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The bridge to possible

BGP EVPN Solution in Enterprise Campus

Catalyst 9000

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BRKENS- 2003

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Agenda

- Introduction and Overview
- Product Matrix and Scale
- Underlay Network
- Overlay Network
- Fabric Interworking
- Multicast over VXLAN
- Wireless Integration and Services
- Conclusion

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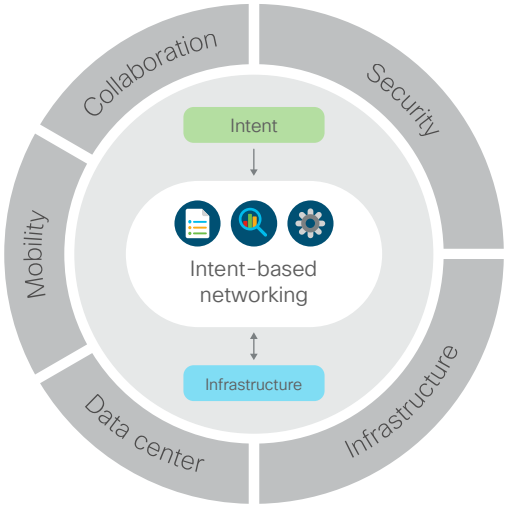
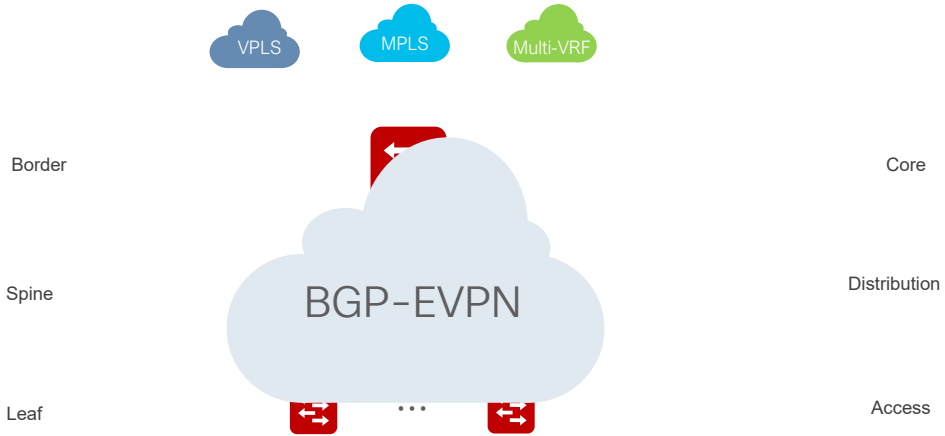
Enterprise fabric architectures

SD-Access



- Leading architecture for enterprise providing **seamless mobility and enhanced security**
- Integrated Automation, Assurance Analytics capabilities **driven from Cisco DNA-Center**
- Integrated Wireless capabilities driving **consistent policies across wired and wireless networks**

BGP EVPN



- Industry based solution providing **interoperability with 3rd party devices**
- Solution for **Brownfield environments** – MPLS, VPLS, Multi-VRF, GRE.
- **Single Overlay Solution** from campus to datacenter, all the way to cloud
- **DIY based provisioning and automation** for fabric deployment

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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
...

IETF®

DRAFT	RFC	Authors
137	10	37

Cisco
Patent

Filed	Issued
400+	150+

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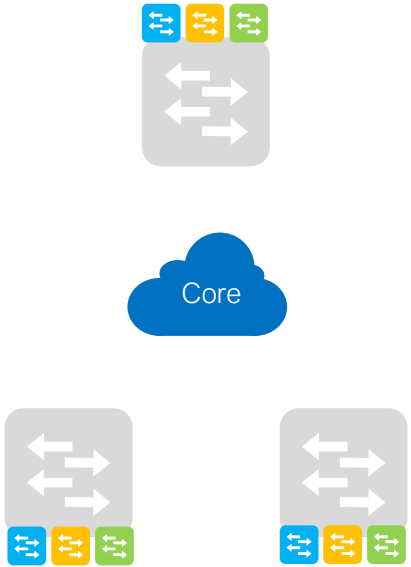
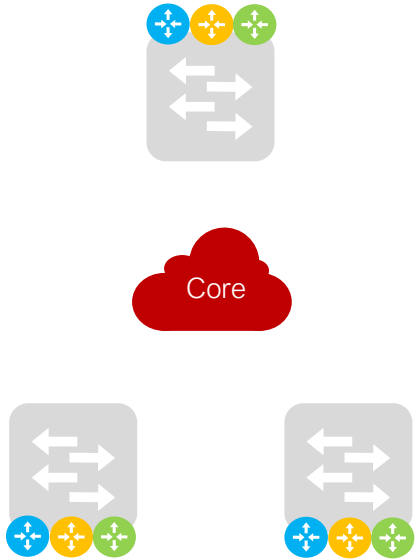
BGP EVPN Drivers in Enterprise

Network Extension



- **Bridge** connection between across Core network
- User devices are virtually in common L2 segment
- Logical topologies with deterministic overlay Layer 2 network infrastructure.

Network Segmentation



- **Routed** connection at first-hop gateway
- User devices are segmented across Core network
- Logical overlay IP routed network providing flexible topology support

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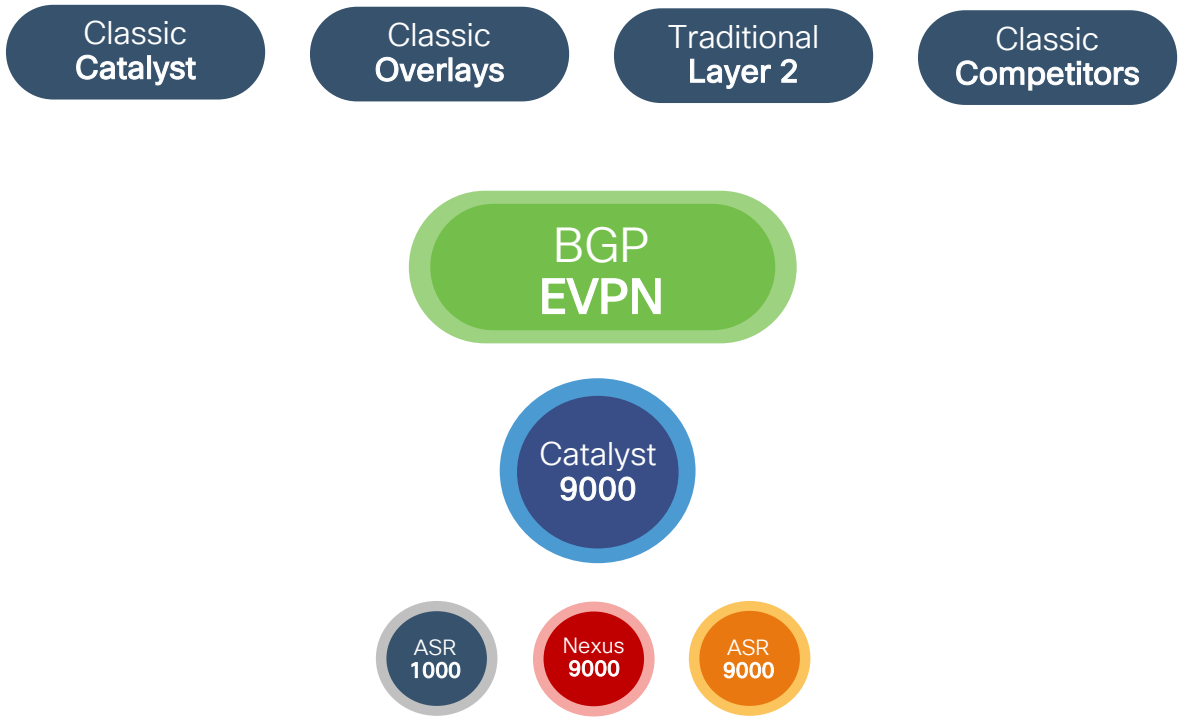
BGP EVPN Solution For Enterprise



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VxLAN Overview

VXLAN Concepts

- VXLAN Overlay
  - A VXLAN Overlay or VXLAN segment is a Layer-2 broadcast domain identified by the VNID that extends or tunnels traffic from one VTEP to another.
- VXLAN Tunnel End Point (VTEP)
  - A VTEP is a device that provides both encapsulation and de-capsulation of classical Ethernet and VXLAN packets to and from a VXLAN segment
  - Each VTEP may have the following types of interfaces:
    - Switchport interfaces on the local LAN segment to support local endpoints
    - Layer-3 interfaces to the transport IP network
    - SVI interfaces
- VXLAN Gateway
  - A VTEP that bridges traffic between VXLAN segments

