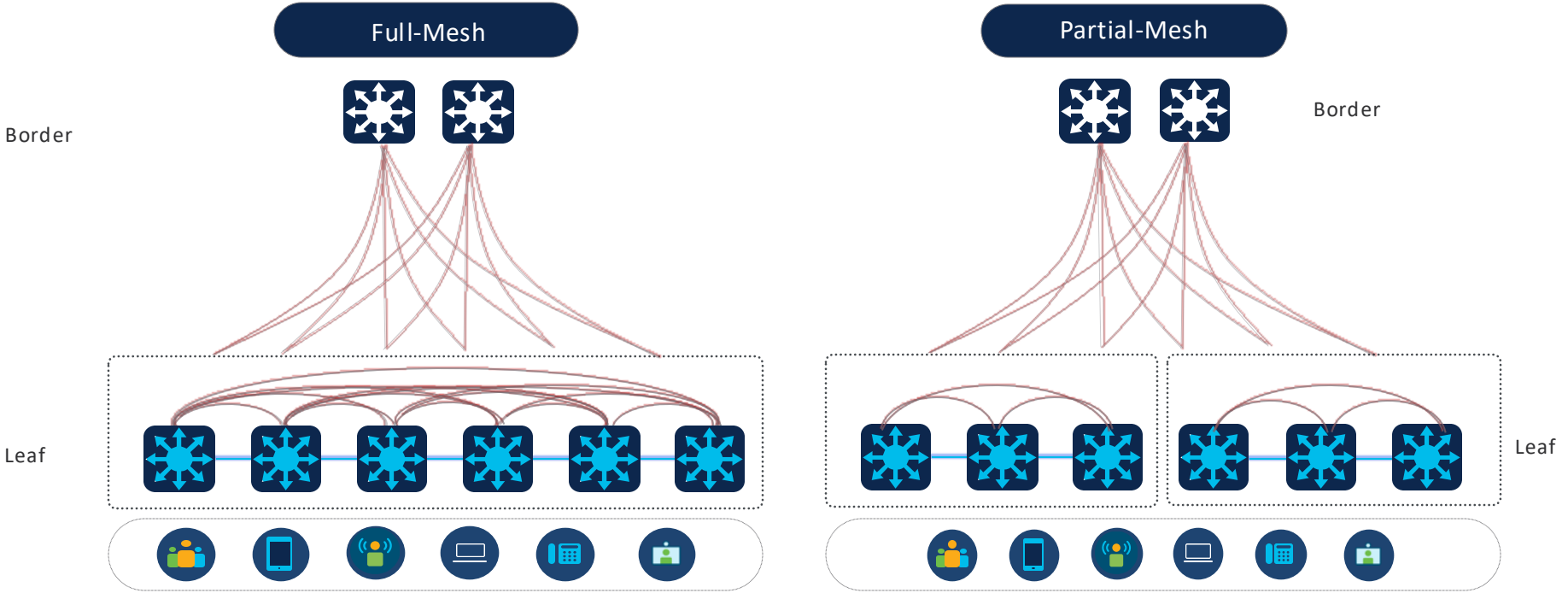
Point to Point



Hub & Spoke



Flexible Routing and Bridging Overlay Topologies

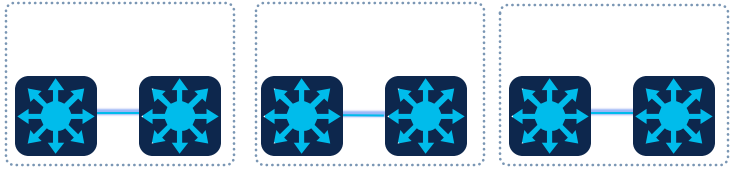


Segmentation Switch Group | Single Switch | VN | Subnet | VLAN | Port | App

Efficient Layer 2 Broadcast domain

Point-to-Point

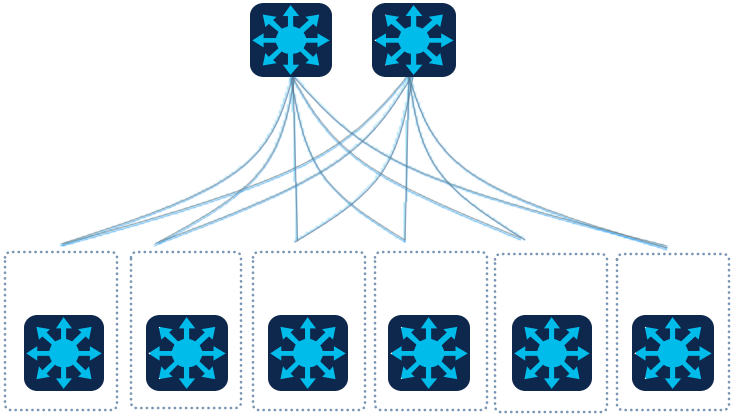
Leaf



VLAN	VNI	BUM
401	40001	Ingress Replication
402	40002	
403	40003	

Hub-n-Spoke

Border



Leaf

VLAN	VNI	BUM
301	30001	Ingress Replication
302	30002	
303	30003	

Scalable L2 BUM

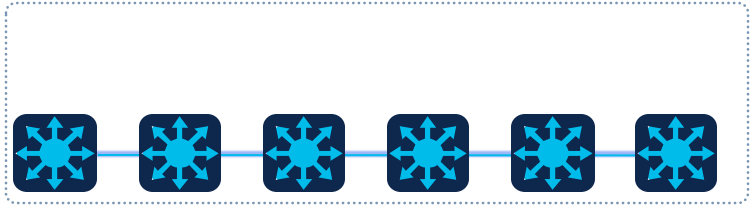
- Per L2VNI BUM replication-type support. Deterministic BUM traffic management with BUM Rate-Limiter
- BUM replication-type selection based on Layer 2 overlay topology
- Controlled Multicast BUM based on broadcast domain boundary (*n* x L2VNI ID : 1 Multicast Group)
- Simplified Ingress-Replication for point-to-point Layer 2 overlay fabric

L3 VXLAN Tunnel

L2 VXLAN Tunnel

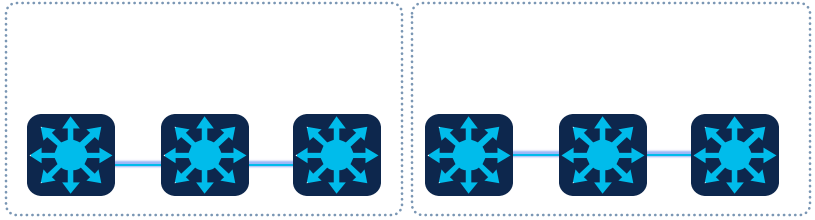
Efficient Layer 2 Broadcast domain

Full – Mesh



VLAN	VNI	BUM
101	10001	Multicast Group – 1
102	10002	
103	10003	

Partial – Mesh



VLAN	VNI	Group
201	20001	Multicast Group – 1
202	20002	
203	20003	

VLAN	VNI	BUM
201	20001	Multicast Group – 2
202	20002	
203	20003	

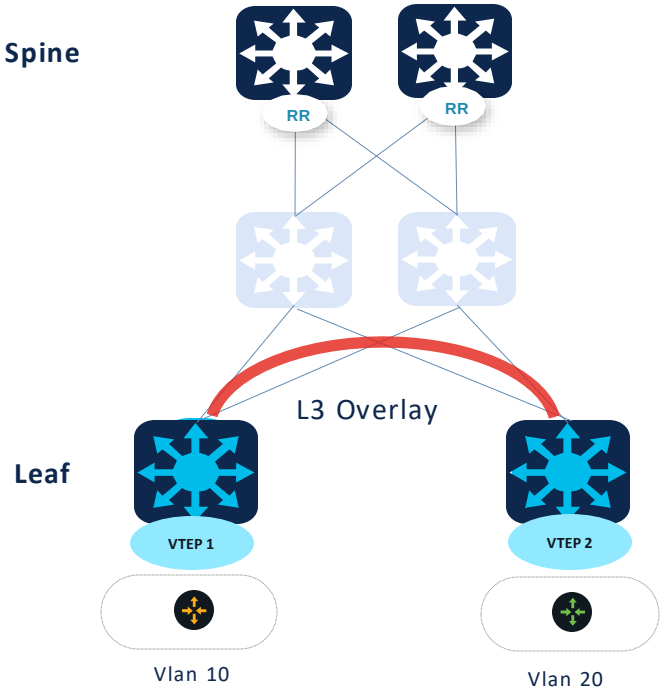
Scalable L2 BUM

- Per L2VNI BUM replication-type support. Deterministic BUM traffic management with BUM Rate-Limiter
- BUM replication-type selection based on Layer 2 overlay topology
- Controlled Multicast BUM based on broadcast domain boundary (*n* x L2VNI ID : 1 Multicast Group)
- Simplified Ingress-Replication for point-to-point Layer 2 overlay fabric

L3 VXLAN Tunnel

L2 VXLAN Tunnel

Layer 3 Only Overlay



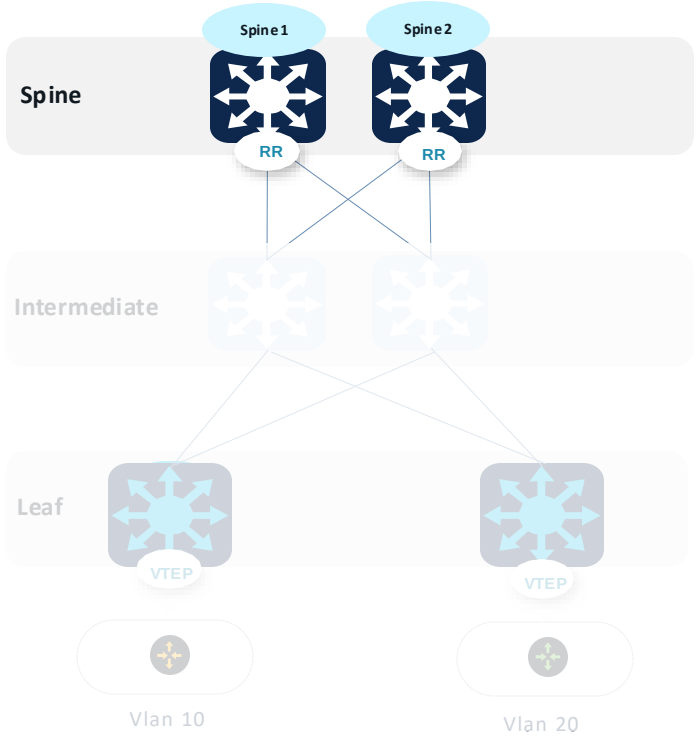
- **Use Case**: Flexible Layer 3 Routing
- Layer 3 overlay network allows host devices in different Layer 2 networks to send Layer 3 or routed traffic to each other
- The network forwards the routed traffic using a Layer 3 virtual network instance (VNI) and an IP VRF.
- Route first. Bridge when-and-where need rule for scalable fabric architecture.

Feature rich Layer 3 overlay network support – Unicast | Multicast – IPv4 | IPv6

Overlay Spine Configuration – BGP EVPN Control Plane

Spine-1

```
router bgp 64500
 neighbor 3.3.3.3 remote-as 64500
 neighbor 3.3.3.3 update-source Loopback0
 neighbor 4.4.4.4 remote-as 64500
 neighbor 4.4.4.4 update-source Loopback0
!
 address-family l2vpn evpn
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community both
  neighbor 3.3.3.3 route-reflector-client
  neighbor 4.4.4.4 activate
  neighbor 4.4.4.4 send-community both
  neighbor 4.4.4.4 route-reflector-client
  maximum-paths 2
```



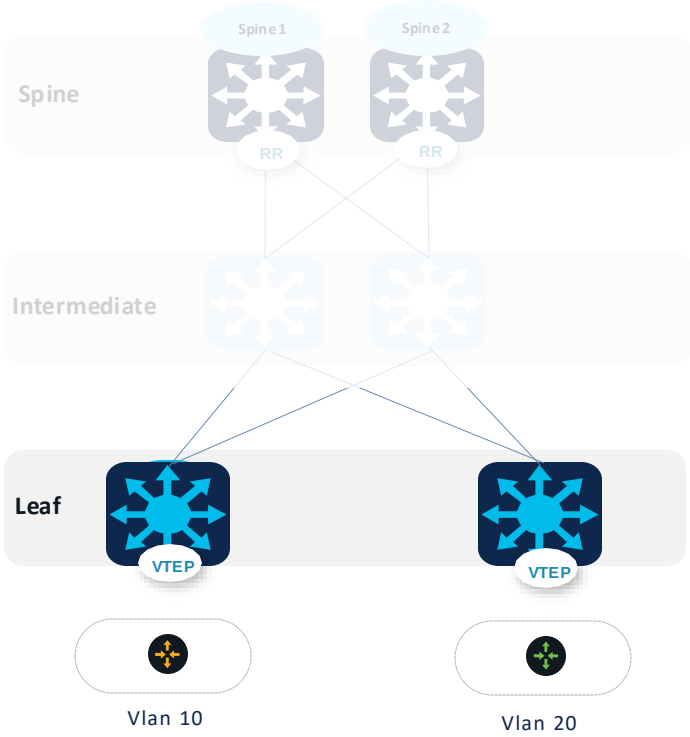
Spine-2

```
router bgp 64500
 neighbor 3.3.3.3 remote-as 64500
 neighbor 3.3.3.3 update-source Loopback0
 neighbor 4.4.4.4 remote-as 64500
 neighbor 4.4.4.4 update-source Loopback0
!
 address-family l2vpn evpn
  neighbor 3.3.3.3 activate
  neighbor 3.3.3.3 send-community both
  neighbor 3.3.3.3 route-reflector-client
  neighbor 4.4.4.4 activate
  neighbor 4.4.4.4 send-community both
  neighbor 4.4.4.4 route-reflector-client
  maximum-paths 2
```

Overlay Leaf Configuration – BGP EVPN Control Plane

Leaf-1

```
router bgp 65000
 neighbor 1.1.1.1 remote-as 64500
 neighbor 1.1.1.1 update-source Loopback0
 neighbor 2.2.2.2 remote-as 64500
 neighbor 2.2.2.2 update-source Loopback0
 !
 address-family l2vpn evpn
  neighbor 1.1.1.1 activate
  neighbor 1.1.1.1 send-community both
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community both
 exit-address-family
```



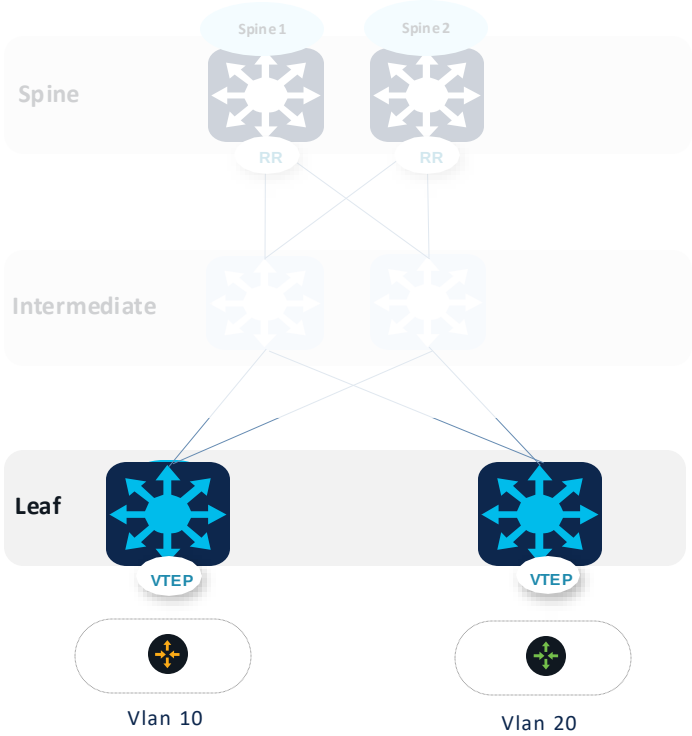
Leaf-2

```
router bgp 65000
 neighbor 1.1.1.1 remote-as 64500
 neighbor 1.1.1.1 update-source Loopback0
 neighbor 2.2.2.2 remote-as 64500
 neighbor 2.2.2.2 update-source Loopback0
 !
 address-family l2vpn evpn
  neighbor 1.1.1.1 activate
  neighbor 1.1.1.1 send-community both
  neighbor 2.2.2.2 activate
  neighbor 2.2.2.2 send-community both
 exit-address-family
```

VRF Configuration

Leaf-1

```
vrf definition S1-EVPN
 rd 1:1
 !
 address-family ipv4
 route-target 1:1 stitching
 exit-address-family
!
router bgp 64500
!
 address-family ipv4 vrf S1-EVPN
  advertise l2vpn evpn
  redistribute connected
 exit-address-family
```



Leaf-2

```
vrf definition S1-EVPN
 rd 2:2
 !
 address-family ipv4
 route-target 1:1 stitching
 exit-address-family
!
router bgp 64500
!
 address-family ipv4 vrf S1-EVPN
  advertise l2vpn evpn
  redistribute connected
 exit-address-family
```

Layer 3 Overlay Routing Configuration-L3VNI

Leaf-1

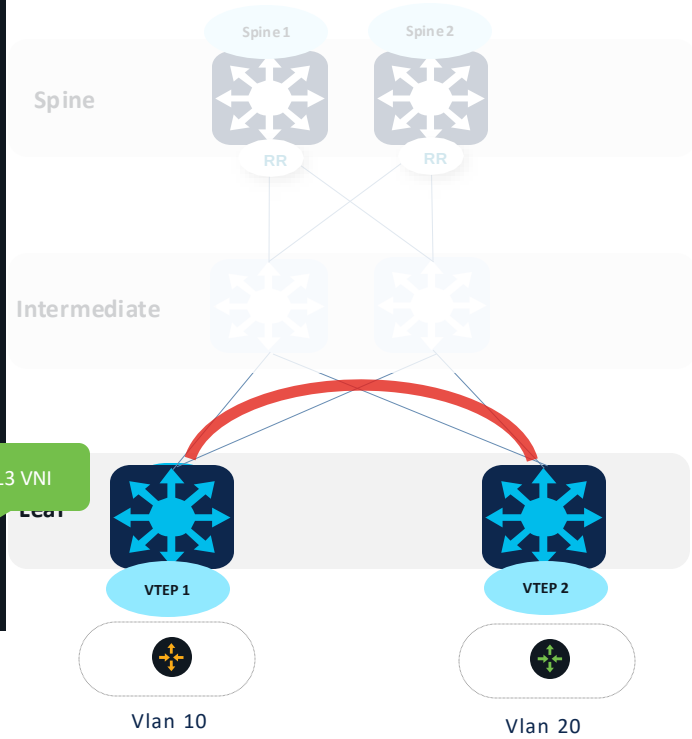
L3 VNI

```
vlan configuration 102
 member vni 50901
!
interface Vlan102
 vrf forwarding S1-EVPN
 ip unnumbered Loopback0
!
int vlan 10
vrf forwarding VRF-A
ip add 10.10.10.1 255.255.255.0
!
interface nve1
 no ip address
 source-interface Loopback0
 host-reachability protocol bgp
 member vni 50901 vrf S1-EVPN
```

Core Interface

Edge Vlan

L3 VNI



Leaf-2

L3 VNI

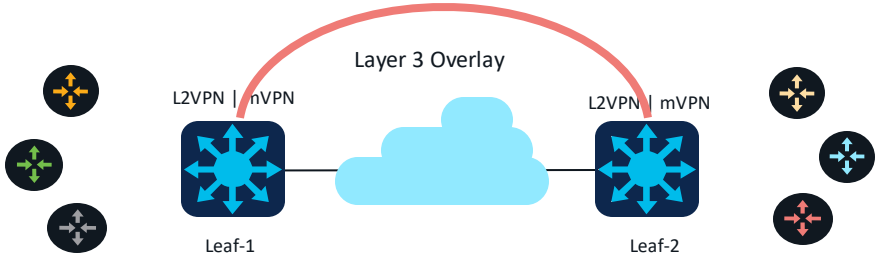
```
vlan configuration 102
 member vni 50901
!
interface Vlan102
 vrf forwarding S1-EVPN
 ip unnumbered Loopback0
!
int vlan 20
vrf forwarding VRF-A
ip add 20.20.20.1 255.255.255.0
!
interface nve1
 no ip address
 source-interface Loopback0
 host-reachability protocol bgp
 member vni 50901 vrf S1-EVPN
```

Core Interface

Edge Vlan

L3 VNI

Point-Point Topology



Leaf-1

```
vrf definition S1-EVPN
 rd 1:1
 !
 address-family ipv4
  route-target 1:1 stitching
exit-address-family
```

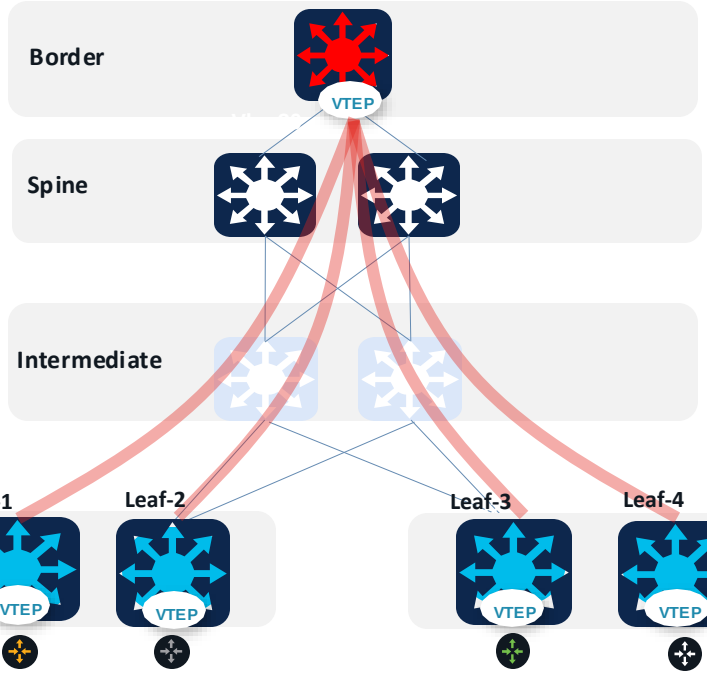
Leaf-2

```
vrf definition S1-EVPN
 rd 2:2
 !
 address-family ipv4
  route-target 1:1 stitching
exit-address-family
```

Overlay Network Design- Hub-n-Spoke

Border:

```
vrf definition S1-EVPN
 rd 1:1
 !
address-family ipv4
route-target export 1:1 stitching
route-target import 2:2 stitching
exit-address-family
```



Leaf-1-Spoke:

```
vrf definition S1-EVPN
 rd 2:2
 !
 address-family ipv4
  route-target import 1:1 stitching
  route-target export 2:2 stitching
exit-address-family
```

Leaf-2-Spoke:

```
vrf definition S1-EVPN
 rd 3:3
 !
 address-family ipv4
  route-target import 1:1 stitching
  route-target export 2:2 stitching
  exit-address-family
```

Leaf-3-Spoke:

```
vrf definition S1-EVPN
 rd 4:4
 !
 address-family ipv4
  route-target import 1:1 stitching
  route-target export 2:2 stitching
exit-address-family
```

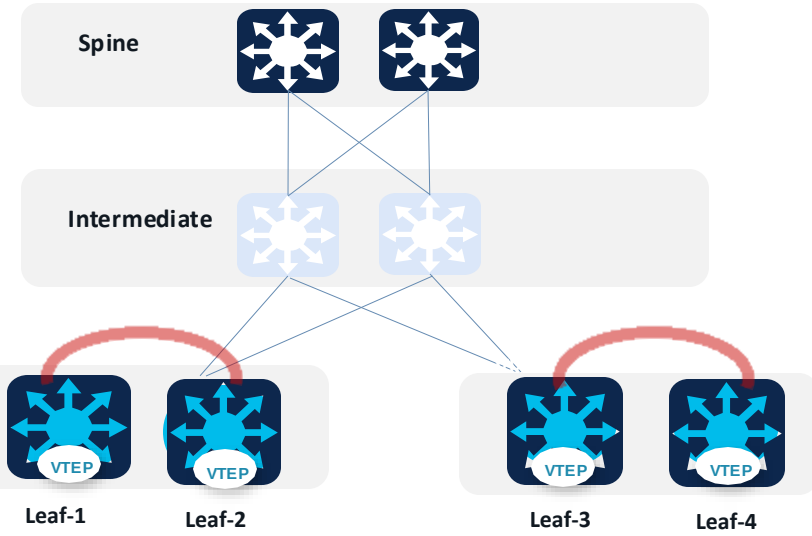
Leaf-4-Spoke:

```
vrf definition S1-EVPN
 rd 5:5
 !
 address-family ipv4
 route-target import 1:1 stitching
 route-target export 2:2 stitching
 exit-address-family
```

Overlay Network Design- Partial Mesh

Leaf-1
```
vrf definition S1-EVPN
 rd 2:2
 !
 address-family ipv4
  route-target import 1:1 stitching
 exit-address-family
```

Leaf-2
```
vrf definition S1-EVPN
 rd 3:3
 !
 address-family ipv4
  route-target import 1:1 stitching
exit-address-family
```



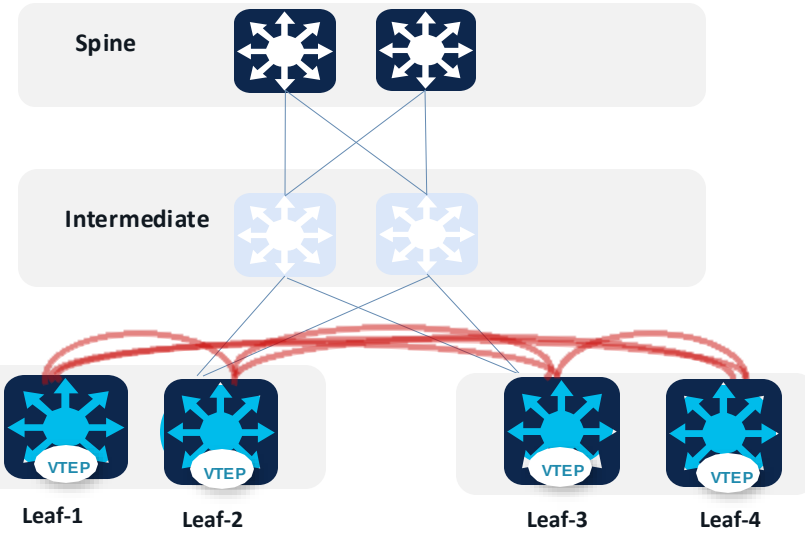
Leaf-3
```
vrf definition S1-EVPN
 rd 4:4
 !
 address-family ipv4
  route-target import 2:2 stitching
exit-address-family
```

Leaf-4
```
vrf definition S1-EVPN
 rd 5:5
 !
 address-family ipv4
  route-target import 2:2 stitching
exit-address-family
```

Overlay Network Design- Full Mesh

Leaf-1
```
vrf definition S1-EVPN
 rd 2:2
 !
 address-family ipv4
  route-target import 1:1 stitching
 exit-address-family
```

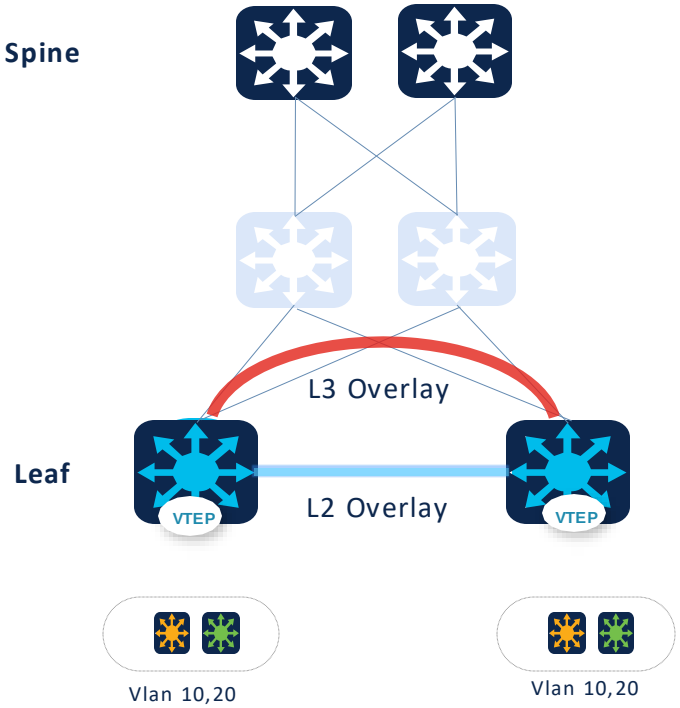
Leaf-2
```
vrf definition S1-EVPN
 rd 3:3
 !
 address-family ipv4
  route-target import 1:1 stitching
exit-address-family
```



Leaf-3
```
vrf definition S1-EVPN
 rd 4:4
 !
 address-family ipv4
  route-target import 1:1 stitching
exit-address-family
```

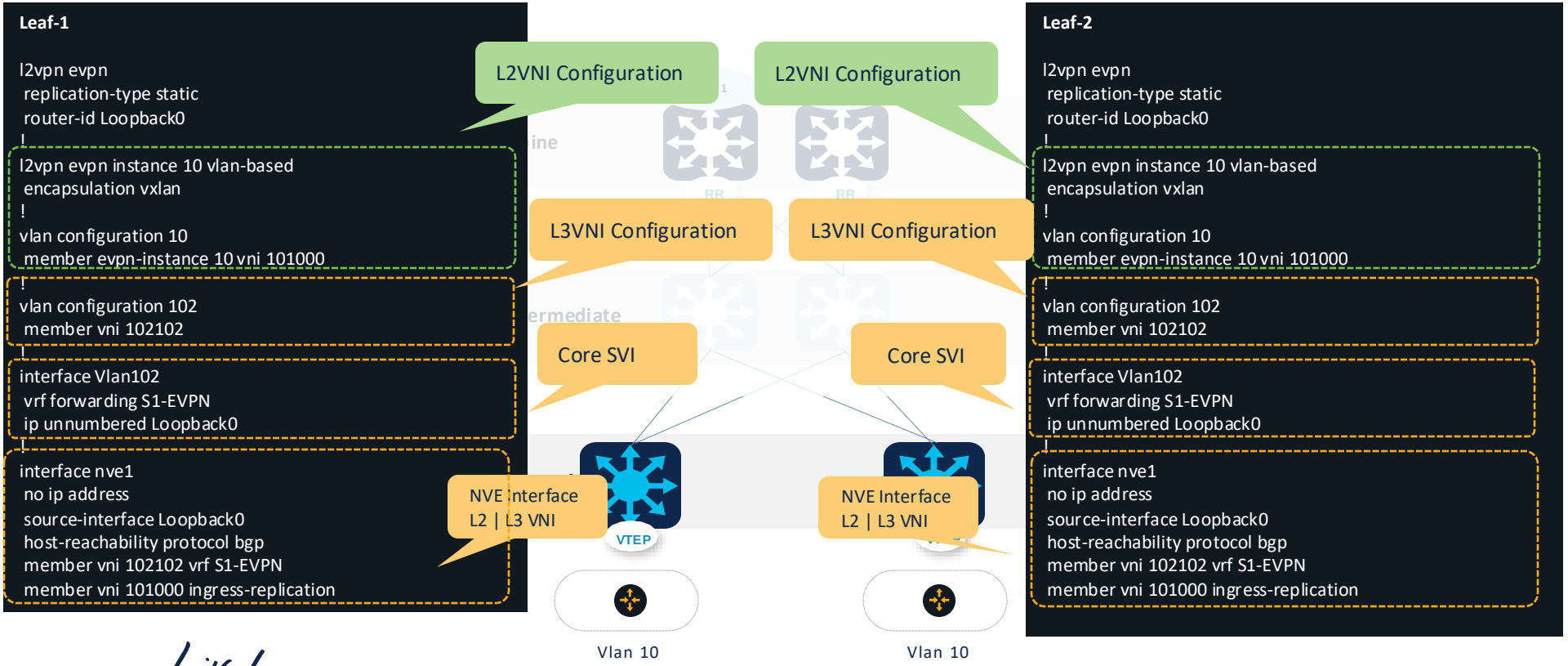
Leaf-4
```
vrf definition S1-EVPN
 rd 5:5
 !
 address-family ipv4
  route-target import 1:1 stitching
exit-address-family
```

Distributed Anycast Gateway



- **Use Case**: Seamless Routing/bridging with Distributed Anycast gateway
- The same anycast gateway virtual IP address and MAC address are configured on all VTEPs.
- Gateway is always active
  - no redundancy protocol, hello exchange etc.
- Combination of Layer 2 and Layer 3 Vxlan tunnels for seamless Migration.
- The feature allows flexible workload placement, host mobility, and optimal traffic forwarding across the BGP EVPN VXLAN fabric.

