

The background is a vibrant, abstract graphic. It features a central bright white light source from which numerous colorful rays emanate, creating a sunburst or starburst effect. The rays transition through a spectrum of colors including yellow, orange, red, and various shades of blue and green. Overlaid on this are large, flowing, wavy shapes in similar colors, giving the impression of liquid or smoke being illuminated by the light. The overall effect is energetic and celebratory.

cisco *Live!*

Let's go

#CiscoLive



The bridge to possible

# Service Overlay Cookbook

Powered by EVPN

Jiri Chaloupka - Principal Technical Marketing Engineer

BRKSPG-2041



#CiscoLive

# Cisco Webex App

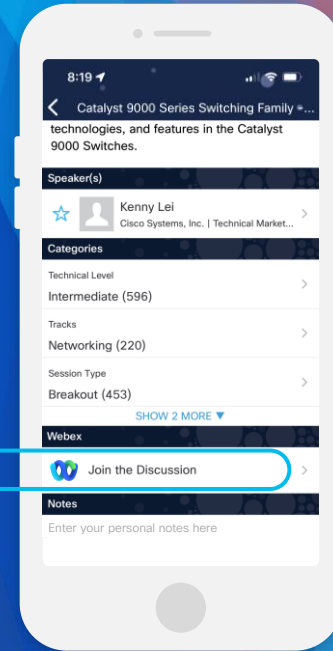
## Questions?

Use Cisco Webex App to chat with the speaker after the session

## How

- 1 Find this session in the Cisco Live Mobile App
- 2 Click “Join the Discussion”
- 3 Install the Webex App or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until June 9, 2023.

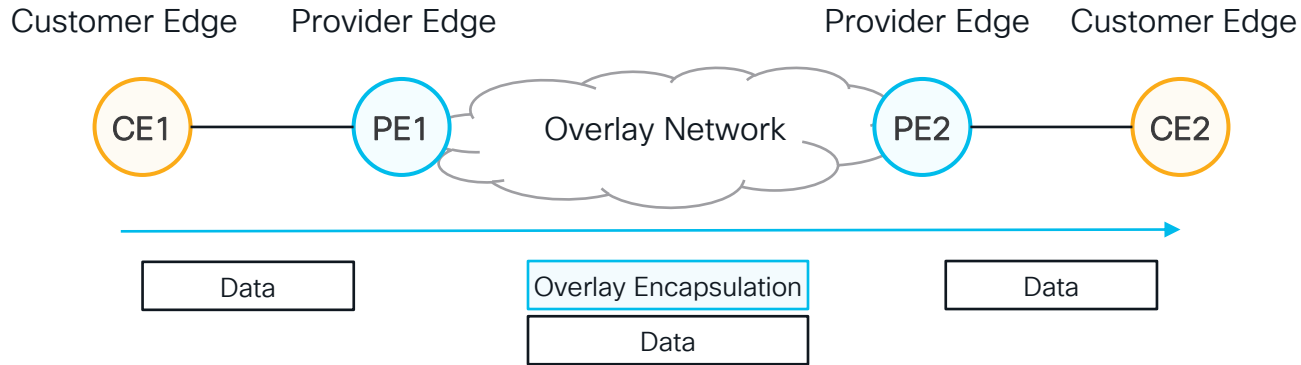


<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKSPG-2041>

# Agenda

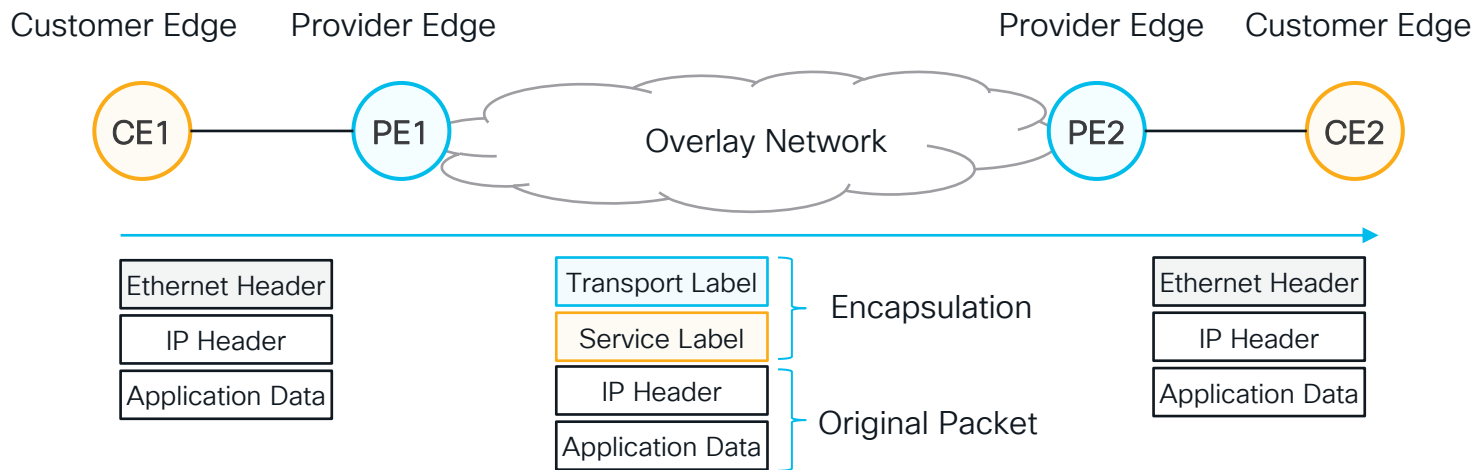
- What is Service Overlay?
- Introduction
- Usecases / How to deploy new services overlay into existing network
- BGP Signaling
- MPLS and IP Data Plane
- Advanced Usecases
- Summary

