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The bridge to possible

Designing seamless integration between Campus BGP EVPN and External Domains

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CCDE 2013::60

BRKENS-2050

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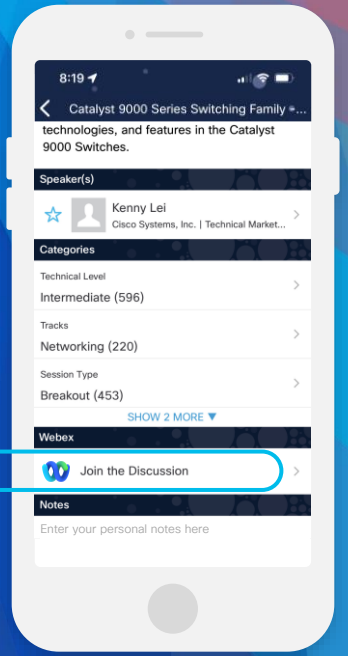

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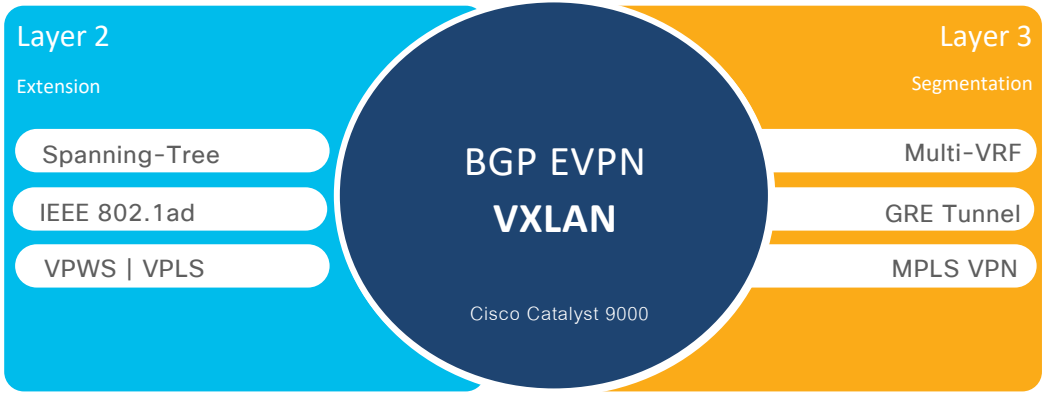
Agenda

- Introduction
- Enterprise EVPN Reference Architecture
- External Fabric Domain Hand-off
  Terminate | Interworking | Re-Originate
- Layer-2 External Domain Handoff
- Layer-3 External Domain Handoff
- Border Network Extensions
- Catalyst 9000 EVPN Reference



EVPN Evolution

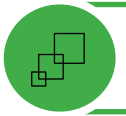
- **Product transition drives architecture transitions**
- **Convergence of traditional L2 overlay to simplified and scalable fabric**
- **Transition classic L3 overlays to enterprise-grade scalable fabric**
- **Unified end-to-end common fabric architecture reducing cost and complexity**

Enterprise Campus BGP EVPN Drivers

Industry Standard

One Fabric Architecture

Proven and Scalable



Hierarchical Fabric Domain

Flexible Overlay

Multi-vendor IT strategy

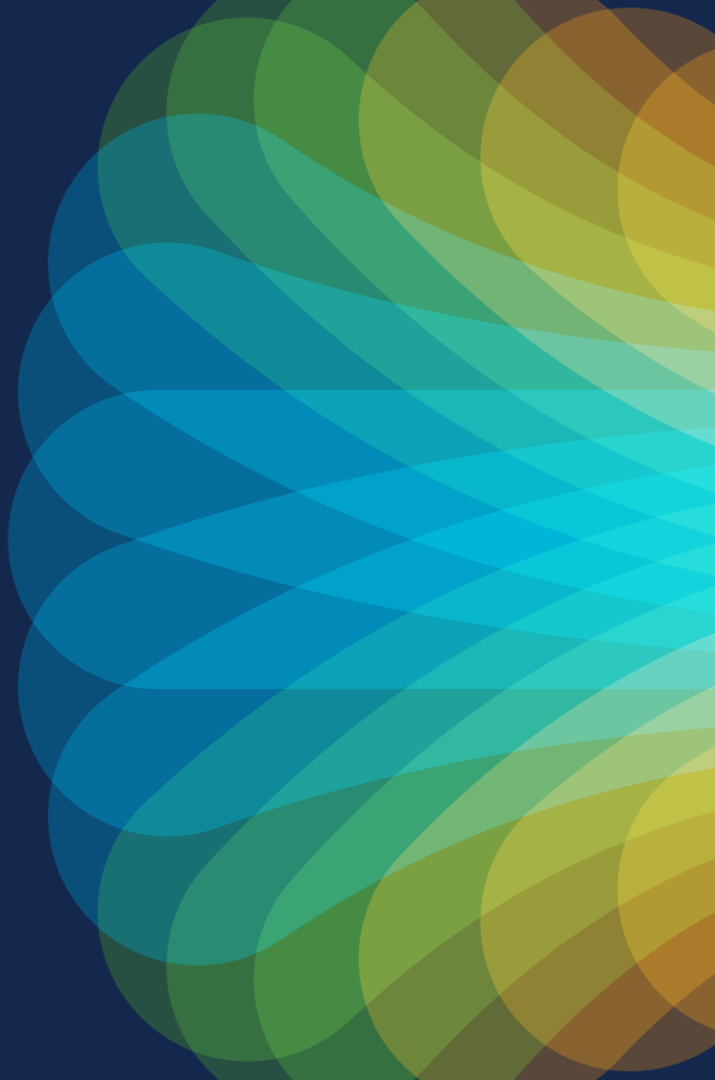
Unified operation across – Campus | DC | WAN

BGP Protocol History. Minimum new learning curve

Multi-tier Overlay network architecture

Use-case driven customize Overlay networks Types and Topologies

Enterprise EVPN Reference Architecture



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BGP EVPN System Role

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

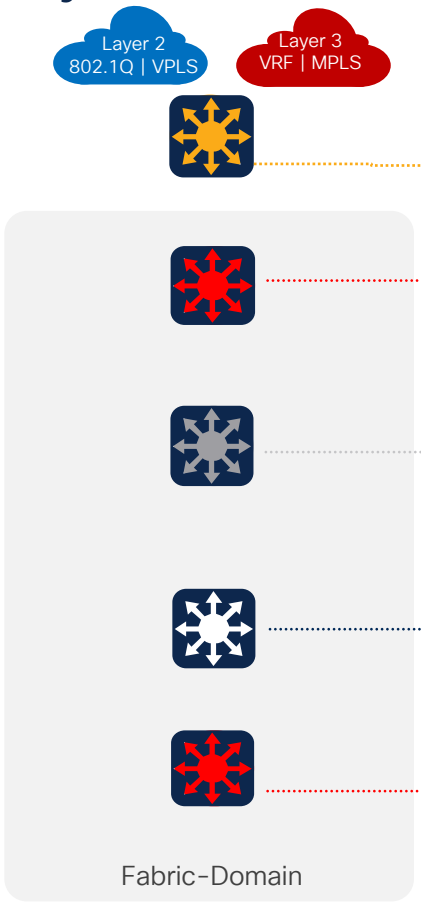
BORDER :
A gateway point between EVPN fabric and external network domain.

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

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

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

* - Roadmap
★ - Recommended



Catalyst EVPN Scale and Performance Matrix

Cisco Catalyst BGP EVPN Configuration Guide
Scale and Performance Chapter

System Support	Mode
Nexus 9000	Standalone

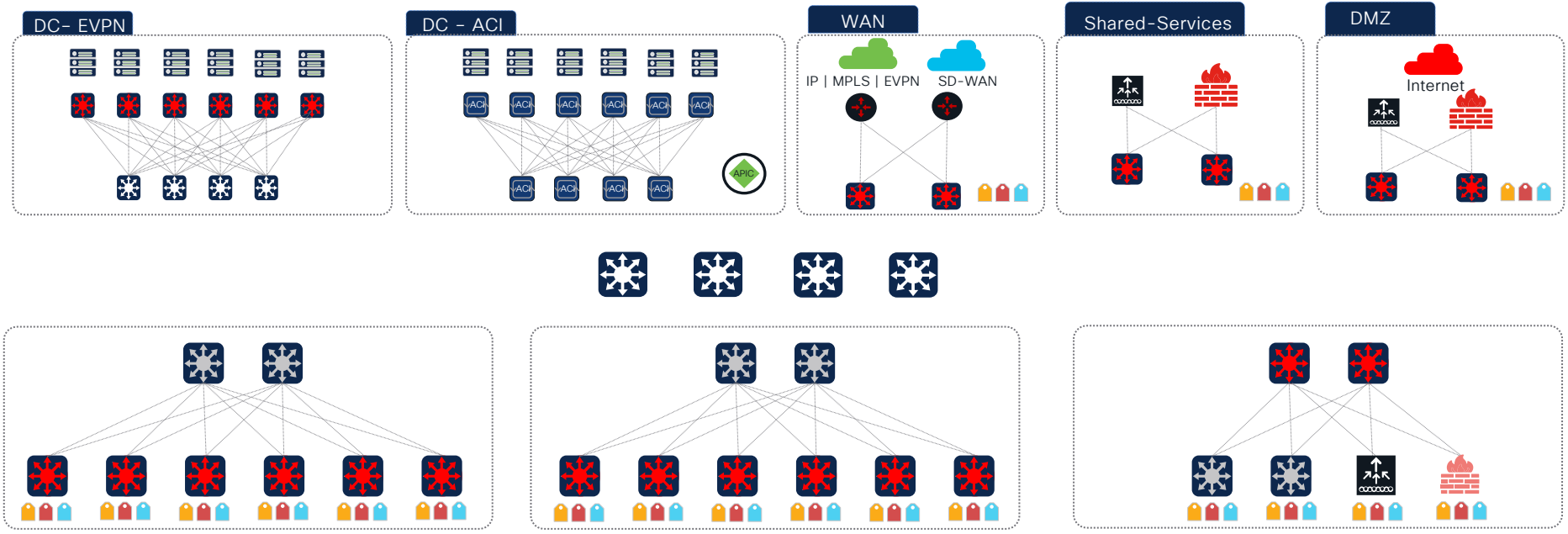
System Support	Mode
Catalyst 9300 – 9600 (9500-H/X/9600/X)	Standalone | Stack ★
Catalyst 8000 Edge | ASR 1000	Physical
Nexus 9000	Standalone
ASR 9000	Standalone