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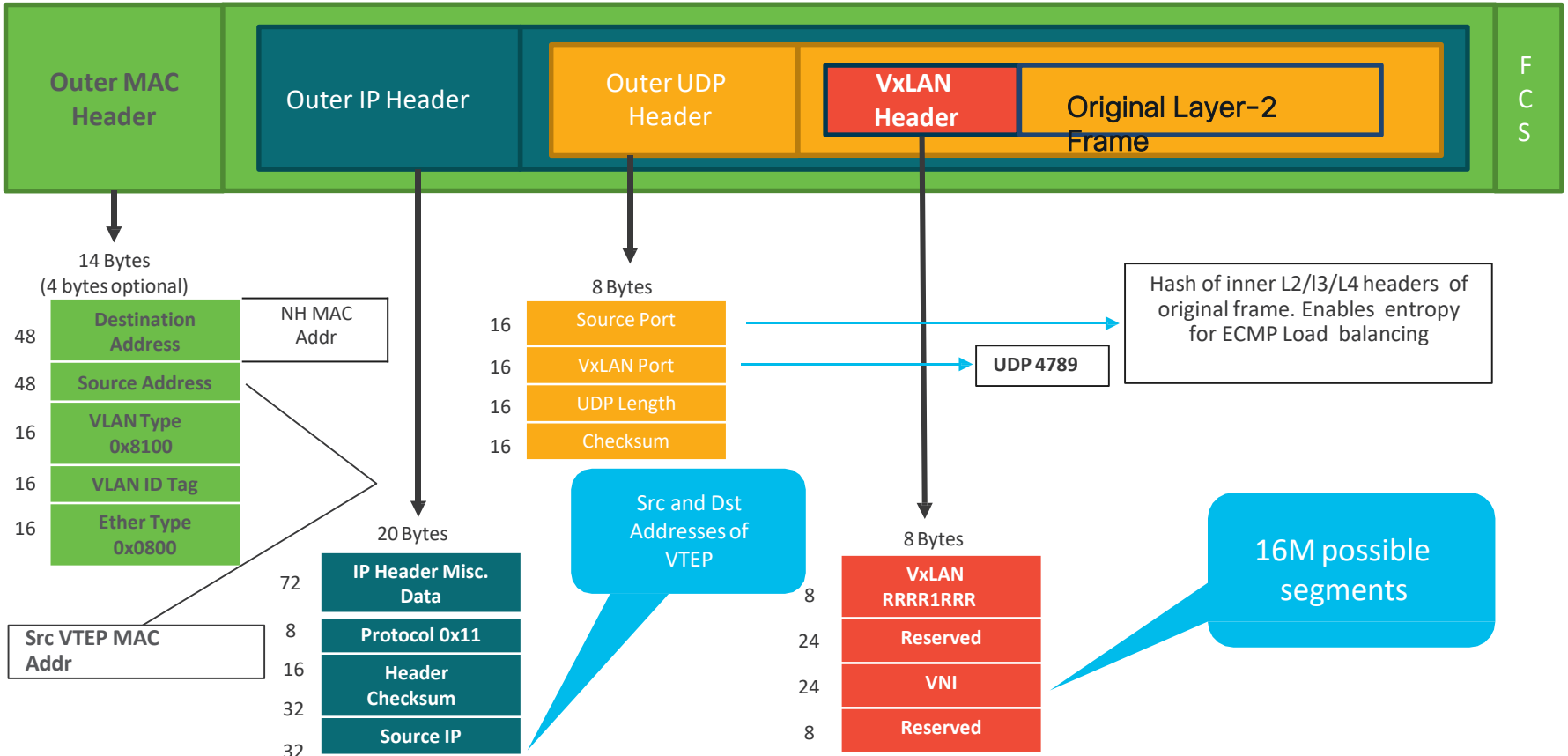
VxLAN Packet Structure



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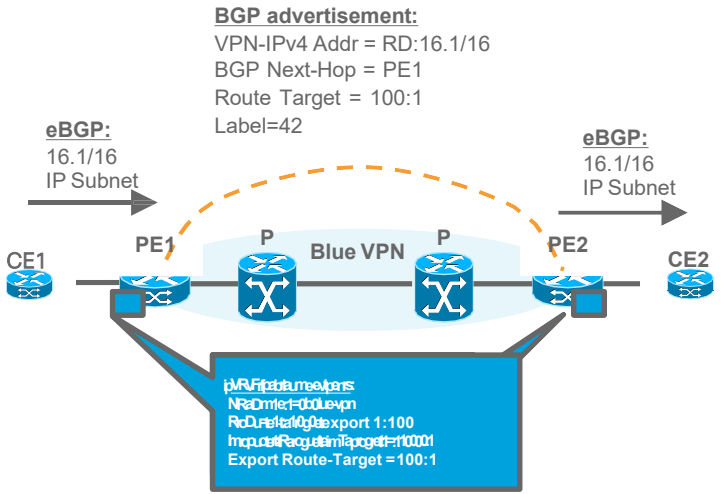
EVPN Primer --- MP-BGP Review

Virtual Routing and Forwarding (VRF)
Layer-3 segmentation for tenants' routing space

Route Distinguisher (RD):
8-byte field, VRF parameters; unique value to make
VPN IP routes unique: RD + VPN IP prefix
Selective distribute VPN routes:

Route Target (RT): 8-byte field, VRF parameter, unique value to define the import/export rules for VPNv4 routes

VPN Address-Family:
Distribute the MP-BGP VPN routes



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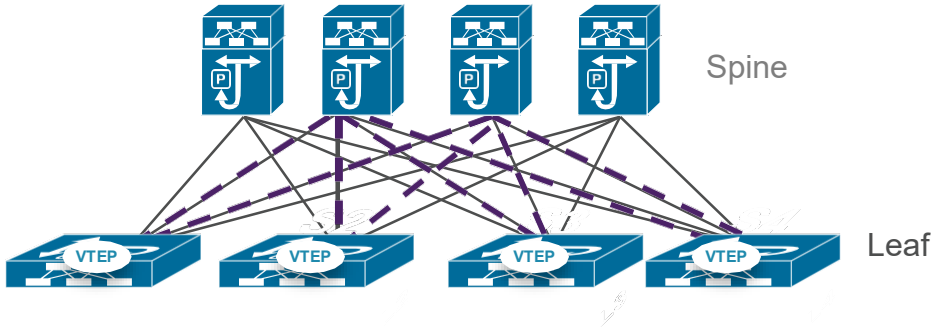
EVPN Control Plane

EVPN Control Plane -- Host and Subnet Route Distribution

BGP Update
- Host-MAC
- Host-IP
- Internal IP Subnet
- External Prefixes



- Use MP-BGP with EVPN Address Family on leaf nodes to distribute internal host MAC/IP addresses, subnet routes and external reachability information
- MP-BGP enhancements to carry up to 100s of thousands of routes with reduced convergence time

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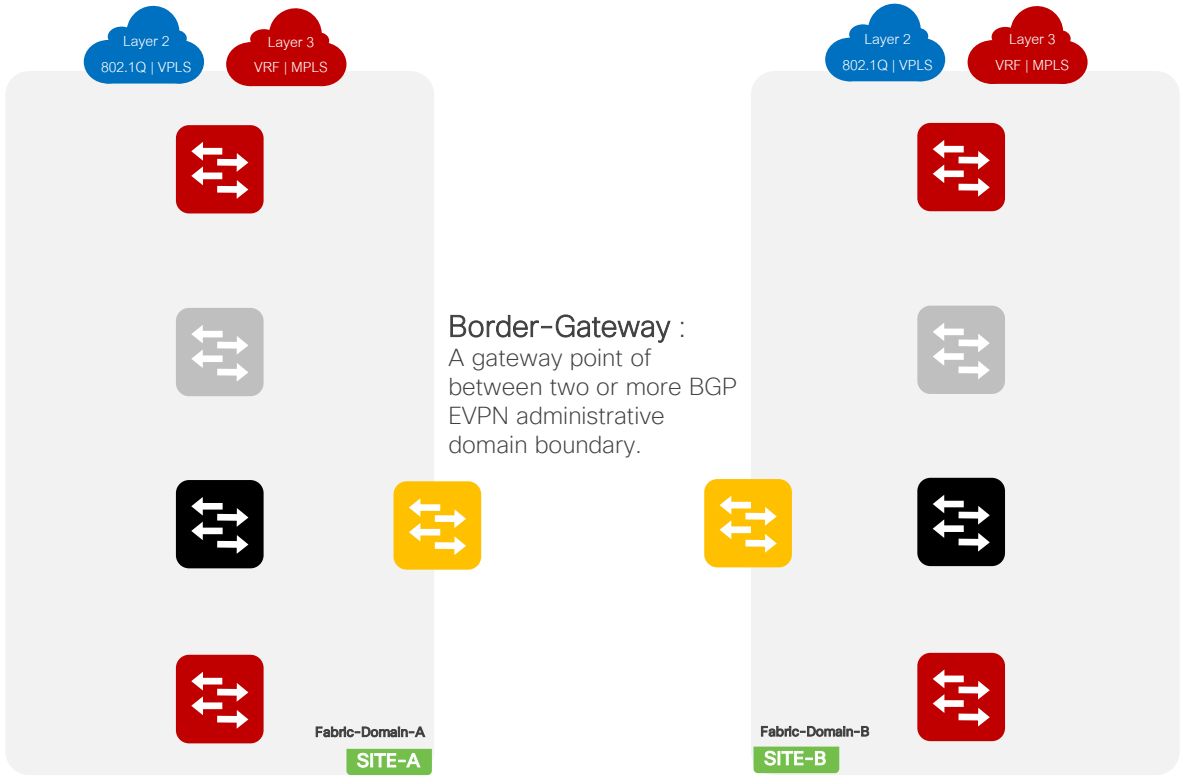
BGP EVPN System Role

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 :
An origination and termination point of VXLAN enabled overlay network.