# What is Service Overlay?



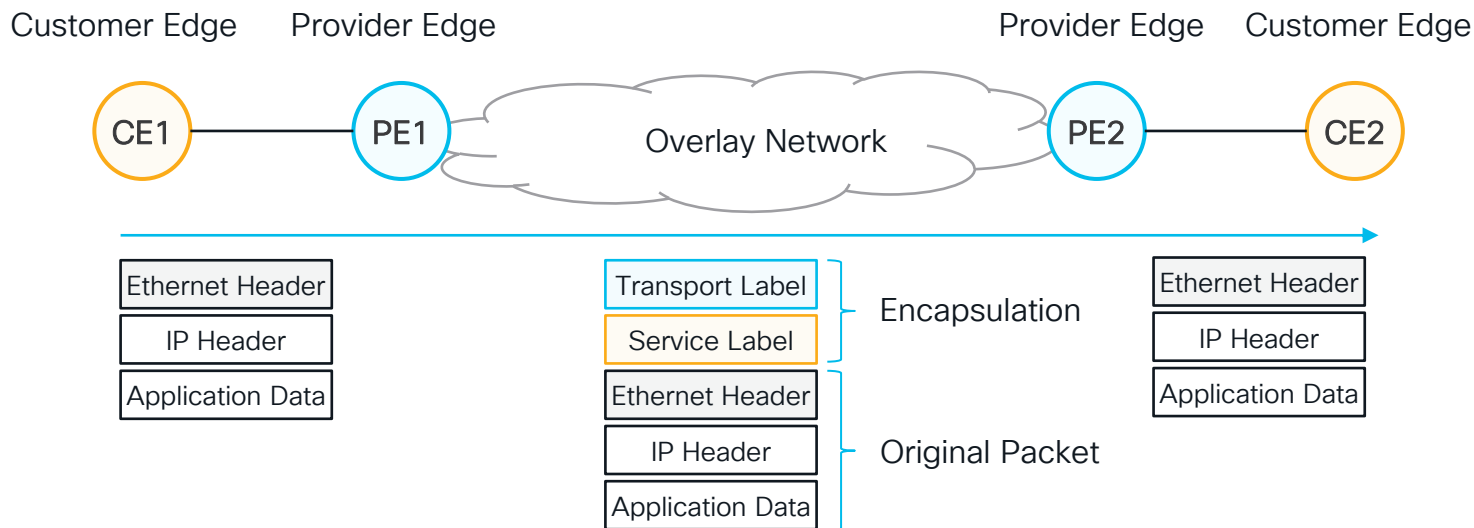
# What is Service Overlay?

## L3VPN – MPLS Data Plane



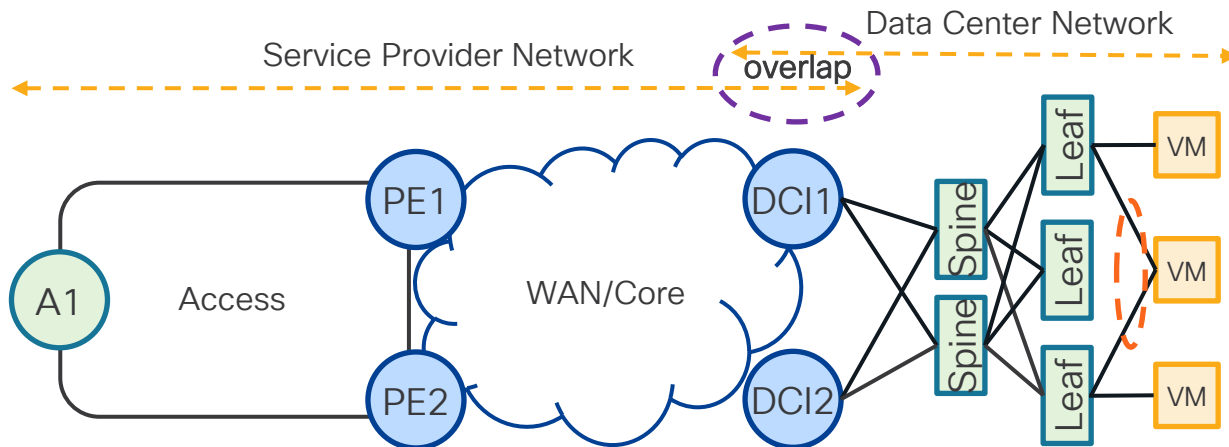
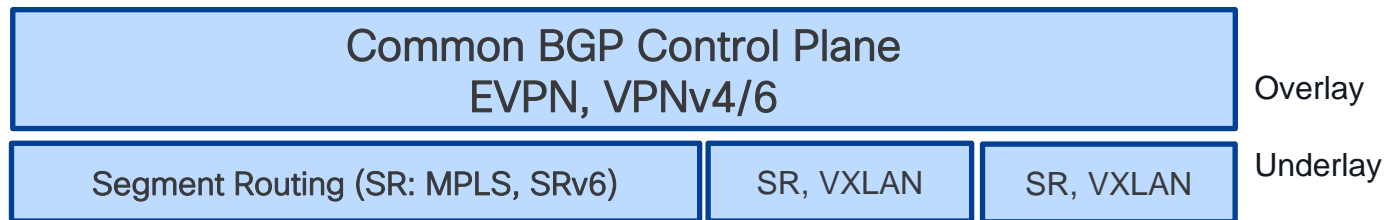
# What is Service Overlay?