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 ★

Enterprise BGP EVPN Reference Architecture



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

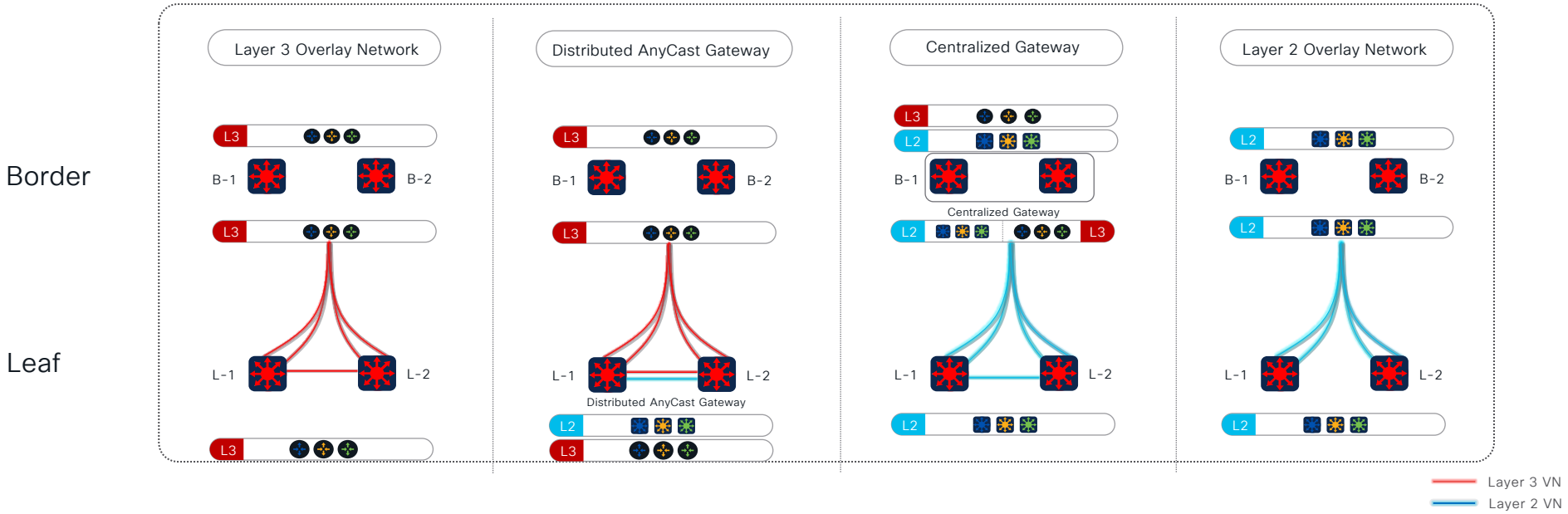
Unified Fabric
- Cross-PIN single fabric
- Extensible beyond site
- Simplified Management

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

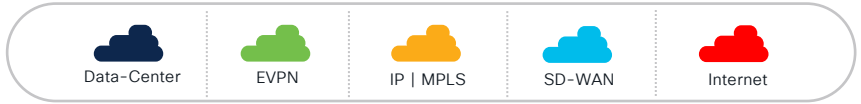
Border – BGP EVPN Overlay Network Types



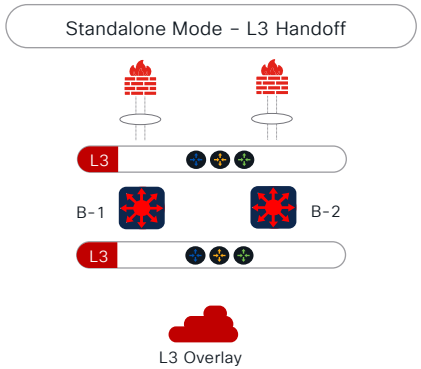
Flexible Overlays

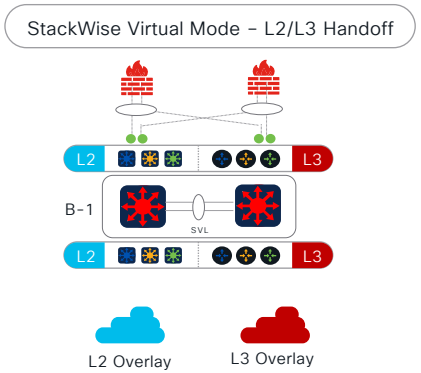
- Flexible Routing and Bridging overlay network support
- Unique overlay Layer 3 or Layer 2 forwarding network to address key use-cases
- Tailored L2/L3 network boundary point at Border and Leaf
- Seamless Layer 2 and 3 network handoff external domains

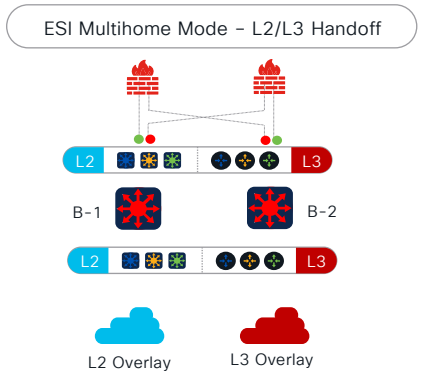
Border – Catalyst 9000 System Modes



Border







Forwarding VLAN
Blocking VLAN

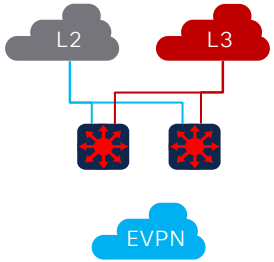
Route First rule.
Bridge-only – IF and where needed
Borders in individual Standalone mode
Seamless Layer 3 handoff

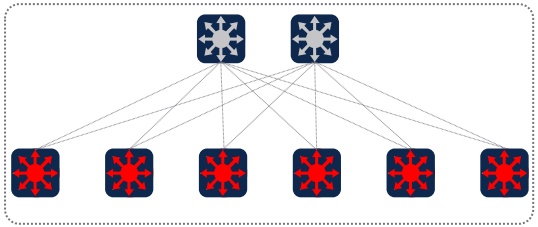
Layer 2 bridging beyond fabric.
Borders in StackWise Virtual mode
Loop-free L2 and overlay fabric
Flexible Layer 2 and 3 handoff

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





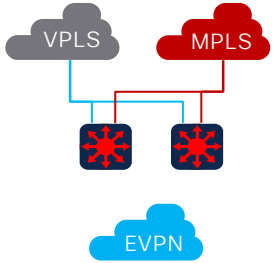
BGP EVPN fabric termination at Border

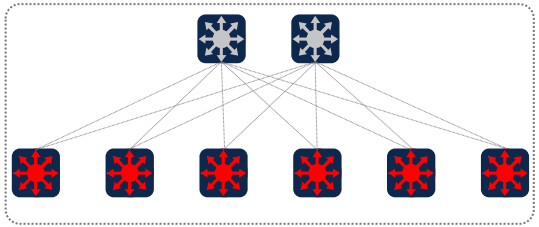
Simple Layer 2 / Layer 3 handoff

Layer 3 VRF segmentation to L3 system

L2 extension handoff, only if needed.

Interworking





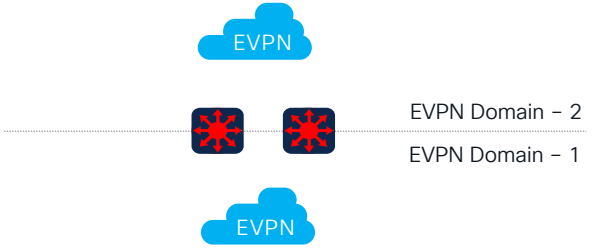
Integrated fabric interworking at Border

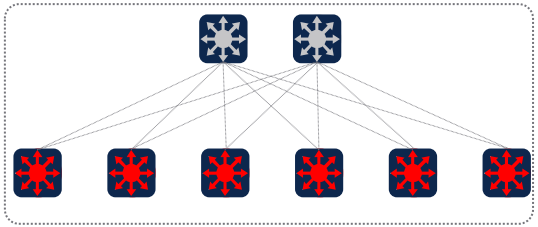
Seamless EVPN & classic overlay ”stitching”

End-to-End network segmentation

Loop-free Layer 2 overlays across domains

Re-Originate





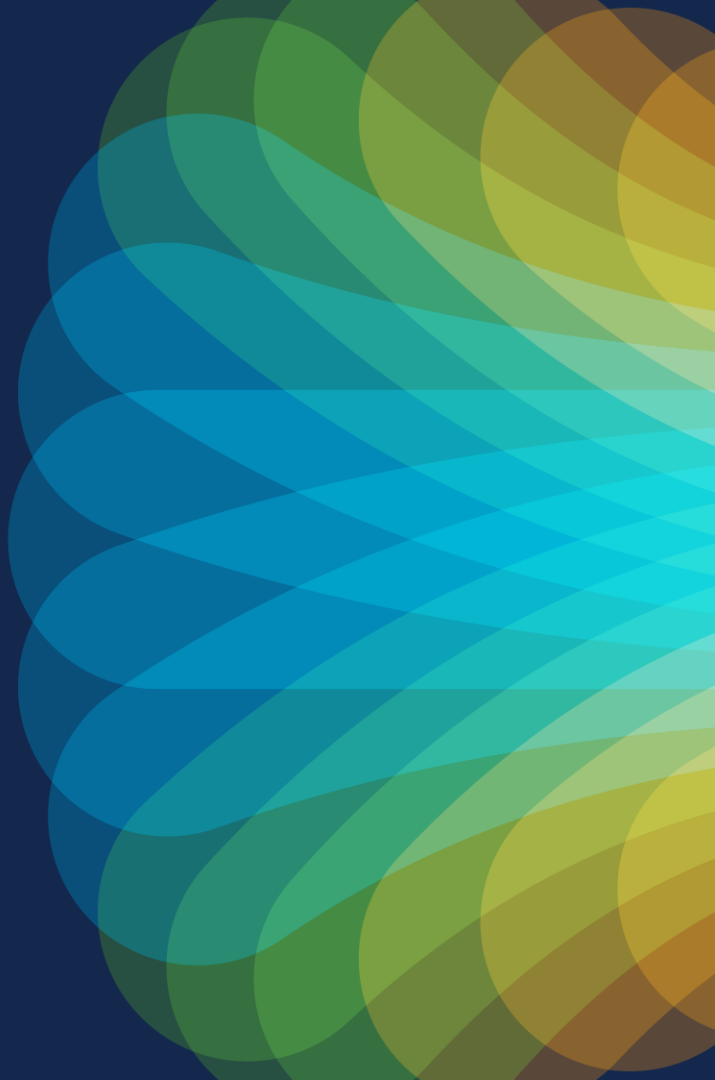
BGP EVPN fabric re-origination at Border