Distributed Anycast Gateway

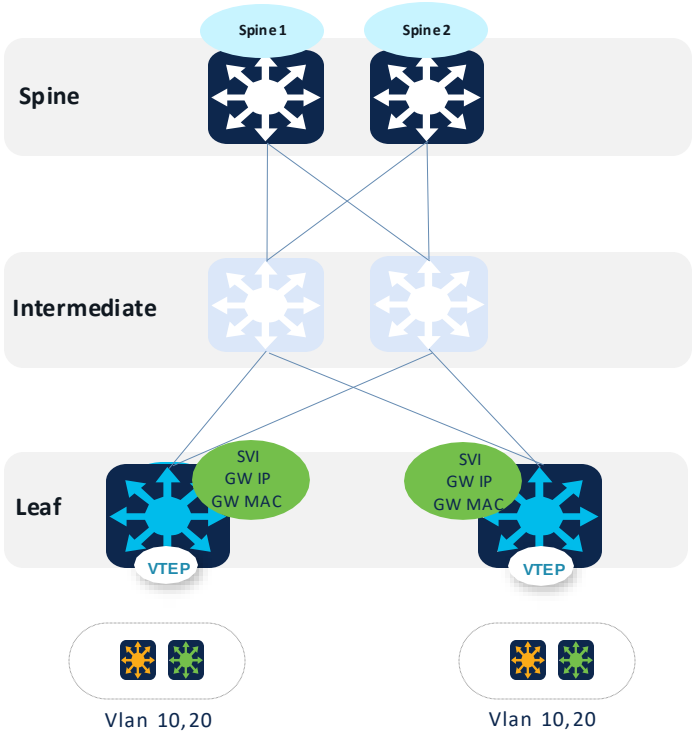


Distributed Anycast Gateway

Leaf-1

interface Vlan10
mac-address 0001.0001.0001
vrf forwarding S1-EVPN
ip address 10.10.10.1 255.255.255.0

interface Vlan20
mac-address 0002.0002.0002
vrf forwarding S1-EVPN
ip address 20.20.20.1 255.255.255.0



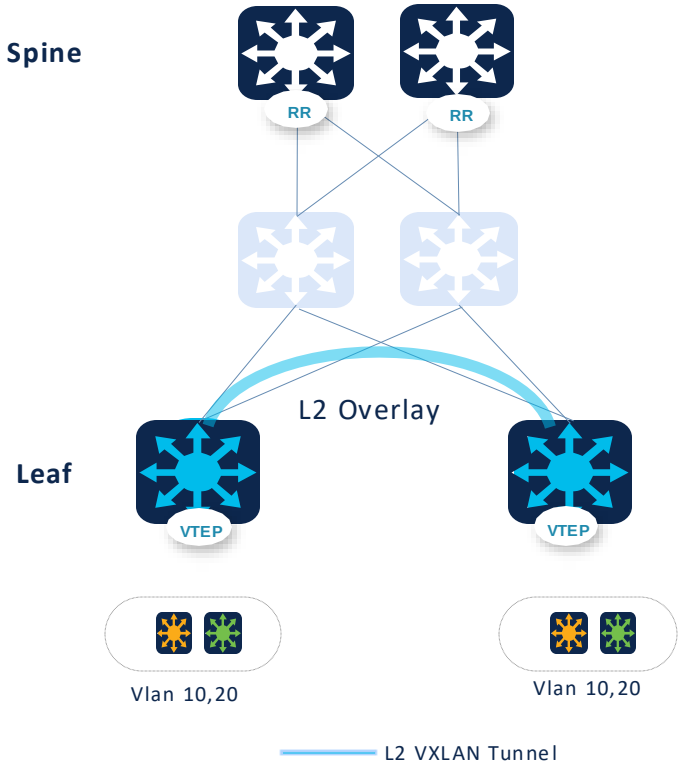
Leaf-2

interface Vlan10
mac-address 0001.0001.0001
vrf forwarding S1-EVPN
ip address 10.10.10.1 255.255.255.0

interface Vlan20
mac-address 0002.0002.0002
vrf forwarding S1-EVPN
ip address 20.20.20.1 255.255.255.0

Same Anycast Gateway Virtual IP address and MAC address on all VTEPs

Layer 2 Overlay Bridging

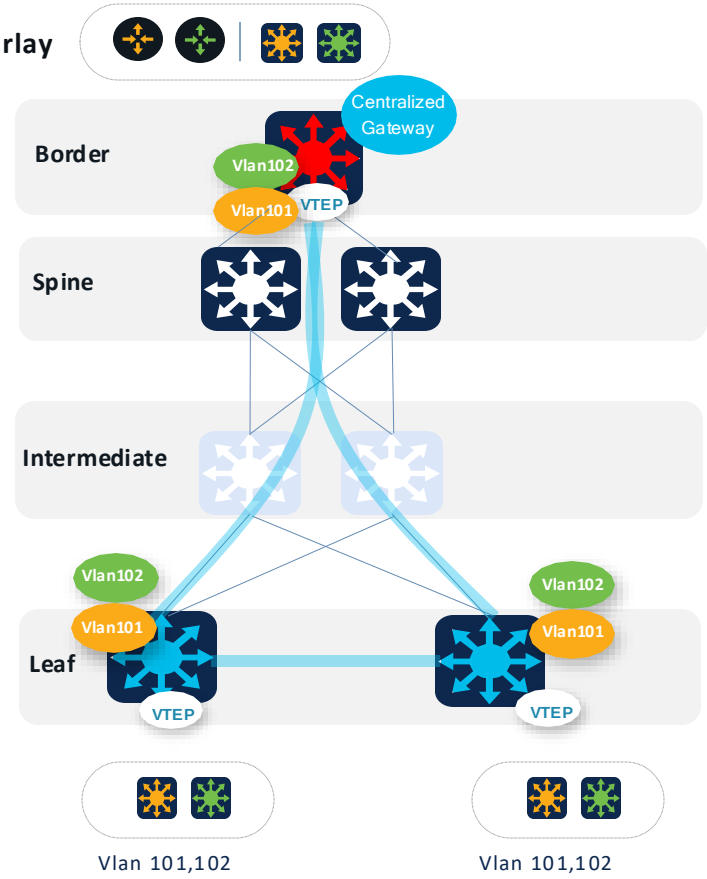


- **Use Case**: Layer 2 VLAN Extension
- VTEP Functions are on leaf/Border nodes
- Spine nodes don't need to be VTEP
- Scalable Layer 2 overlay solution with suppression, flood management.
- The network forwards the bridged traffic using a Layer 2 virtual network instance (VNI).

Centralized Gateway

Inter-Subnet Traffic routed through Centralized Gateway

Intra-Subnet Traffic Bridged through Layer 2 VNI




```
l2vpn evpn instance 101 vlan-based
 encapsulation vxlan
 replication-type ingress
 default-gateway advertise enable
!
l2vpn evpn instance 102 vlan-based
 encapsulation vxlan
 replication-type ingress
 default-gateway advertise enable
!
vlan configuration 101
member evpn-instance 101 vni 10101
vlan configuration 102
member evpn-instance 102 vni 10102
```

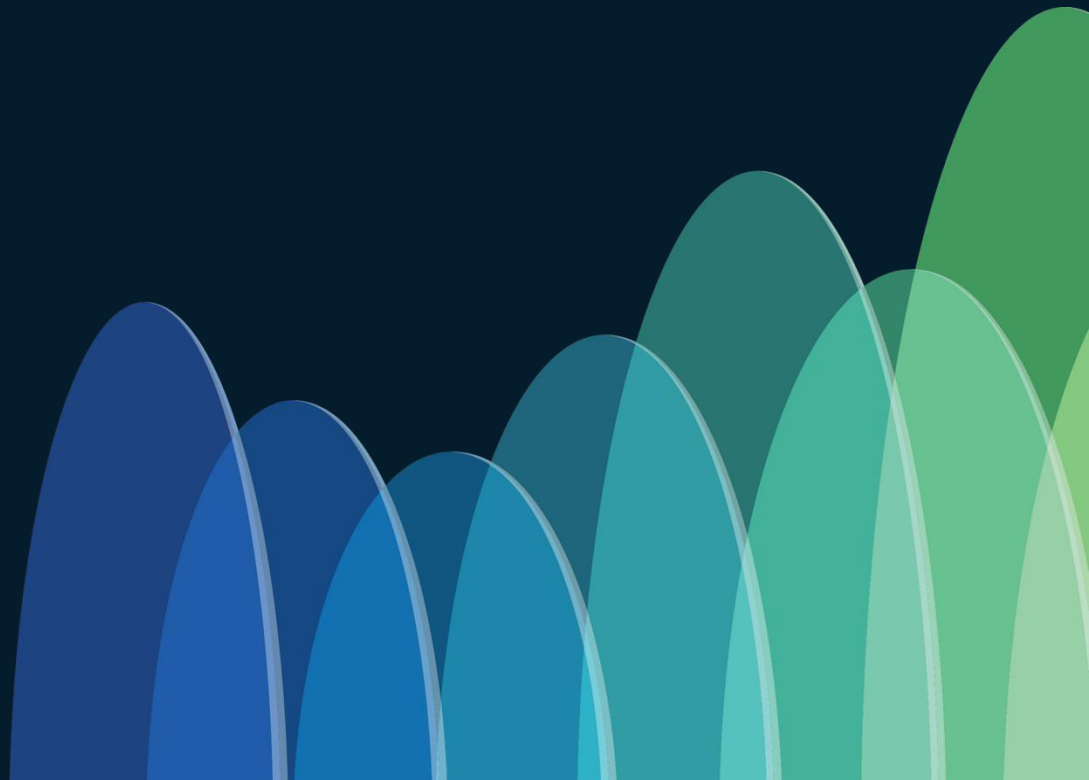
```
interface Vlan101
vrf forwarding green
ip address 10.1.101.1 255.255.255.0
!
interface Vlan102
vrf forwarding green
ip address 10.1.102.1 255.255.255.0
```

```
interface nve1
no ip address
source-interface Loopback0
host-reachability protocol bgp
member vni 10101 mcast-group 225.0.0.101
member vni 10102 ingress-replication
!
```

Continuation …

- BGP EVPN Design Options
- Building a Secure Fabric
- Multicast in Vxlan BGP EVPN Fabric
- Handoff Options
- Fabric Deployment Options

BGP EVPN Fabric Architecture



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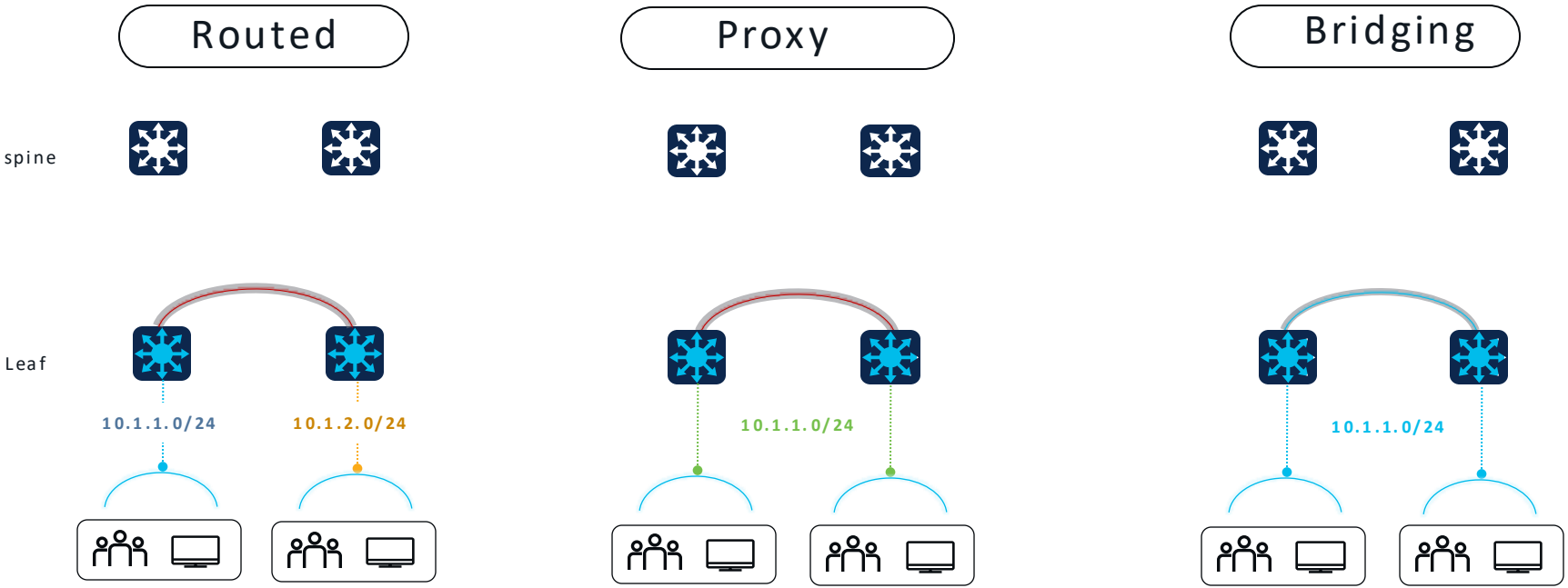
Scalable Fabric Overlays



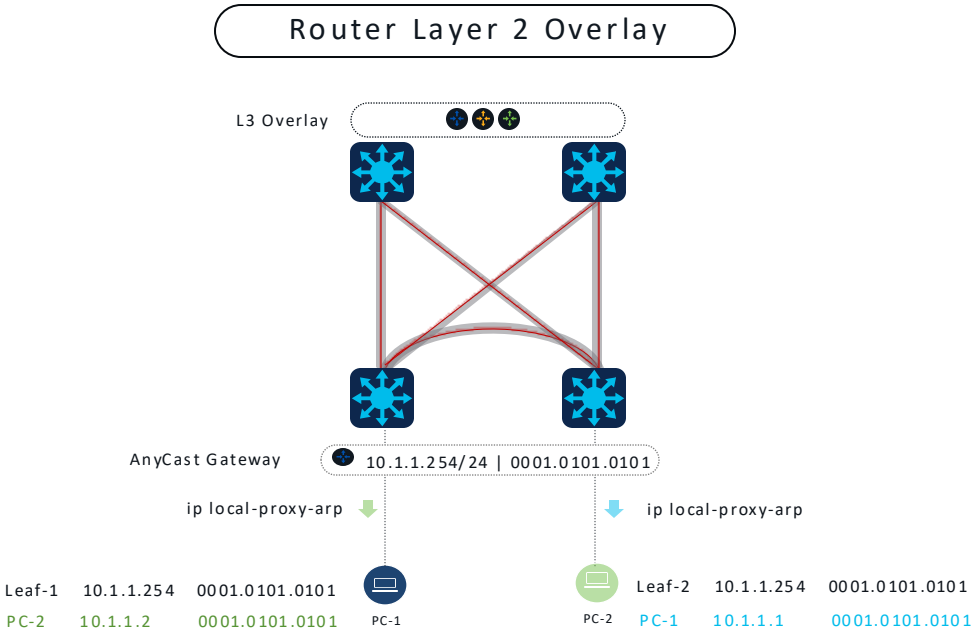
Scalable Routing & Bridging Options

- Route first. Bridge only when-and-where for scalable fabric architecture
- Network stretch using IPv4/IPv6 Proxy without extending Layer 2 flood boundaries
- Flexible Routed and Proxy Overlays in Single or Multi-Cluster hierarchical fabric
- Extend selective Vlan to support non-IP end point communication over Fabric with Bridging

L3 Vxlan tunnel

L2 Vxlan tunnel

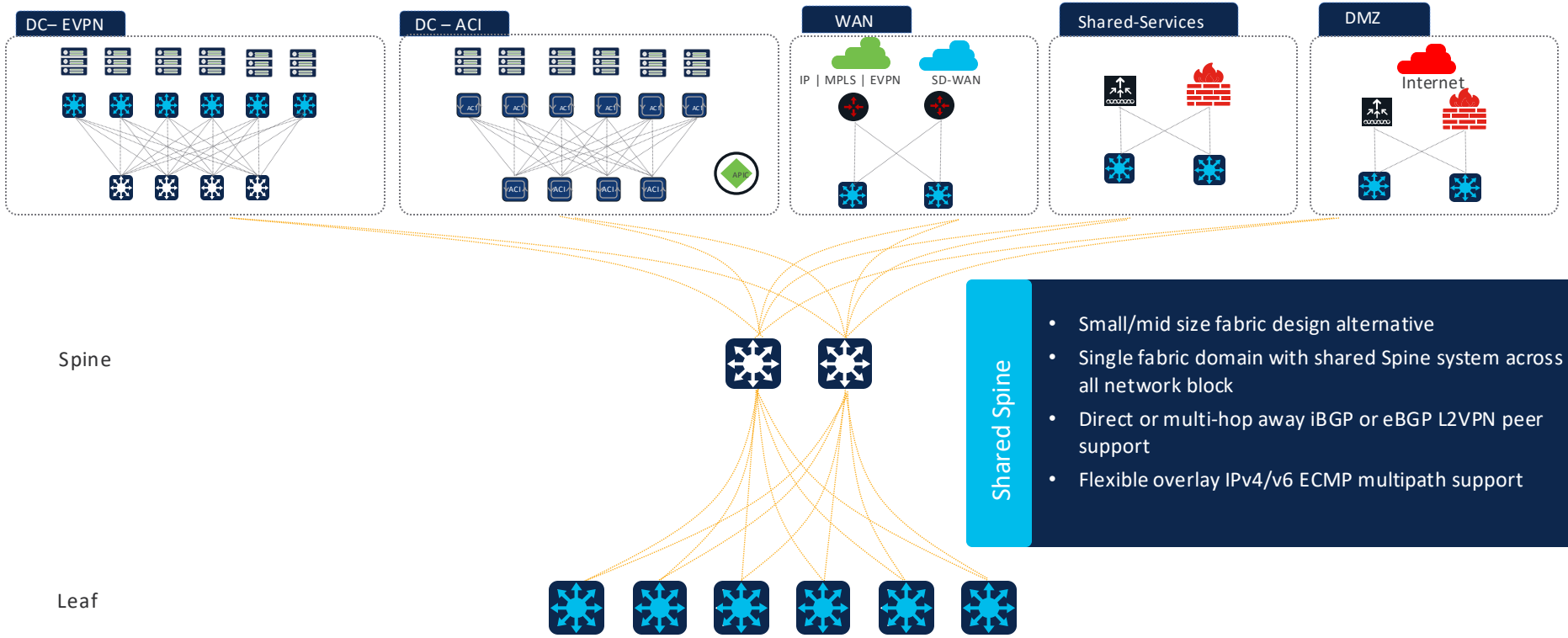
Proxy – Layer 2 without flooding



Routed Layer 2

- Layer 2 network stretch without Layer 2 overlay extensions (Bridging)
- Manual override building dynamic Layer 2 VXLAN tunnel peer across fabric
- Dynamic local host discovery and MAC/IP (RT-2) prefix advertisement following IP VRF routing policy
- Local proxy function for remote IPv4 ARP and IPv6 ND discovery Leaf local AnyCast MAC address

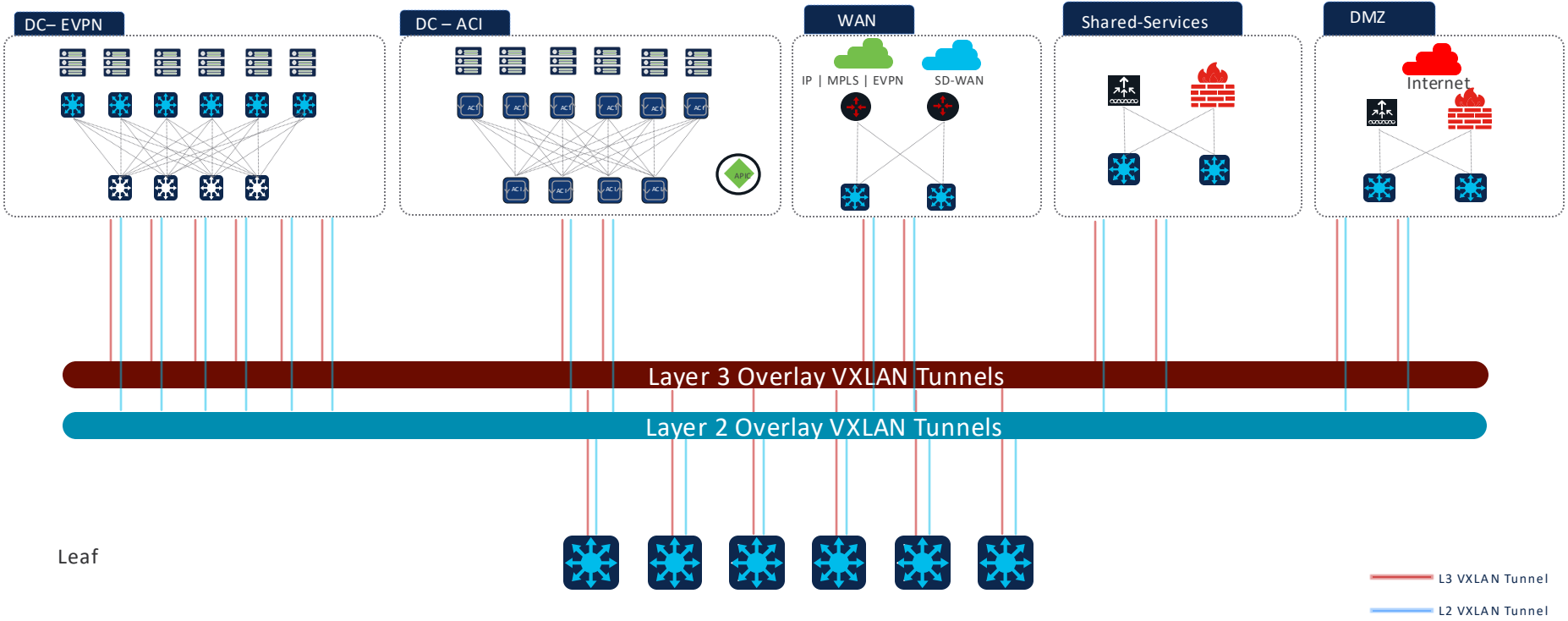
Single Cluster Fabric Architecture



Shared Spine

- Small/mid size fabric design alternative
- Single fabric domain with shared Spine system across all network block
- Direct or multi-hop away iBGP or eBGP L2VPN peer support
- Flexible overlay IPv4/v6 ECMP multipath support

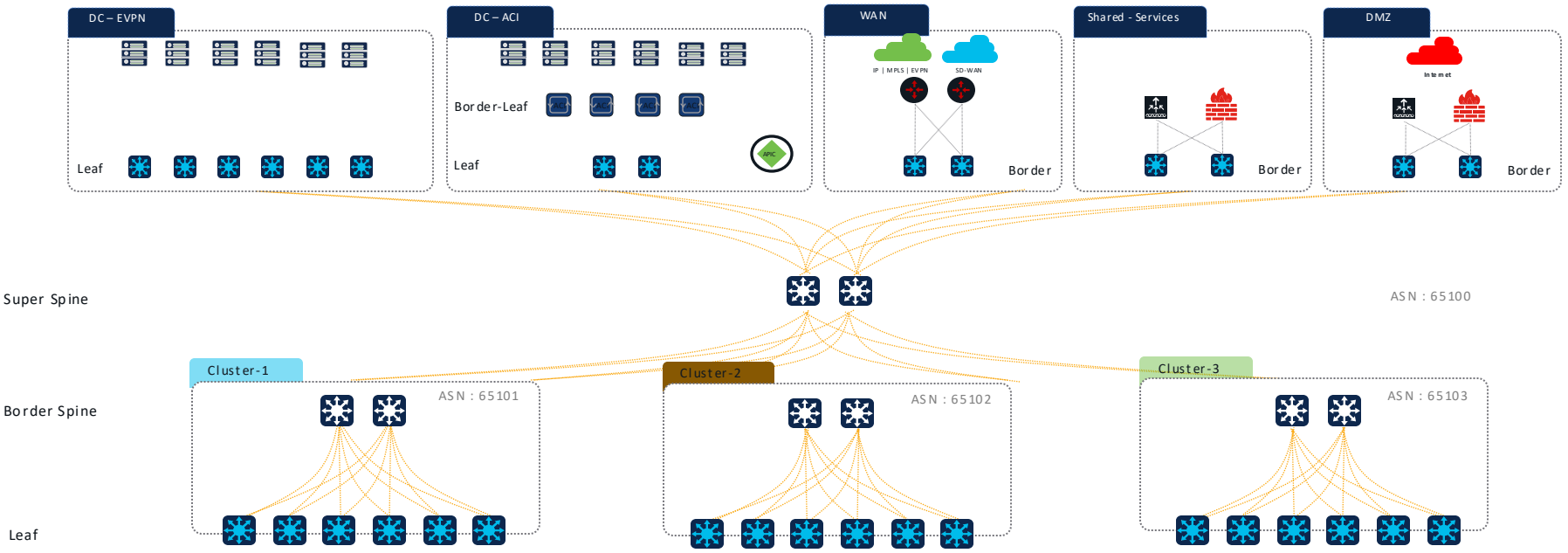
Non-Hierarchical Fabric Design



Non-Hierarchical Fabric

- Non-hierarchical dynamic overlay VXLAN tunnels
- Layer 2 / 3 overlay topologies based on route-target policies
- Linear VN & Leaf growth may impact overall fabric domain scale
- Limited Layer 2 flood control support

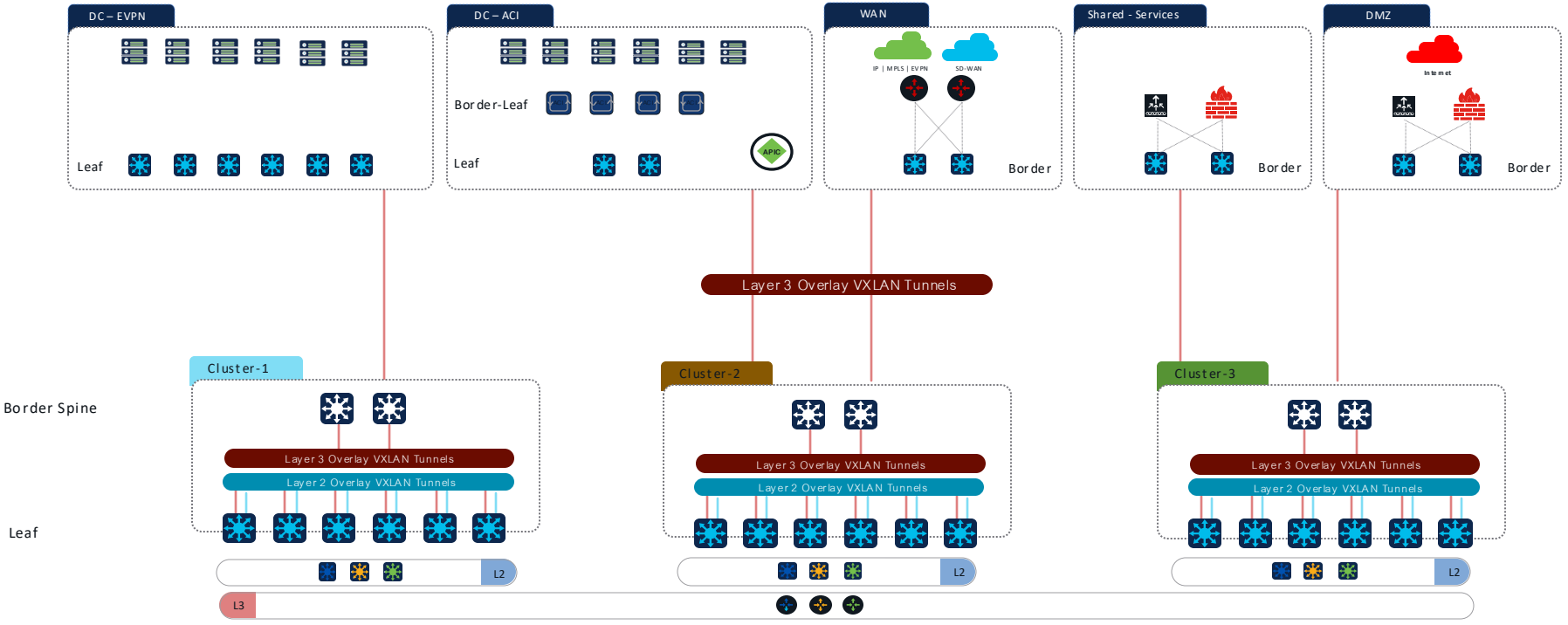
Multi Cluster Fabric Architecture



Distributed Spine

- Mid to large size fabric design alternative
- Reduce fault-domain with distributed RR & RRC clusters for high scale fabric
- Structured fabric control-plane architecture between distributed Spine and Super-Spine
- Optimized fabric and system scale, performance and resiliency