## L2VPN – MPLS Data Plane



# Unified Control Plane and Data Plane

Next Generation  
Services Overlay &  
Data Plane



Legacy Solution:





# EVPN Advantages:

## Integrated Services

- Integrated Layer 2 and Layer 3 VPN services
- L3VPN-like principles and operational experience for scalability and control
- All-active Multi-homing & PE load-balancing (ECMP)

## Network Efficiency

- Fast convergence (link, node, MAC moves)
- Control-Place (BGP) learning. PWs are no longer used.
- Optimized Broadcast, Unknown-unicast, Multicast traffic delivery

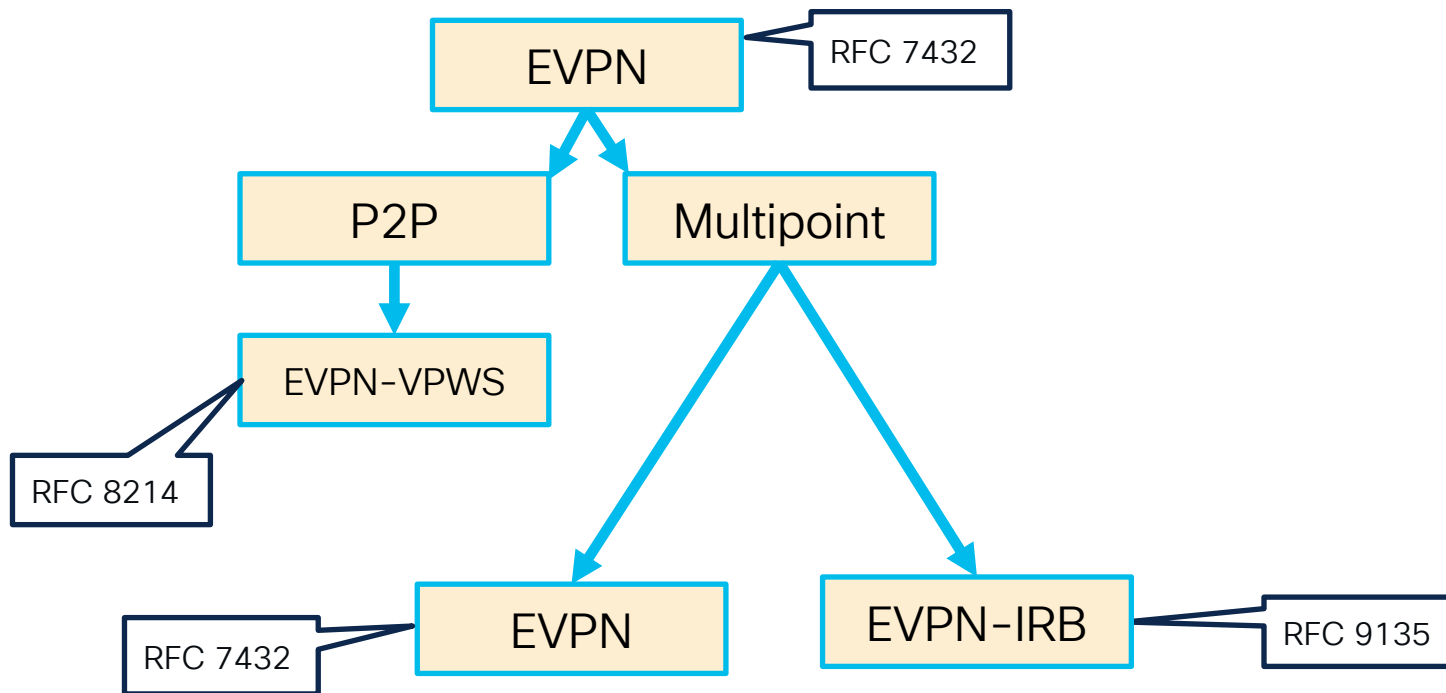
## Service Flexibility

- Choice of MPLS, VxLAN or SRv6 data plane encapsulation
- Support existing and new services types (E-LAN, E-Line, E-TREE)
- Peer PE auto-discovery. Redundancy group auto-sensing

## Investment Protection

- Fully support IPv4 and IPv6 in the data plane and control plane
- Open-Standard and Multi-vendor support