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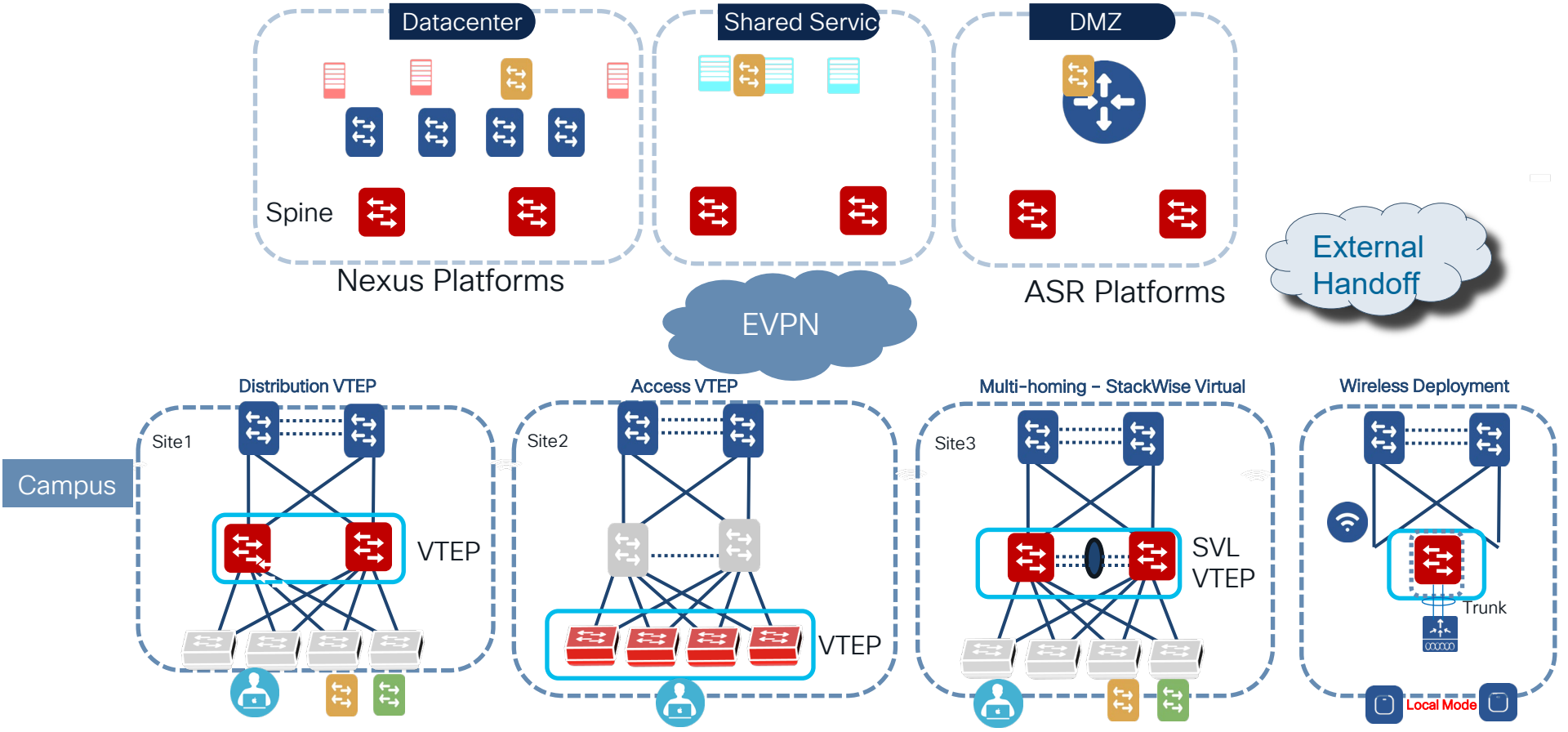
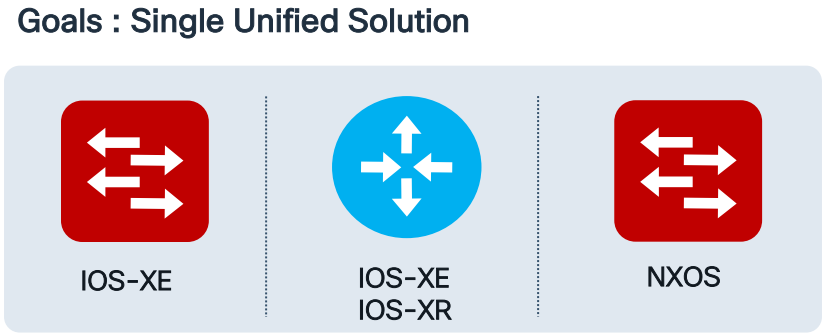
C9K VXLAN BGP EVPN Solution

End-to-End Design and Interoperability



Cisco BGP EVPN Strategy and Solution



- Common cross-OS goals to have single unified BGP EVPN solution
- Consistent end-to-end solution architecture with feature parities across any network tier
- Any system in any role providing complete interoperability inside and outside EVPN fabric domain

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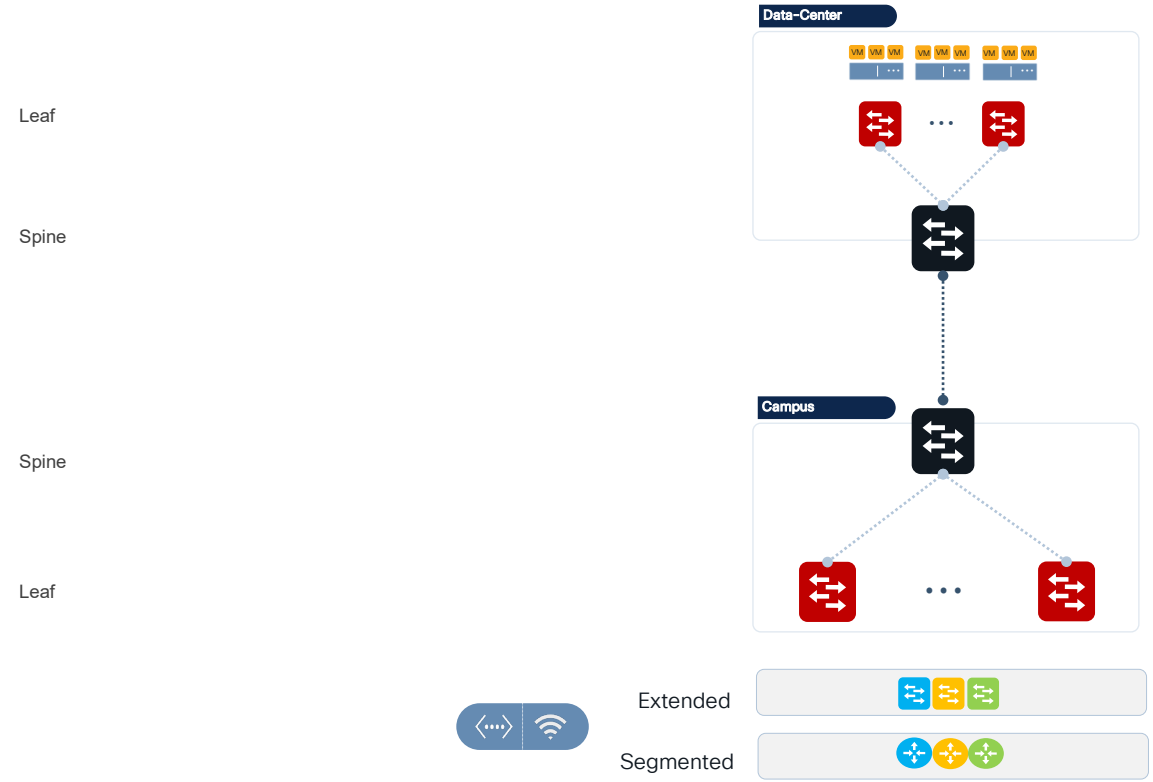
BGP EVPN Inter-Domain Routing



Single Site – Inter-domain EVPN fabric

Hierarchical control-plane for better scale

Spine and Leaf BGP peering in separate domain

Spine-to-Spine BGP Peering

EVPN prefix exchange Next-Hop-Unchanged

BGP EVPN Peers

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Product Matrix and Scale

Catalyst 9000 – Product Support and Role

Catalyst 9000	Role
Catalyst 9200	Unsupported
Catalyst 9300	Leaf | Spine
Catalyst 9400	Leaf | Spine
Catalyst 9500	Leaf | Spine
Catalyst 9500H	Leaf | Spine | Border
Catalyst 9600	Leaf | Spine | Border

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Catalyst 9000 – BGP EVPN Scale Matrix