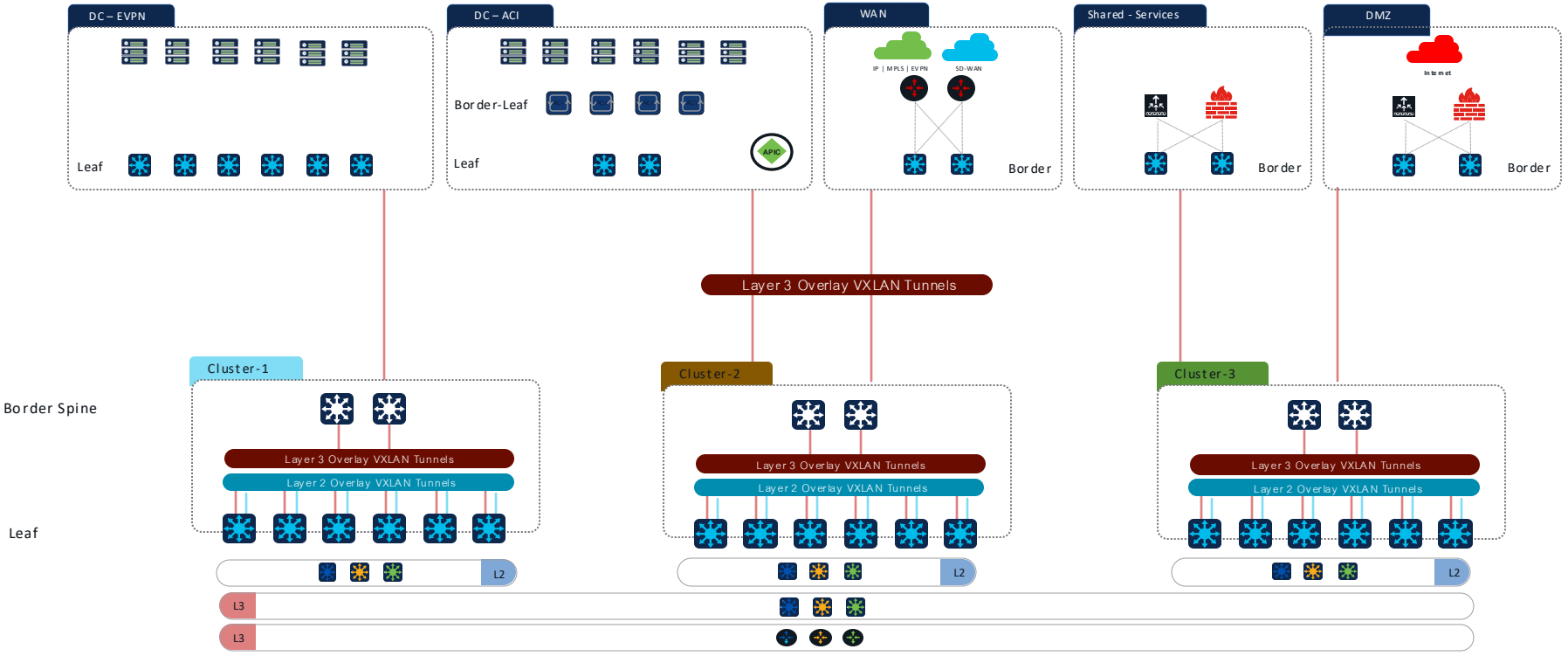
Scalable Multi Cluster Fabric Architecture



Scalable Fabric Cluster

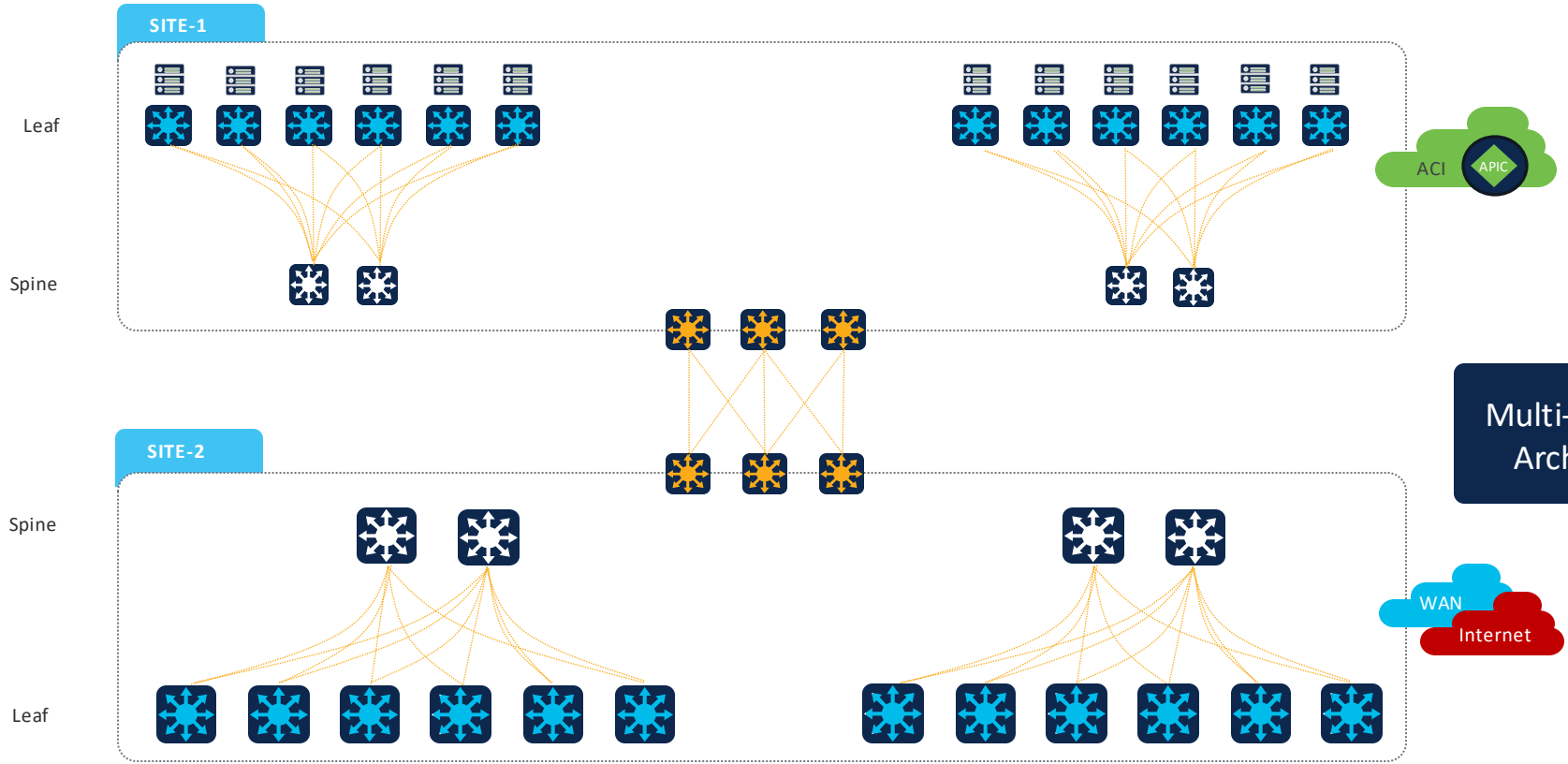
- Increase fabric domain scale with hierarchical dynamic overlay VXLAN tunnels per fabric cluster
- Consistent Layer 2 domain scale size as traditional non-fabric networks
- Scalable overlay routing with per-VN prefix summarization and re-origination by each Border Spine cluster
- End-to-End Unicast IPv4/IPv6 support for Layer 2/3 overlay. Multicast overlay limited per cluster

Scalable Multi Cluster Fabric Architecture



Routed Core Fabric

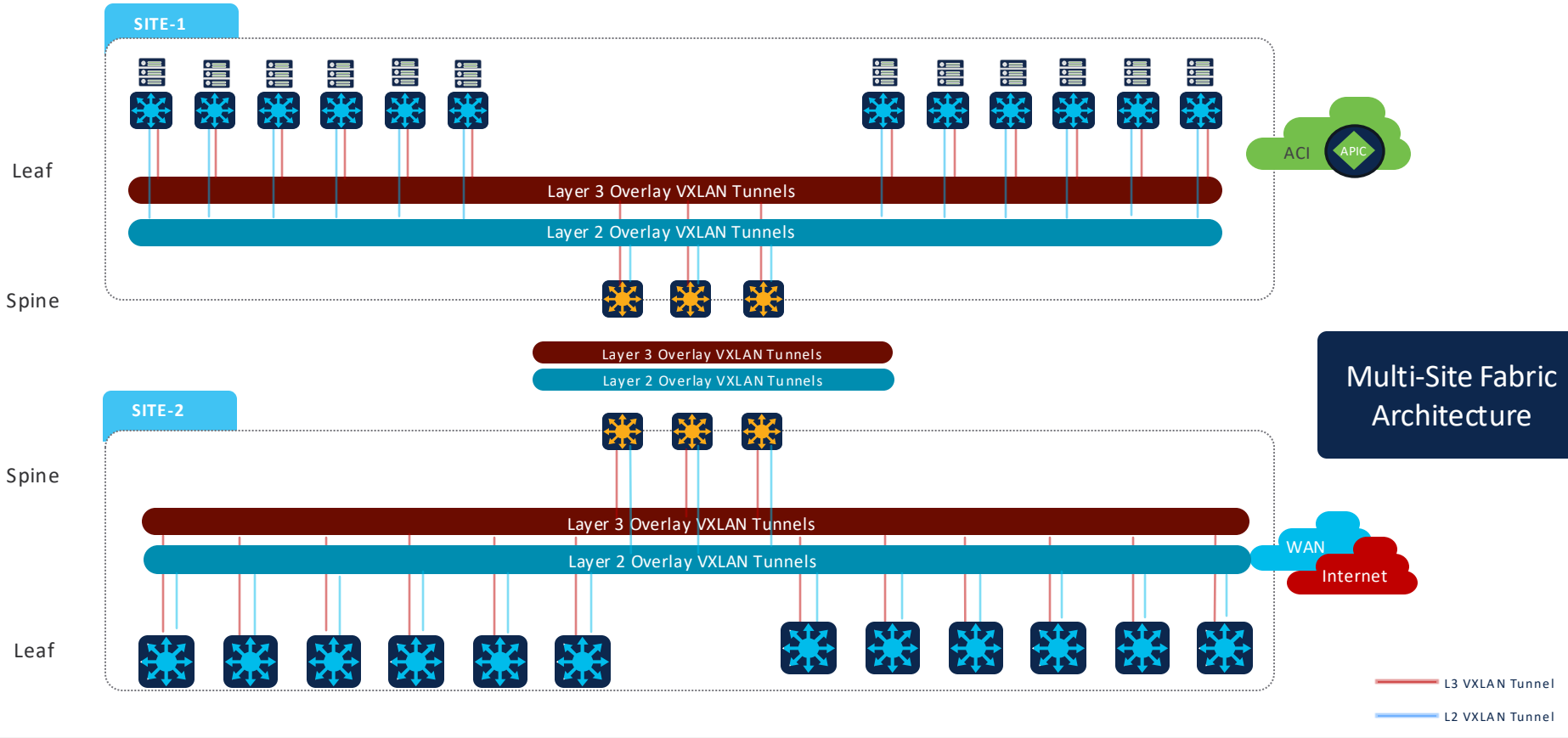
- Extend Layer 2 networks without extending flood-boundaries beyond each fabric cluster using Proxy function
- Retain Layer 2 flood-boundary at Layer 3 Access. No MAC-VRF required on Border Spine
- Scalable extended networks assists in reducing security fault domains, low scale network devices, endpoints and application performance
- End-to-End non-broadcast routed Layer 2 Unicast IPv4/IPv6 support across fabric domain. BUM, Non-IP and Mobility not supported



Multi-Site Fabric Architecture

Multisite Fabric

- Well-structured fabric overlay solution for large EN/DC networks
- Single fabric site representation enables scalable overlay network hierarchy
- Granular control of Layer 2 and Layer 3 overlay flood and routing control
- Seamless integration between Catalyst and Nexus 9K (Border-GW)



Multi-Site Fabric Architecture

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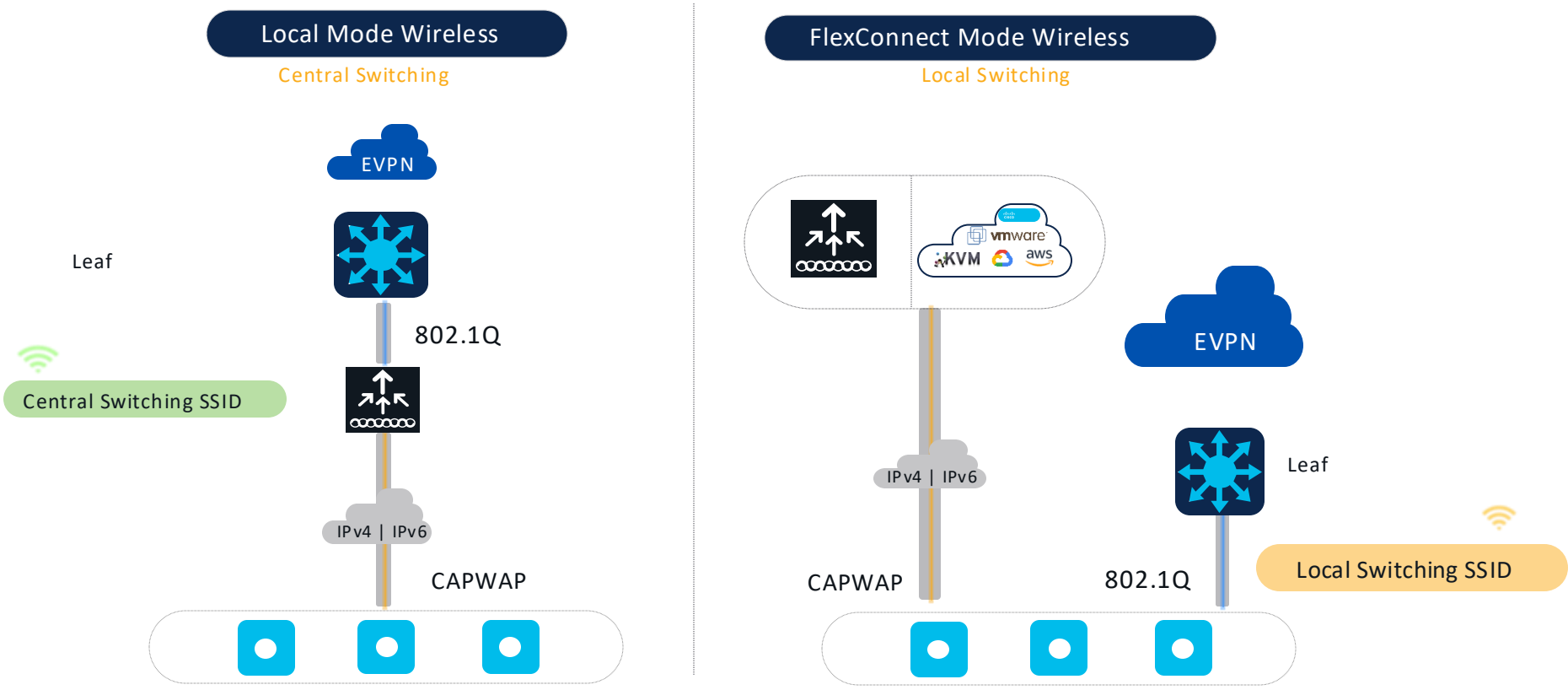


Wireless

Over the Top Wireless. Intact WLC and AP communication in Underlay

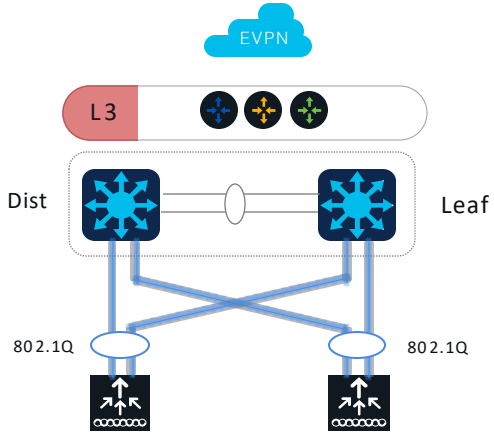
Flexible SSID alternatives – Central Switching, Local Switching, Central + Local Switching

Fabric boundary initiates from Wireless Client IP gateway.

Wireless Overlay Mobility

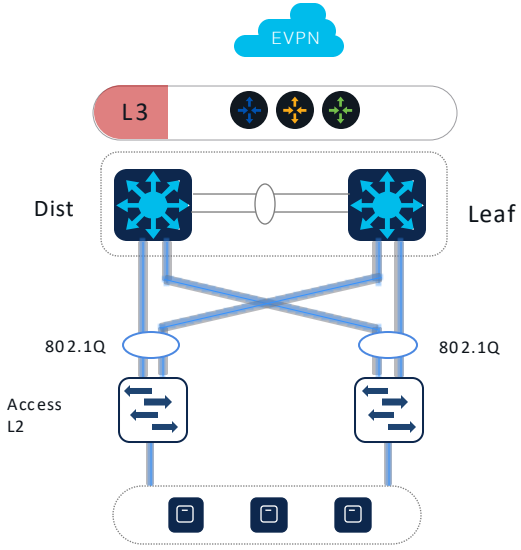
Local Mode Wireless

Central Switching



FlexConnet Mode Wireless

Local Switching



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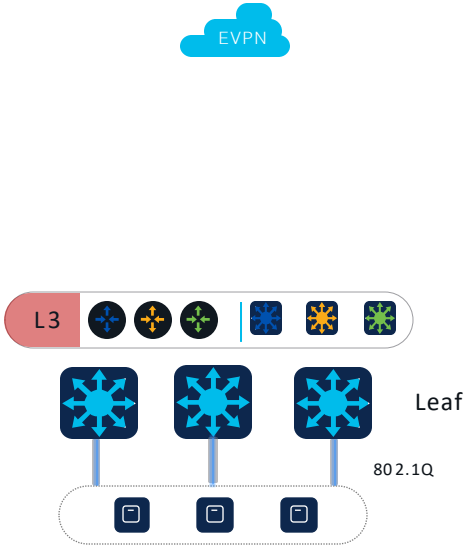


Wireless Mobility

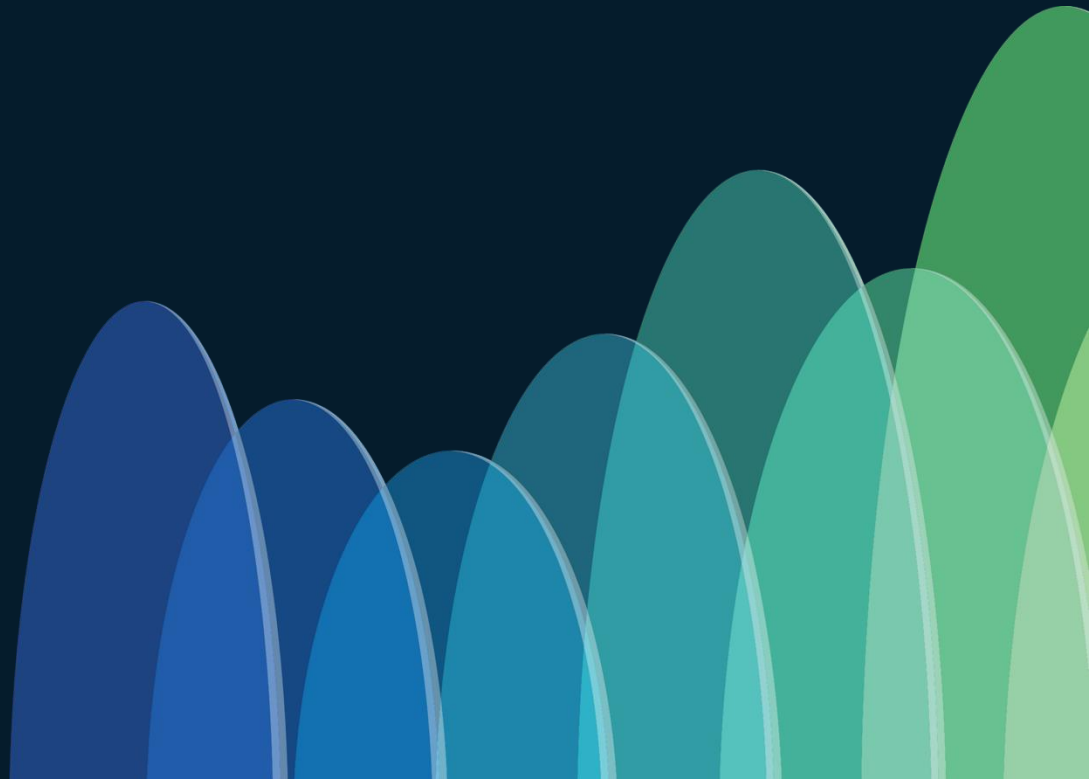
Central-switching Wireless offers network independent mobility events within WLC. Route SSID/Client VLANs.

The seamless wireless mobility relies on LAN network in distributed Wireless design.

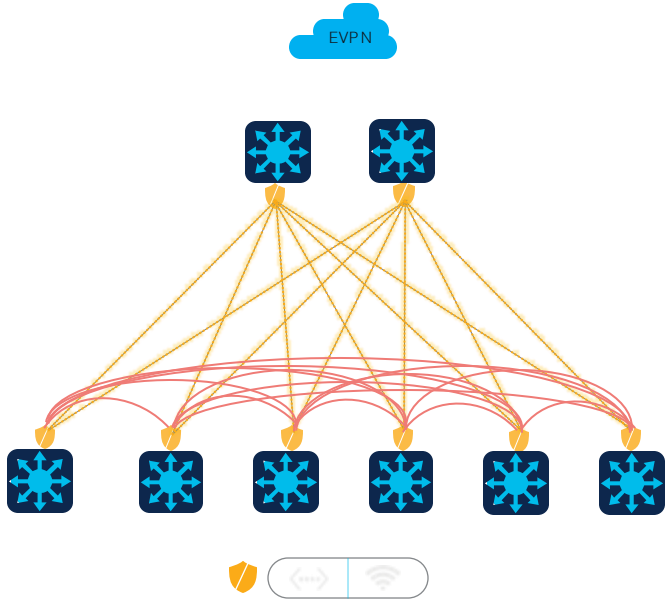
Align Wireless RF coverage with network fabric to support seamless mobility.

Non-blocking STP or VXLAN based network architecture offers seamless fast roaming.

Secure Fabric



Encrypted Underlay Network



Encrypted Underlay

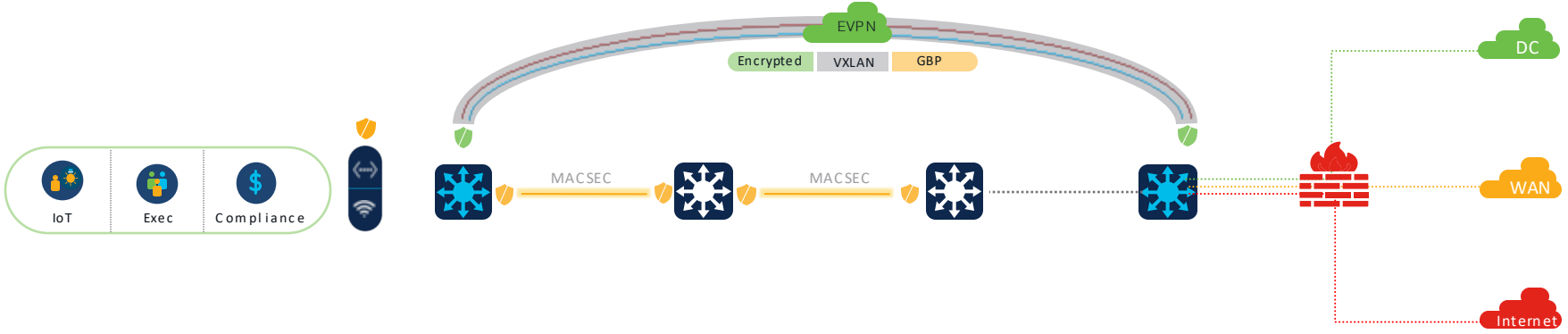
Hop-by-hop IEEE 802.3AE based MACSEC encryption

Secure authentication, confidentiality and data integrity management in Underlay networks

Encrypts Underlay and Overlay network applications with AES GCM cryptography using 256 or128 bits keys.

Uncompromised wire-speed encrypted network performance delivery at scale.