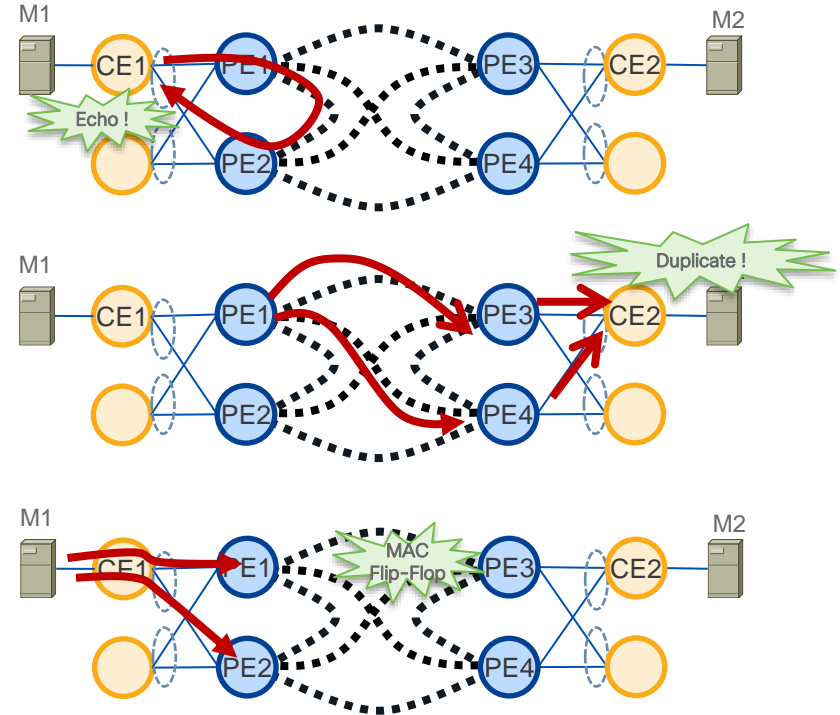
# EVPN Standardization - IETF



# Next-Generation Solutions for L2VPN

## Solving VPLS challenges for per-flow Redundancy

- Existing VPLS solutions do not offer an All-Active per-flow redundancy
- Looping of Traffic Flooded from PE
- Duplicate Frames from Floods from the Core
- MAC Flip-Flopping over Pseudowire
  - E.g. Port-Channel Load-Balancing does not produce a consistent hash-value for a frame with the same source MAC (e.g. non MAC based Hash-Schemes)

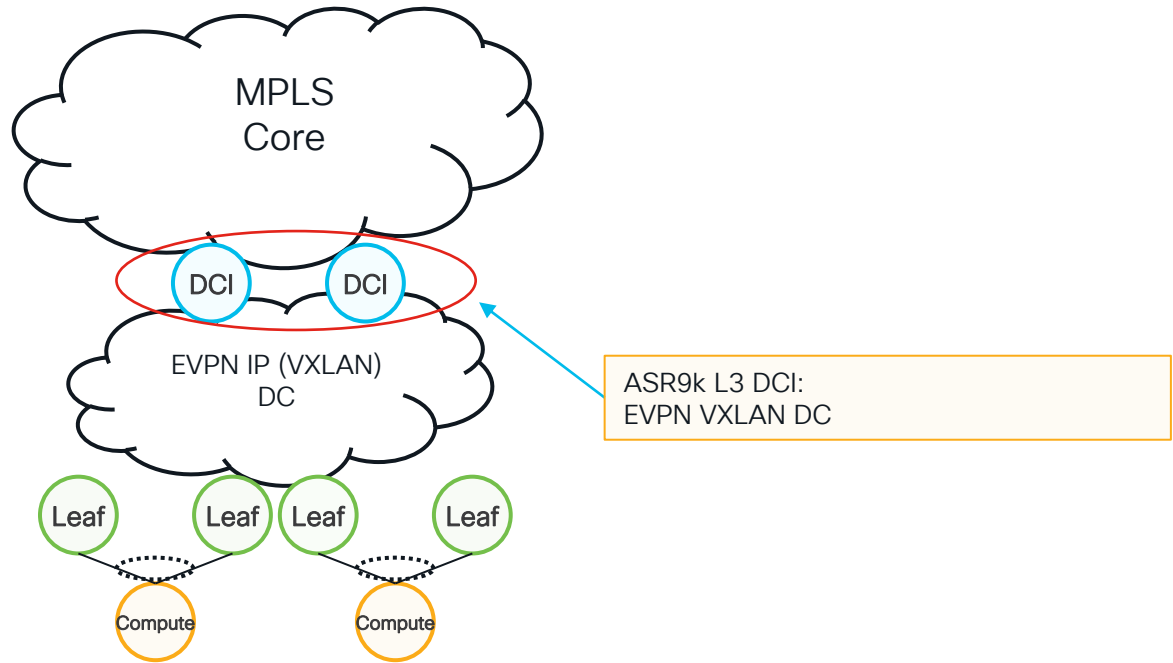


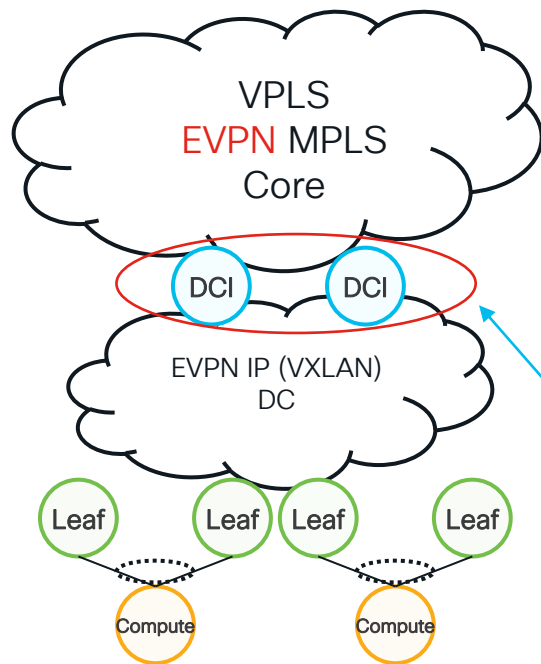
# EVPN Flavors

- Multi-Homed All-Active Ethernet Access
  - Replacement of: mLACP, STP, T-LDP, BGP-AD, etc.
- Standards-based Multi-chassis / Cluster Control Plane
  - Replacement of: vPC, VSS, nVCluster, etc.
  - Replacement of: HSRP, VRRP, etc.