L3 segmentation between fabric domains

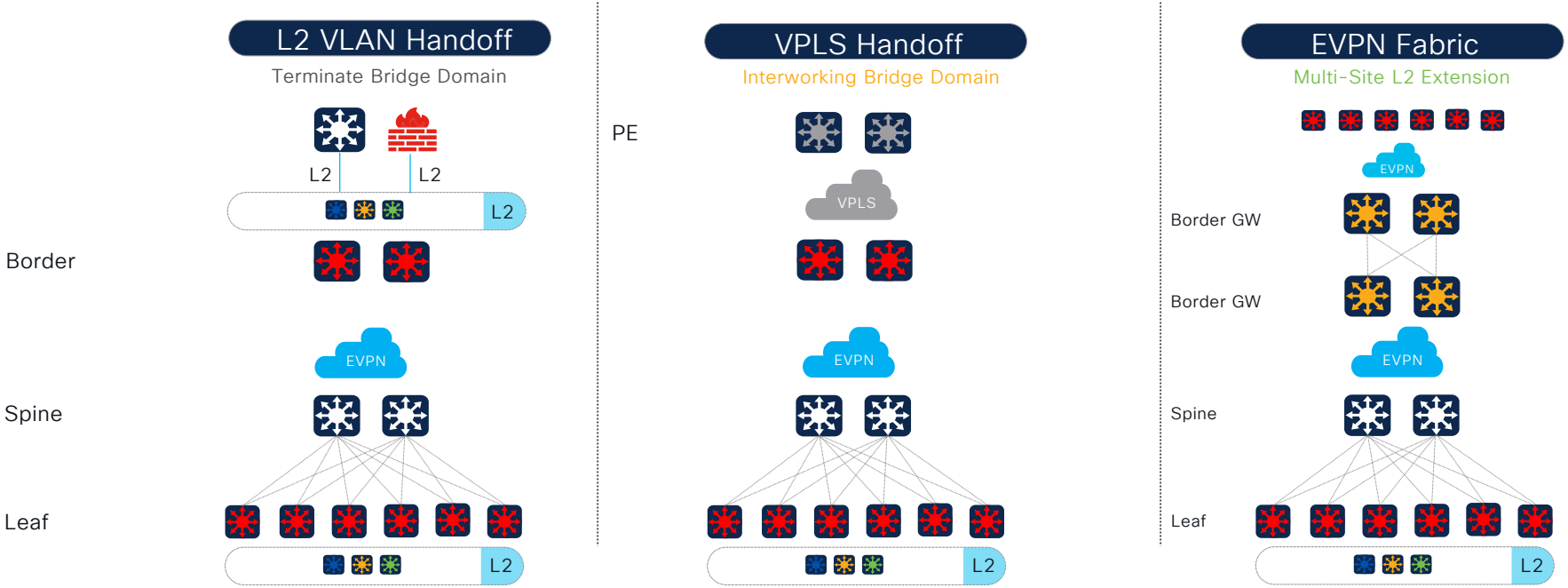
Can collapse with Border/Spine role

L2 and Multicast in overlay unsupported

Layer 2 – External Domain Handoff Types



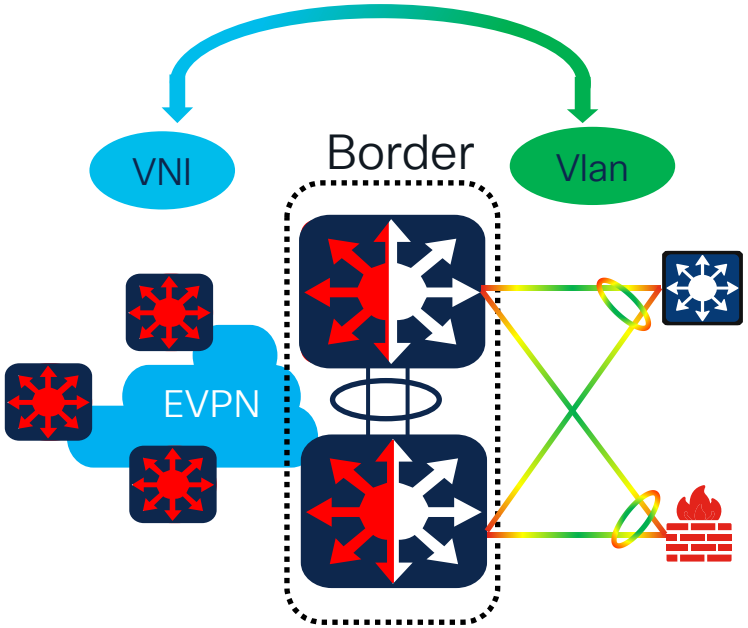
Layer – 2 Handoffs Alternatives



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)




```
vlan configuration 101
member evpn-instance 101 vni 10101
!
vlan configuration 102
member evpn-instance 102 vni 10201
!
interface GigabitEthernet 1/0/1
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
!
```

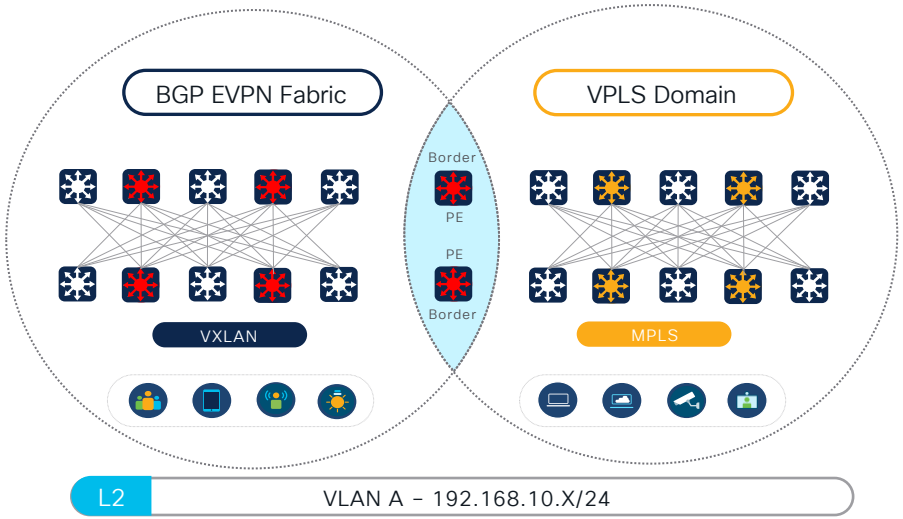
Transparent Handoff

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

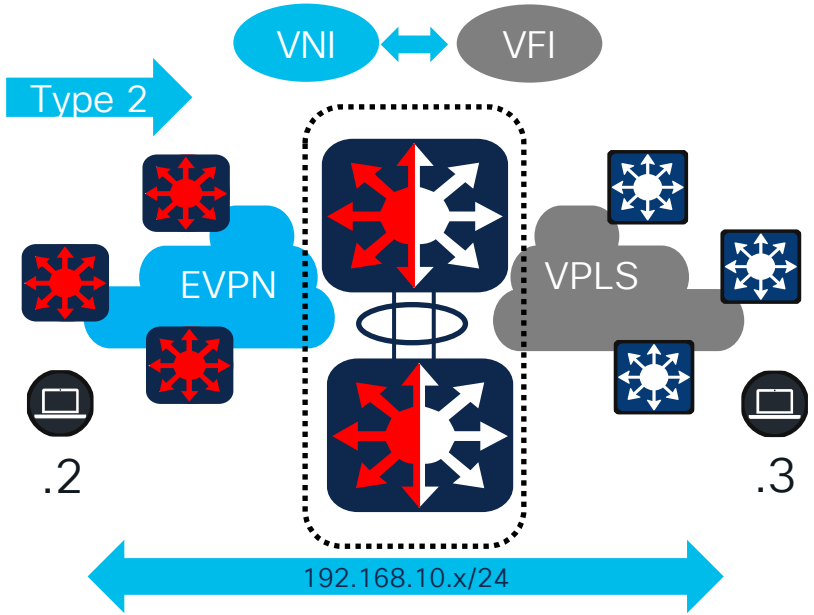
Interdomain L2 Extensions (Interworking)



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)

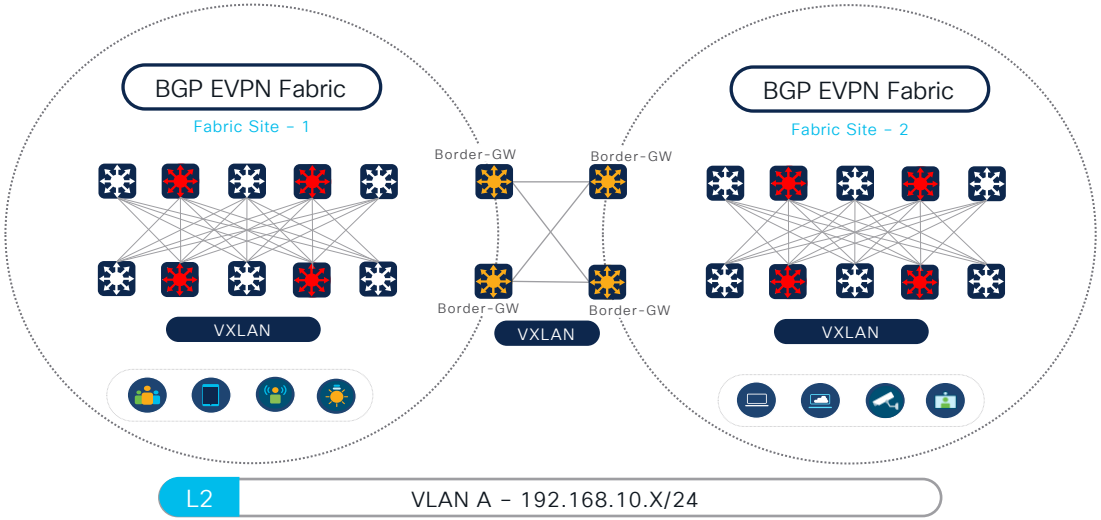



```
l2vpn vfi context VPLS-VFI
vpn id 1
member 10.12.12.5 encapsulation mpls
!
vlan configuration 11
member access-vfi VPLS-VFI
member evpn-instance 1 vni 6000
!
```

Intuitive Interworking

- Simplified command-line syntax to “stitch” bridge-domain between VPLS VFI and BGP EVPN VXLAN EVI
- Loop-free Layer 2 domains with two Catalyst 9000 Border System mode alternatives –
  - Cisco StackWise Virtual - Loop-free, all-active VFI to EVI mappings supporting best-in-class inter-domain load-sharing and redundancy
  - Standalone – Loop-free, automatic per VFI to EVI active/standby forwarding between two individual Border/PE systems