Encrypted Overlay Network



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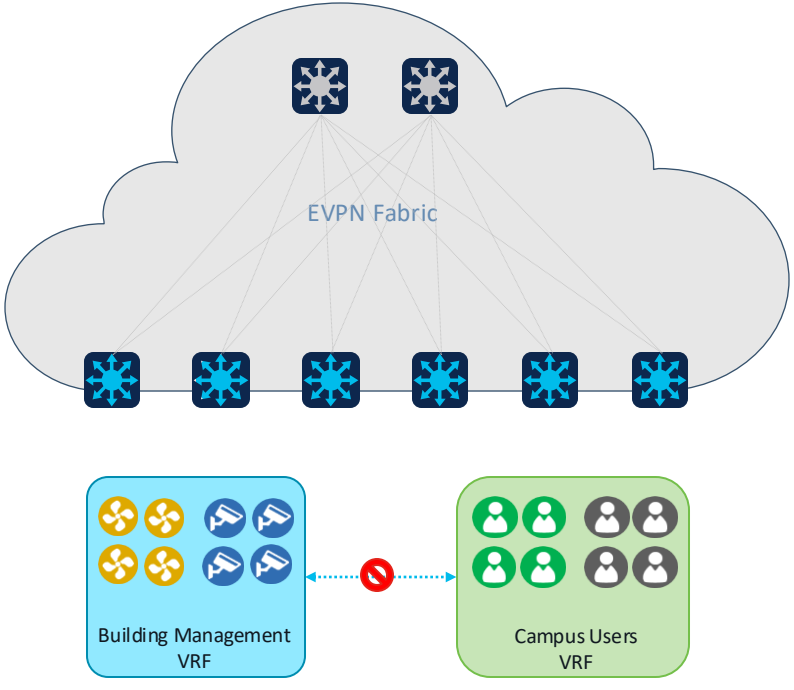
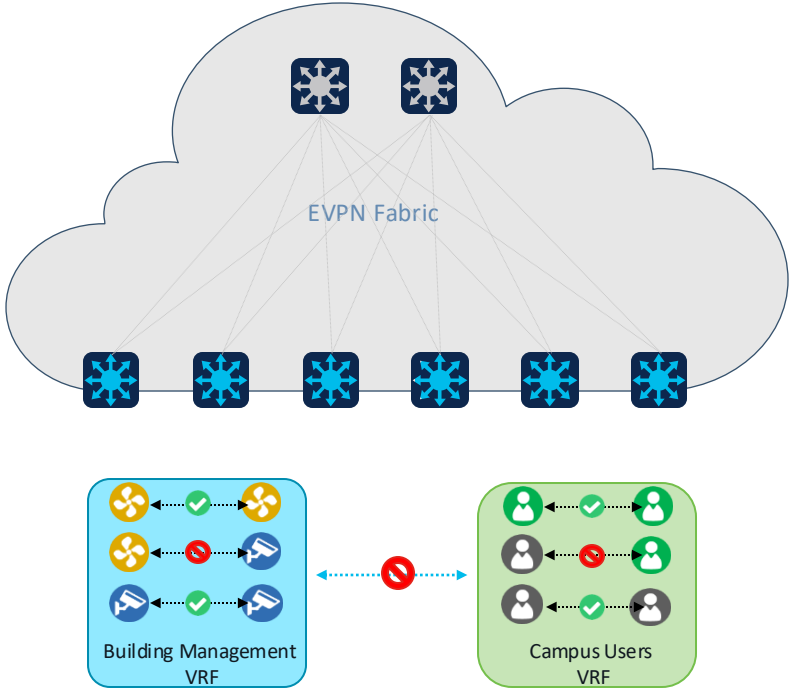
Fabric Segmentation Options

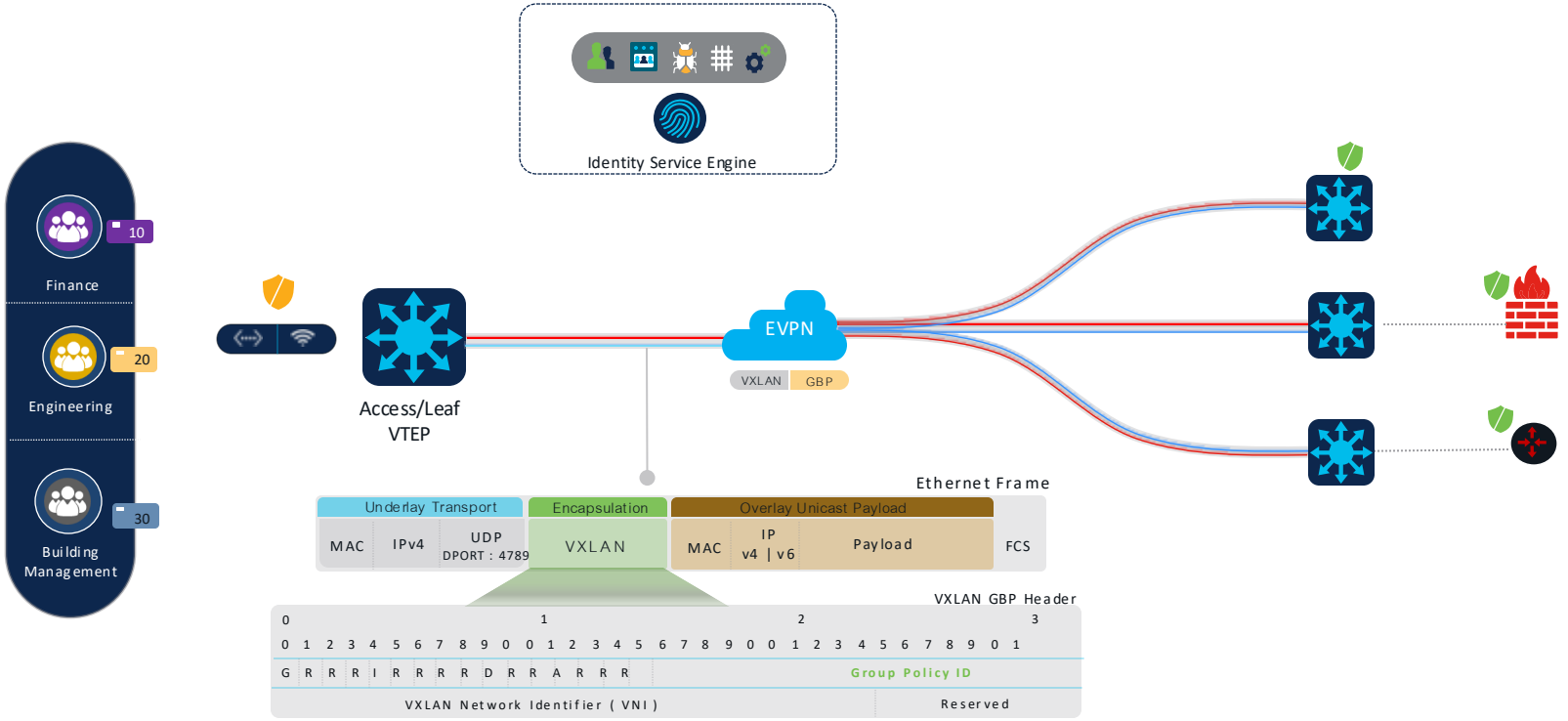


Macro Segmentation: No communication between VRF's



Micro Segmentation: Second level Segmentation between groups within a VRF

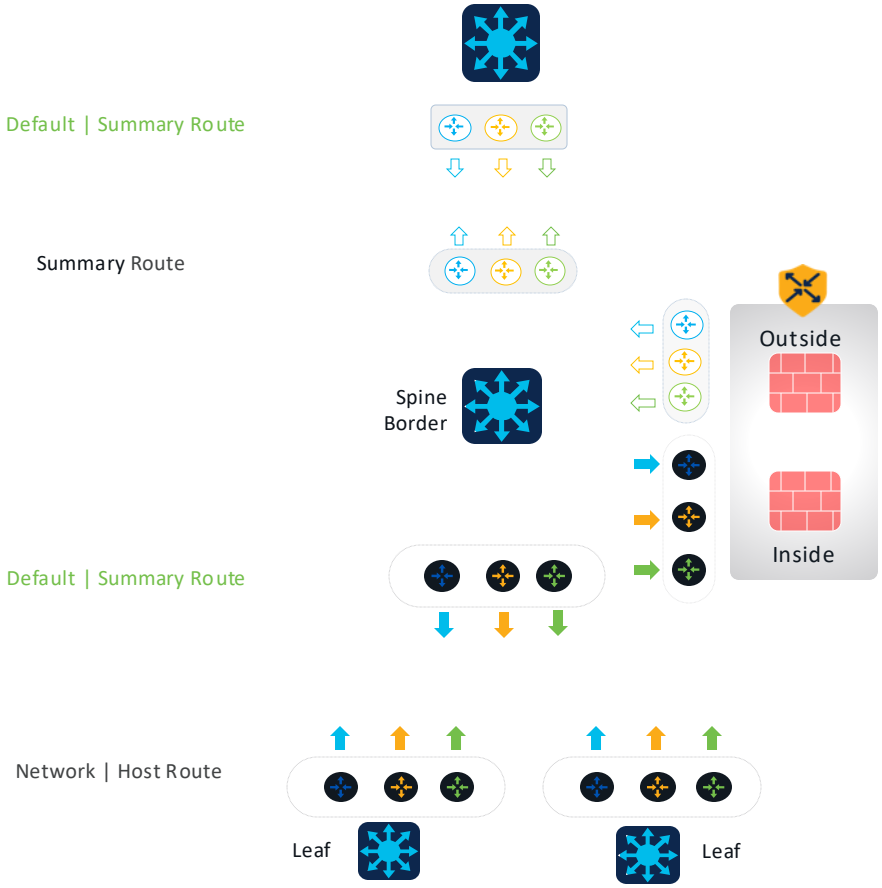
BGP EVPN – Micro Segmentation



Classification
Enforcement

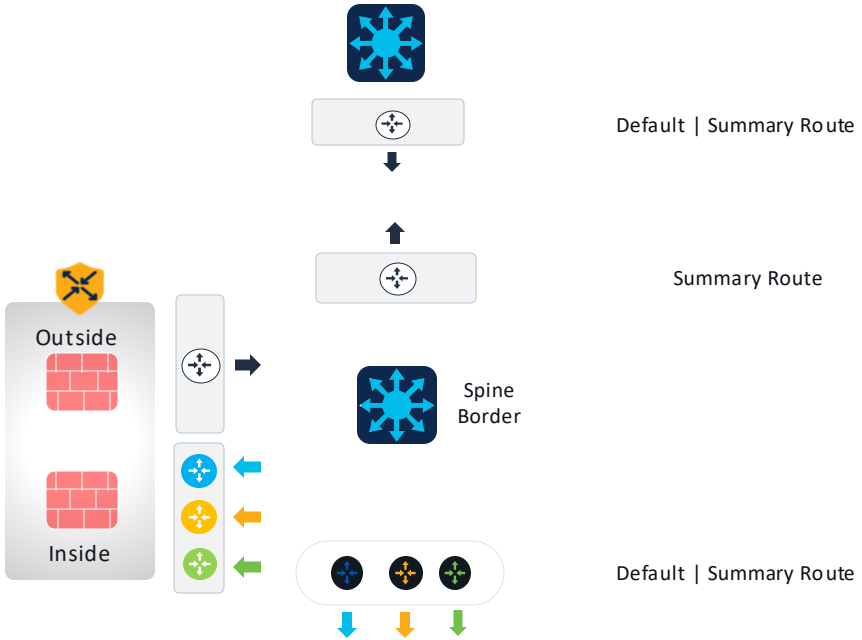
Secure VN Extension

Design 1 – Stateful VN Extension



Secure Shared Extension

Design 2 – Stateful Global Extension



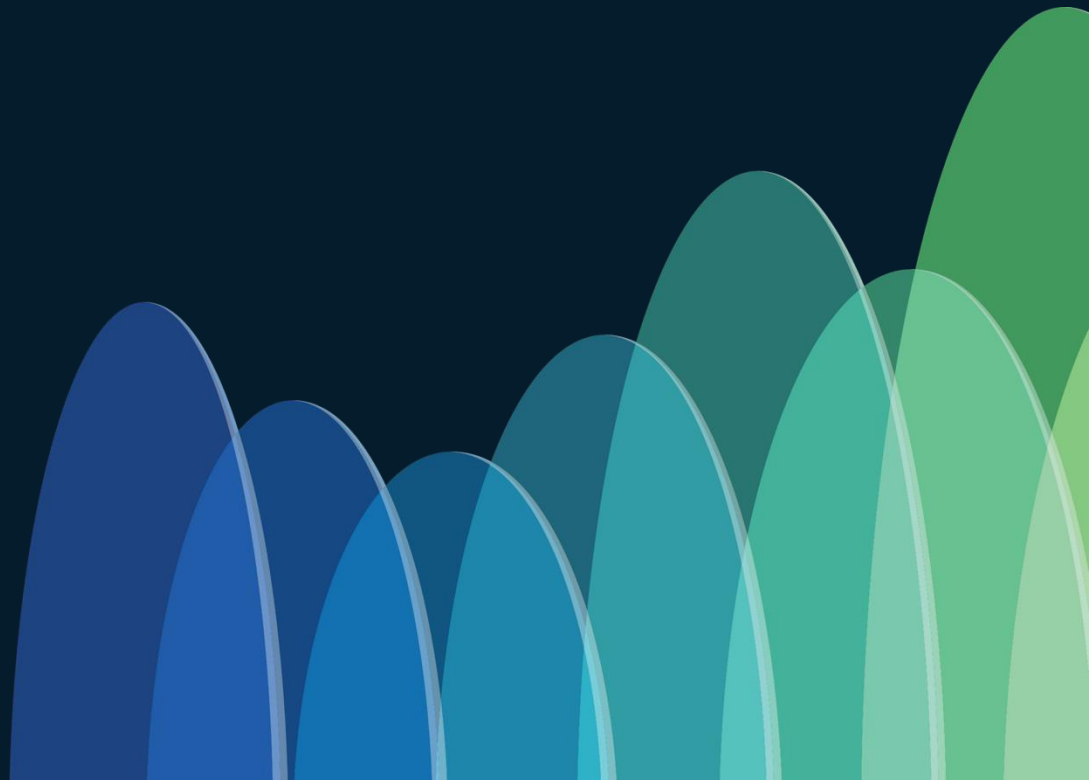
Stateful extranet routing solution

Enforce network security with Firewall to Fabric integration

Extend or terminate trust boundary beyond checkpoint

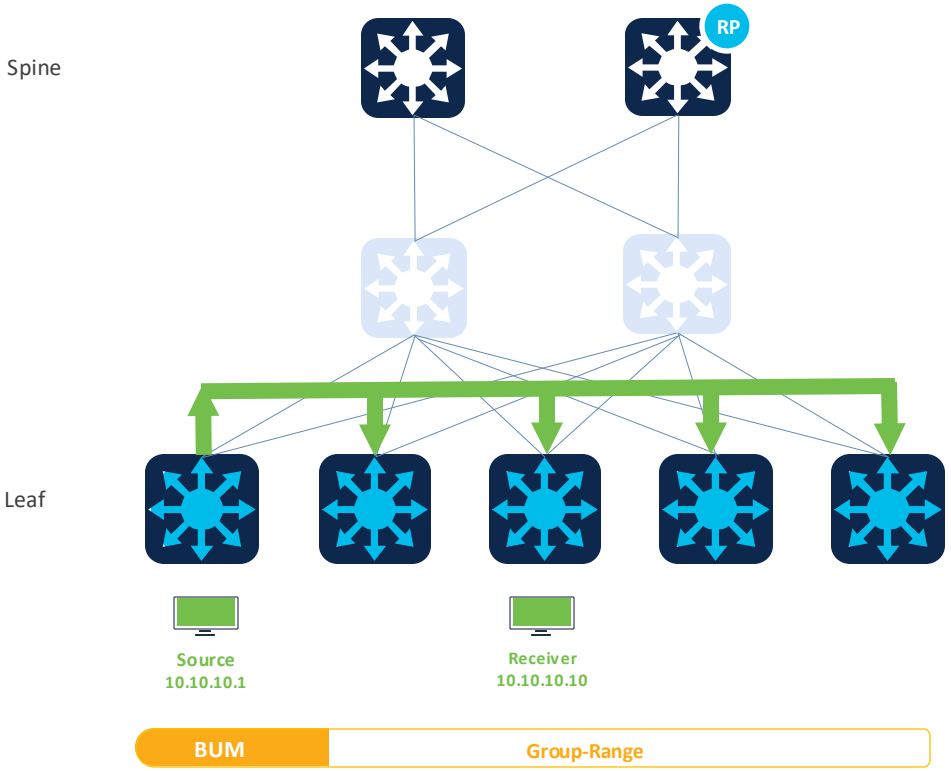
Flexible Firewall integration – Transparent | Routed Mode

Overlay Multicast Services with TRM



cisco Live!

Traditional Multicast Forwarding in EVPN Fabric

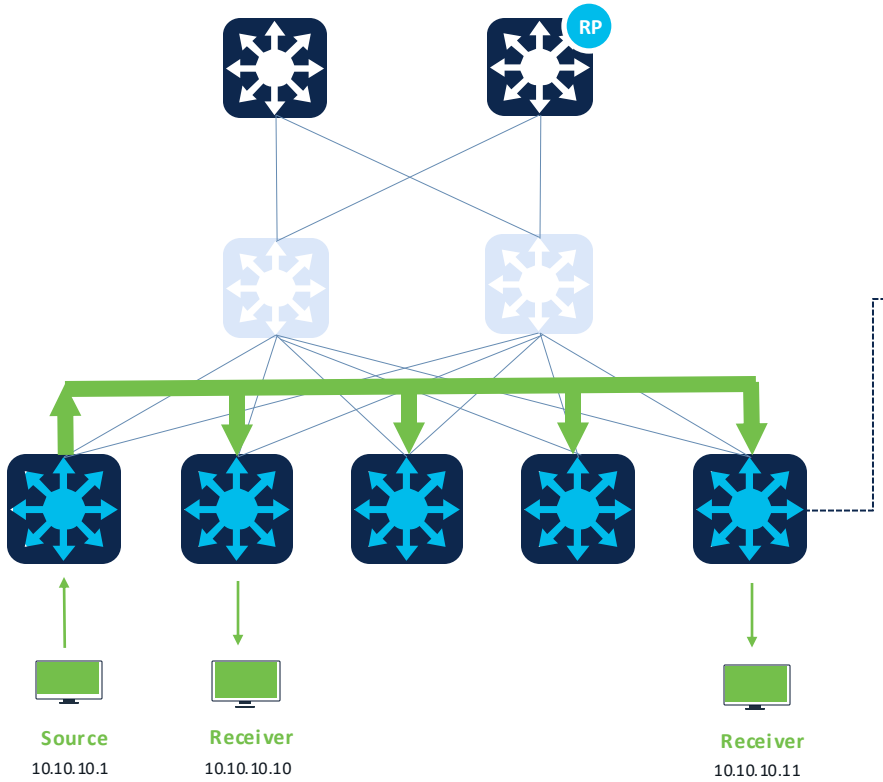


- Multicast within a single subnet
- Single Copy in core is forwarded as part of BUM traffic
- No pruning on Local Interfaces, Traffic is forwarded to all VTEPS

BUM Group

```
interface nve1
 no ip address
 source-interface Loopback0
 host-reachability protocol bgp
 member vni 10103 vrf green
 member vni 10101 mcast-group 225.0.0.101
```

Traditional Multicast Forwarding in EVPN Fabric



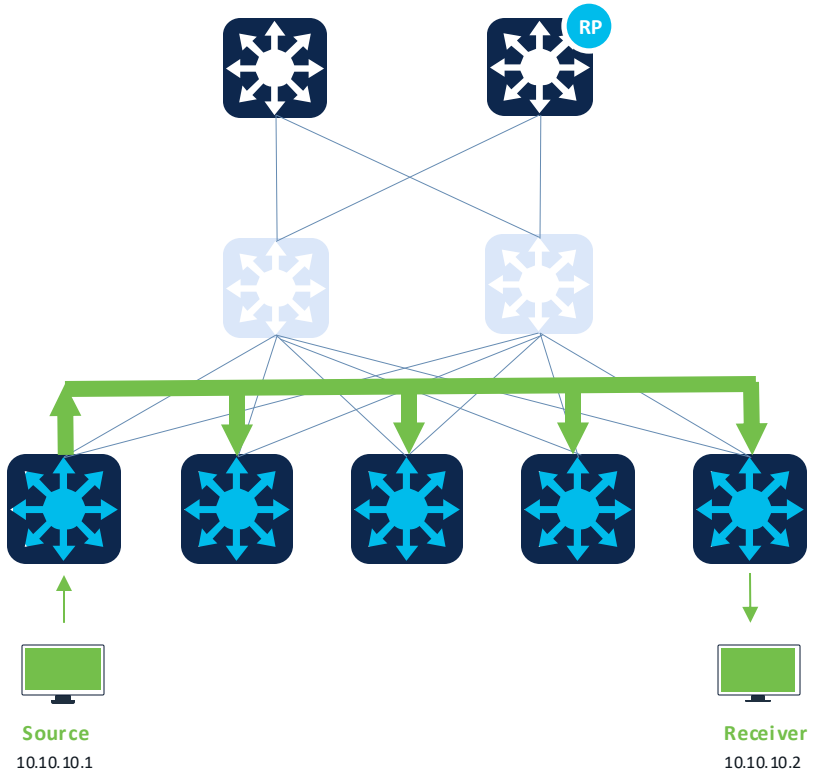

```
interface nve1
 no ip address
 source-interface Loopback0
 host-reachability protocol bgp
 member vni 10103 vrf green
 member vni 10101 mcast-group 225.0.0.1

ip pim rp-address 172.168.10.1 → underlay RP
```

- VXLAN traffic encapsulated to the L2VNI Multicast group
- Single copy in the core with Multicast Replication

RP → Underlay RP

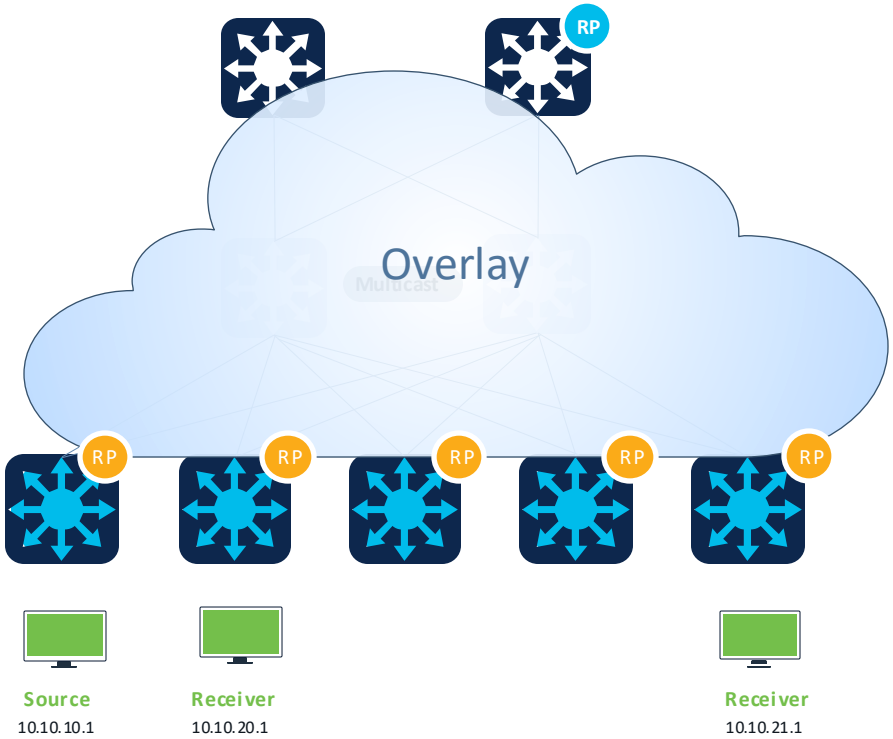
Traditional Multicast Forwarding in EVPN Fabric




```
Leaf-1#sh ip mfib active
Active Multicast Sources - sending >= 4 kbps
Default
Group: 225.0.0.1 → BUM group
 Source: 172.168.1.1, → Source VTEP
  SW Rate: 0 pps/0 kbps(1sec), 0 kbps(last 53459 sec)
  HW Rate: 17016 pps/21537 kbps(1sec)
```

```
Leaf-5#sh ip mfib active
Active Multicast Sources - sending >= 4 kbps
Default
Group: 225.0.0.1 → BUM group
 Source: 172.168.1.1, → Source VTEP
  SW Rate: 0 pps/0 kbps(1sec), 0 kbps(last 53459 sec)
  HW Rate: 17016 pps/21537 kbps(1sec)
```

Tenant Routed Multicast

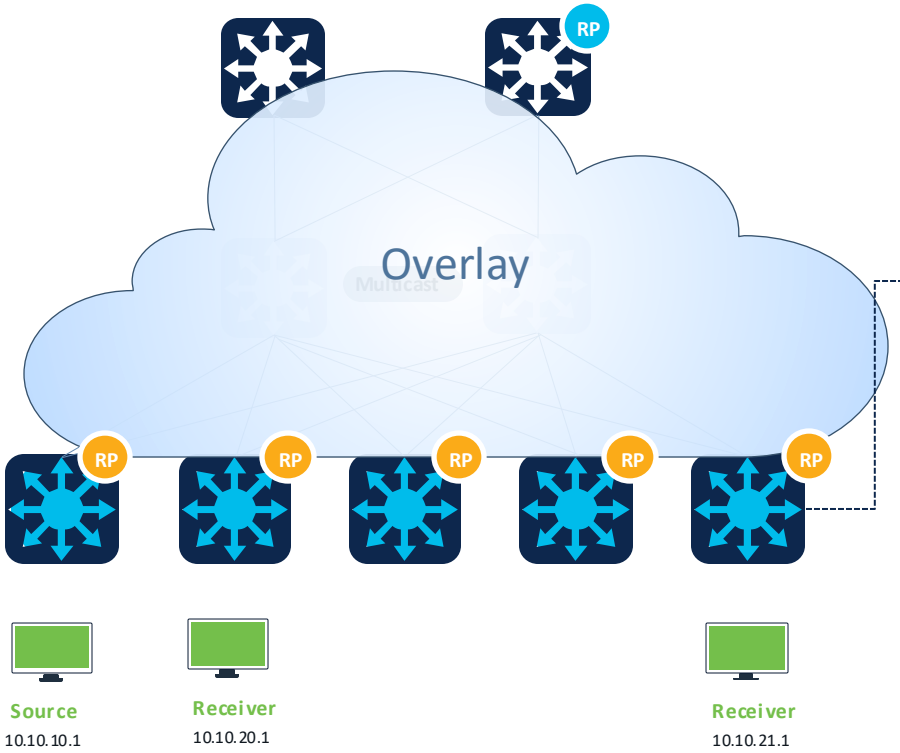


- BGP Based Control Plane using ngMVPN (Next-Generation Multicast VPN)
- PIM SM and SSM mode
- Leverages existing Route reflector
- Distributed Anycast RP
- All VTEPS acts as senders and receivers
- Leverages existing Multicast underlay
- Separate Multicast Group for L2-VNI BUM
- Separate MCAST group for each L3VNI

RP → Underlay RP

RP → Overlay RP

Tenant Routed Multicast

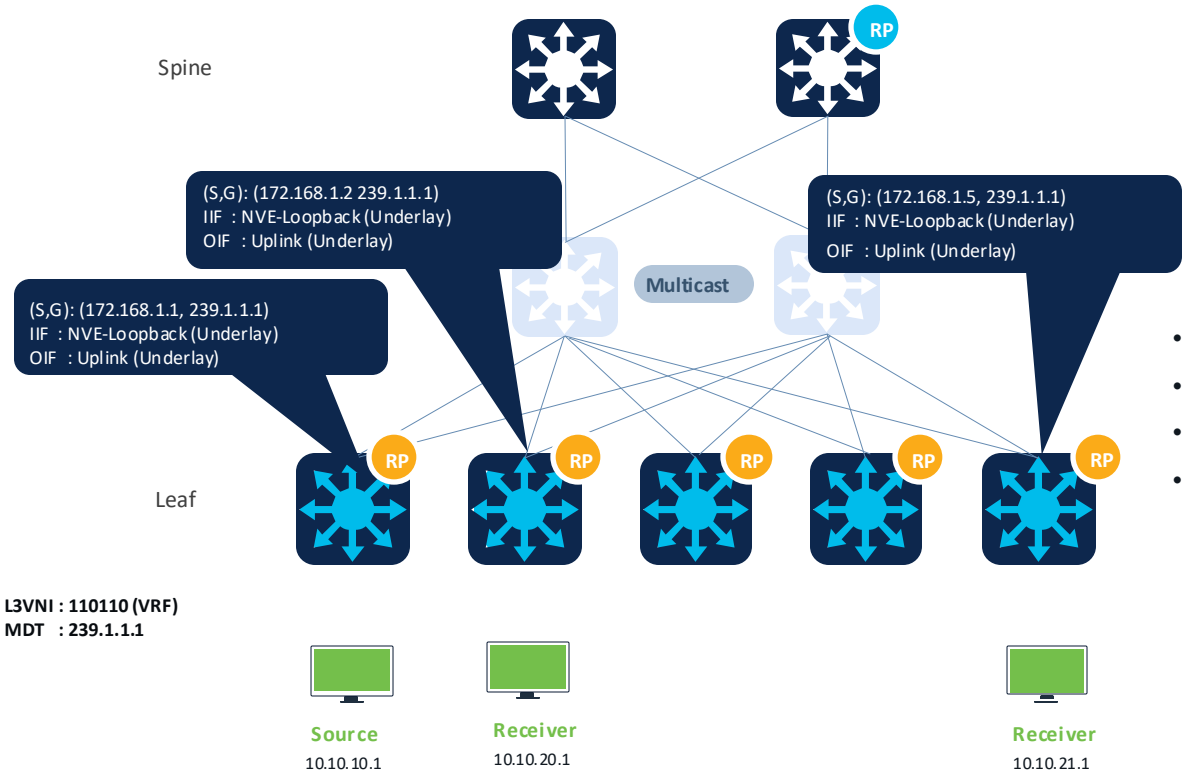



```
vrf definition S1-EVPN
 rd 10:10
 !
 address-family ipv4
  mdt auto-discovery vxlan inter-as
  mdt default vxlan 239.1.1.1 → MDT group
  mdt overlay use-bgp spt-only
```

RP — Underlay RP

RP — Overlay RP

Tenant Routed Multicast



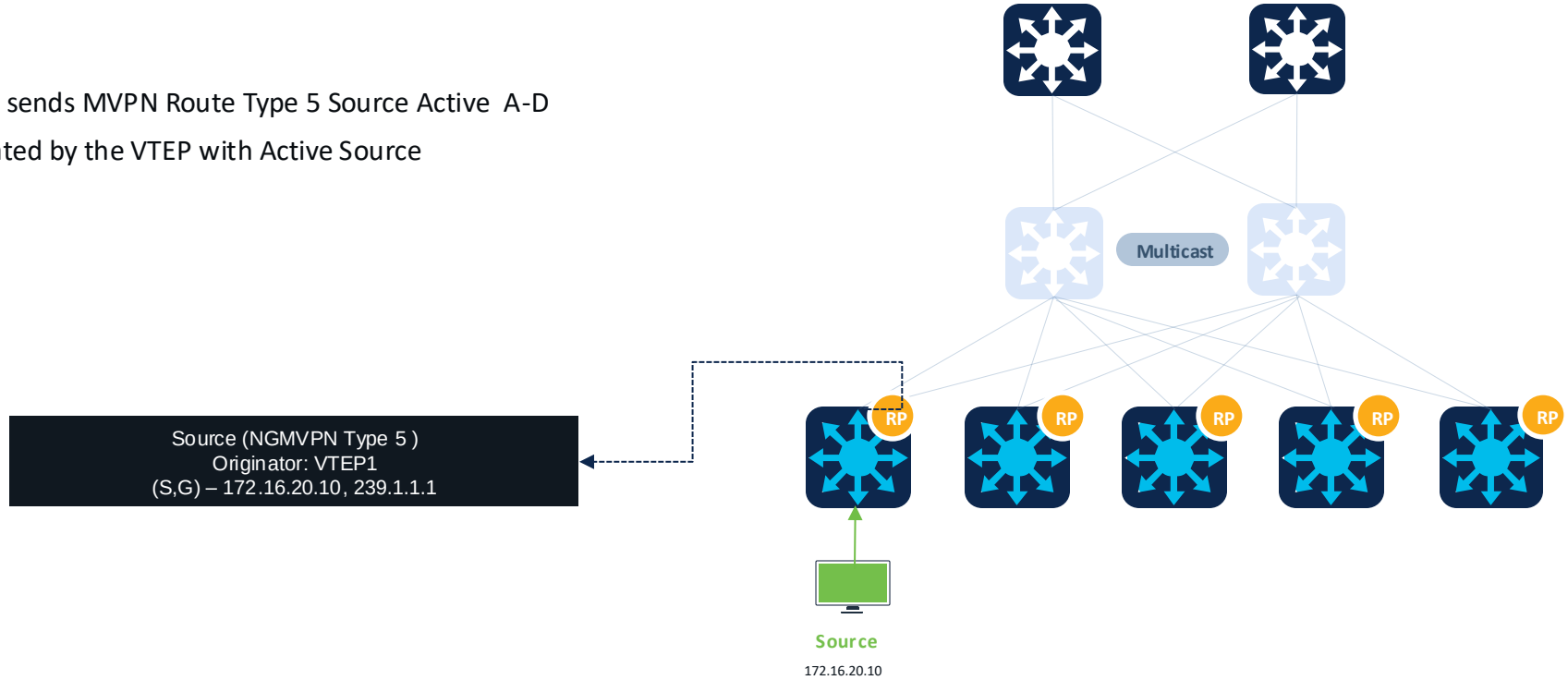
- Default MDT Initiates (*,G) join on VTEP
- Each VTEP with VRF configured initiates (S,G)
- Separate Groups for BUM and MDT
- Distributed Anycast RP on VTEPs for overlay multicast traffic.