	C9300	C9400 – Sup1XL	C9500	C9500-H	C9600
EVPN Bridge-Domain (VLAN)	225	225	225	225	225
Core VLAN	225	225	225	225	225
VNI	225	225	225	225	225
VTEP Peers	200	200	200	200	200
MAC (Local + Remote)	32000	64000	64000	80000	80000
VRF	255	255	255	1000	1000
Routes (v4 / v6)	8000 / 4000	144000 / 56000	64000 / 32000	200000 / 100000	200000 / 100000
Host Routes (v4 / v6)	24000 / 12000	48000 / 24000	48000 / 24000	80000 / 40000	80000 / 40000

Refer to Product Datasheet for other feature scale

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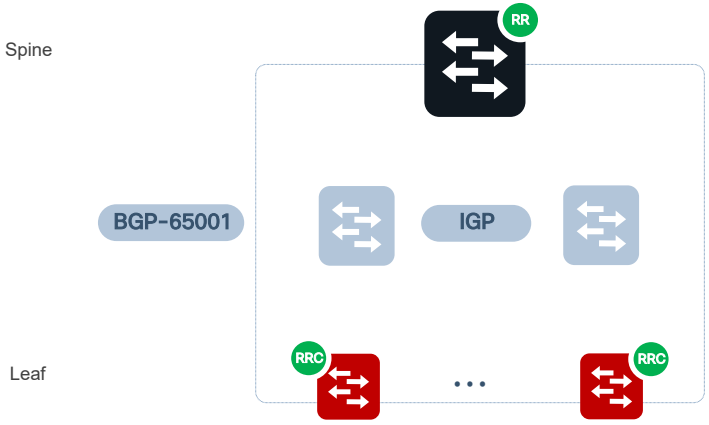
Underlay Network

Unicast Routing

Internal BGP

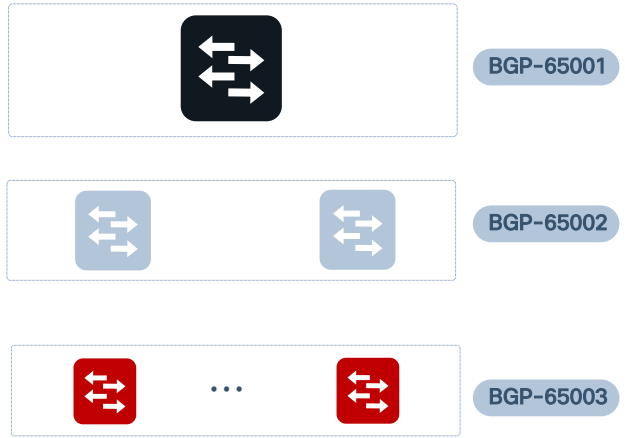


Any choice of IGP to build Underlay unicast routing

Spine and Leaf may be direct/in-direct attachment

Route-Reflector on Spine and Leaf's as Clients

External BGP



Single Routing Protocol for Underlay and Overlay

IPv4 AF to build Underlay and advertise routes.

L2VPN AF to build EVPN peering

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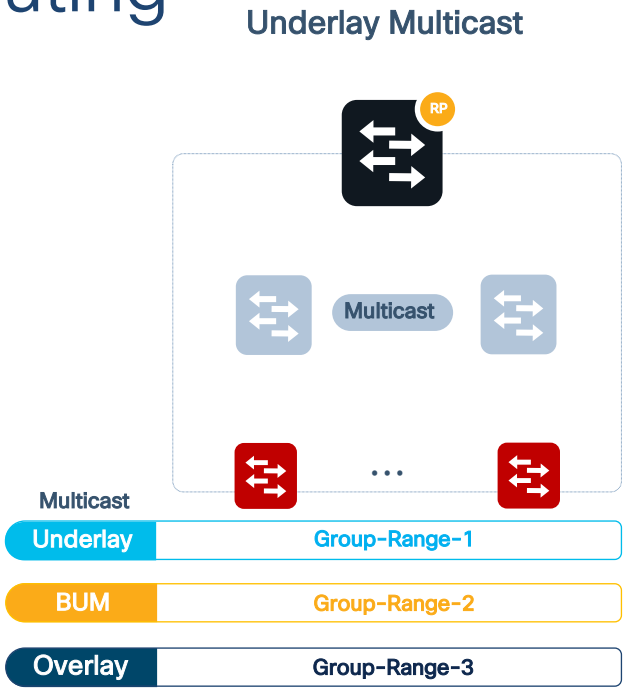
Multicast Routing



Multicast RP integrated on Spine or separate system

Non-overlapping Multicast Group for different purpose

Recommended to large scale EVPN deployments

Default MDT Group Range for Overlay TRM Multicast

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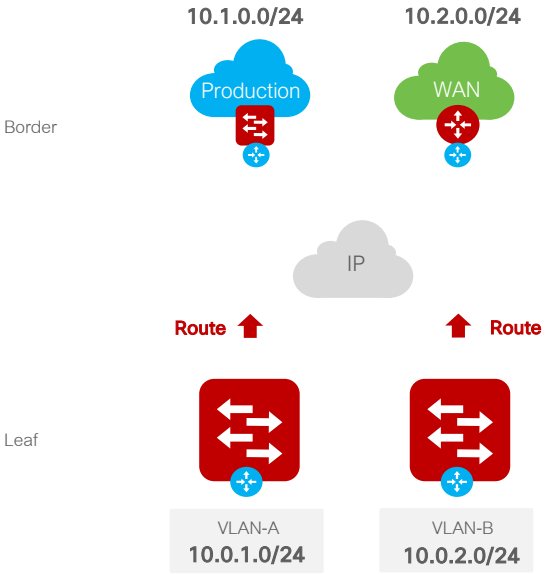
Overlay Network Topologies

L3VNI – Network Segmentation and Routing



Routing

- First-Hop Distributed Gateway at Access
- Access Network policy enforcement point
- Network address routing across fabric
- Data plane segmentation thru VXLAN
- IPv4 / v6 support

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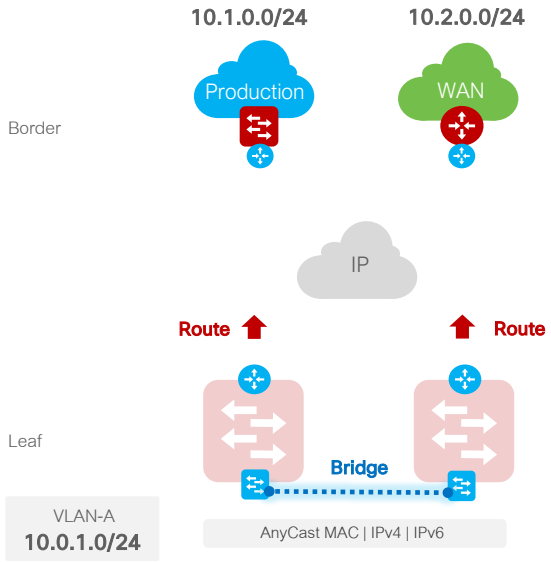
IRB – Distributed AnyCast Gateway



Routing + Bridging

- First-Hop Distributed Anycast Gateway at Access
- Bridge in same VLAN across Leaf's in fabric
- Route locally based on local routing policy
- Access Network policy enforcement point
- Host + Network address routing across fabric
- Data plane segmentation thru VXLAN
- IPv4 / v6 support

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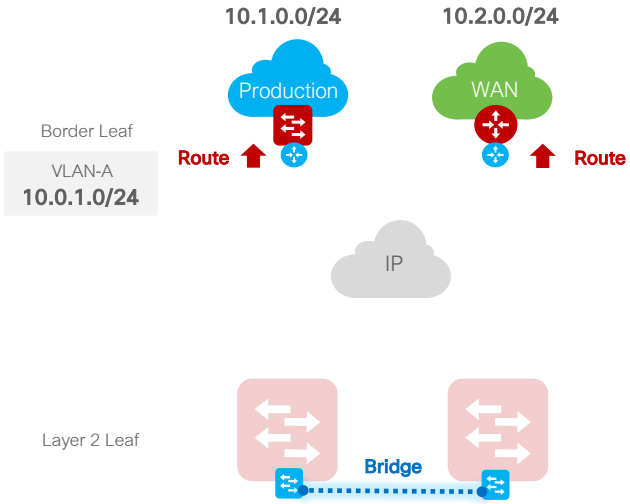
IRB – Centralized Gateway



Remote Routing + Bridging

- Multi-Hop Centralized Gateway
- Bridge in same VLAN across Leaf's in fabric
- Route remotely based on remote routing policy
- Access Network policy enforcement point
- Host address routing across fabric
- Data plane segmentation thru VXLAN
- IPv4 / v6 support