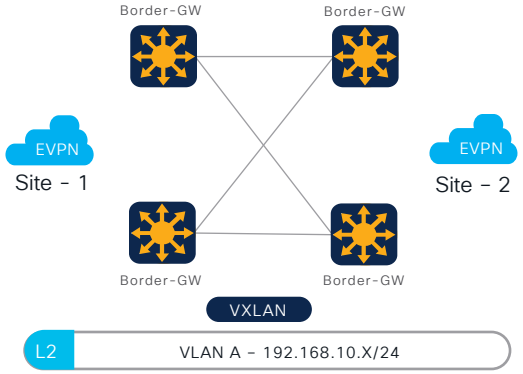
Multisite EVPN L2 Extensions (Re-Originate)



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

Multisite EVPN L2 Extensions (Re-Originate)



NXOS - BGW

```
vlan 2
!
evpn
 vni 2000002 l2
!
evpn multisite border-gateway 100
 split-horizon per-site
!
interface nve1
  multisite border-gateway interface loopback2
  member vni 2000002
   multisite ingress-replication
     mcast-group 225.1.0.1
!
```

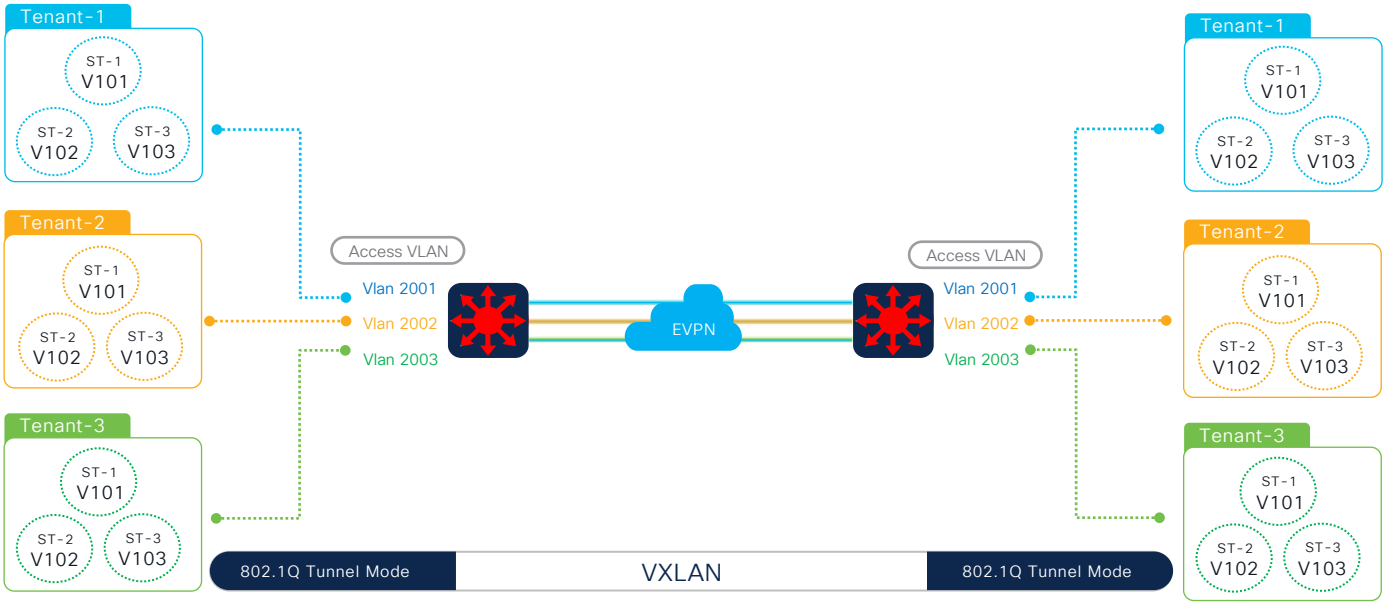
NXOS - BGW

```
!
interface Ethernet1/1
  description CONNECTED TO REMOTE BGW
 evpn multisite dci-tracking
 !
 interface Ethernet1/2
   description CONNECTED TO INTERNAL SPINE
  evpn multisite fabric-tracking
!
router bgp 200
  rd dual id 1
  neighbor 172.16.0.29
    remote-as 200
    peer-type fabric-external
    address-family l2vpn evpn
      rewrite-evpn-rt-asn
```

Structured Network Extension

- Loop-free Layer 2 overlay extension with overlay control and data-plane hierarchy
- Isolated BUM domains with rate-limit BUM control-management at Border-Gateway
- Flexible underlay BUM replication modes – Multicast | Ingress
- Seamless Catalyst 9000 to Nexus 9000 interworking function

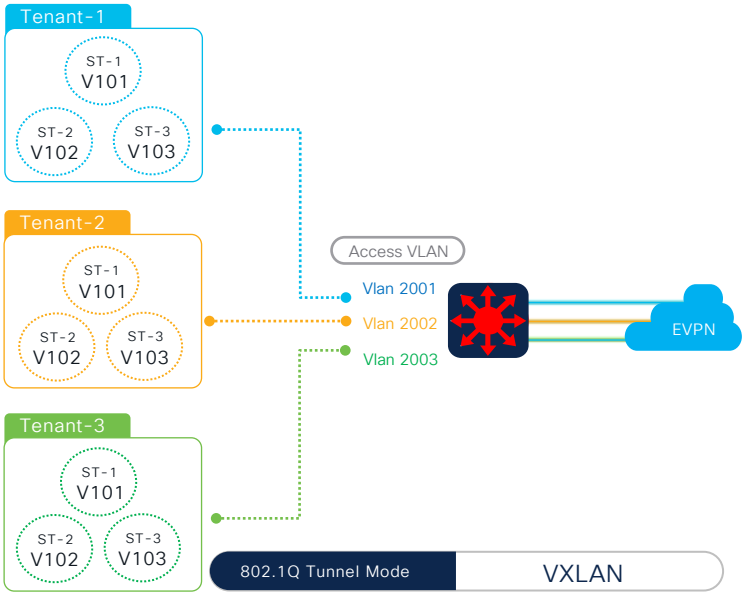
Multi-Tenant Layer 2 Network Extensions



Scalable Multi-Tenant L2 Networks

- Scalable Layer 2 EVPN VXLAN architecture for multi-tenant solutions
- *N Sub-Tenant* VLAN IDs : 1 Access VLAN mapping with CE facing interface in IEEE 802.1Q tunnel mode
- Single, unused Access VLAN mapped to EVI transparently forward 802.1Q over VXLAN
- Flexible L2 overlay topology – Point-to-Point, Partial-Mesh, Hub-n-Spoke or Full-mesh across fabric

IEEE 802.1Q over VXLAN




```
!
l2vpn evpn instance 1 vlan-based
 encapsulation vxlan
 replication-type static
 ip local-learning disable
!
device-tracking policy MULTI-TENANT-L2-POLICY
 no protocol ndp
 no protocol dhcp6
 no protocol arp
 no protocol dhcp4
!
vlan 2001
! name MULTI-TENANT-ACCESS-VLAN
!
vlan configuration 2001
 member evpn-instance 1 vni 10001
 device-tracking attach-policy MULTI-TENANT-L2-POLICY
!
interface nve1
member vni 10001 mcast-group 239.1.1.1
!
interface Teng1/0/1
 description CONNECTED TO TENANT-1 L2 NETWORK
 switchport mode dot1q-tunnel
 switchport access vlan 2001
!
```

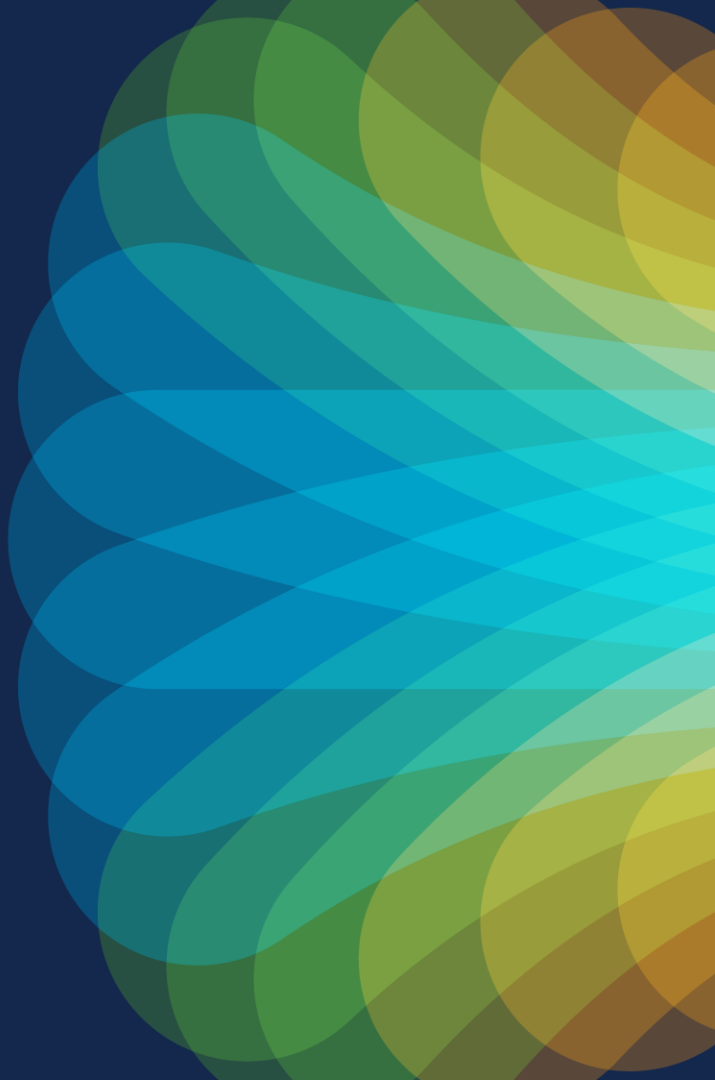
One Access VLAN per Tenant network

Layer 2 overlay network support. Layer 3 routing unsupported.