# Cisco IOS XR EVPN Evolution Useases

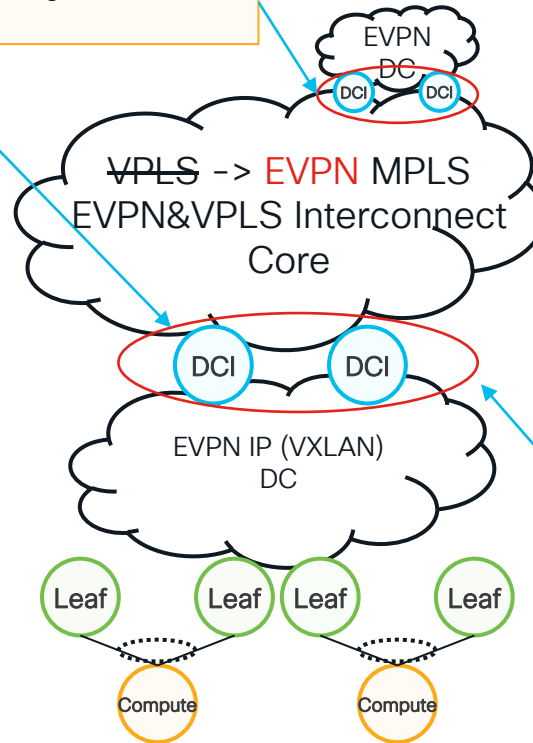






ASR9k L3 DCI:  
EVPN VXLAN DC  
ASR9k L2 DCI:  
EVPN VXLAN DC & EVPN MPLS Core  
**ASR9k L2 EVPN (ELAN)**

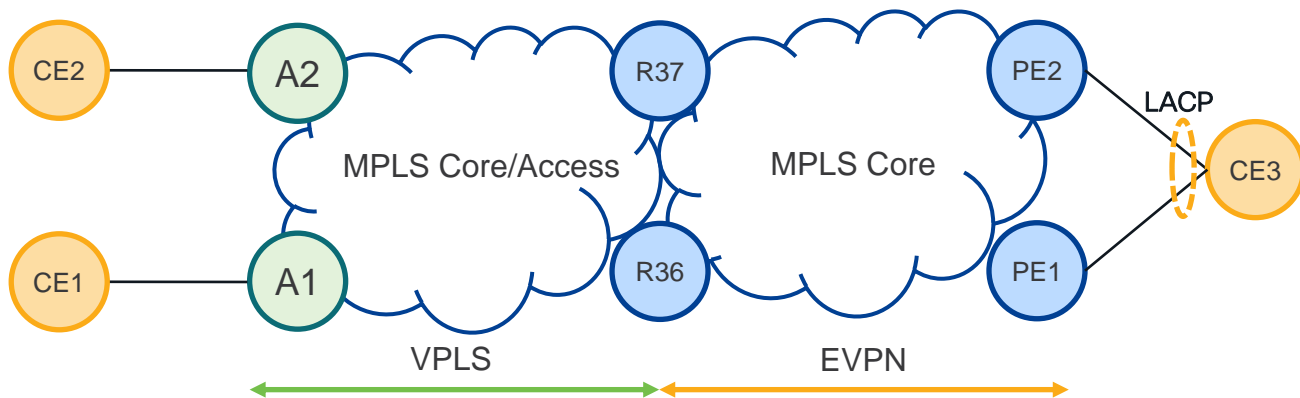
ASR9k/NCS VPLS to EVPN Seamless Migration  
ASR9k VPLS to EVPN Interconnect



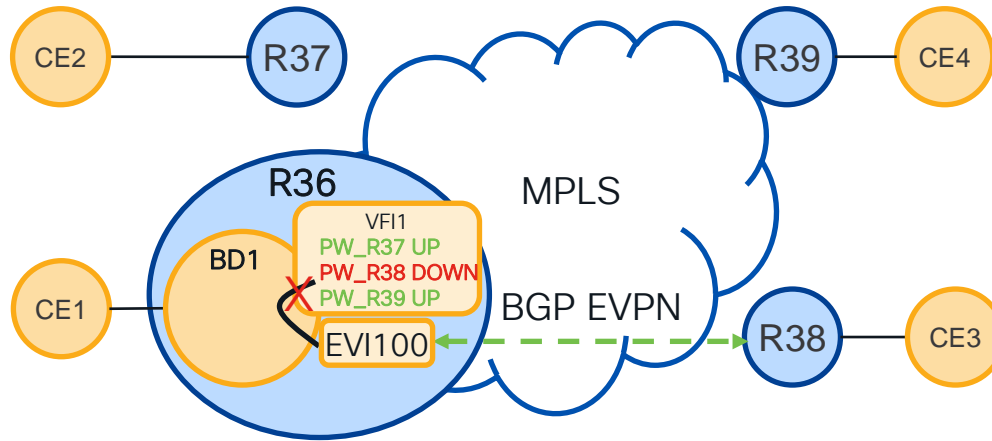
ASR9k L3 DCI:  
EVPN VXLAN DC  
ASR9k L2 DCI:  
EVPN VXLAN DC & EVPN MPLS Core  
**ASR9k L2 EVPN (ELAN)**