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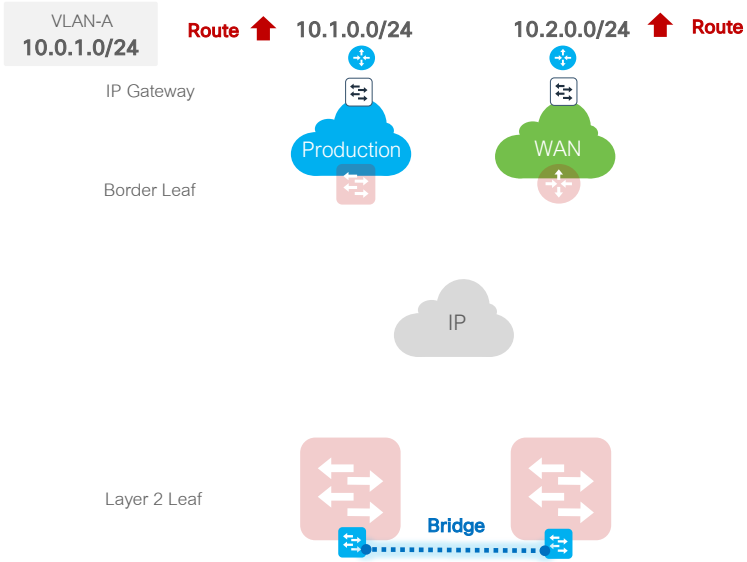
L2 – Layer 2 Network Extensions



Bridging

- IP Gateway beyond EVPN fabric
- Bridge in same VLAN across Leaf's in fabric
- Route outside fabric based on remote routing policy
- Access Network policy enforcement point
- Host address routing across fabric
- Data plane segmentation thru VXLAN
- IPv4 / v6 support

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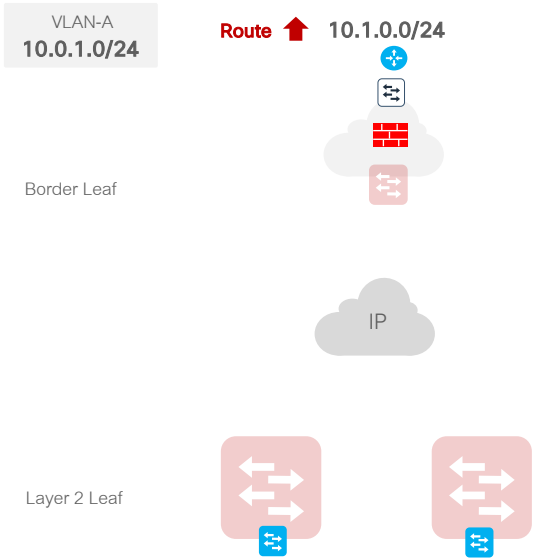
L2 – Hub-n-Spoke Network Extension



Bridging

- IP Gateway beyond EVPN fabric
- Border L2 Leaf Hub. Layer 2 Leaf Spokes.
- Point-to-Point L2VNIs to Hub
- Route outside fabric based on remote routing policy
- Access Network policy enforcement point
- Host address routing across fabric
- Data plane segmentation thru VXLAN
- IPv4 / v6 support

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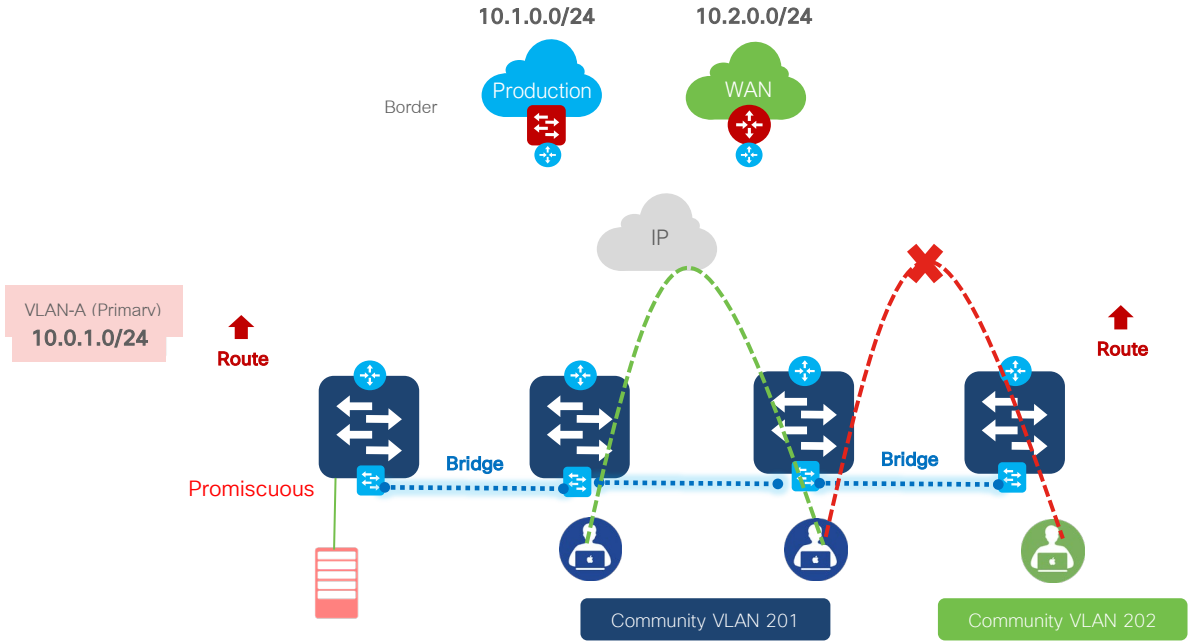
Private VLAN Integration with EVPN

Differentiated features

Routing + Private VLAN Bridging (Community VLAN)



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EVPN Fabric InterWorking

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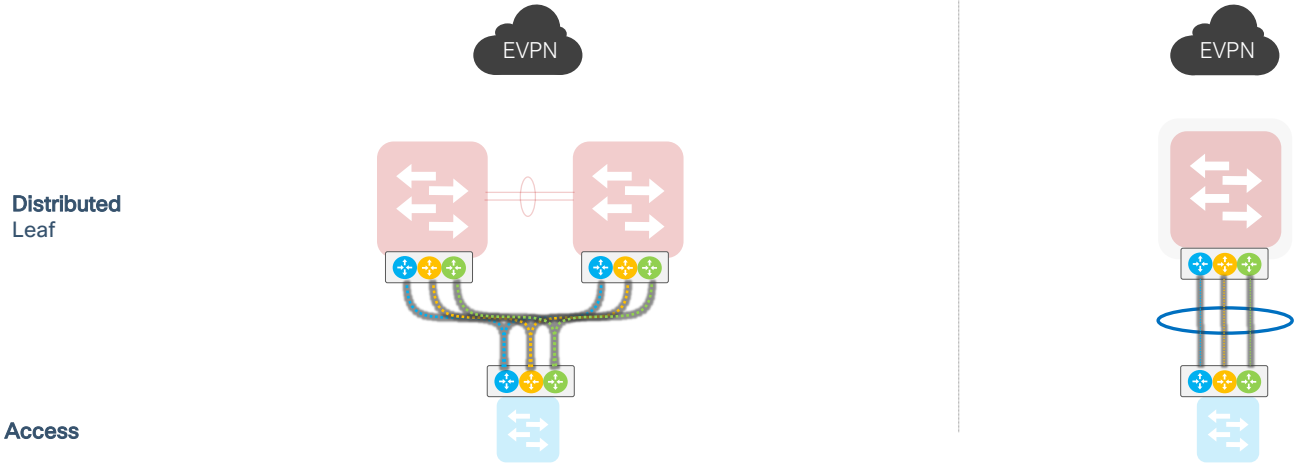
Catalyst 9000 – L3 Leaf Design Alternatives

Design 1 – Dual-Home Standalone Leaf

Design 2 – Dual-Home StackWise Virtual Leaf



- Layer 3 Multipath requirement varies based on Leaf design – Standalone vs StackWise Virtual
- The Standalone mode support traditional L2 with challenges, FHRP, variable scale/performance and redundancy
- The StackWise Virtual mode enables hardware accelerated multi-homing Active/Active load sharing with protocol-independent and deterministic network resiliency without operational complexities.

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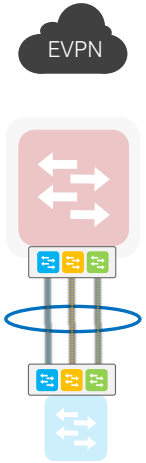
Catalyst 9000 – L2 Leaf Design Support

Dual-Home StackWise Virtual Leaf



Distributed
Leaf

Access

- Layer 2 Multipath in Standalone Mode is not supported.
- Cisco StackWise Virtual technologies supports Active/Active Layer 2 Multi-homing without any additional protocol dependencies and operational complexities
- Cisco StackWise Virtual member switch supports distributed VXLAN forwarding with BGP control-plane protocol redundancy using standard SSO/NSF