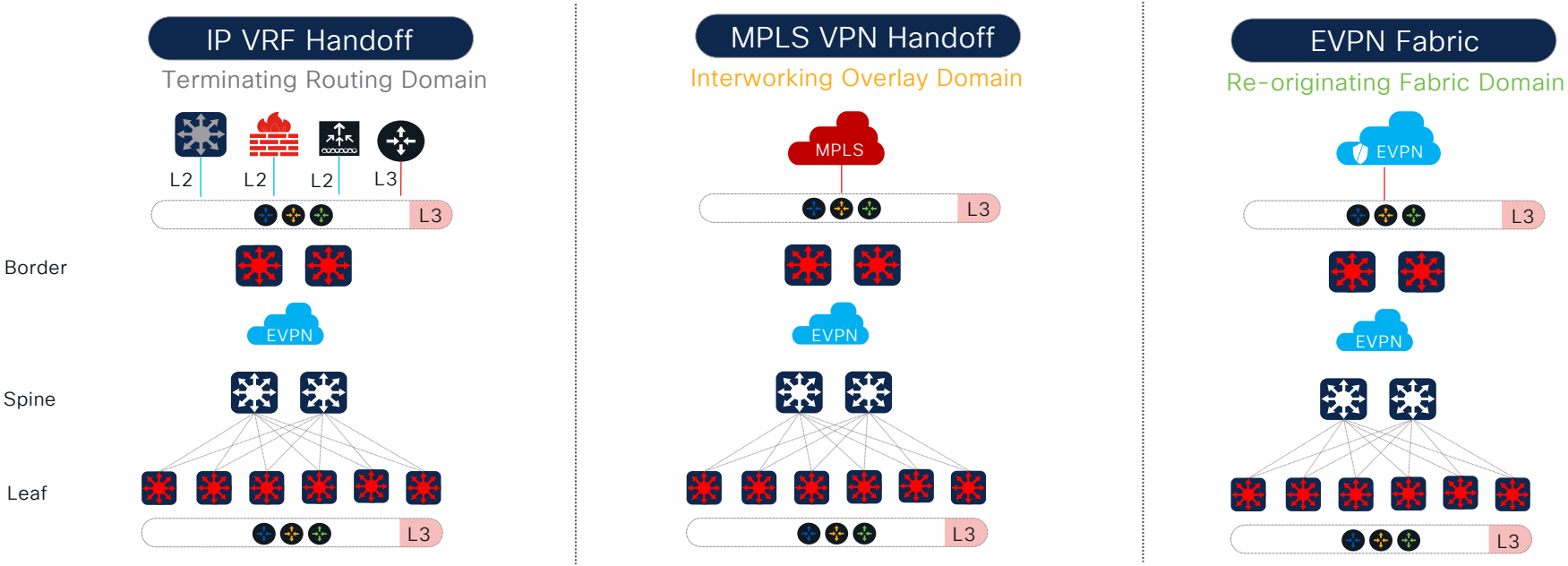
Disable protocol validation policy on local VXLAN Access VLAN

Co-exist with Access/Trunk ports for standard Layer 2 and Layer 3 overlay network

Layer 3 – External Domain Handoff Types



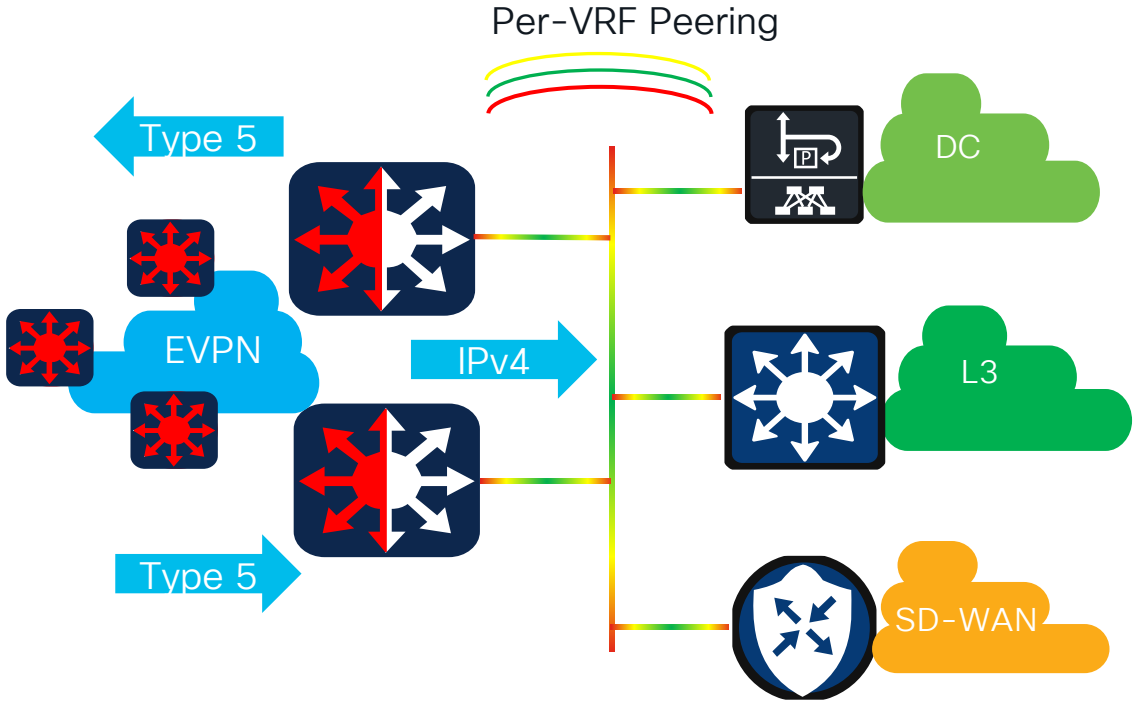
Layer – 3 Handoffs Alternatives



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)

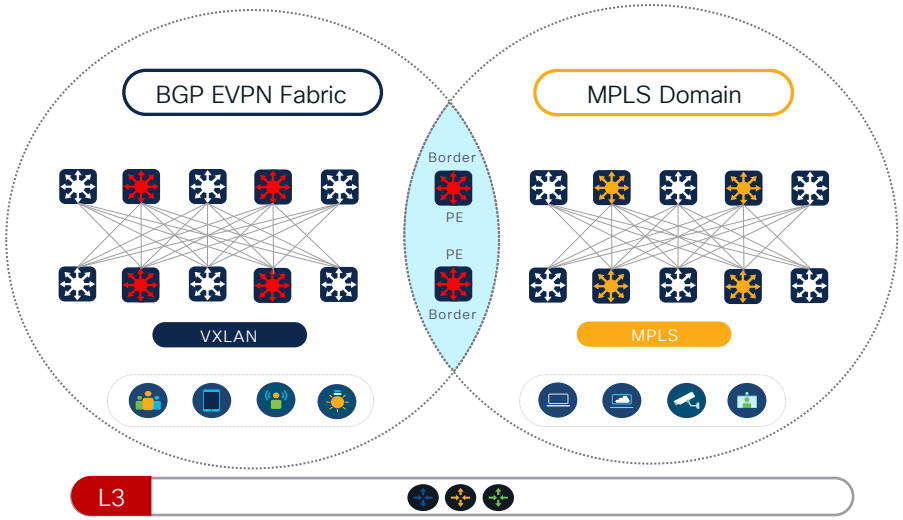



```
!
vrf definition green
rd 192.168.255.1:101
 address-family ipv4 unicast
   route-target both 65535:101
   route-target both 65535:101 stitching
!
interface Vlan 10
 vrf forwarding green
 ip address 192.168.1.2 255.255.255.252
!
router bgp 65535
 address-family ipv4 vrf green
   advertise l2vpn evpn
   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.

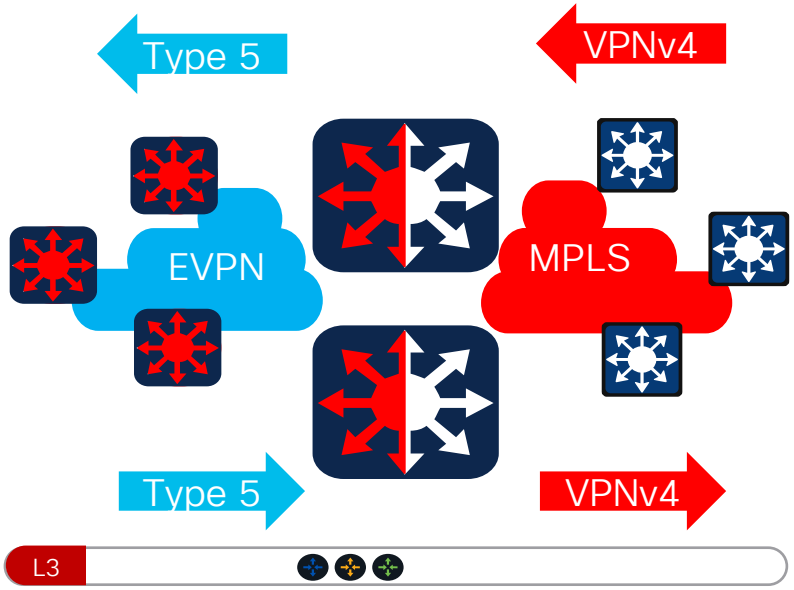
Interdomain L3 Segmentations (Interworking)



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

L3 Overlay Handoff (Interworking)




```
!
mpls label mode all-vrfs protocol all-afs per-vrf
!
router bgp 65001
!
address-family vpnv4 unicast
  import l2vpn evpn re-originate
  neighbor <RR> next-hop-self all
!
address-family l2vpn evpn
  import vpnv4 unicast re-originate
 neighbor <RR> next-hop-self all
!
```

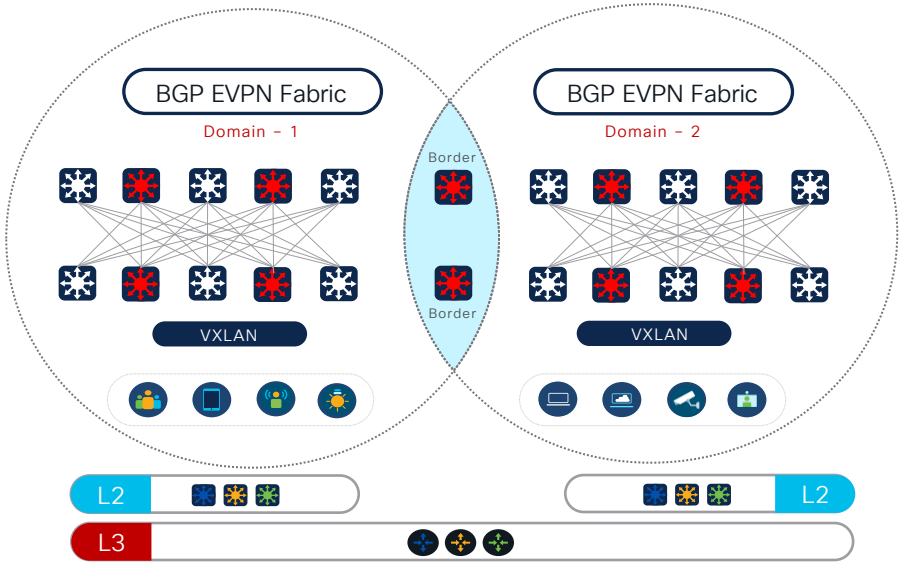
Integrated Overlay Interworking

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

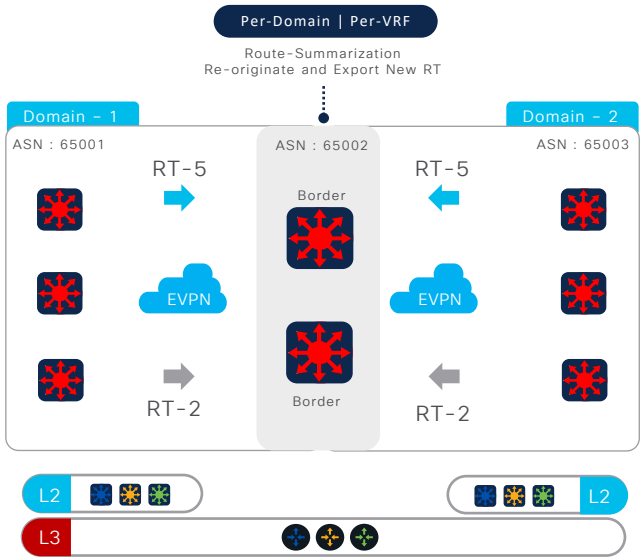
Multi-Domain BGP EVPN Fabric (Re-Originate)



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
- Layer 2 overlay and Multicast overlay boundary limited within each domain. Multi-Site recommended for cross–domain.

Multi-Domain Border Route Re-origination