RP — Underlay RP

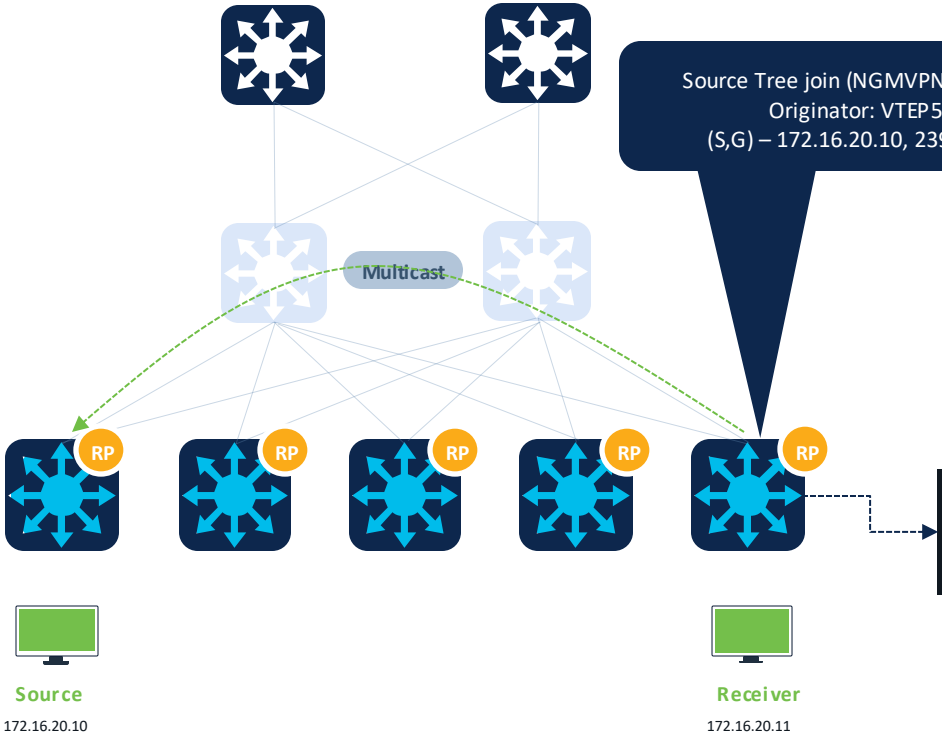
RP — Overlay RP

NGMVPN – Tenant Routed Multicast

- VTEP 1 sends MVPN Route Type 5 Source Active A-D
- Originated by the VTEP with Active Source



NGMVPN – Tenant Routed Multicast



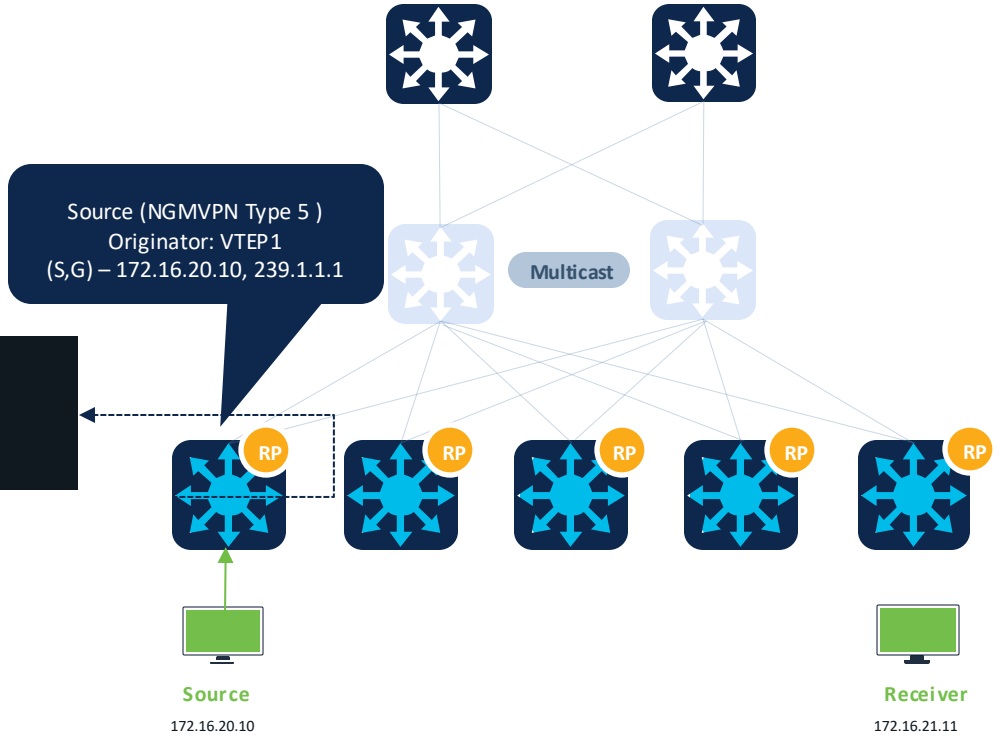
- VTEP's receive MVPN RT-5 and install Source A-D for (S,G)
- (S,G) created at VTEP-5 and VTEP-5 sends MVPN RT-7 Source Tree Join towards VTEP 1

```
(172.16.20.10, 239.1.1.1), 00:03:12/00:02:47, flags: TgQ
  Incoming interface: Vlan110, RPF nbr 172.168.1.1 → L3VNI
  Outgoing interface list:
    Vlan30, Forward/Sparse, 00:03:12/00:02:18 à Receiver SVI
```

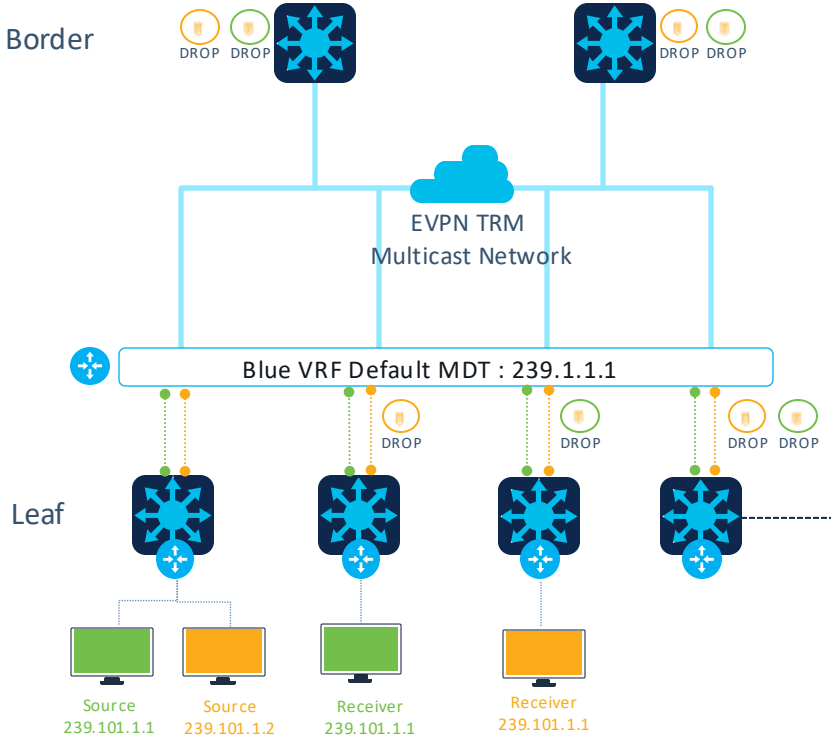
NGMVPN – Tenant Routed Multicast

- VTEP 1 receives and installs MVPN RT-7
- Installs L3VNI as OIF and forwards traffic

```
(172.168.20.10, 239.1.1.1), 00:17:42/00:01:47, flags: FTGqx → Source
  Incoming interface: Vlan20, RPF nbr 0.0.0.0
  Outgoing interface list:
Vlan110, VXLAN v4 Encap: (110110, 239.1.1.1), Forward/Sparse, 00:17:42/stopped
```



TRM Default MDT




```
vrf definition S1-EVPN
 rd 10:10
 !
 address-family ipv4
  mdt auto-discovery vxlan inter-as
  mdt default vxlan 239.1.1.1 → MDT Default
  mdt overlay use-bgp spt-only
```

Challenges

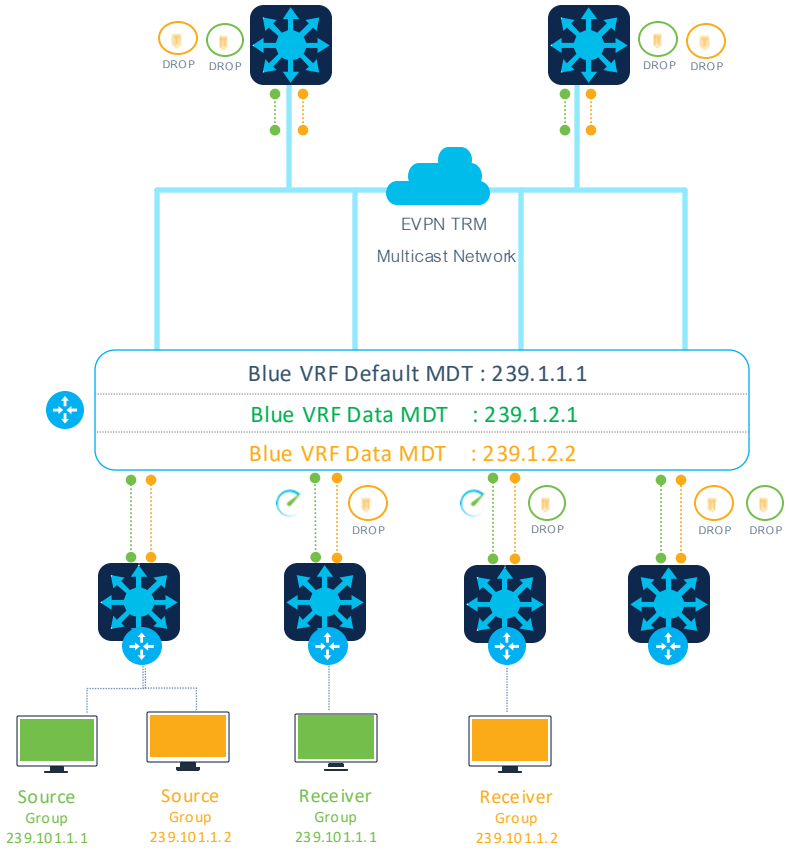
Non-selective overlay Multicast replication

Inessential core network bandwidth utilization

Redundant system resources utilization

Limited scale for dense network environment

TRM Data MDT



Key Benefits

Stateful L2 Multicast Overlay network

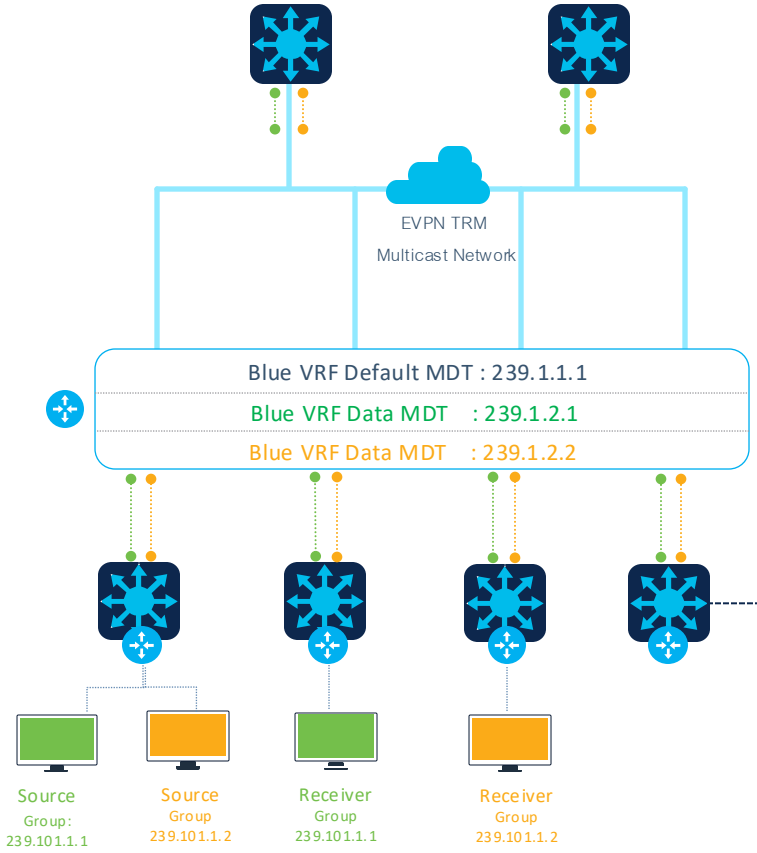
Industry-standard based control-plane

Applicable to Centralized Gateway or Cross-Connect Overlay networks

Scale. Performance. Security.

TRM Data MDT

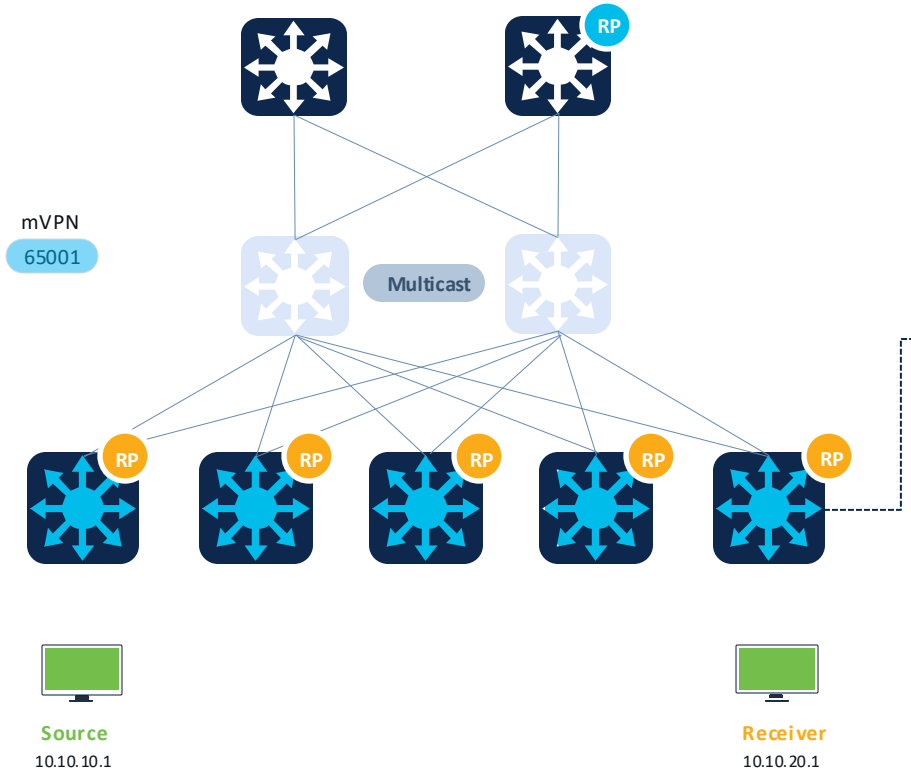
Border



Leaf

```
vrf definition S1-EVPN
 rd 10:10
 !
  address-family ipv4
  mdt auto-discovery vxlan inter-as
  mdt default vxlan 239.1.1.1
  mdt data vxlan 239.1.2.0 0.0.0.255 → MDT Data
  mdt data threshold 1
  mdt overlay use-bgp spt-only
```

TRM – Distributed Anycast RP

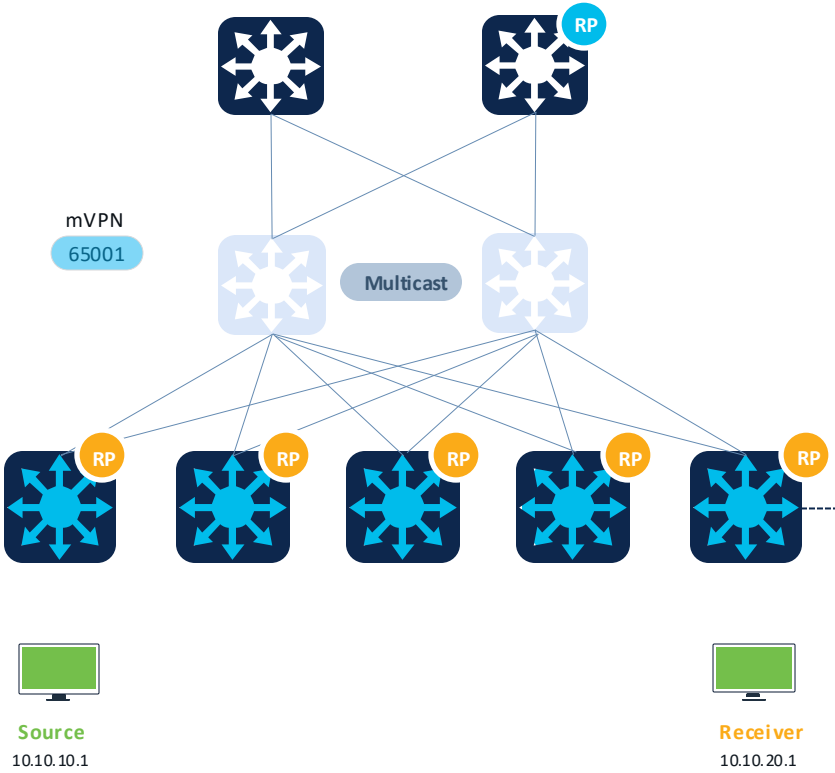



```
router bgp 1
 bgp log-neighbor-changes
 bgp graceful-restart
 no bgp default ipv4-unicast
 neighbor 172.168.1.3 remote-as 1
 neighbor 172.168.1.3 update-source Loopback0
 !
 address-family ipv4 mvpn → activate MVPN AF
  neighbor 172.168.1.3 activate
  neighbor 172.168.1.3 send-community extended
 exit-address-family

interface Loopback1
 vrf forwarding S1-EVPN
 ip address 192.168.10.1 255.255.255.255
 ip pim sparse-mode

ip pim vrf S1-EVPN rp-address 192.168.10.1 → Anycast RP
ip pim vrf S1-EVPN register-source Loopback1
```

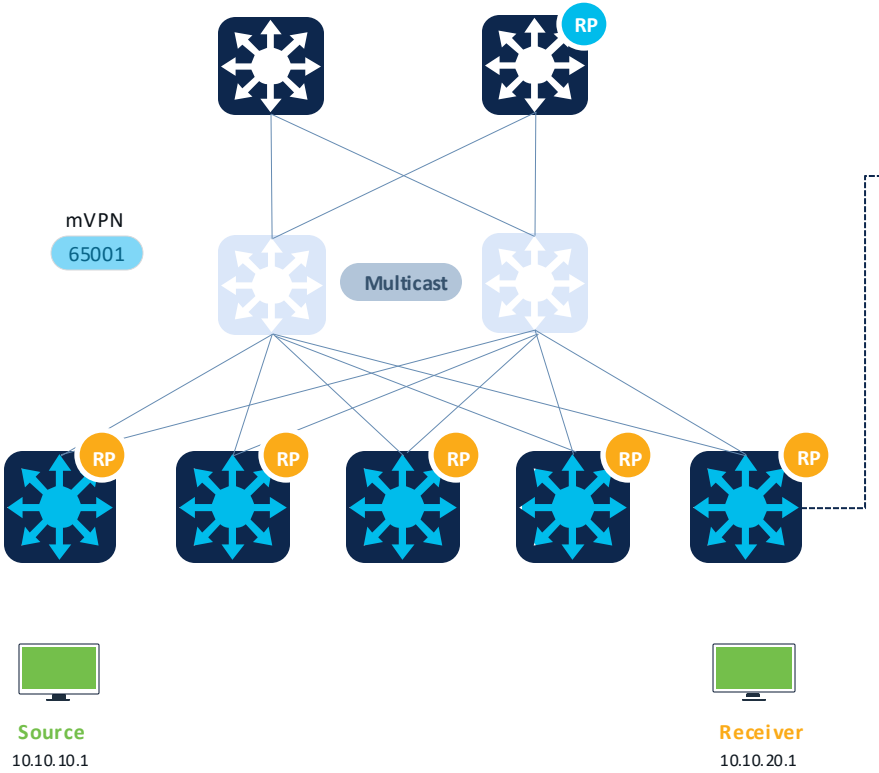
TRM – Distributed Anycast RP




```
interface Vlan110 → enable PIM for L3VNI
 vrf forwarding S1-EVPN
 ip unnumbered Loopback0
 ip pim sparse-mode
 no autostate

interface Vlan10 → enable PIM on DAG
 mac-address 0001.0001.0001
 vrf forwarding S1-EVPN
 ip address 10.10.10.1 255.255.255.0
 ip pim sparse-mode
!
interface Vlan20 → enable PIM on DAG
 mac-address 0002.0002.0002
 vrf forwarding S1-EVPN
 ip address 20.20.20.1 255.255.255.0
 ip pim sparse-mode
```

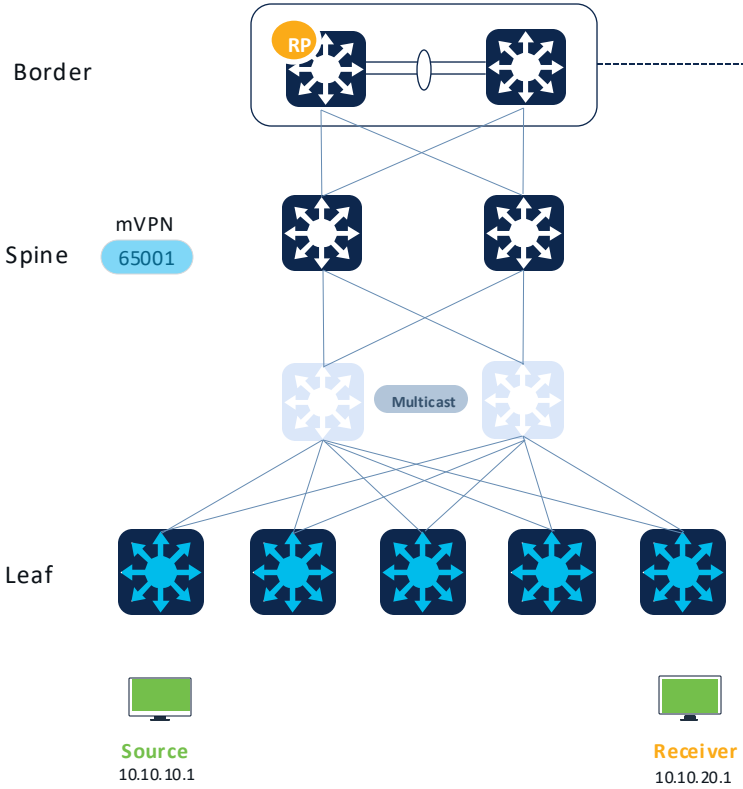
TRM – Distributed Anycast RP



VRF	RP	IP	MDT
Blue	Anycast	Lo1: 10.1.1.101	239.1.1.101
Yellow	Anycast	Lo2: 10.2.1.101	239.2.1.101
Green	Anycast	Lo3: 10.3.1.101	239.3.1.101

- Standard-based Multicast overlay network design support
- Flexible Multicast RP design alternatives to address scale, performance, resiliency
- Anycast RP enables distributed Multicast administrative domains

TRM – Fabric Border RP




```
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 bgp log-neighbor-changes
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 address-family ipv4 mvpn → activate MVPN AF
  neighbor 172.168.1.3 activate
  neighbor 172.168.1.3 send-community extended
 exit-address-family

interface Loopback1
 vrf forwarding S1-EVPN
 ip address 192.168.10.10 255.255.255.255
 ip pim sparse-mode

ip pim vrf S1-EVPN rp-address 192.168.10.10 → RP
ip pim vrf S1-EVPN register-source Loopback1
```
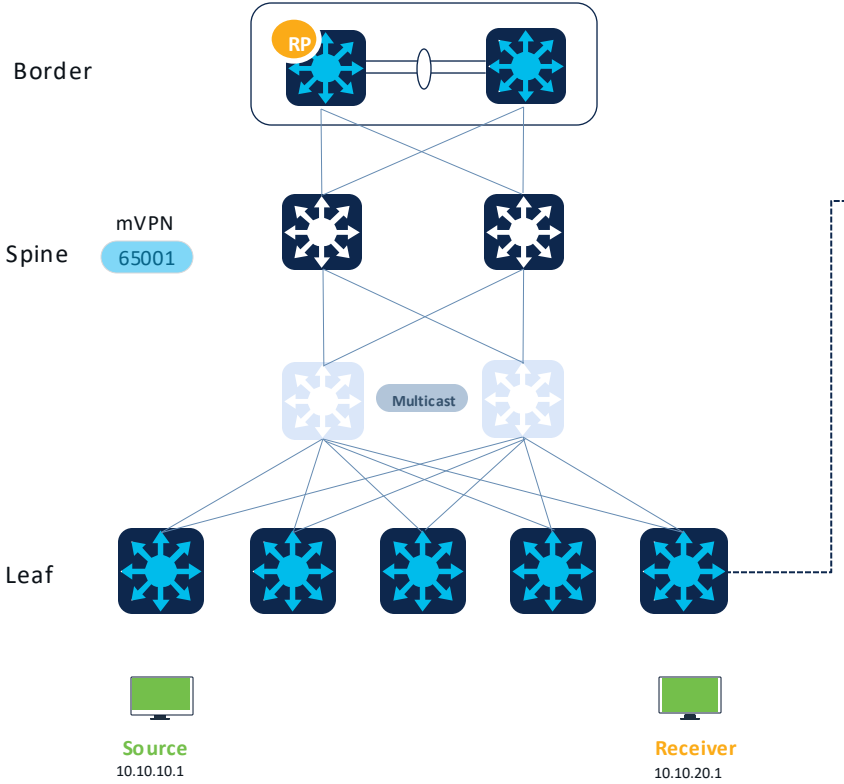
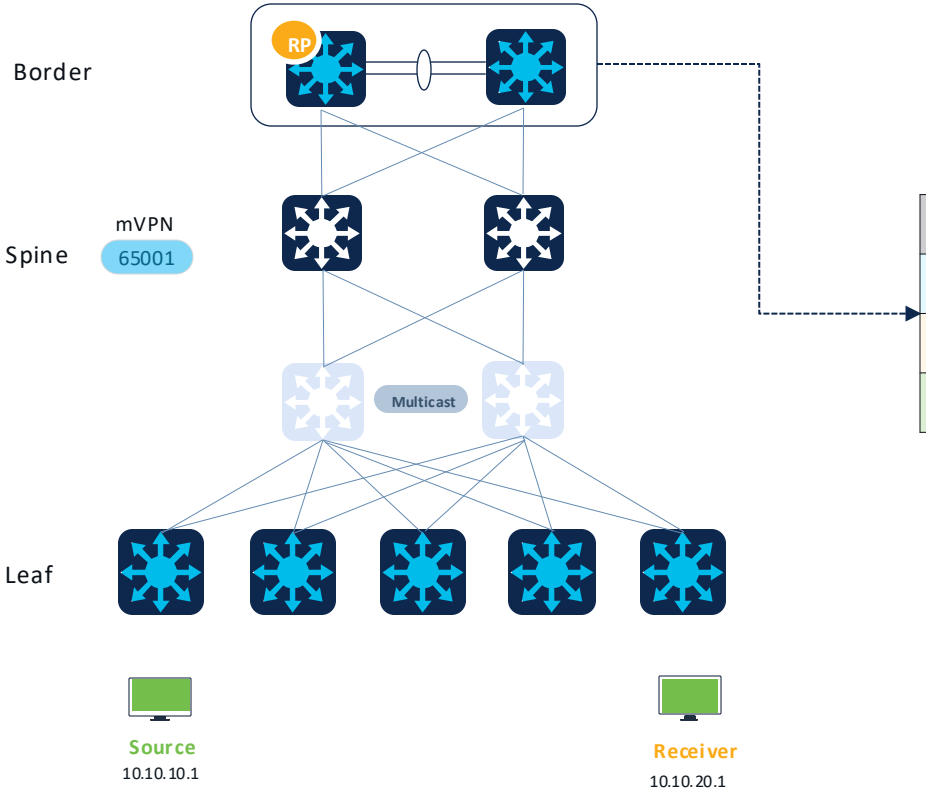

TRM – Fabric Border RP



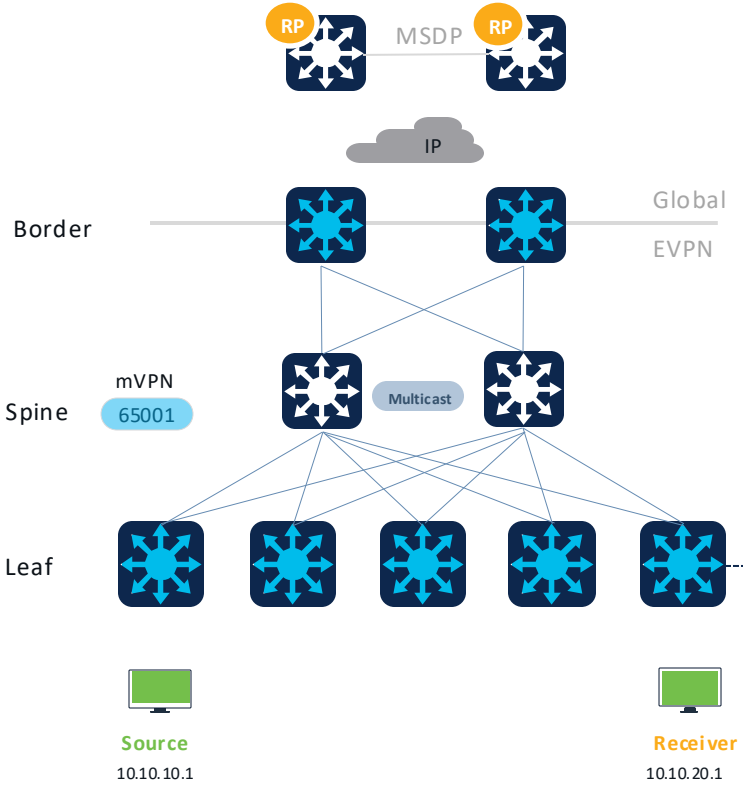

```
router bgp 1
 bgp log-neighbor-changes
 bgp graceful-restart
 no bgp default ipv4-unicast
 neighbor 172.168.1.3 remote-as 1
 neighbor 172.168.1.3 update-source Loopback0
 !
 address-family ipv4 mvpn
 neighbor 172.168.1.3 activate
  neighbor 172.168.1.3 send-community extended
 exit-address-family

ip pim vrf S1-EVPN rp-address 192.168.10.10 → Border RP
```

TRM – Fabric Border RP



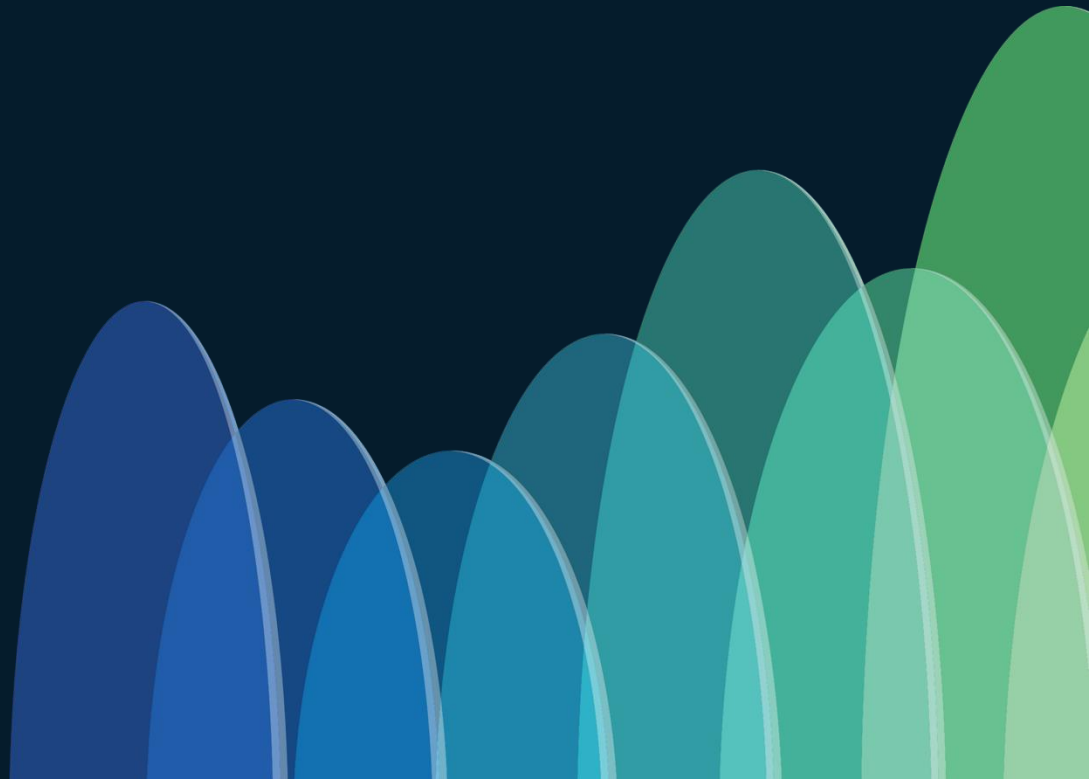
VRF	RP	IP	MDT
Blue	Border	10.1.1.101	239.1.1.101
Yellow	Border	10.2.1.101	239.2.1.101
Green	Border	10.3.1.101	239.3.1.101

TRM – External Domain RP



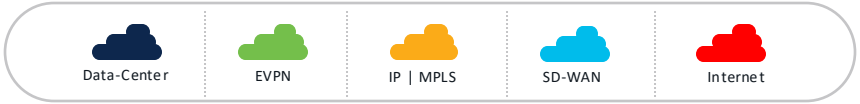
VRF	RP	IP	MDT
Blue	External	172.168.1.1	239.1.1.101
Yellow	External	172.168.1.1	239.2.1.101
Green	External	172.168.1.1	239.3.1.101

Fabric Border Handoff Designs

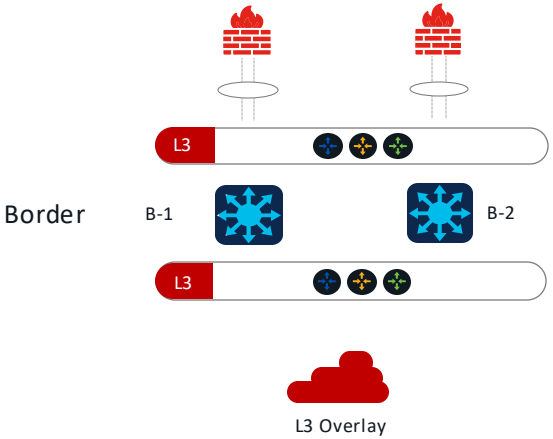


cisco Live!