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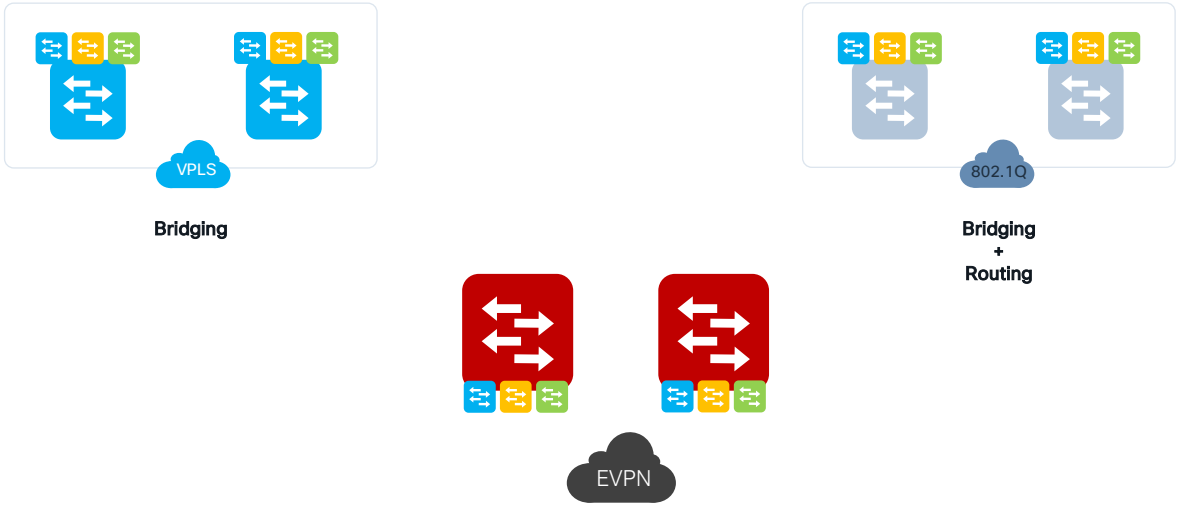
Catalyst 9000 – Layer 2 Border-Leaf Support



- Layer 2 Network Extension to classic STP or ”stitched” across VPLS enabled overlay network
- Single system solution supporting interworking function between EVPN and MPLS LDP overlay infrastructure
- Full IRB support for 802.1Q handoff and Bridging-only support for VPLS handoff

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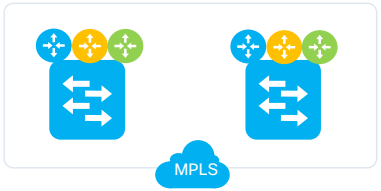
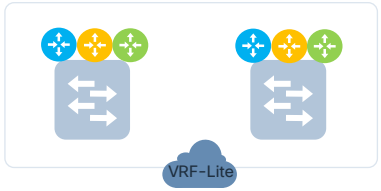
Catalyst 9000 – Layer 3 Border-Leaf Support

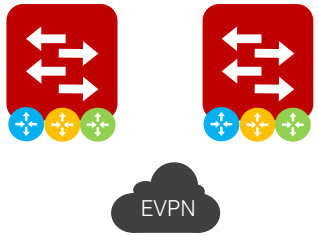
MPLS PE





Multi-VRF

MPLS PE
Border-Leaf



- Layer 3 Network Segmentation to per-hop Multi-VRF with 802.1Q based segmentation.
- Single system solution supporting interworking function between EVPN and MPLS LDP overlay infrastructure
- Full EVPN to MPLS VPN route and label propagation support for IPv4 and IPv6 prefixes between two overlay networks.

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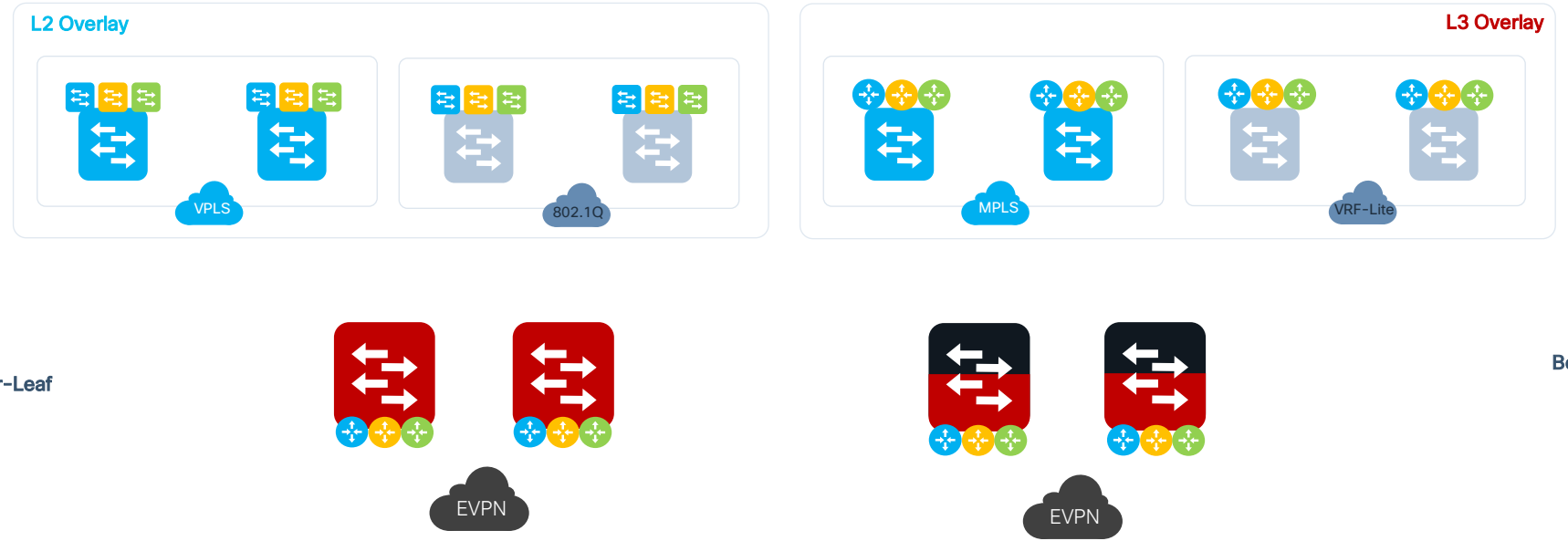
Catalyst 9000 – Multi-Function Role Support



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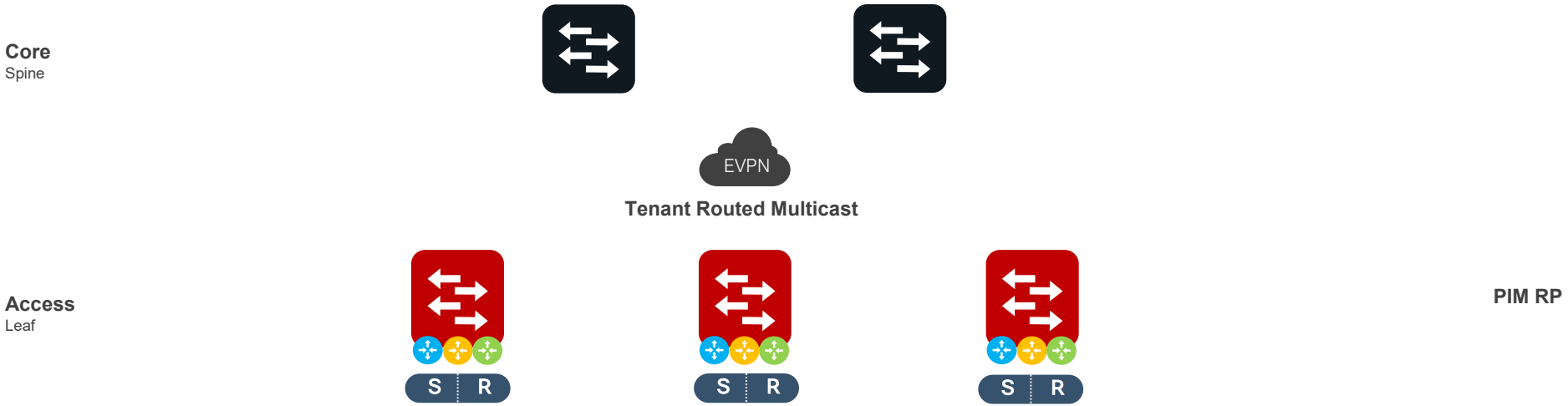
Multicast over VXLAN

Tenant Routed Multicast Architecture



- TRM enables Multicast over VXLAN enabled network for Layer 3 network segments. NXOS Compatible
- Integrated PIM RP and PIM-SM in Underlay support enables fabric-enabled source and receivers Multicast forwarding topologies.
- VTEP provides integrated PIM RP function