```
!
vrf definition green
 rd 192.168.255.1:101
!
address-family ipv4 unicast
 route-target import 65001:101 stitching
 route-target export 65001:1001 stitching
 route-target import 65003:101 stitching
 route-target export 65003:1001 stitching
!
router bgp 65002
!
address-family ipv4 unicast vrf green
 aggregate-address <DOMAIN-1-NETWORK> <MASK> route-map <DOMAIN-1> summary-only
 aggregate-address <DOMAIN-2-NETWORK> <MASK> route-map <DOMAIN-2> summary-only
!
route-map DOMAIN-1 permit 10
 set extcommunity rt 65001:1001
!
route-map DOMAIN-2 permit 10
 set extcommunity rt 65003:1001
!
```

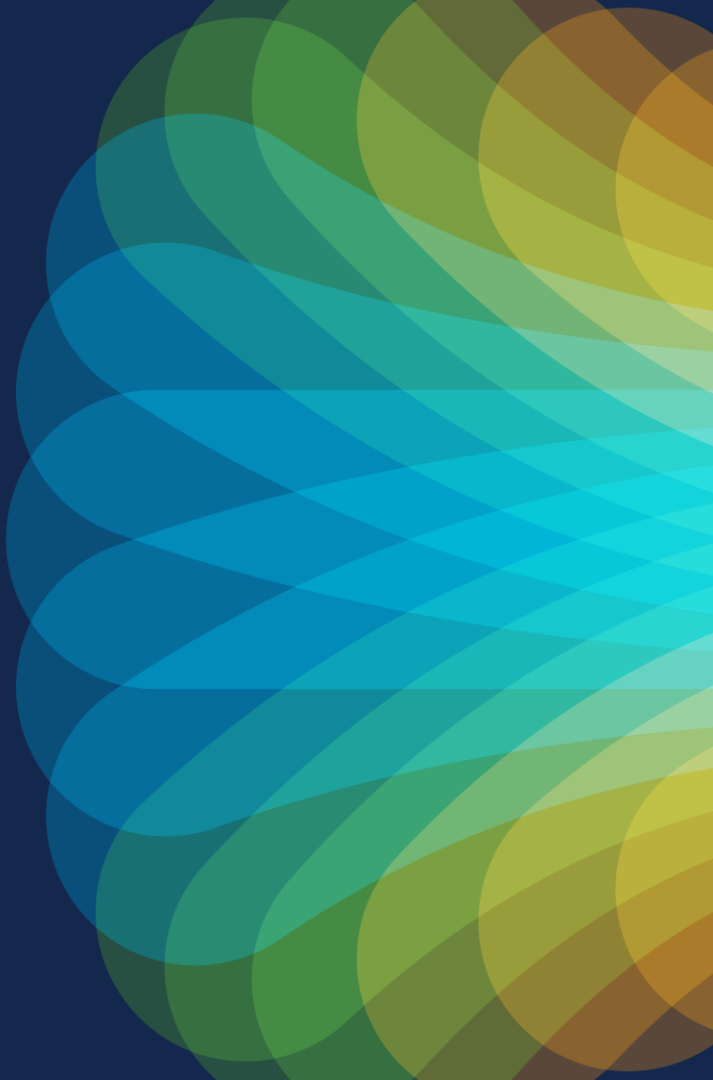
Per-VRF IPv4/v6 Route-Summarization at Border

Per EVPN domain route summarization at the Border system

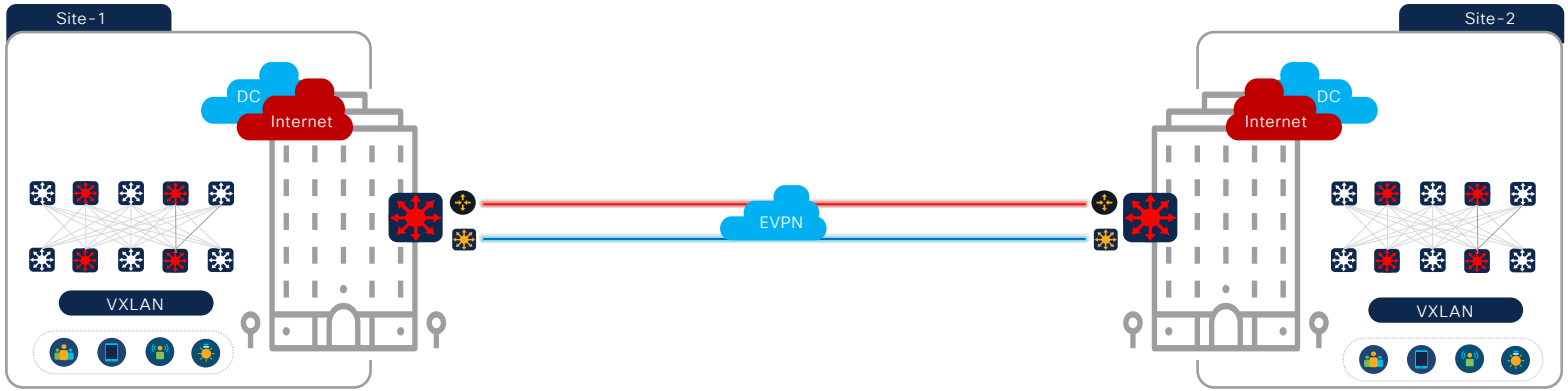
New Summary route = New export Route-Target to be imported by remote Leaf. Border automatically sets itself as Next-Hop

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

EVPN Border Network Extensions



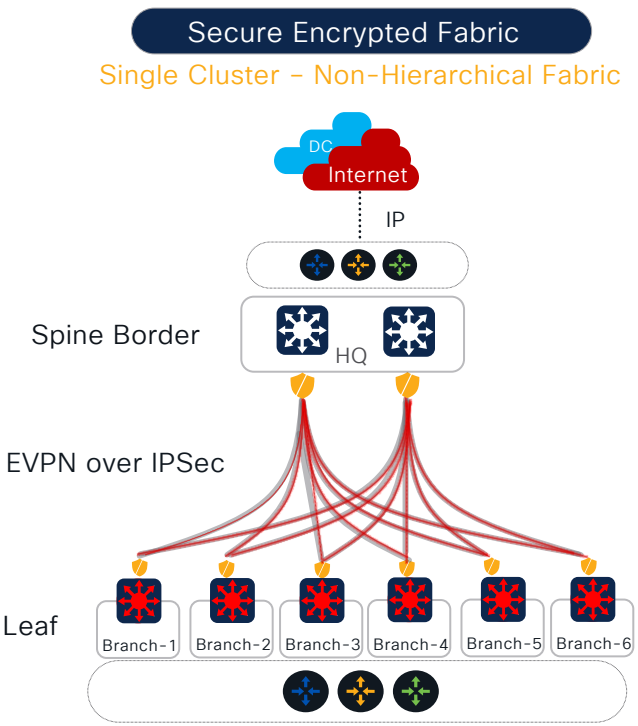
Site-to-Site Fabric Extension

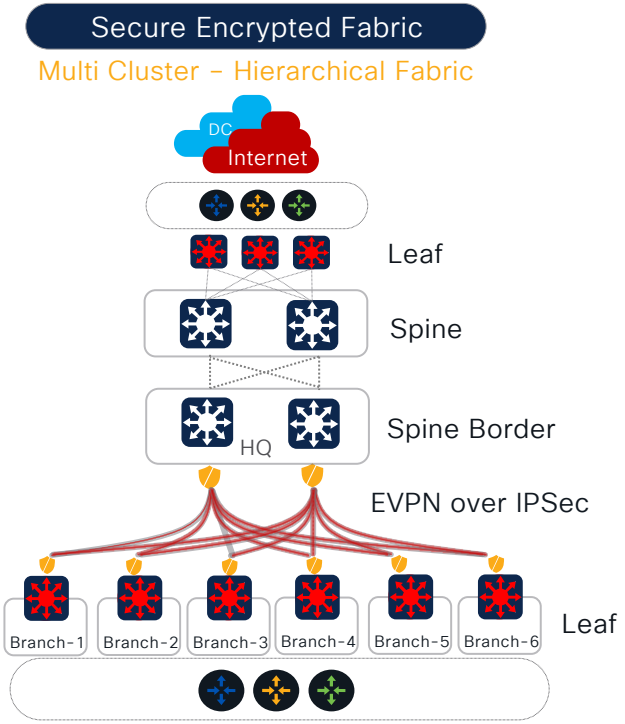


Inter-Site EVPN Fabric

- Simple point-to-point BGP EVPN Fabric between two sites
- Spine-less design with direct i-BGP/e-BGP peering.
- Flexible Underlay – IP or MPLS. MTU size consideration with Static, Path-MTU discovery, MSS-Adjust.
- Flexible Overlay – Layer 2 extension, Layer 3 segmentation or both.

Encrypted BGP EVPN Fabric Extension

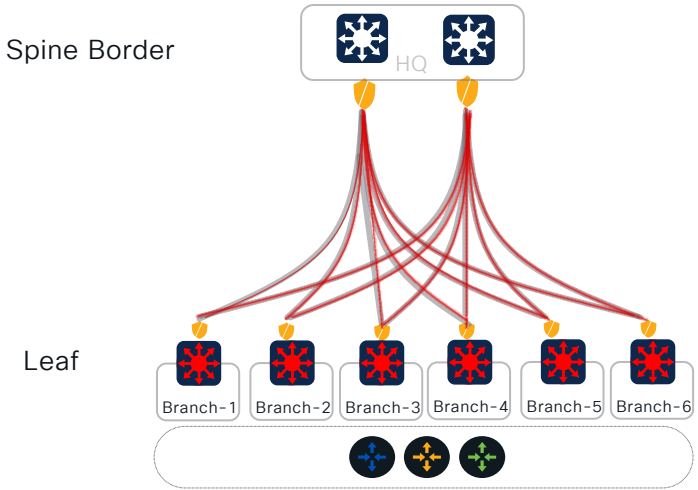




Encrypted EVPN Fabric

- High performance Catalyst 9300-X/9400X IPsec underlay network solution
- Simplified and scalable Layer 3 overlay fabric with integrated or co-located Spine/RR
- Single fabric cluster across WAN or “stitch” to EVPN fabric at central-office
- Unicast | Multicast support for IPv4 and IPv6 in overlay

Encrypted BGP-EVPN Fabric Configuration

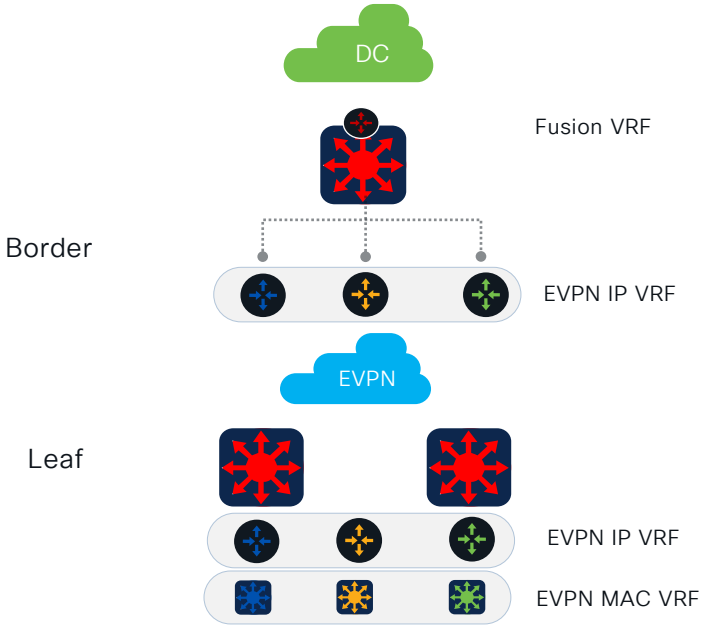