# EVPN & VPLS Interconnect

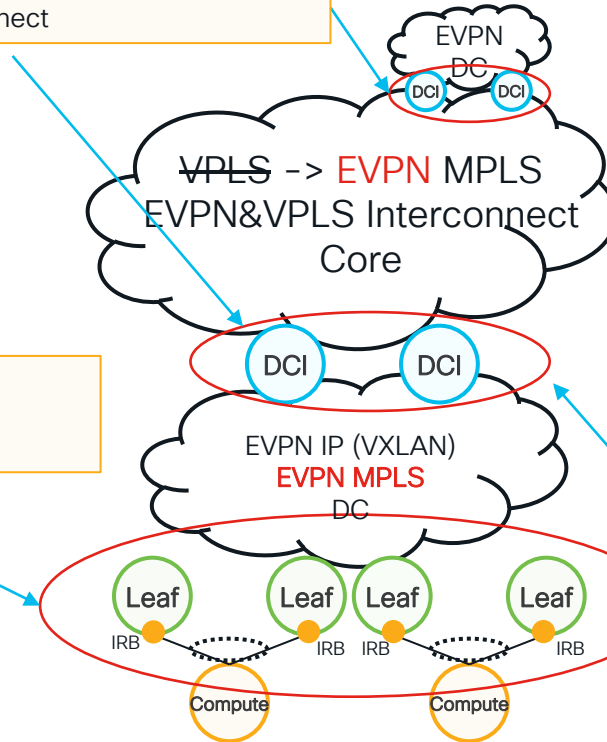


# VPLS & EVPN Seamless Integration - Migration



ASR9k/NCS VPLS to EVPN Seamless Migration  
ASR9k VPLS to EVPN Interconnect

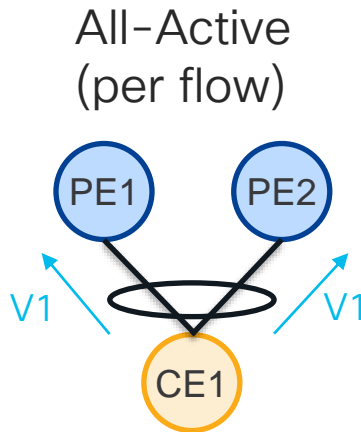
ASR9k/NCS L2 EVPN (ELAN)  
**All-Active Multihoming**  
ASR9k/NCS EVPN Distributed Anycast GW



ASR9k L3 DCI:  
EVPN VXLAN DC  
ASR9k L2 DCI:  
EVPN VXLAN DC & EVPN MPLS Core  
**ASR9k L2 EVPN (ELAN)**

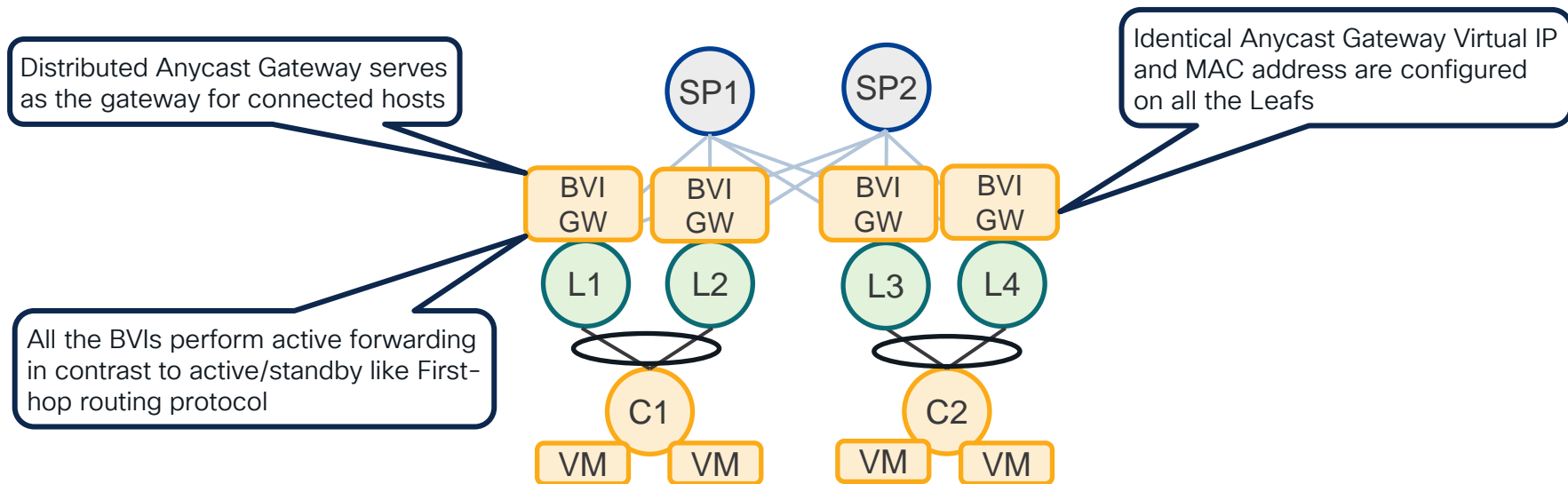
# EVPN - Load-Balancing Modes

## All-Active



Single LAG at the CE  
VLAN goes to both PE  
Traffic hashed per flow  
**Benefits:** Bandwidth, Convergence

# EVPN – Distributed Symmetric Anycast Gateway







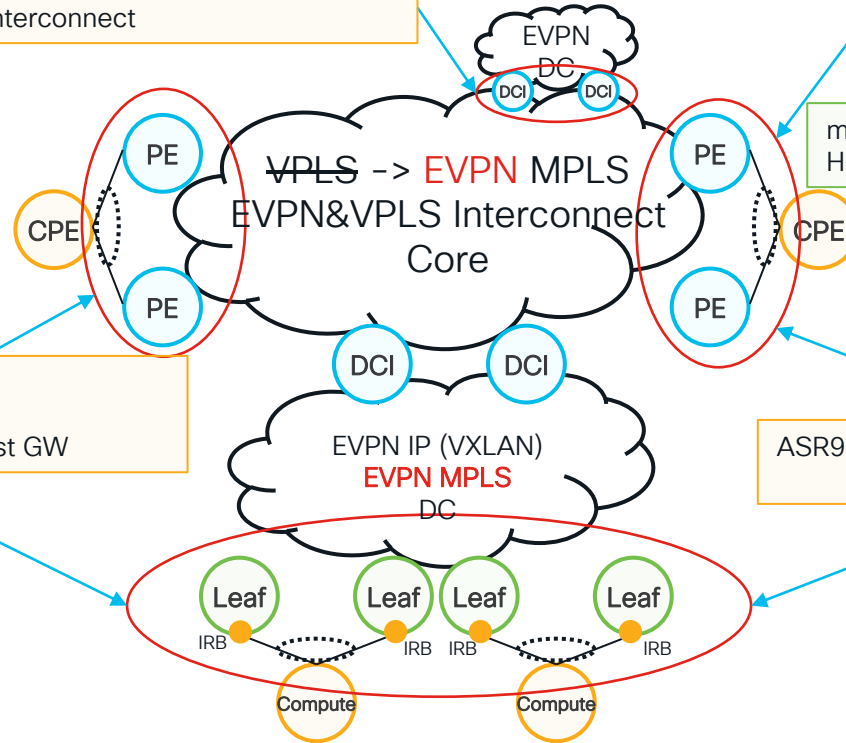
ASR9k/NCS VPLS to EVPN Seamless Migration  
ASR9k VPLS to EVPN Interconnect