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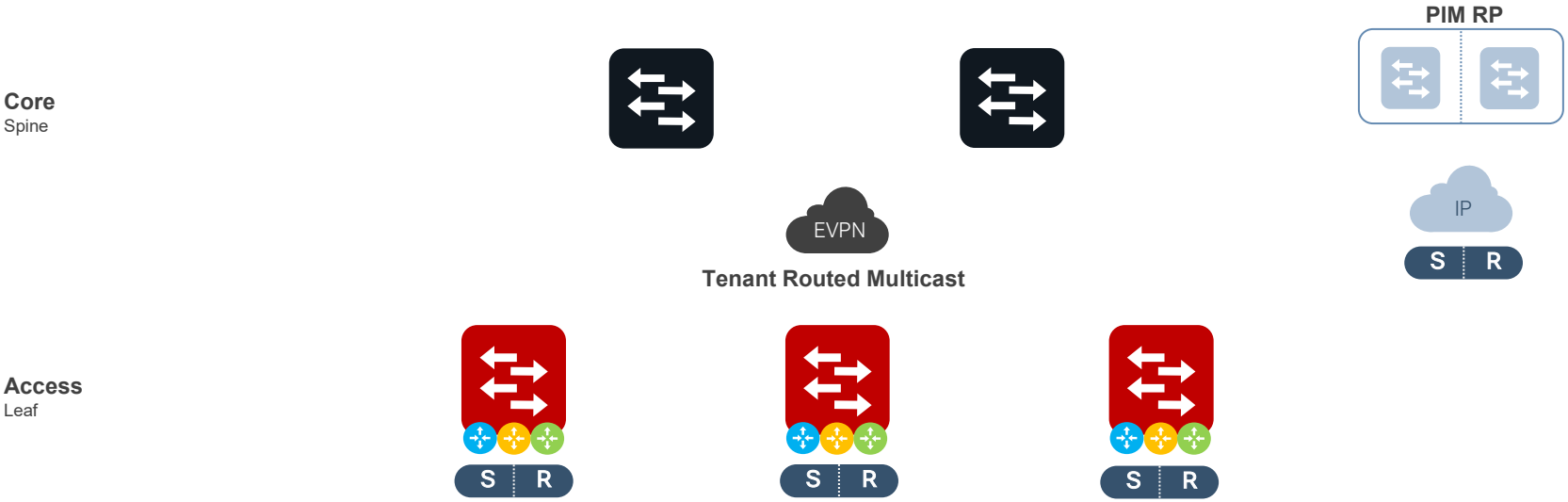
Tenant Routed Multicast Architecture



- TRM enables Multicast over VXLAN enabled network for Layer 3 network segments. NXOS Compatible
- Integrated PIM RP and PIM-SM in Underlay support enables fabric-enabled source and receivers Multicast forwarding topologies.
- Layer 2 TRM support planned for future release. By default Multicast applications follows flood-n-learn mechanics.

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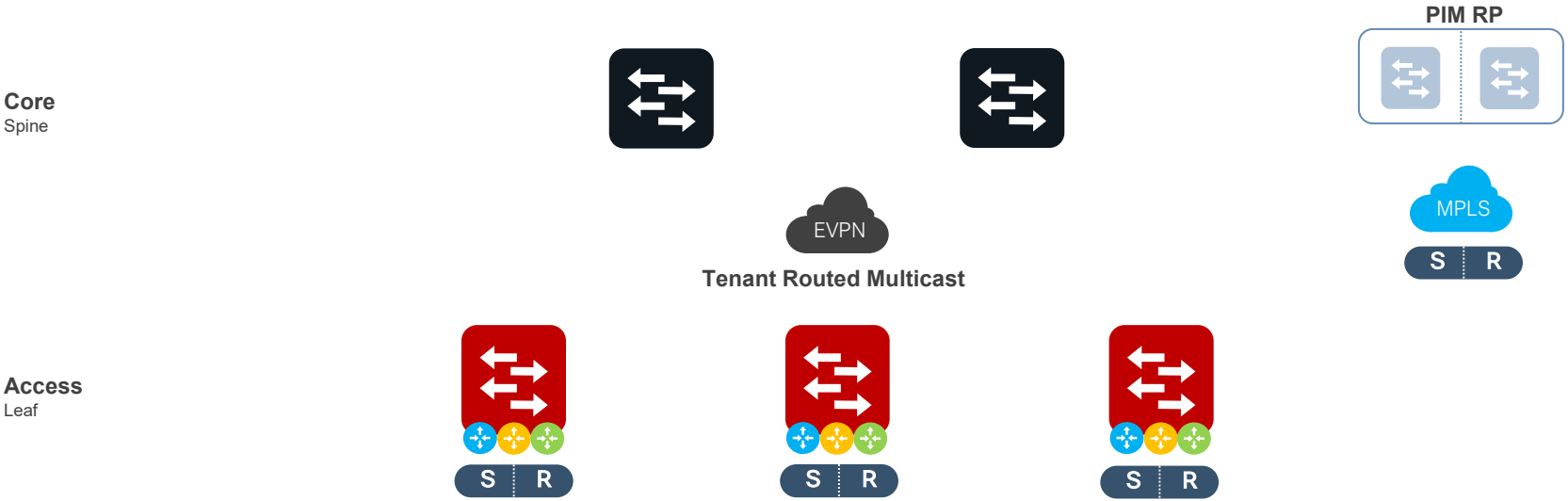
TRM / MPLS mVPN Interworking



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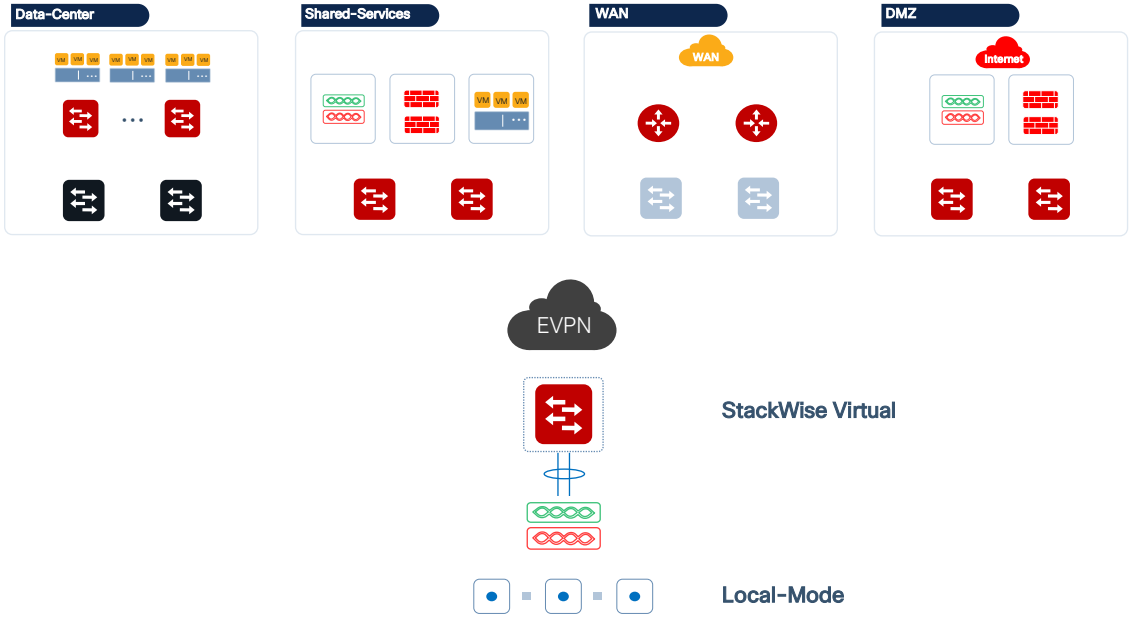
EVPN Overlay Network Services

Wireless Integration in EVPN Networks



- Transparent Wireless network integration into BGP EVPN fabric network
- Underlay CAPWAP communication between AP and WLC. User Policy enforcement maintains at WLC.
- VTEP in Wireless aggregation can overlay network traffic based on routing policy.

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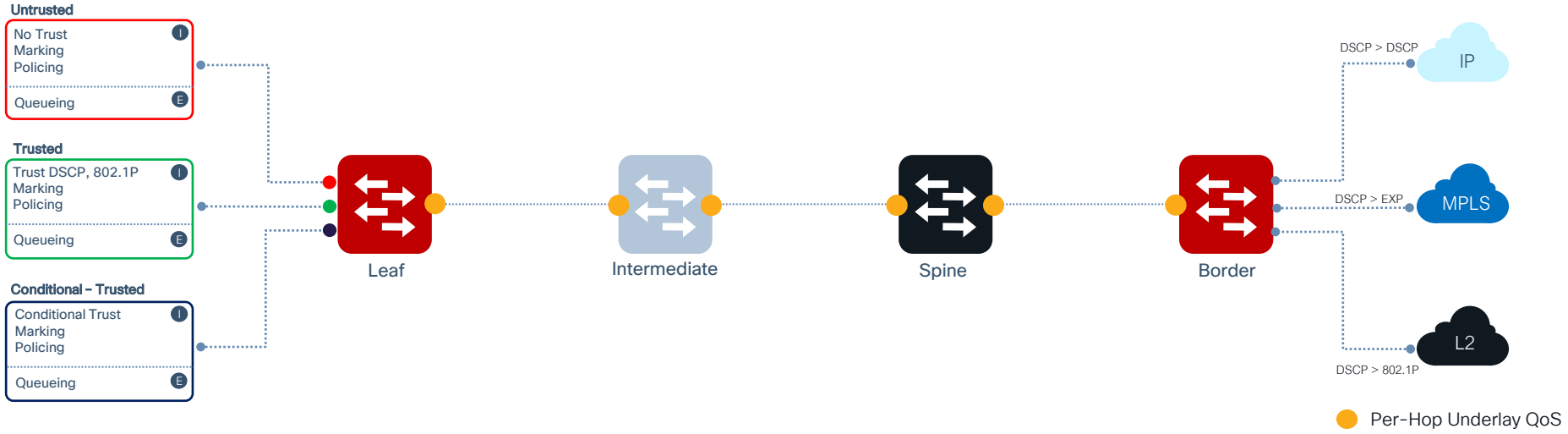
VXLAN QoS Management