```
interface Loopback 0
 description BGP ROUTER ID
 ip address <IP> <MASK>
 ip ospf <BGP ROUTER INSTANCE ID1> area <ID>
!
interface Loopback 1
 description IPSEC TUNNEL SOURCE INTERFACE
 ip address <IP> <MASK>
 ip ospf <IPSEC-TUNNEL-IGP-INSTANCE-ID1> area <ID>
!
interface Loopback 10
 description IPSEC UNDERLAY TUNNEL SOURCE INTERFACE
 ip address <IP> <MASK>
 ip ospf <IPSEC-TUNNEL-UNDERLAY IGP-INSTANCE-ID2> area <ID>
!
interface Tunnel <ID>
 ip address <IP> <MASK>
 ip ospf <IPSEC-TUNNEL-IGP-INSTANCE-ID> area <ID>
 tunnel mode ipsec ipv4
 tunnel source Loopback 1
 tunnel destination <HUB-1 IP ADDRESS>
 tunnel protection ipsec profile <IPSEC-PROFILE-NAME>

router bgp 1
 bgp router-id interface Loopback0
 no bgp default ipv4-unicast
 neighbor <REMOTE BGP ROUTER ID> remote-as 1
 neighbor <REMOTE BGP ROUTER ID> update-source Loopback0
!
```

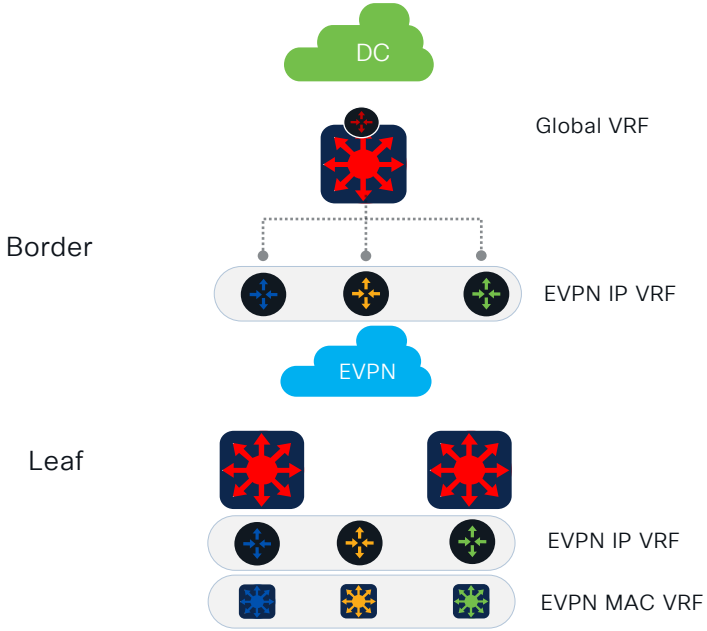
Fusion VRF Extranet

EVPN | Non-EVPN VRF Route-Leaking



Global VRF Extranet

EVPN | Global VRF Route-Leaking

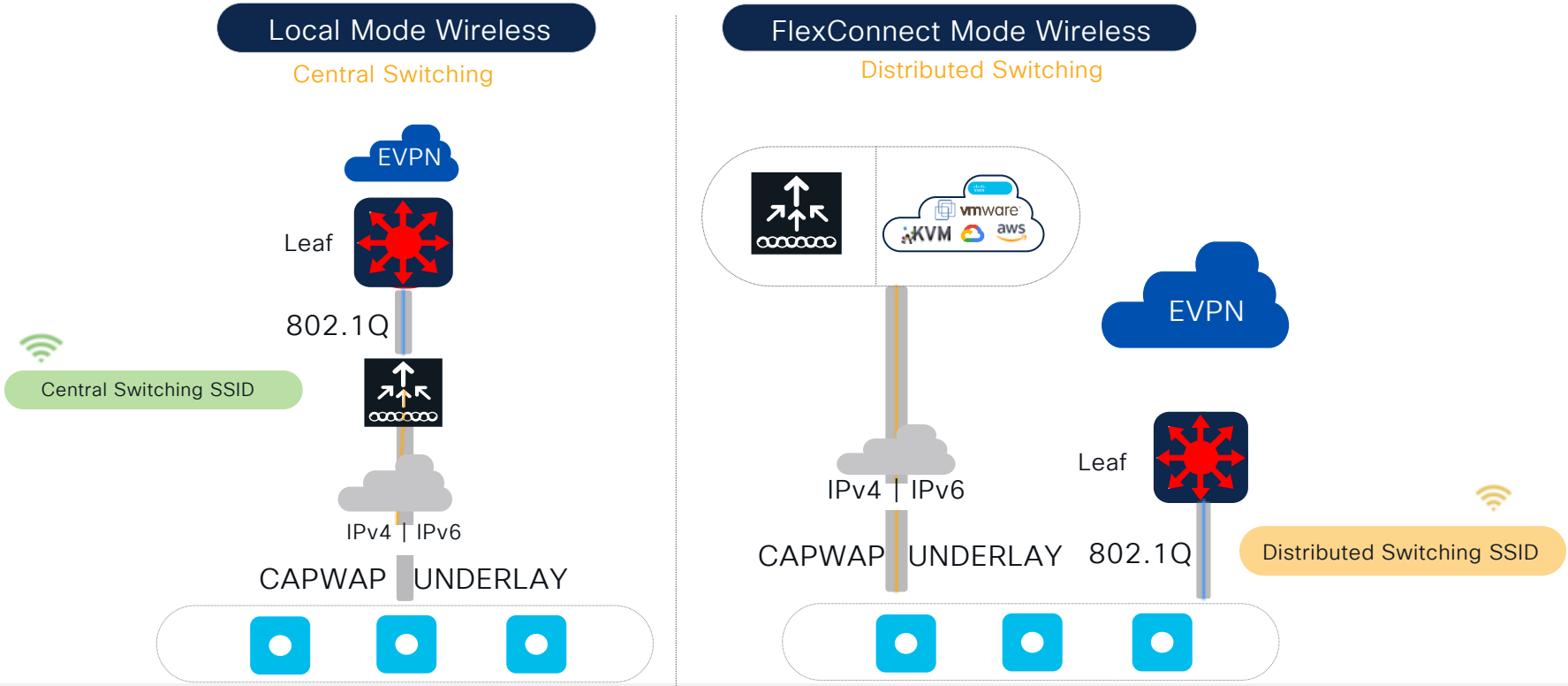


Integrated Extranet

Policy-based stateless extranet Unicast routing

Flexible route-leaking solution - EVPN-EVPN | EVPN-Non EVPN VRF | EVPN-Global

Various external Unicast routing protocol handoff



Seamless Wireless

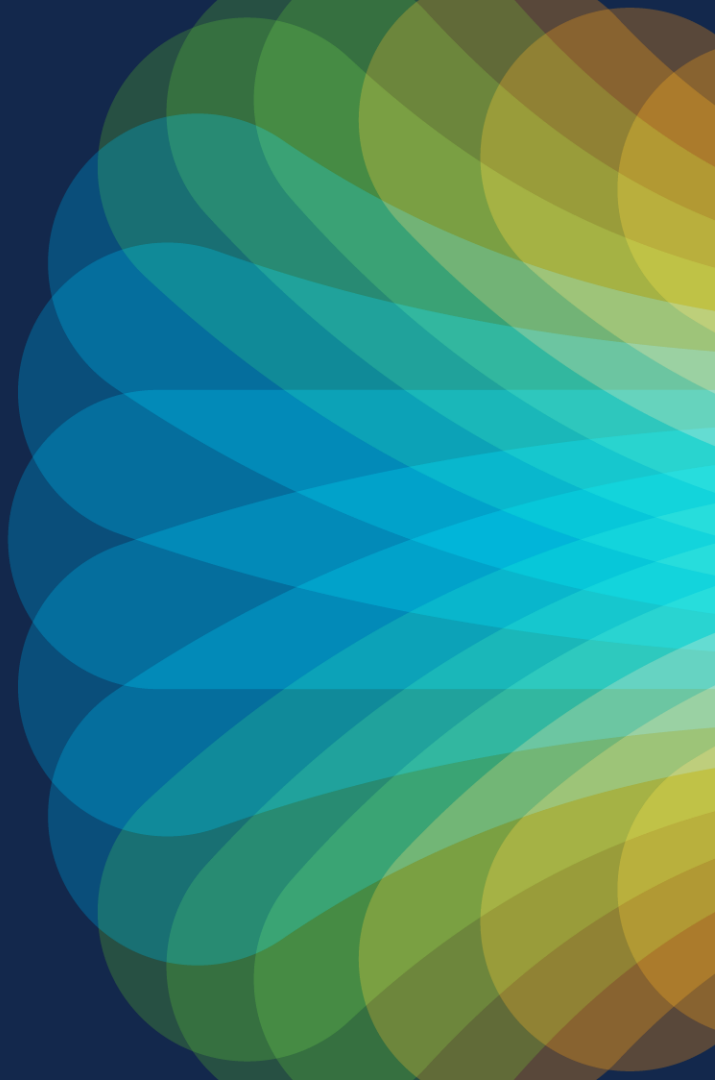
Transparent Wireless integration in fabric. Intact WLC and AP communication in Underlay

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