ASR9k/NCS EVPN-VPWS  
**All-Active Multihoming**

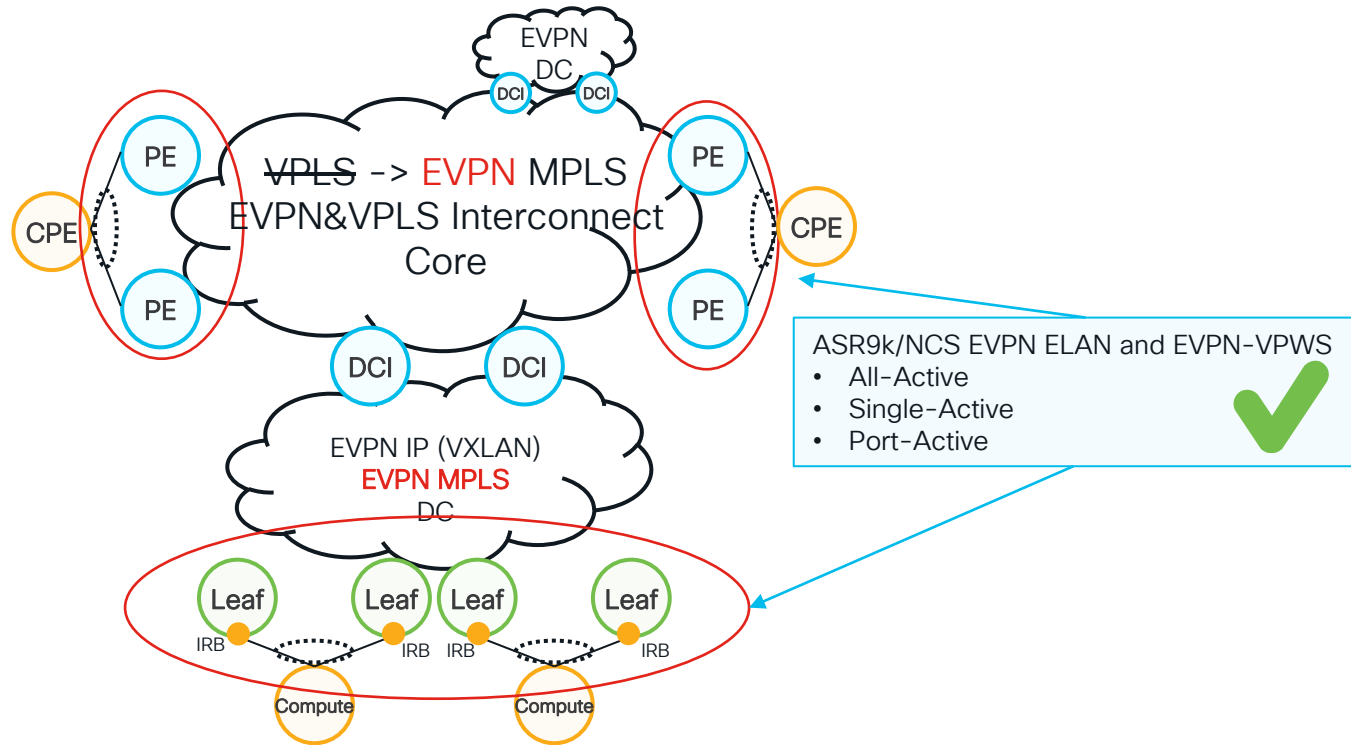
mLACP/Cluster Replacement  
HSRP/VRRP Replacement Phase 1

ASR9k/NCS L2 EVPN (ELAN)  
**All-Active Multihoming**  
ASR9k/NCS EVPN Distributed Anycast GW

ASR9k/NCS EVPN (RT7/8)  
Multicast IGMP join/leave sync

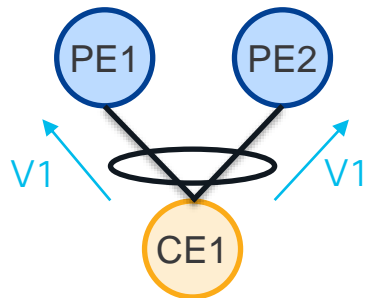






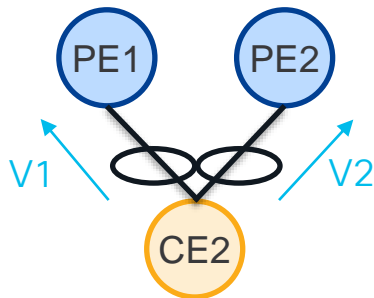
# EVPN - Load-Balancing Modes

All-Active  
(per flow)