Border – Catalyst 9000 System Modes



Standalone Mode – L3 Handoff



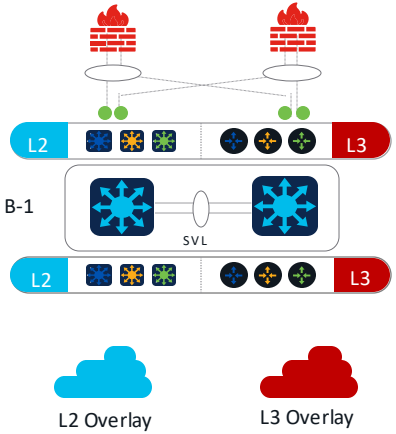
Route First rule.

Bridge-only – IF and where needed

Borders in individual Standalone mode

Seamless Layer 3 handoff

StackWise Virtual Mode – L2/L3 Handoff



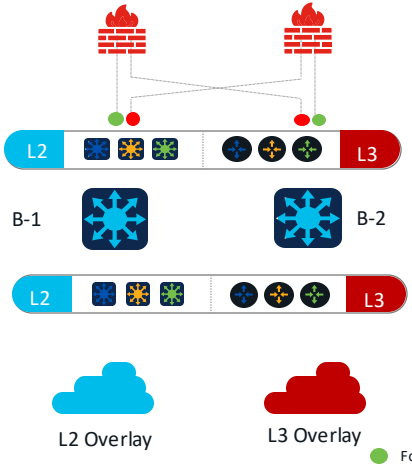
Layer 2 bridging beyond fabric.

Borders in StackWise Virtual mode

Loop-free L2 and overlay fabric

Flexible Layer 2 and 3 handoff

ESI Multihome Mode – L2/L3 Handoff



Layer 2 bridging beyond fabric

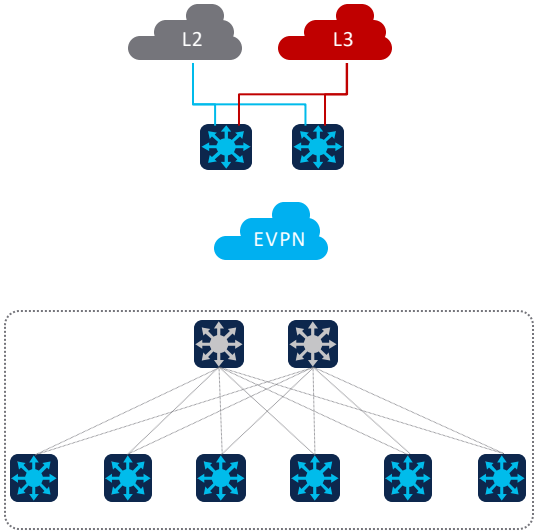
Standard-based EVPN ESI support

Per-VLAN auto load-balancing

Loop-free L2 and overlay fabric

External Domain Handoff Types

Terminate



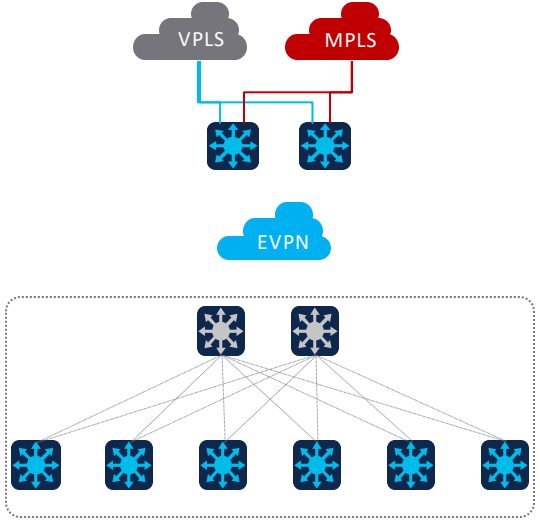
BGP EVPN fabric termination at Border

Simple Layer 2 / Layer 3 hand off

Layer 3 VRF segmentation to L3 system

L2 extension handoff, only if needed.

Interworking



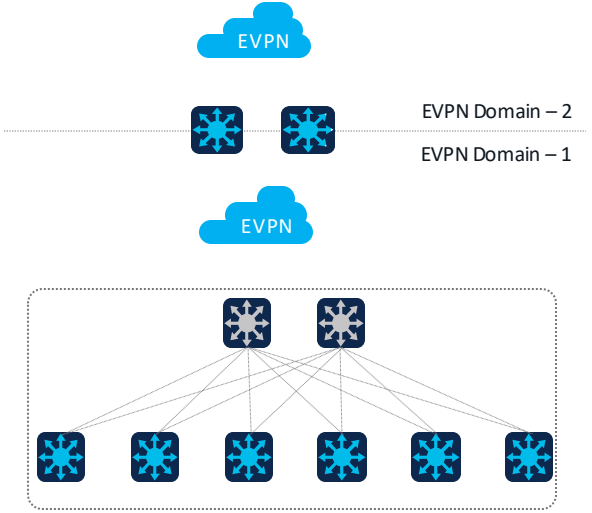
Integrated fabric interworking at Border

Seamless EVPN & classic overlay ”stitching”

End-to-End network segmentation

Loop-free Layer 2 overlays across domains

Re-Originate



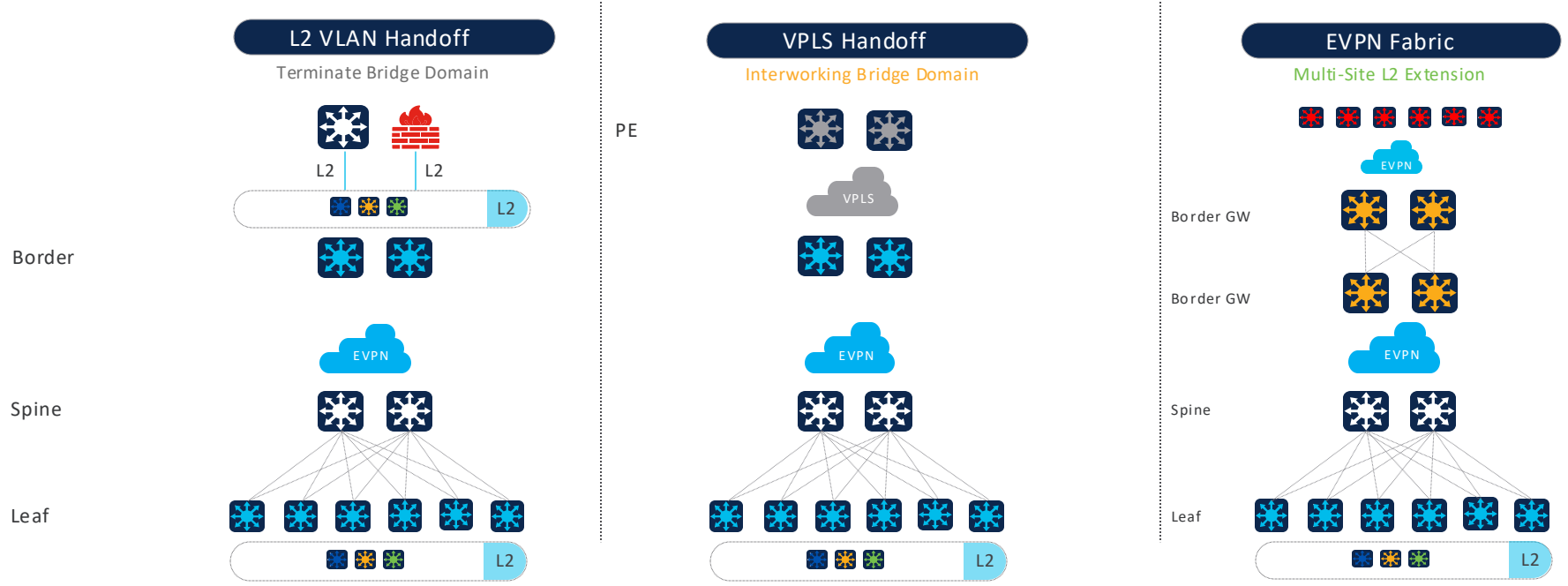
BGP EVPN fabric re-origination at Border

L3 segmentation between fabric domains

Can collapse with Border/Spine role

L2 and Multicast in overlay unsupported

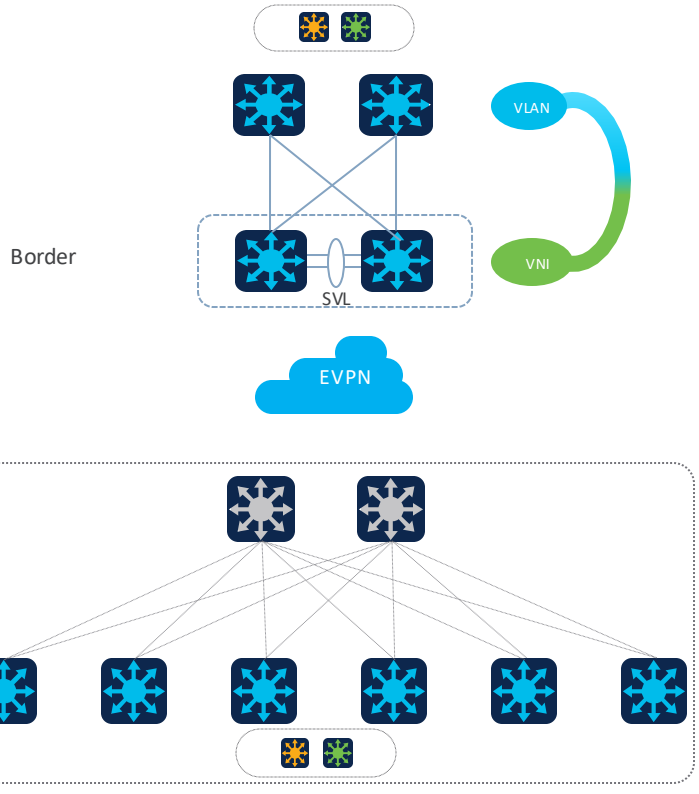
Layer – 2 Handoffs Alternatives



Seamless Layer 2 Handoff

- Multiple end-to-end seamless Layer 2 extensions supports across fabric and beyond
- Terminate L2 overlays and perform simple Layer 2 trunk handoff to non-fabric devices, i.e., Firewalls
- Integrated EVPN Border and VPLS PE function to extend multi-domain L2 for seamless migrations
- Extendable Layer 2 EVPN domains with highly scalable Catalyst and Nexus 9000 Multisite Border Gateway

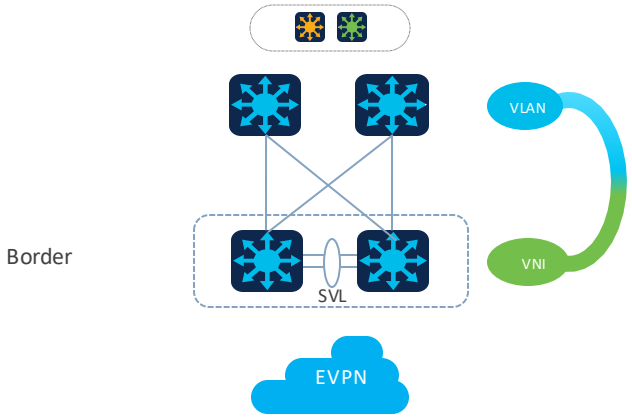
L2 VLAN Handoff (Terminate)




```
Border:

vlan configuration 101
member evpn-instance 101 vni 10101
!
vlan configuration 102
member evpn-instance 102 vni 10201
!
interface  Port-channel10
switchport mode trunk
switchport allowed vlan 101,102
!
interface nve1
no ip address
source-interface Loopback0
host-reachability protocol bgp
member vni 10101 mcast-group 225.0.0.101
member vni 10102 mcast-group 225.0.0.101
!
```

- Loop-free Traditional Network. Loop-free Fabric.
- Cisco StackWise Virtual with unified system simplifies Layer 2 interworking between EVPN L2 VNI and traditional Layer 2 VLAN based networks
- Layer 2 Multi-home with All-Active supporting per-flow load-sharing and best-in-class redundancy

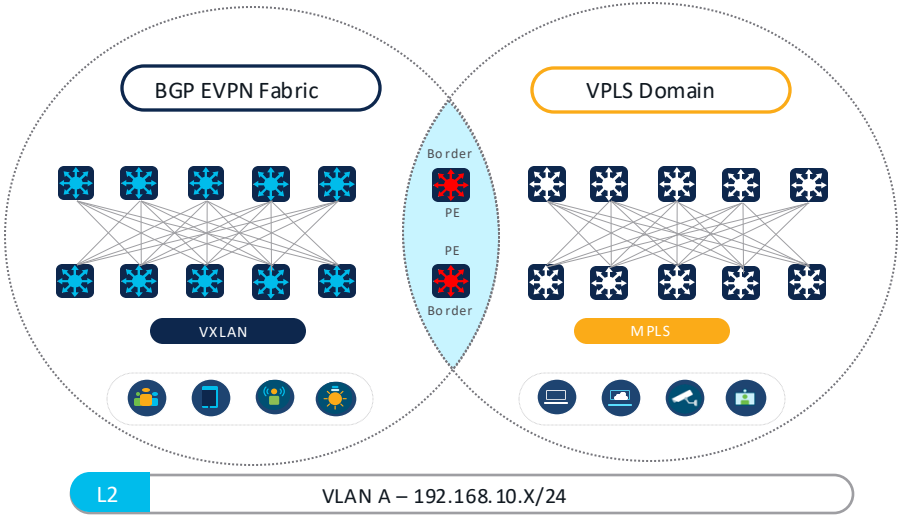
L2 VLAN Handoff




```
IP# sh mac address-table address aabb.cc80.7300
          Mac Address Table
------------------------------------------

Vlan    Mac Address      Type      Ports
----    -----------      --------  -----
  20    aabb.cc80.7300   DYNAMIC   Et3/0
Total Mac Addresses for this criterion: 1
```

```
Border# sh bgp l2vpn evpn aabb.cc80.7300
BGP routing table entry for [2][200:200][0][48][AABBCC807300][0][*]/20, version 54
Paths: (2 available, best #1, table evi_20)
  Not advertised to any peer
  Refresh Epoch 2
  Local
    172.168.1.2 (metric 21) (via default) from 172.168.2.1 (172.168.2.1)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      EVPN ESI: 00000000000000000000, Label1 20200
      Extended Community: RT:100:20 RT:200:200 ENCAP:8
      Originator: 172.168.1.2, Cluster list: 172.168.2.1
      rx pathid: 0, tx pathid: 0x0
      Updated on Jul 7 2023 11:48:00 EST
```

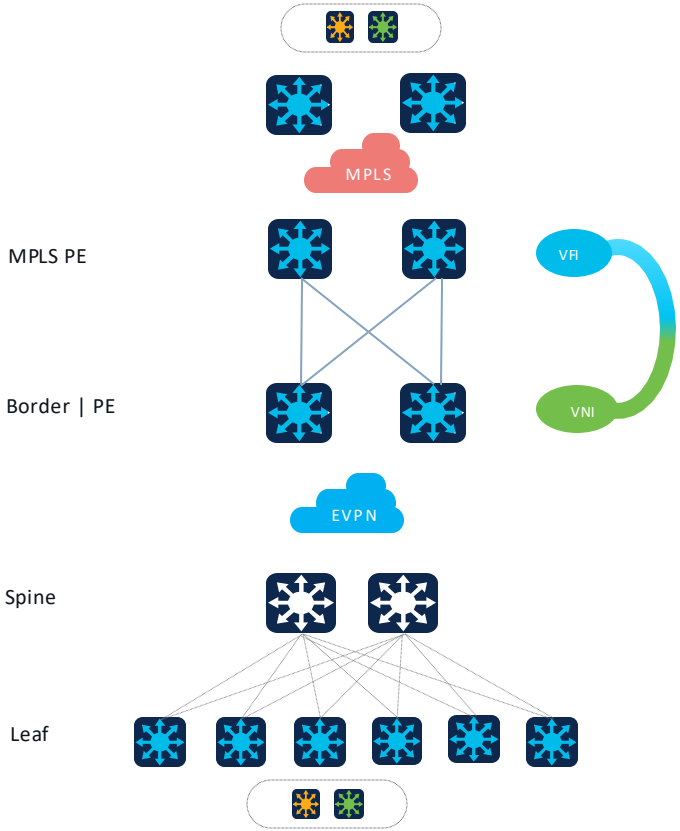
Interdomain L2 Extensions (Interworking)



Flexible Layer 2 Interworking

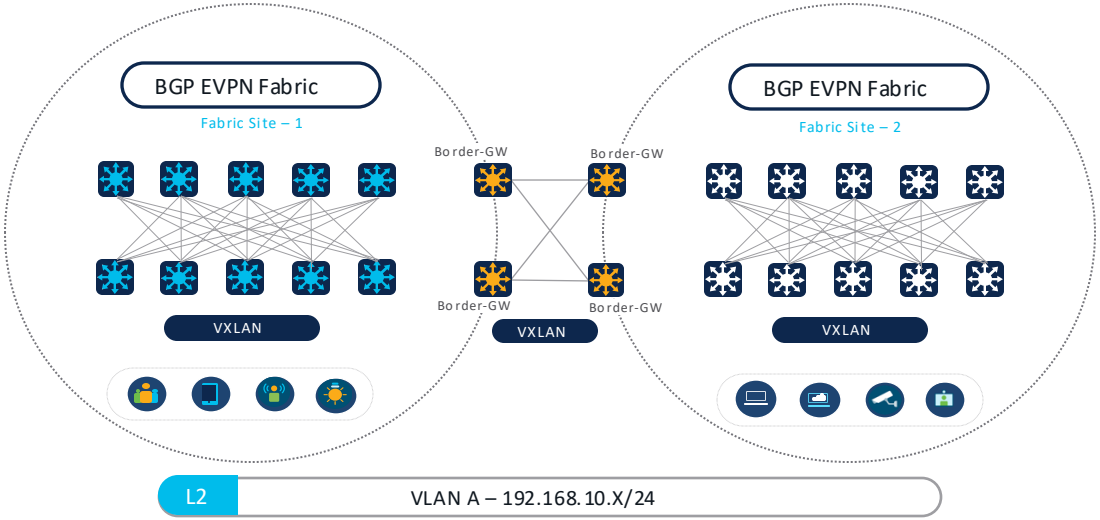
- Seamless VPLS to BGP EVPN VXLAN Layer 2 interworking function
- Two Catalyst 9000 Border design alternatives –
  - Shared Border/PE with integrated BGP EVPN and VPLS interworking
  - Dedicated Border with Layer 2 VLAN handoff to remote VPLS PE system
- Flexible Bridging-only, integrated Routed and Bridging interworking between EVPN and VPLS domains

L2 VPLS Handoff (Interworking)




```
Border:

l2vpn vfi context VPLS-VFI
vpn id 1
member 10.12.12.5 encapsulation mpls
!
vlan configuration 11
member access-vfi VPLS-VFI
member evpn-instance 1 vni 6000
!
```

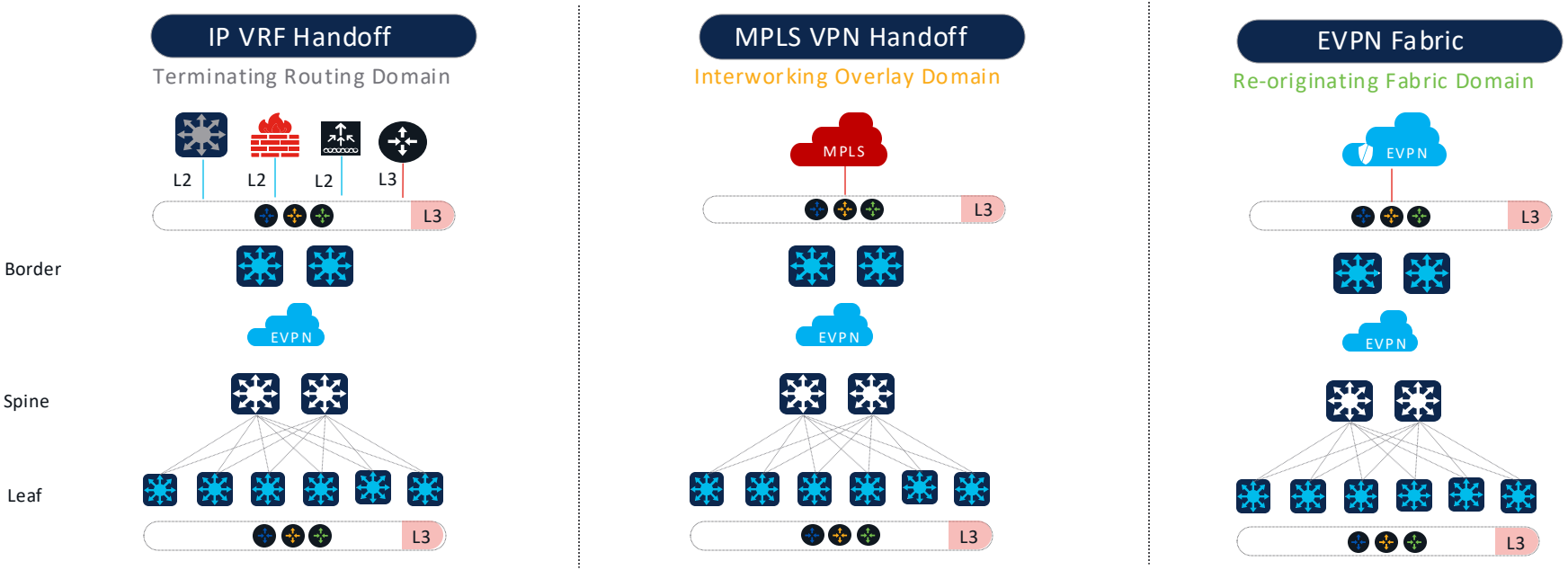
Multisite EVPN L2 Extensions (Re-Originate)



Hierarchical Layer 2 Architecture

- Structured and hierarchical end-to-end Layer 2 overlay network architecture
- Nexus 9K Multisite – Across geographic locations or sub-divided single large site
- Multisite EVPN fabric domains reduce fault-domain size with multi-tier broadcast control management
- Termination and re-origination for each Layer 2 overlay segments at Nexus 9K Border-Gateway

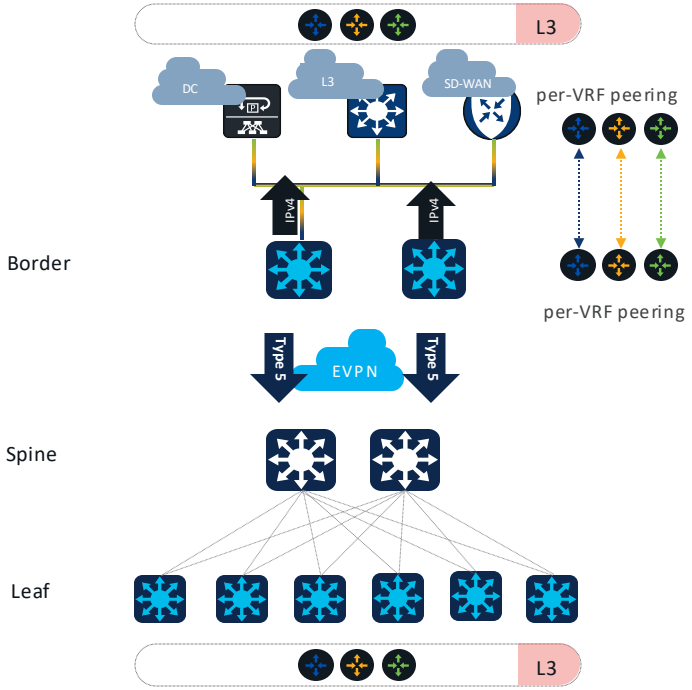
Layer – 3 Handoffs Alternatives



Integrated Extranet

- Transparent EVPN handoff to Layer 2 or Layer 3 to traditional underlay segmented networks
- Seamless multi-domain interworking at Border – IP, MPLS VPN, EoMPLS/VPLS, SD-WAN, etc.
- Extendable Unicast | Multicast support for IPv4 and IPv6 between EVPN to external domain
- Dedicated or collapsed system-role – Leaf, Spine, Border, Border-Leaf, Border-Spine

L3 Network Handoff (Terminate)

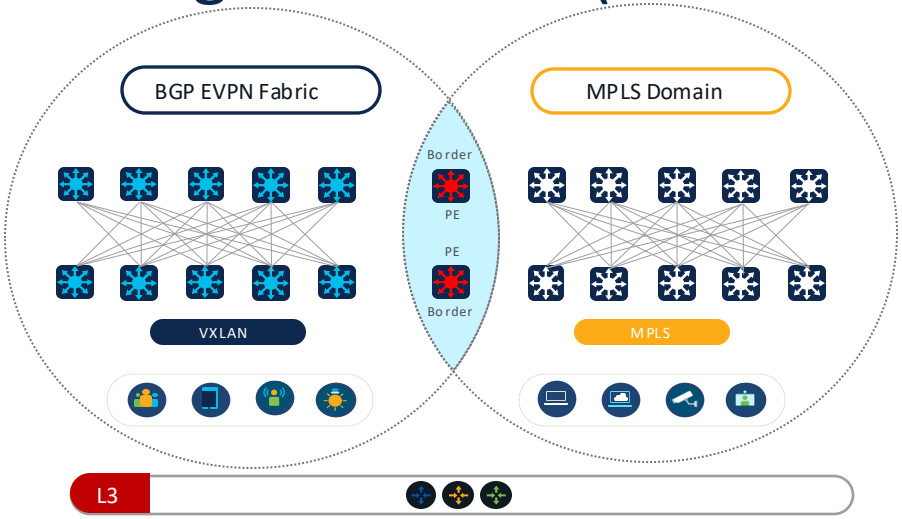



```
vrf definition green
 rd 101:101
 !
 address-family ipv4 unicast
  route-target 101:101
  route-target 101:101 stitching
!
interface Vlan 10
 vrf forwarding green
 ip address 192.168.1.2 255.255.255.252
!
router bgp 65535
 address-family ipv4 vrf green
   advertise l2vpn evpn
   neighbor 192.168.1.1 remote-as 65534
 !
```

L3 Domain Handoff

- End-to-End segmentation between Campus, DC, & SDWAN Domains
- Standard Multi-VRF handoff over L2 Trunk SVI, Layer 3 Sub-interface and more
- Integration to L3 services to Firewall, Fusion Router, etc.