Fabric boundary initiates from Wireless Client IP gateway. Flex Local seamless roaming* up to 100 AP.

Consistent Wired and Wireless network access control policy enforcement

Catalyst 9000 EVPN Reference



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Configuration Guide

Completed Chapters

BGP EVPN VXLAN Overview
Configuring EVPN VXLAN Layer 2 Overlay Network
Configuring EVPN VXLAN Layer 3 Overlay Network
Configuring EVPN VXLAN Integrated Routing and Bridging
Configuring Spine Switches in a BGP EVPN VXLAN Fabric
Configuring DHCP Relay in a BGP EVPN VXLAN Fabric
Configuring VXLAN-Aware Flexible NetFlow
Configuring Tenant Routed Multicast
Configuring EVPN VXLAN External Connectivity
Cisco DNA Service for Bonjour Overview
Configuring Cisco DNA Service for Bonjour over EVPN VXLAN Layer 3 Overlay Networks
Troubleshooting BGP EVPN VXLAN
Feature History and Information for BGP EVPN VXLAN

More Coming Soon ...

Reference

https://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst9600/software/release/17-5/configuration_guide/vxlan/b_175_bgp_evpn_vxlan_9600_cg.html

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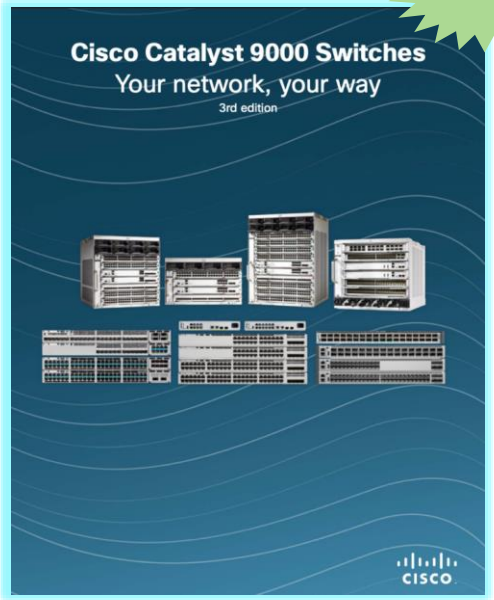

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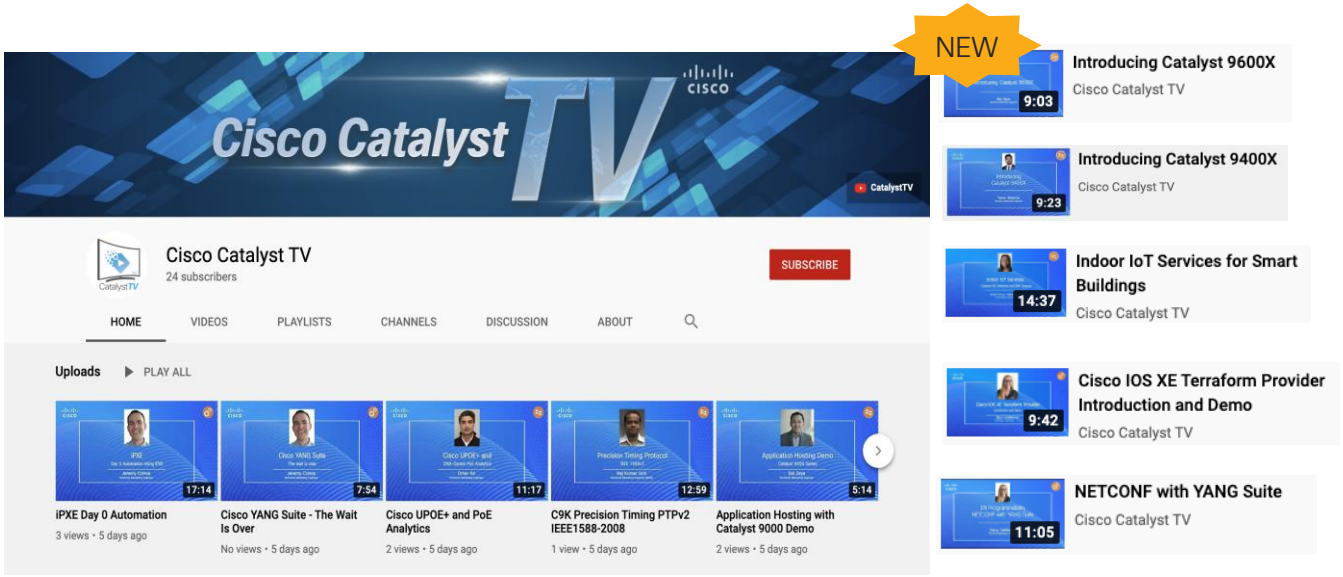

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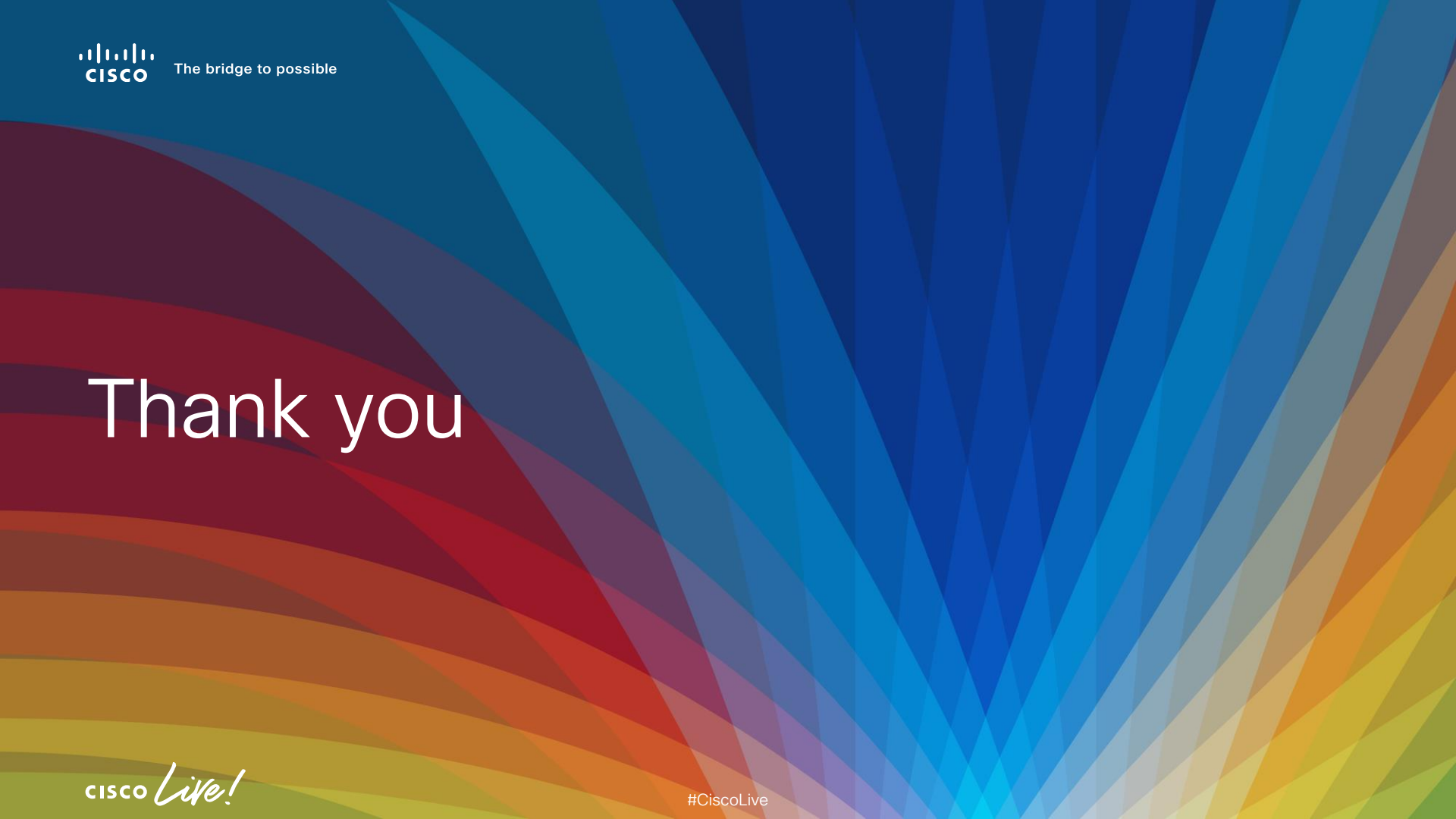
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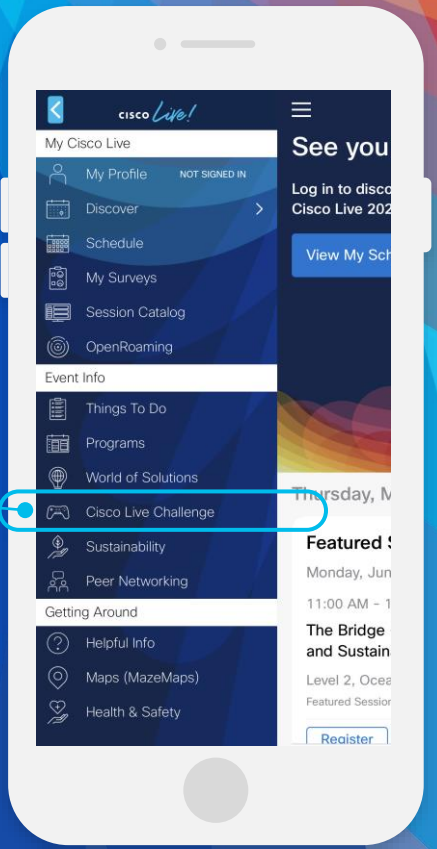


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