- Trust-Boundary and policy enforcement at network edge.
- Per-hop Underlay QoS policy provides differentiated service treatment for combined underlay and overlay traffic class
- QoS policy and marking at Border supports default or user-defined policy with interworking external network domain

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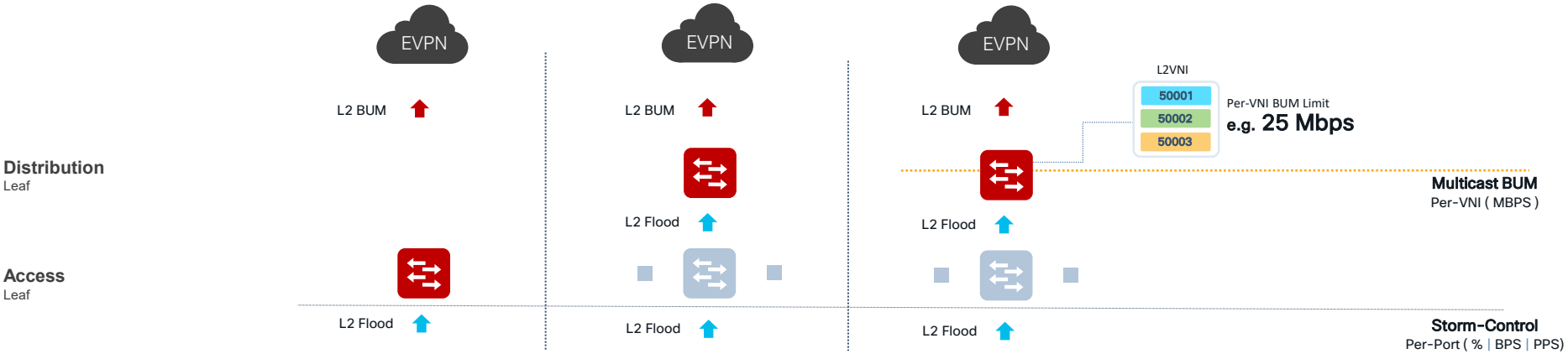
Per-VNI BUM Rate-Limiter



- Protect BUM traffic at network edge ports limiting flood across Layer 2 and EVPN fabric network domain
- Deterministic per VNI Multicast BUM traffic flood protecting Enterprise backbone network performance
- MQC QoS based policer associated to L2VNI performing Multicast-based replication mode

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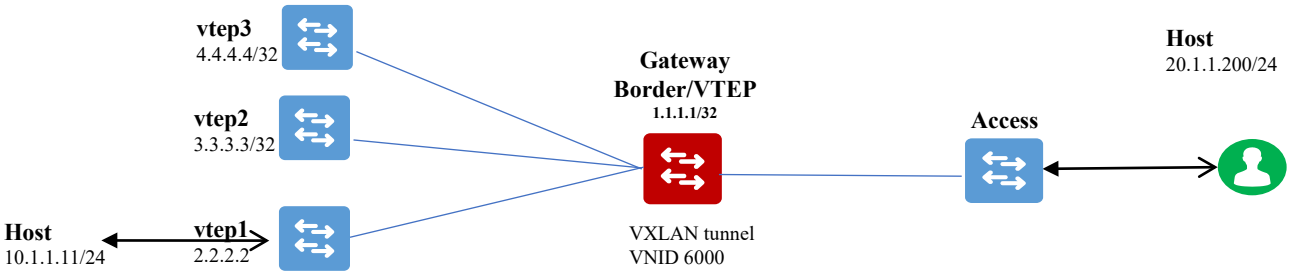
VXLAN Aware Flexible NetFlow



Flow record fields	Packet data
Source Address	10.1.1.11
Destination Address	20.1.1.200
Source Port	47321
Destination Port	80
IP Protocol	6
TCP Flags	0x1A
Source SGT	0
Interface	nve10
Flow direction	input
VNID	**6000**
VXLAN Flags	**I**
VXLAN SRC VTEP	**1.1.1.1**
VXLAN DST VTEP	**2.1.1.1**

- Maximum 128K VxLAN enabled flows per Catalyst 9600/9500-H
- Supports v4 and v6 protocols
- Bi-directional flow detection over the NVE interface
- Rapid Overlay network data flow learning rate support (every 500ms)

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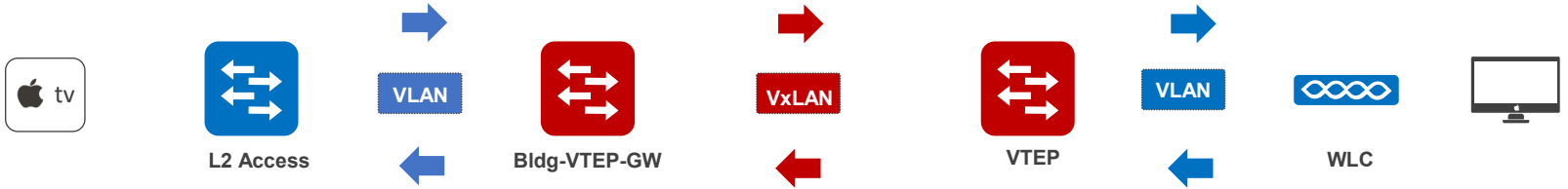
Bonjour Overlay Network Challenges



BUM on VLAN :

- Flood-n-Learn
- Transparent L2 flooding within same VLAN
- Bonjour gateway function in-effective

BUM on EVPN :

- Flood-n-Learn with IR or MR
- IR : 1 mDNS frame = 1 Unicast frame to 1 VTEP
- MR : 1 mDNS frame = 1 Multicast frame to L2VNI

BUM on VLAN :

- Flood-n-Learn
- Transparent L2 flooding within same VLAN
- Bonjour gateway function in-effective

- Extended mDNS flood-domain across network infrastructure
- Ingress-Replication model to handle BUM traffic on EVPN may impact backbone network performance
- Multicast-Replication model is better but still not scalable when expecting 20000-25000 pps mDNS per VTEP in the network

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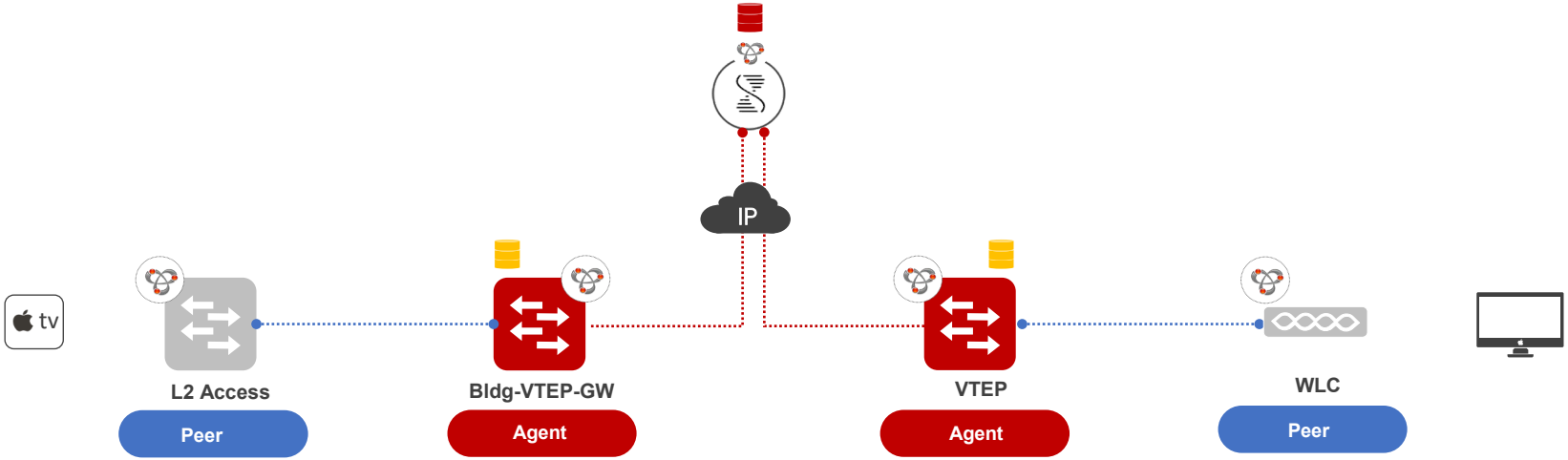
Distributed Bonjour Overlay Network Architecture



- Eliminate mDNS with end-to-end service-routing architecture
- Extended mDNS suppression and flood-control management at L2 boundary – Wired/Wireless or VPLS
- Policy based distributed Bonjour cache management at first-hop BGP EVPN VTEP and Wired/Wireless gateway
- Scalable control-plane architecture for Wired/Wireless and BGP EVPN without impacting end-to-end performance

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Catalyst 9000 EVPN Reference

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Configuration Guide

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 Tenant Routed Multicast

Troubleshooting BGP EVPN VXLAN

Feature History and Information for BGP EVPN VXLAN

Reference

https://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst9600/software/release/17-2/configuration_guide/vxlan/b_172_bgp_evpn_vxlan_9600_cg.html

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The bridge to possible

Thank you


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