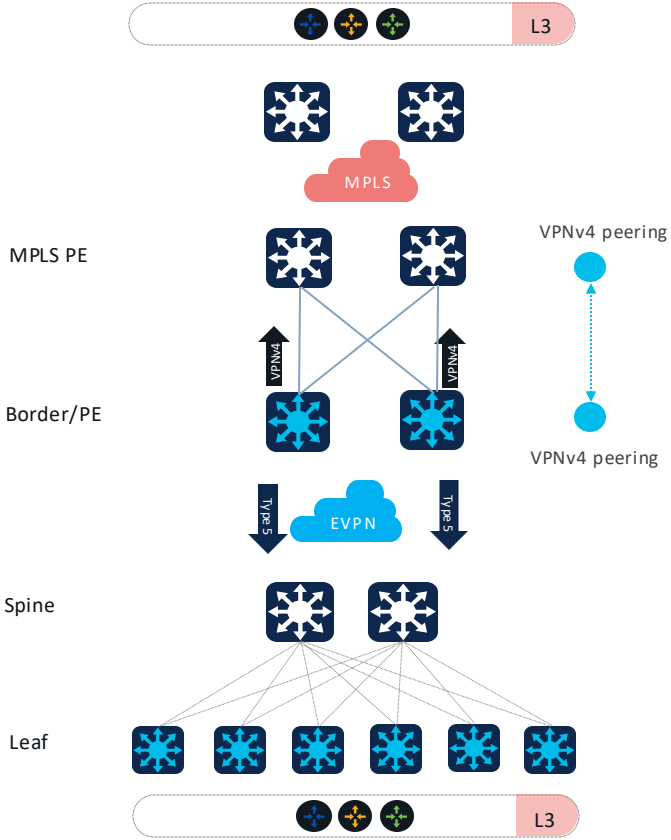
Interdomain L3 Segmentations (Interworking)



Flexible Layer 3 Interworking

- Integrated MPLS VPN to BGP EVPN VXLAN Layer 3 interworking function as EVPN Border + MPLS PE
- Independent control-plane and data-plane, yet tightly integrated for end-to-end transparent segmentation
- Seamless IPv4 and IPv6 overlay network interworking with VPNv4/VPNv6
- Transparent Multicast interworking support between EVPN TRM domain to MPLS mVPN

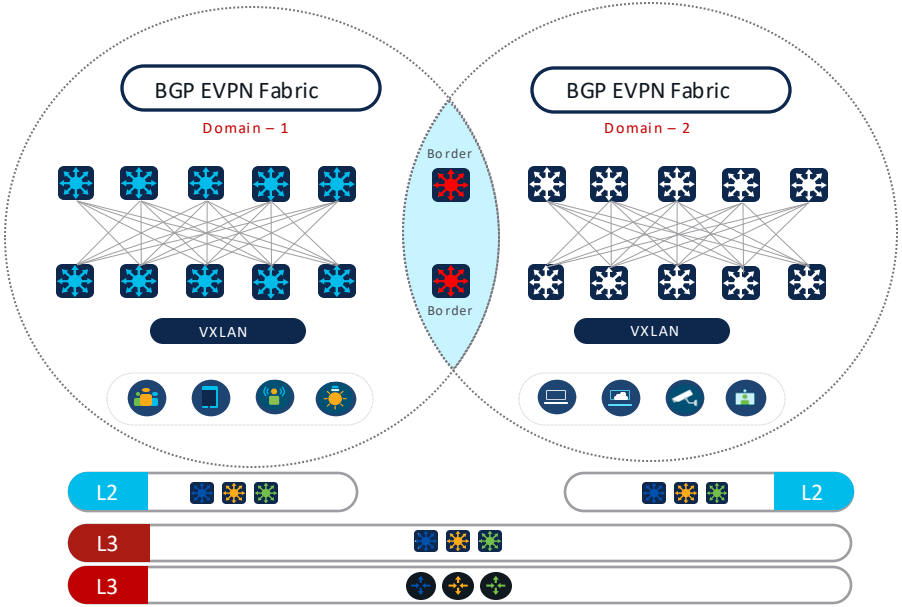
Interdomain L3 Segmentations (Interworking)




```
Boder:

!
mpls label mode all-vrfs protocol all-afs per-vrf
!
router bgp 65001
neighbor 192.168.101.10 remote-as 65001
neighbor 172.168.1.1 remote-as 65001
!
address-family vpnv4 unicast
 import l2vpn evpn re-originate
 neighbor 192.168.101.10 activate
 neighbor 192.168.101.10 send-community both
 neighbor 192.168.101.10 route-reflector-client
 neighbor 192.168.101.10 next-hop-self all
!
address-family l2vpn evpn
 import vpnv4 unicast re-originate
 neighbor 172.168.1.1 activate
 neighbor 172.168.1.1 send-community both
 neighbor 172.168.1.1 next-hop-self all
```

- Simplified command-line syntax to “stitch” routing-domain between MPLS VPNv4/v6 and BGP EVPN address-families
- Flexibility to maintain or rewrite Route-Targets and re-originate on each side domain to support backward compatibility
- Catalyst 9000 Border + PE System mode alternatives – StackWise Virtual or Standalone modes

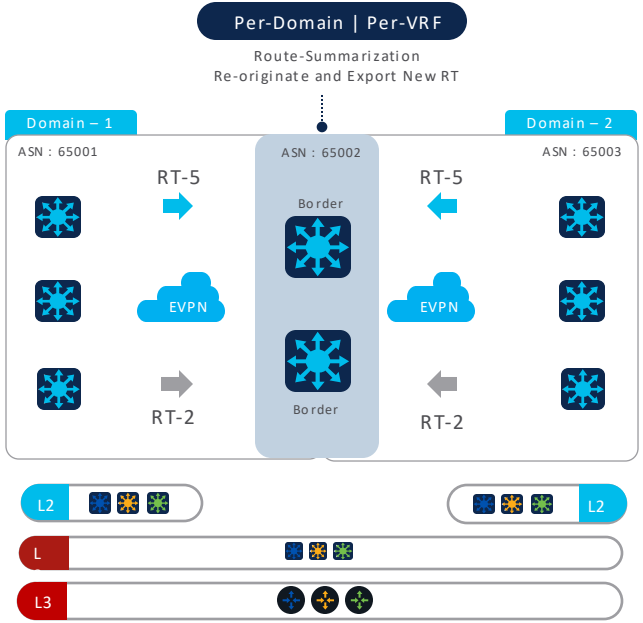
Multi-Domain BGP EVPN Fabric (Re-Originate)



Multi-Domain Layer 3 Extensions

Re-originating Layer 3 BGP EVPN fabric at Border to support multi-domain fabric architecture
Isolated BGP control-plane and VXLAN data-plan within each fabric domains
Border provides overlay network prefix route-summarization, RT re-origination and export as self next-hop
End-to-End non-broadcast routed Layer 2 Unicast IPv4/IPv6 support across fabric domain. BUM, Non-IP and Mobility not supported.

Multi-Domain Border Route Re-origination




```
!
vrf definition green
 rd 192.168.255.1:101
!
address-family ipv4 unicast
 route-target 65001:101 stitching
 route-target import 65001:1001 stitching
!
router bgp 65001
!
address-family l2vpn evpn
rewrite-evpn-rt-asn
!
address-family ipv4 unicast vrf green
 aggregate-address <NETWORK> <MASK> summary-only
 aggregate-address <NETWORK> <MASK> summary-only
```

Per-VRF IPv4/v6 Route-Summarization at Border

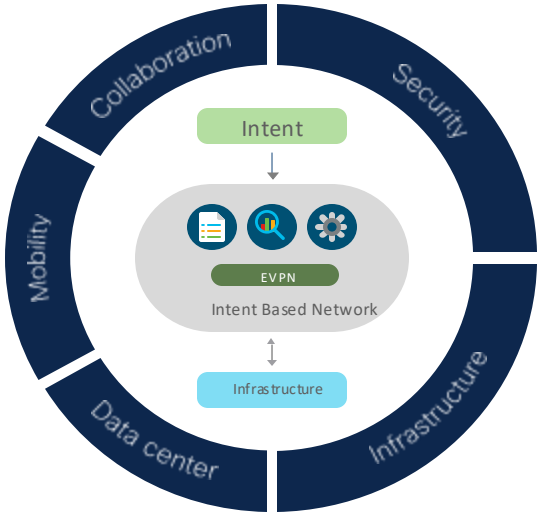
Per EVPN domain route summarization at the Border system

Simple and isolated fault domain with scalable Layer 3 segmented multi-domain fabric extension

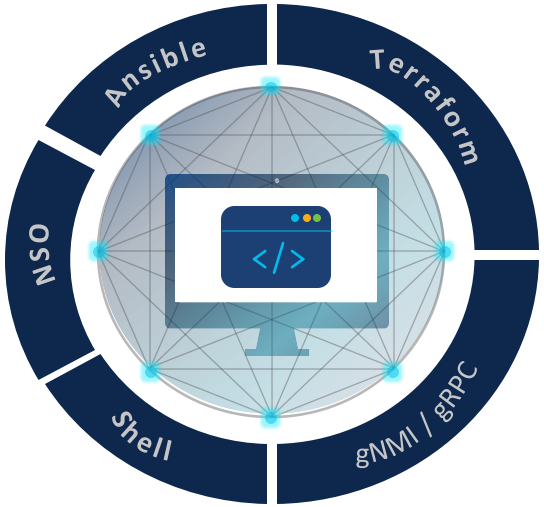
Fabric Deployment Options

Cisco Enterprise BGP EVPN Solution

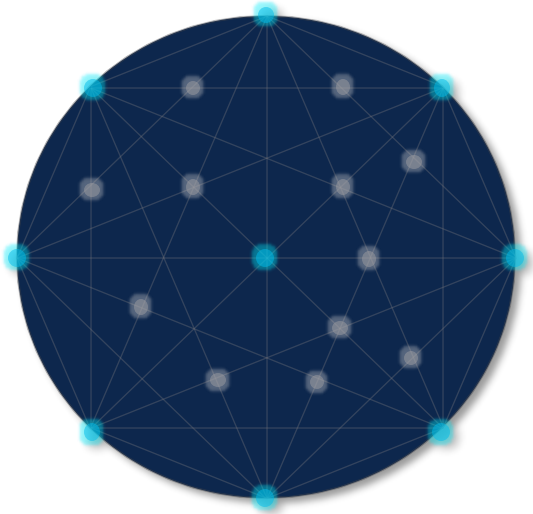
Intent-Based*



Programmable



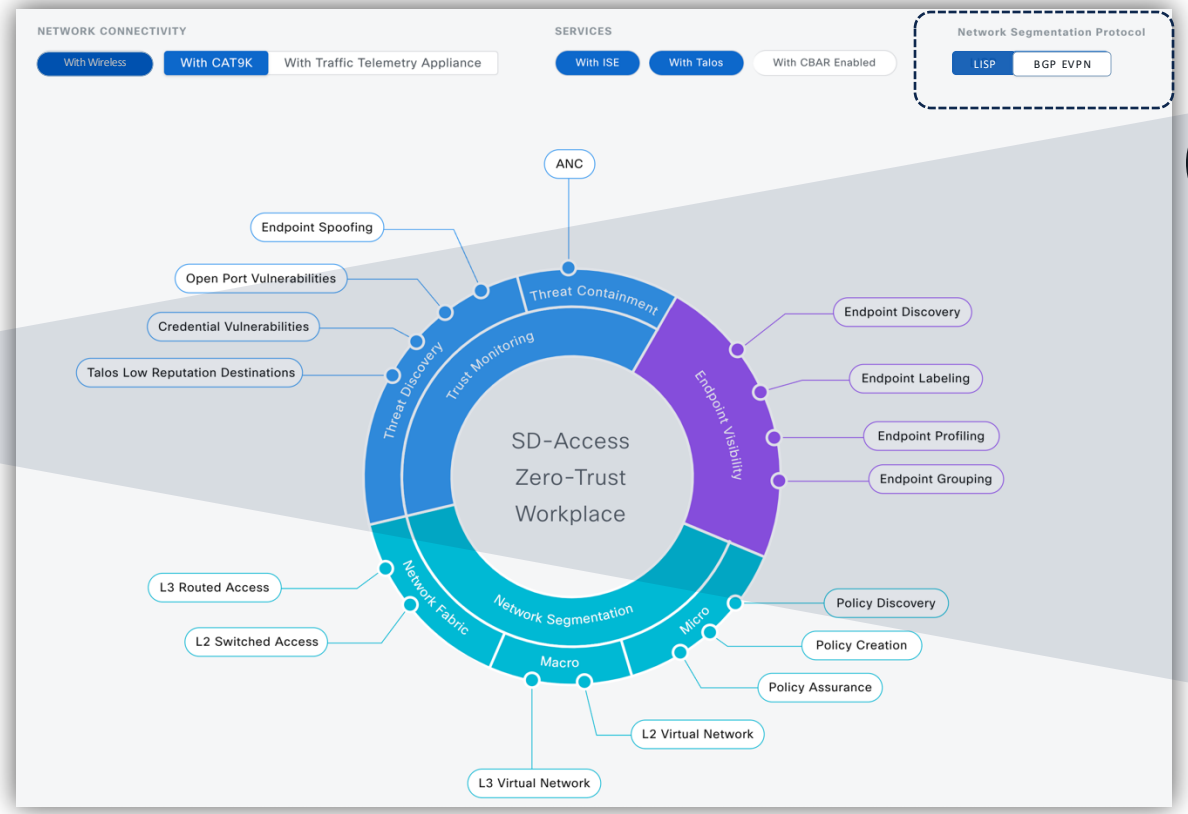
Do-It-Yourself



* Private Beta

Choose Your Fabric Control-Plane *(LISP or BGP EVPN)*

Single Data-Plane Vxlan



IBN based workflow

Automation

Assurance

Macro/Micro Segmentation

Seamless experience irrespective of choice of protocol

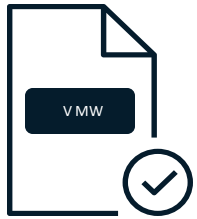
- Either LISP or BGP EVPN Control Plane

Flexible Controller Options

Cisco Catalyst Center

PHYSICAL

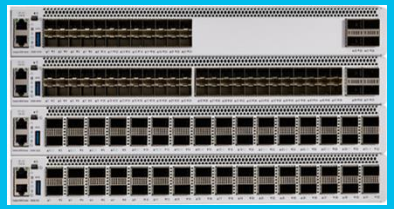
VIRTUAL



Physical Appliance	Virtual Appliance	Cloud
DN2-HW-APL DN2-HW-APL-L DN2-HW-APL-XL	DN2-SW-APL Minimum Requirement: Core : 88 vCPU RAM : 256G Storage : 500G	Amazon Web Services Minimum Requirement: Instance-Type : r5a.8xlarge Core : 32 vCPU RAM : 256G Storage : 4T Storage Type : GP3 EBS

Private Beta: 2.3.7.6

Complete Catalyst Solution



CORE

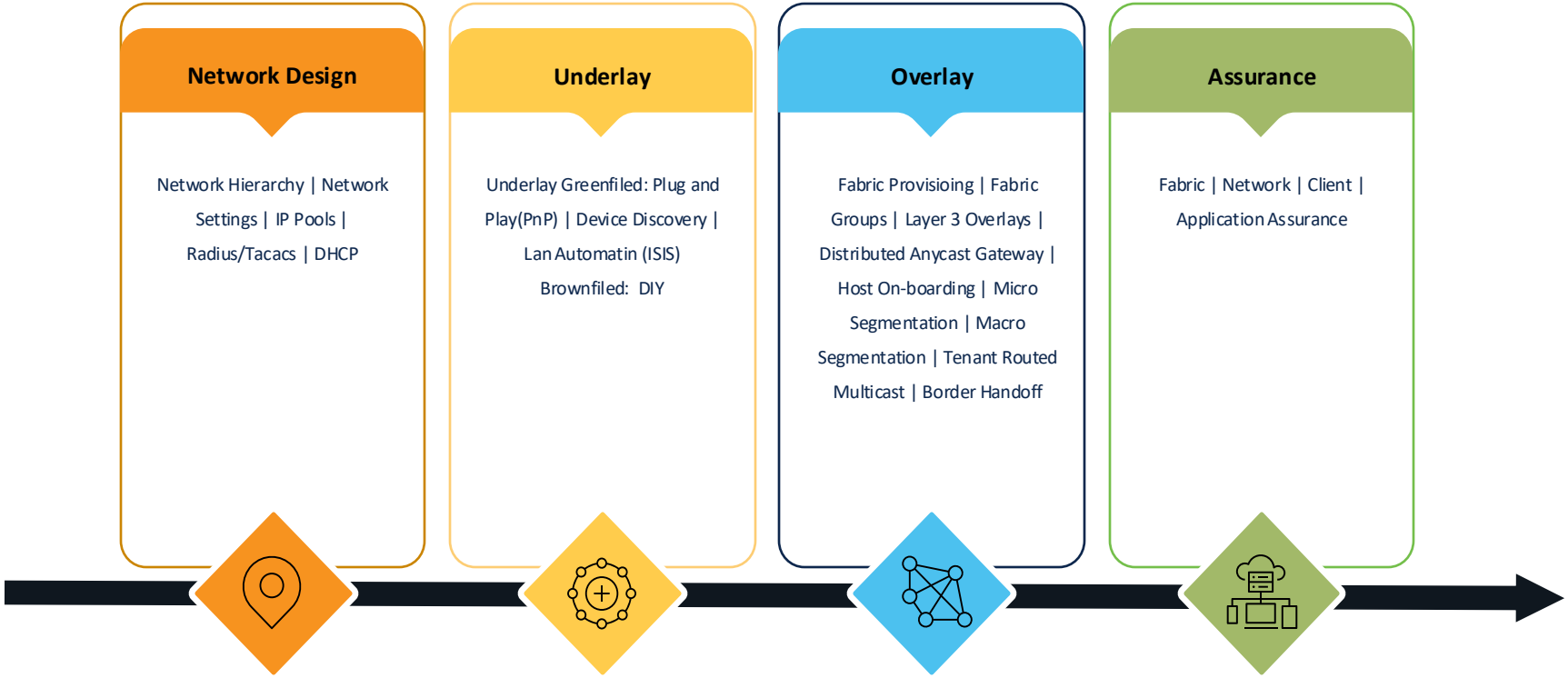
Catalyst 9500 Non-High-Performance
Catalyst 9500 High-Performance
Catalyst 9600 Sup-1

IOS-XE 17.12.X

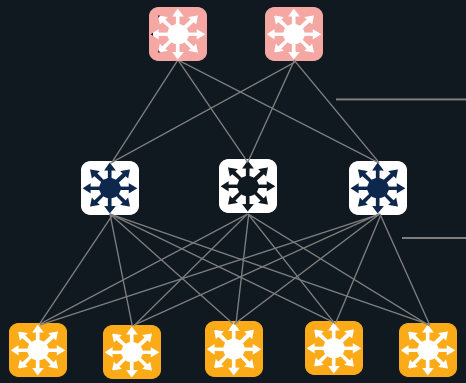
ACCESS

Catalyst 9300L/LM
Catalyst 9300/9300B
Catalyst 9300-X
Catalyst 9400 Sup-1
Catalyst 9400-X Sup-2

Enhanced User experience

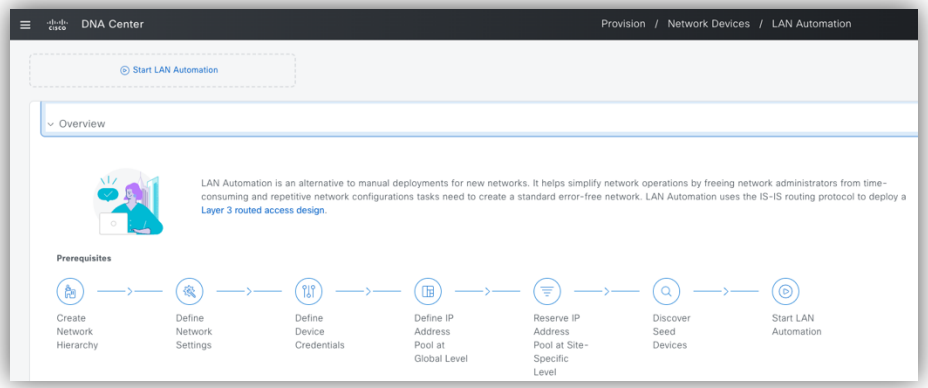


Underlay Provisioning



Build your Underlay

LAN Automation



DIY

DNAC Template Editor

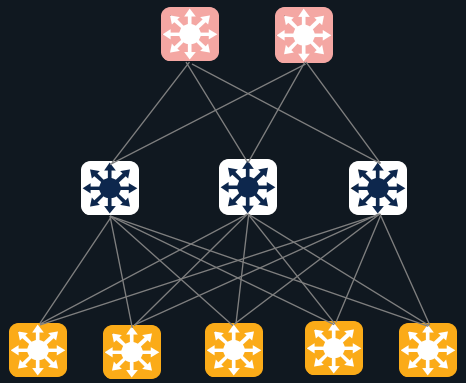
Programmable

CLI

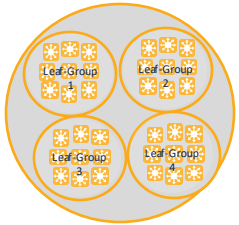
EIGRP | OSPF | ISIS

SDA with EVPN: BGP underlay is not supported

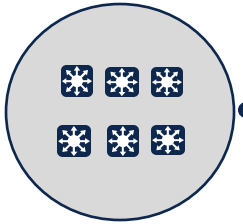
Fabric Roles & Fabric Groups



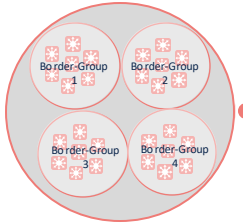
Fabric Groups



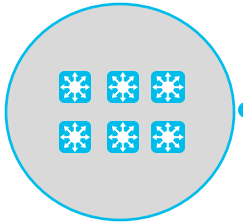
Leaf Groups



Spine Group



Border Groups

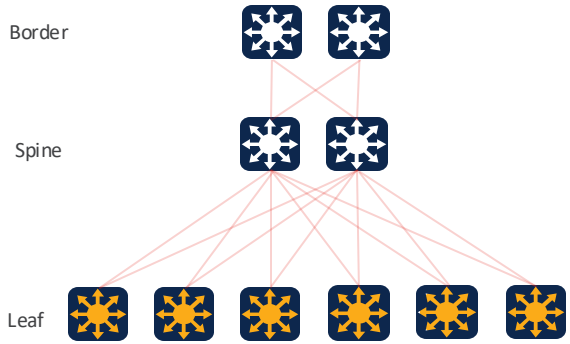


Border Spine Group

Spine Group: 1 per fabric site

SD-Access with BGP EVPN: Supported Underlay's

Layer 3 Access



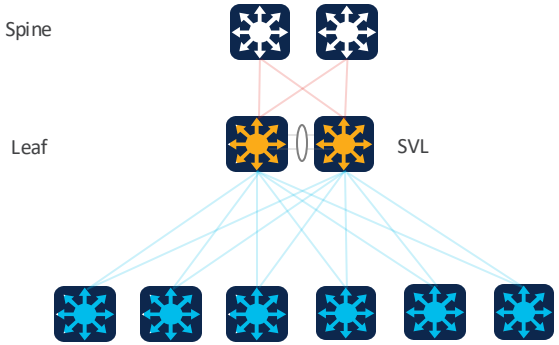
Leaf Layer – Access

Spine/RR – Direct | Multi-hop

Overlay IP gateway

L2 | L3 Overlay support | Multicast

Cisco StackWise-Virtual



Leaf Layer – Access

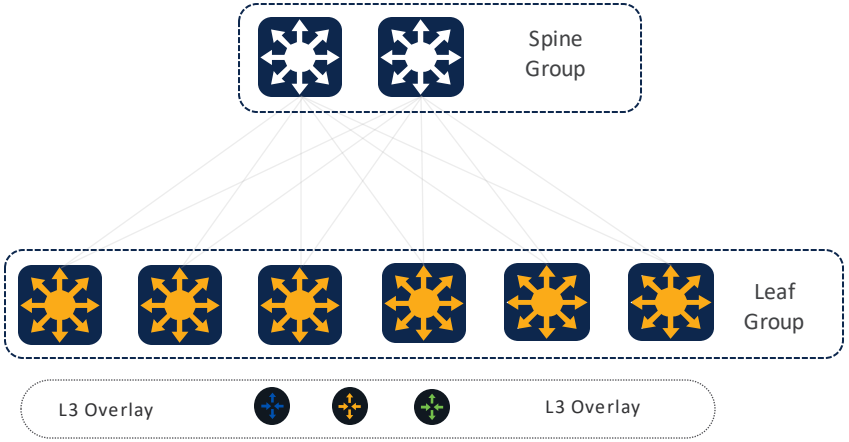
Spine/RR – Direct | Multi-hop

Overlay IP gateway

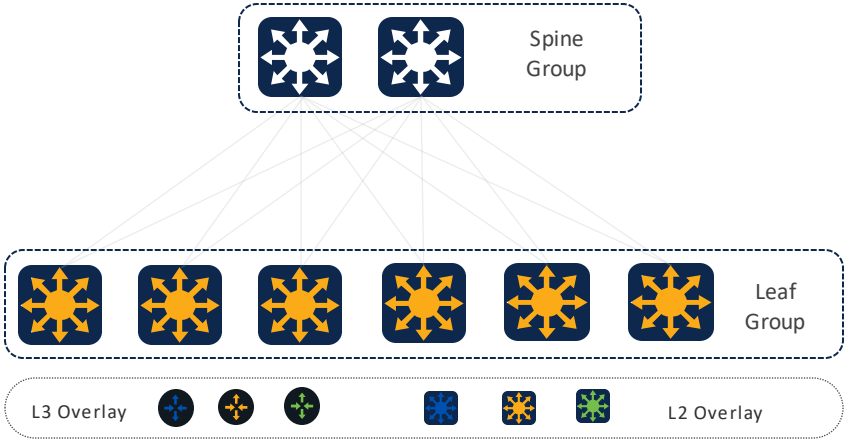
L2 | L3 Overlay support | Multicast

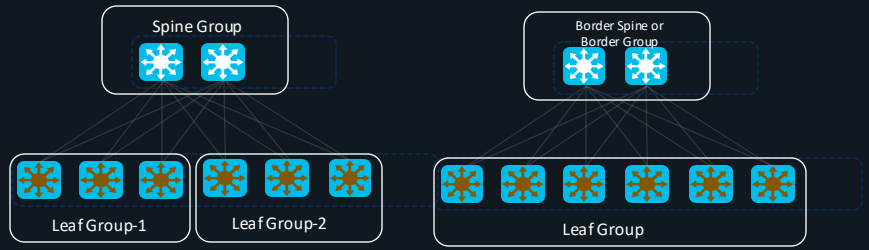
SD-Access with BGP EVPN: Overlay Topologies

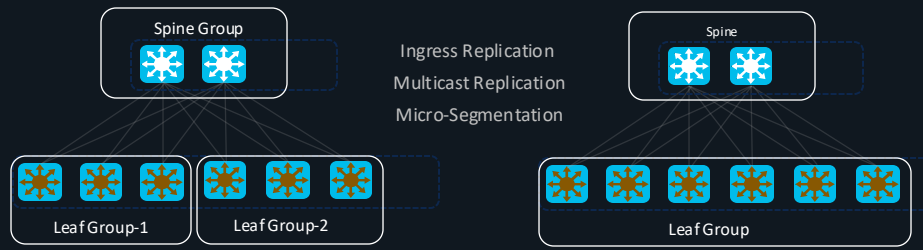
Layer 3 Overlays



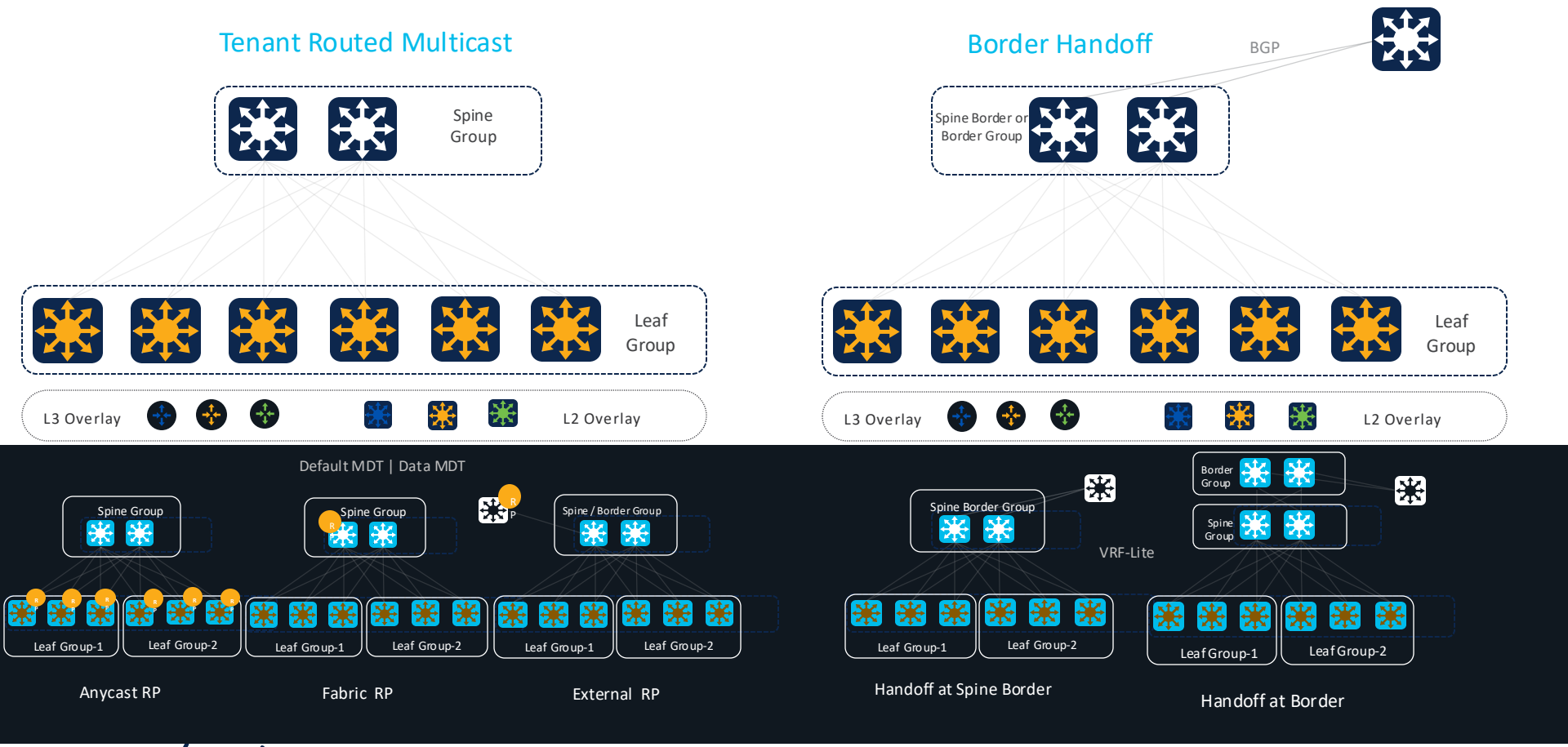
Distributed Anycast Gateway



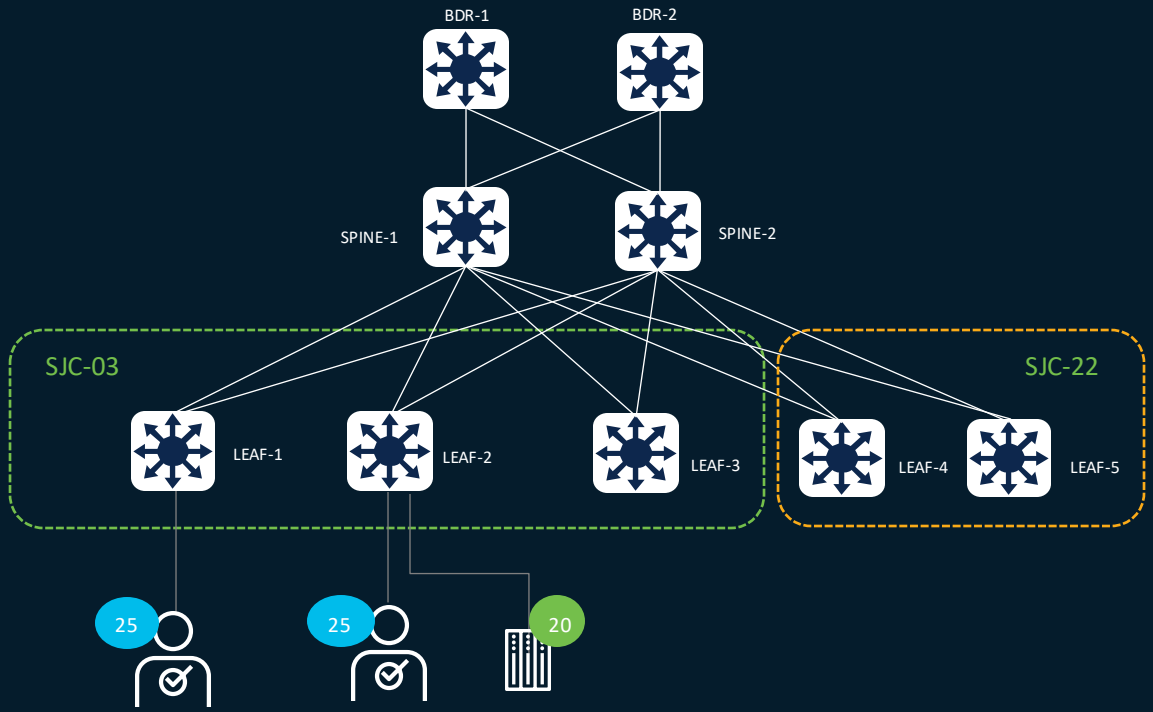




SD-Access with BGP EVPN: TRM & Border Handoff



DEMO



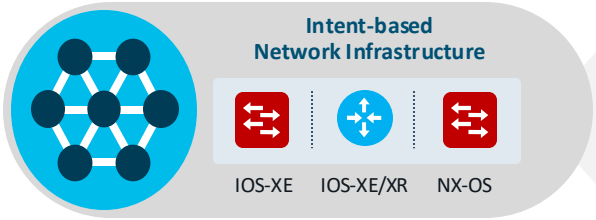
SD-Access with BGP EVPN
Catalyst Center and IOS-XE

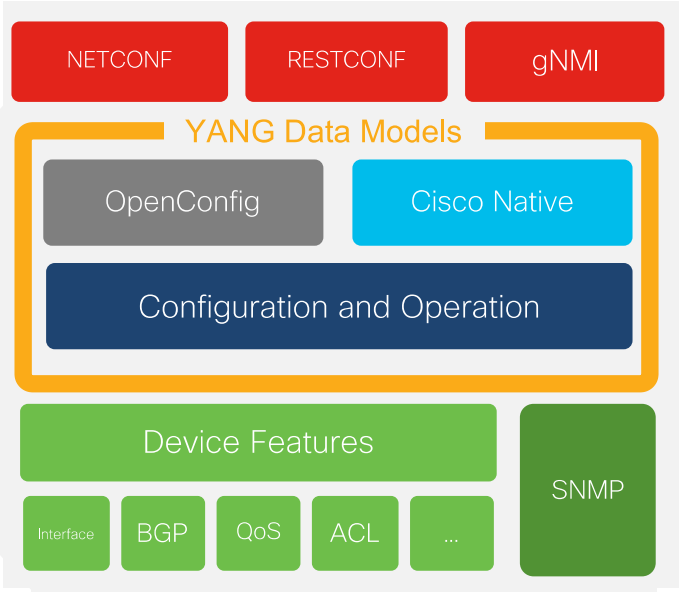
Early Field Trial

IOS XE Programmability

The NETCONF, RETCONF and gNMI are programmatic interfaces that provide additional methods for interfacing with the IOS XE device

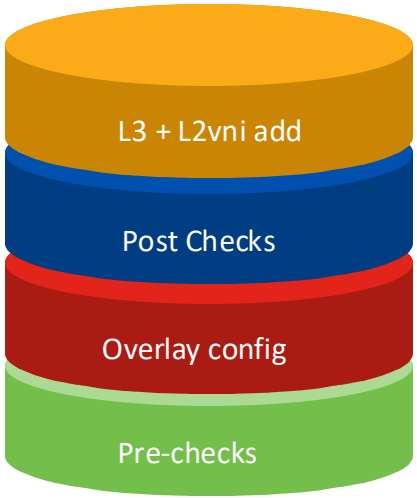
YANG data models define the data that is available for configuration and streaming telemetry





IETF
OPENCONFIG
IEEE
CISCO

EVPN Ansible – Solution Playbook



Same playbook to add L3/L2 VNI's
Eg: Add one or multiple L3/l2vni using same playbook

Framework for post-check
Eg: BGP status up/down, overlay ping checks

Solution level deployment
Eg: Ipv4 + Ipv6 + TRM in a single playbook

Framework for pre-checks
Eg: License check, underlay reachability check

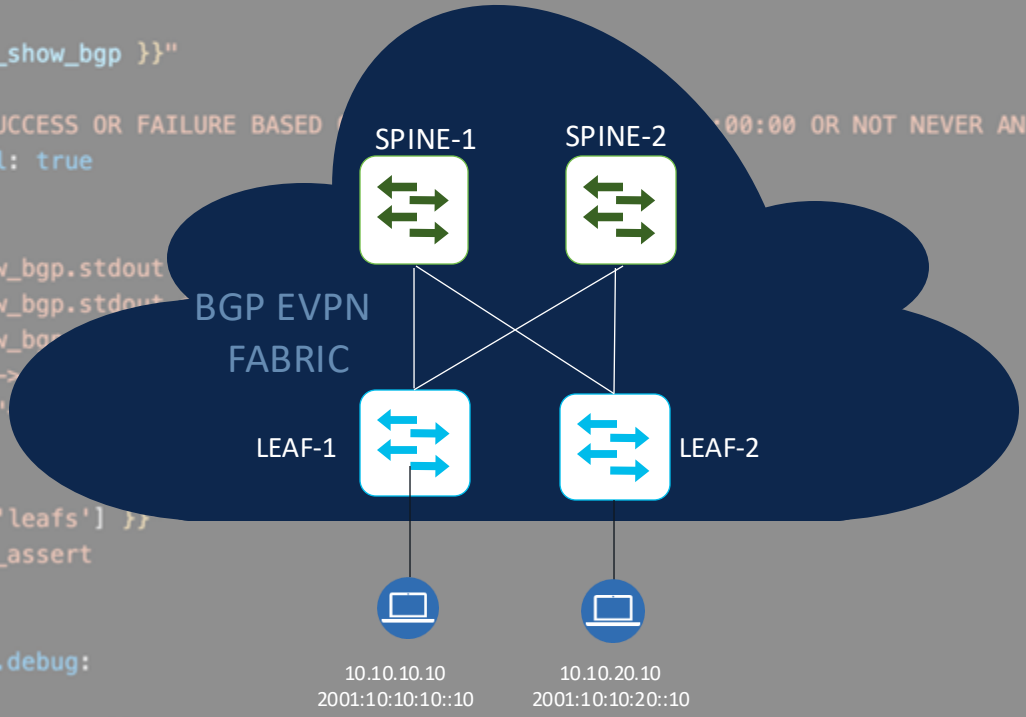
Simple to Use

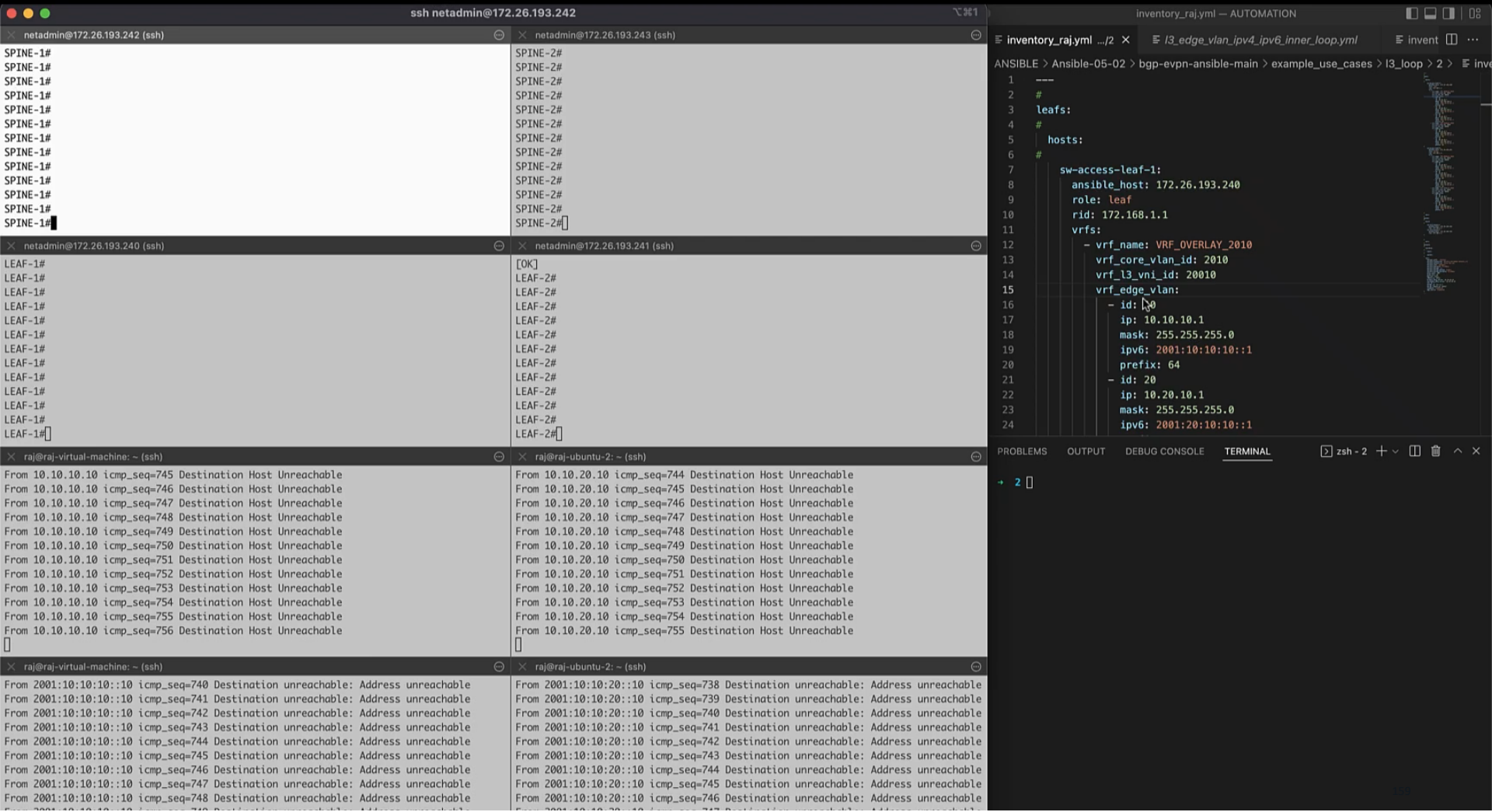
- Single playbook for complete solution
- Single inventory file to add Leaf/Spine variables

```
- name: SHOW IP BGP L2VPN EVPN SUMMARY
  any_errors_fatal: true
  cisco.ios.ios_command:
    commands:
      - "show ip bgp l2vpn evpn summary |
  register: after_show_bgp
#
- name: DEBUG
  ansible.builtin.debug:
    msg:
      - "{{ after_show_bgp }}"
#
- name: "ASSERT SUCCESS OR FAILURE BASED
  any_errors_fatal: true
  assert:
    that:
      - after_show_bgp.stdout
      - after_show_bgp.stdou
      - after_show_bo
    fail_msg: "--->
    success_msg: "
    quiet: no
  with_items:
    - "{{ groups['leafs'] }}
  register: after_assert
#
- name: DEBUG
  ansible.builtin.debug:
    msg:
      - "{{ after_assert }}"
```

DEMO

BGP EVPN Ansible Automation




ssh netadmin@172.26.193.242
netadmin@172.26.193.242 (ssh)
SPINE-1#
netadmin@172.26.193.243 (ssh)
SPINE-2#
netadmin@172.26.193.240 (ssh)
LEAF-1#
netadmin@172.26.193.241 (ssh)
[OK]
LEAF-2#
raj@raj-virtual-machine: ~ (ssh)
From 10.10.10.10 icmp_seq=745 Destination Host Unreachable
From 10.10.10.10 icmp_seq=746 Destination Host Unreachable
From 10.10.10.10 icmp_seq=747 Destination Host Unreachable
From 10.10.10.10 icmp_seq=748 Destination Host Unreachable
From 10.10.10.10 icmp_seq=749 Destination Host Unreachable
From 10.10.10.10 icmp_seq=750 Destination Host Unreachable
From 10.10.10.10 icmp_seq=751 Destination Host Unreachable
From 10.10.10.10 icmp_seq=752 Destination Host Unreachable
From 10.10.10.10 icmp_seq=753 Destination Host Unreachable
From 10.10.10.10 icmp_seq=754 Destination Host Unreachable
From 10.10.10.10 icmp_seq=755 Destination Host Unreachable
From 10.10.10.10 icmp_seq=756 Destination Host Unreachable
raj@raj-ubuntu-2: ~ (ssh)
From 10.10.20.10 icmp_seq=744 Destination Host Unreachable
From 10.10.20.10 icmp_seq=745 Destination Host Unreachable
From 10.10.20.10 icmp_seq=746 Destination Host Unreachable
From 10.10.20.10 icmp_seq=747 Destination Host Unreachable
From 10.10.20.10 icmp_seq=748 Destination Host Unreachable
From 10.10.20.10 icmp_seq=749 Destination Host Unreachable
From 10.10.20.10 icmp_seq=750 Destination Host Unreachable
From 10.10.20.10 icmp_seq=751 Destination Host Unreachable
From 10.10.20.10 icmp_seq=752 Destination Host Unreachable
From 10.10.20.10 icmp_seq=753 Destination Host Unreachable
From 10.10.20.10 icmp_seq=754 Destination Host Unreachable
From 10.10.20.10 icmp_seq=755 Destination Host Unreachable
raj@raj-virtual-machine: ~ (ssh)
From 2001:10:10:10::10 icmp_seq=740 Destination unreachable: Address unreachable
From 2001:10:10:10::10 icmp_seq=741 Destination unreachable: Address unreachable
From 2001:10:10:10::10 icmp_seq=742 Destination unreachable: Address unreachable
From 2001:10:10:10::10 icmp_seq=743 Destination unreachable: Address unreachable
From 2001:10:10:10::10 icmp_seq=744 Destination unreachable: Address unreachable
From 2001:10:10:10::10 icmp_seq=745 Destination unreachable: Address unreachable
From 2001:10:10:10::10 icmp_seq=746 Destination unreachable: Address unreachable
From 2001:10:10:10::10 icmp_seq=747 Destination unreachable: Address unreachable
From 2001:10:10:10::10 icmp_seq=748 Destination unreachable: Address unreachable
raj@raj-ubuntu-2: ~ (ssh)
From 2001:10:10:20::10 icmp_seq=738 Destination unreachable: Address unreachable
From 2001:10:10:20::10 icmp_seq=739 Destination unreachable: Address unreachable
From 2001:10:10:20::10 icmp_seq=740 Destination unreachable: Address unreachable
From 2001:10:10:20::10 icmp_seq=741 Destination unreachable: Address unreachable
From 2001:10:10:20::10 icmp_seq=742 Destination unreachable: Address unreachable
From 2001:10:10:20::10 icmp_seq=743 Destination unreachable: Address unreachable
From 2001:10:10:20::10 icmp_seq=744 Destination unreachable: Address unreachable
From 2001:10:10:20::10 icmp_seq=745 Destination unreachable: Address unreachable
From 2001:10:10:20::10 icmp_seq=746 Destination unreachable: Address unreachable
inventory_raj.yml — AUTOMATION
inventory_raj.yml .../2
l3_edge_vlan_ipv4_ipv6_inner_loop.yml
invent
ANSIBLE > Ansible-05-02 > bgp-evpn-ansible-main > example_use_cases > l3_loop > 2 > inv
---
#
leafs:
#
hosts:
#
sw-access-leaf-1:
ansible_host: 172.26.193.240
role: leaf
rid: 172.168.1.1
vrfs:
- vrf_name: VRF_OVERLAY_2010
vrf_core_vlan_id: 2010
vrf_l3_vni_id: 20010
vrf_edge_vlan:
- id: 10
ip: 10.10.10.1
mask: 255.255.255.0
ipv6: 2001:10:10:10::1
prefix: 64
- id: 20
ip: 10.20.10.1
mask: 255.255.255.0
ipv6: 2001:20:10:10::1
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
zsh - 2
→ 2

EVPN Ansible – Feature + Solution Playbook

playbook_access_add_preview.yml	adding L2VNI and L3VNI
playbook_access_incremental_commit.yml	initial commit for release/2.x.x
playbook_access_incremental_preview.yml	initial commit for release/2.x.x
playbook_cleanup.yml	initial commit for release/2.x.x
playbook_dhcp_add_commit.yml	adding L2VNI and L3VNI
playbook_dhcp_add_preview.yml	adding L2VNI and L3VNI
playbook_dhcp_delete_commit.yml	dhcp incremental commit
playbook_dhcp_delete_preview.yml	dhcp incremental commit
playbook_output.yml	fix playbook_output
playbook_overlay_commit.yml	adding L2VNI and L3VNI
playbook_overlay_delete_commit.yml	ipv6_incremental
playbook_overlay_delete_generate.yml	initial commit for release/2.x.x
playbook_overlay_delete_ipv6_commit.yml	adding L2VNI and L3VNI
playbook_overlay_delete_ipv6_generate.yml	adding L2VNI and L3VNI
playbook_overlay_delete_ipv6_preview.yml	adding L2VNI and L3VNI
playbook_overlay_delete_preview.yml	initial commit for release/2.x.x
playbook_overlay_incremental_commit.yml	adding L2VNI and L3VNI
playbook_overlay_incremental_generate.yml	adding L2VNI and L3VNI
playbook_overlay_incremental_ipv6_commit.yml	adding L2VNI and L3VNI
playbook_overlay_incremental_ipv6_generate.yml	adding L2VNI and L3VNI
playbook_overlay_incremental_ipv6_preview.yml	ipv6_incremental
playbook_overlay_incremental_preview.yml	adding L2VNI and L3VNI
playbook_overlay_precheck.yml	initial commit for release/2.x.x
playbook_overlay_preview.yml	adding L2VNI and L3VNI

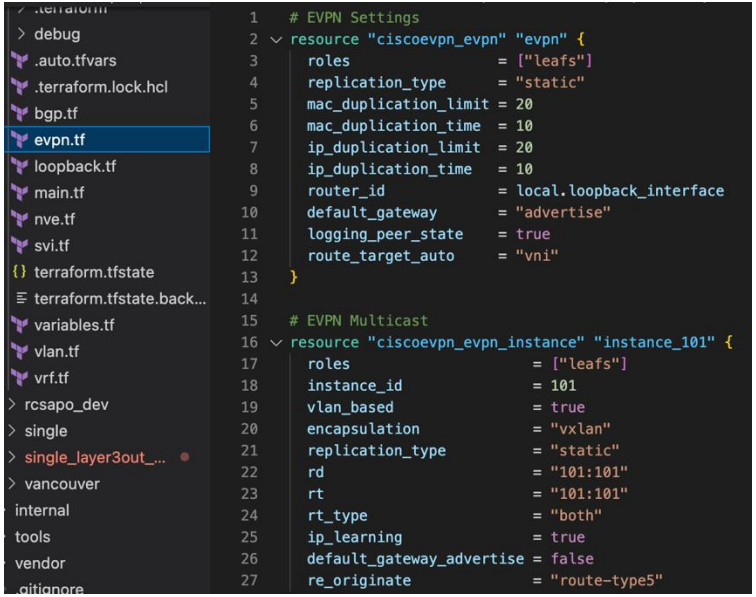
Feature specific Playbooks

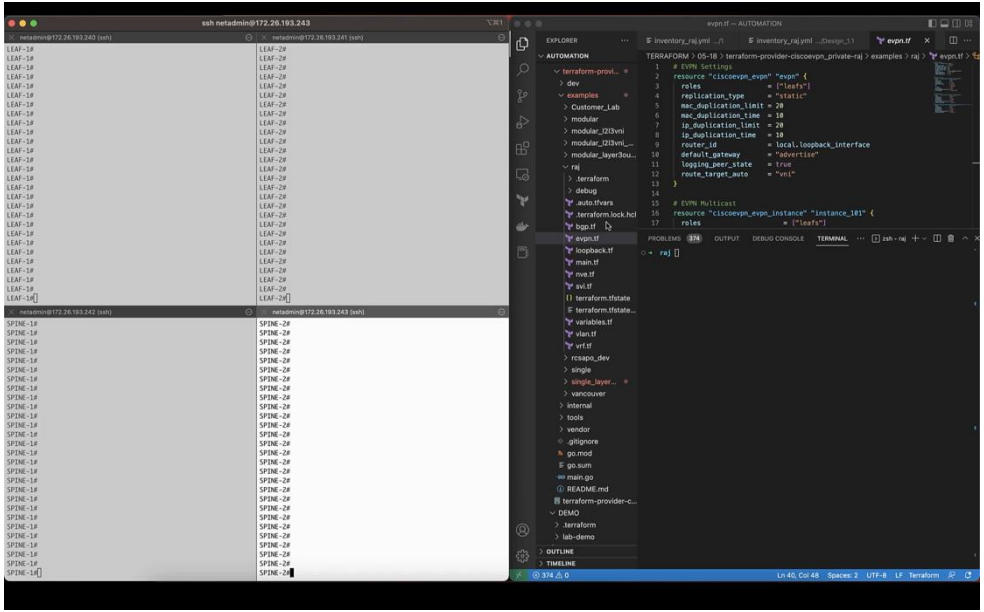
Add/remove a feature

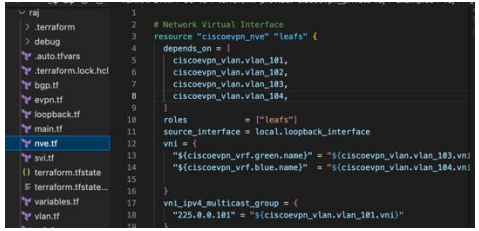
Get playbooks below

[Ansible Playbooks](https://github.com/Cat9kEVPN/cat9k-evpn-ansible)
(https://github.com/Cat9kEVPN/cat9k-evpn-ansible)

EVPN Automation with Terraform







[Terraform Provider](https://registry.terraform.io/providers/robertcsapo/ciscoevpn/1.0.1)
(https://registry.terraform.io/providers/robertcsapo/ciscoevpn/1.0.1)

[Terraform Examples](https://github.com/netascode/terraform-iosxe-evpn-examples)
(https://github.com/netascode/terraform-iosxe-evpn-examples)

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How

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4. Enter messages/questions in the Webex space

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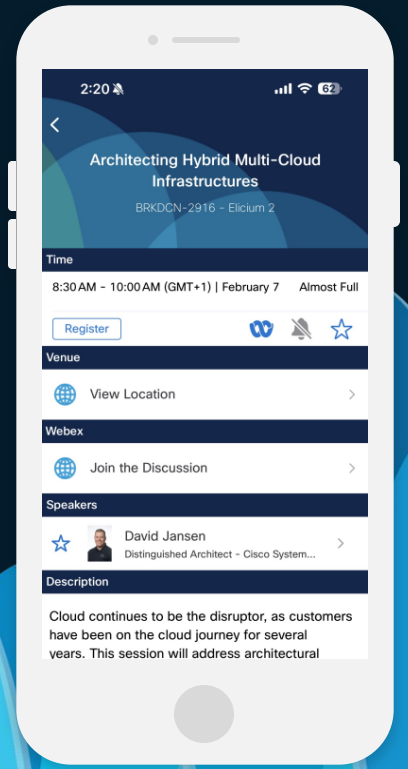

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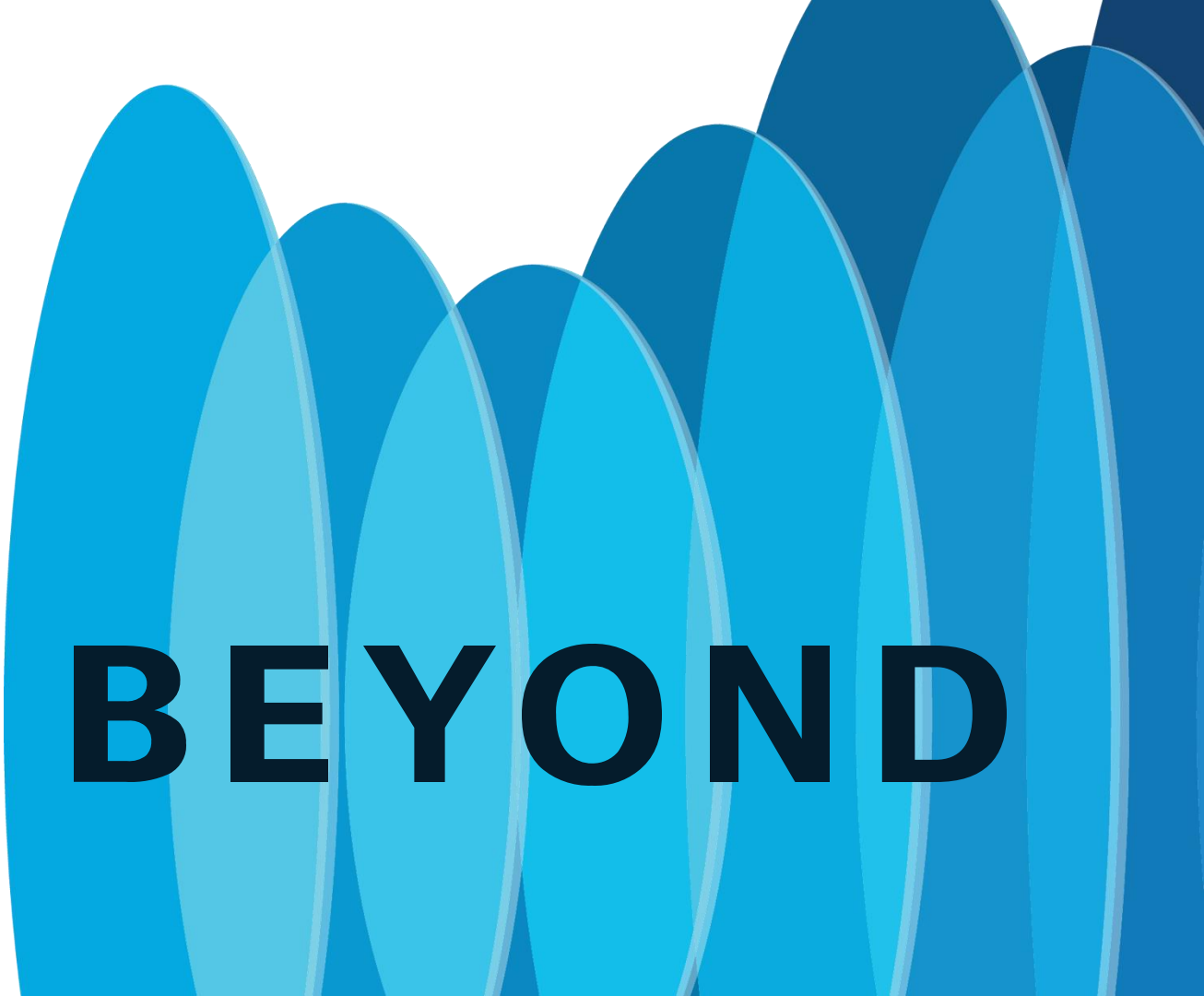

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