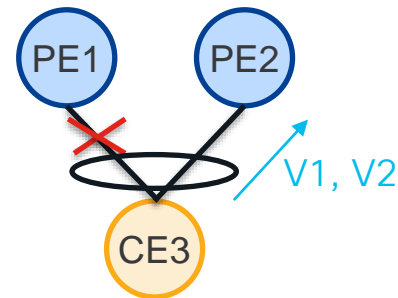
Single LAG at the CE  
VLAN goes to both PE  
Traffic hashed per flow  
**Benefits:** Bandwidth, Convergence

Single-Active  
(per VLAN)



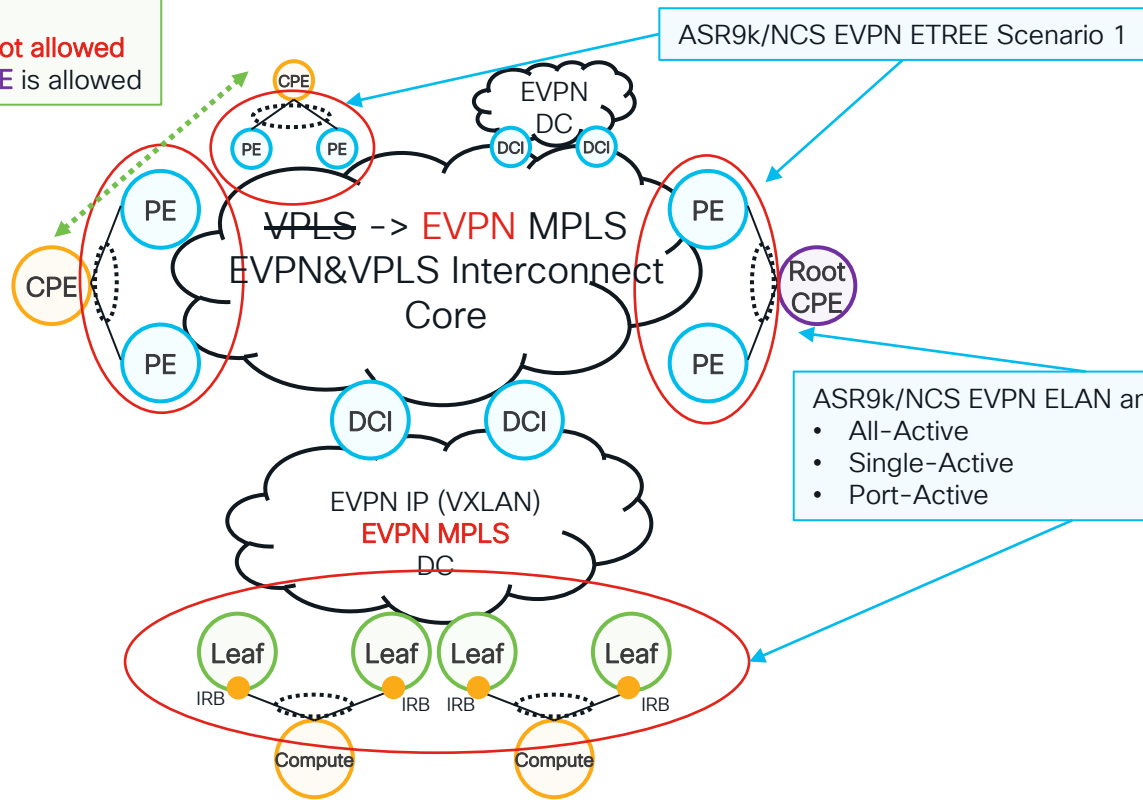
Multiple LAGs at the CE  
VLAN active on single PE  
Traffic hashed per VLAN  
**Benefits:** Billing, Policing

Port-Active  
(per port)



Single LAGs at the CE  
Port active on single PE  
Traffic hashed per port  
**Benefits:** Protocol Simplification

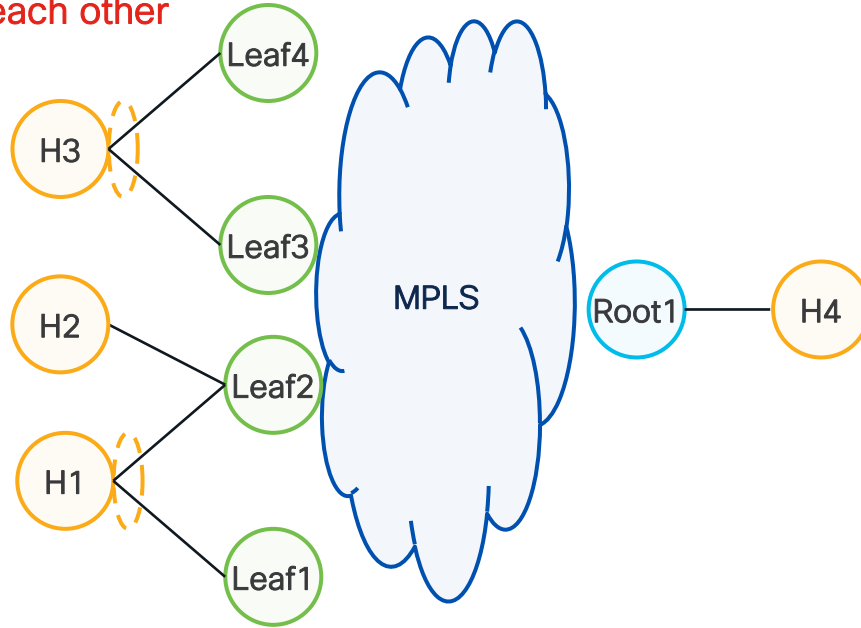
ETREE  
 CPE <-> CPE is **not allowed**  
 CPE <-> Root CPE is allowed



- ASR9k/NCS EVPN ELAN and EVPN-VPWS
- All-Active
  - Single-Active
  - Port-Active

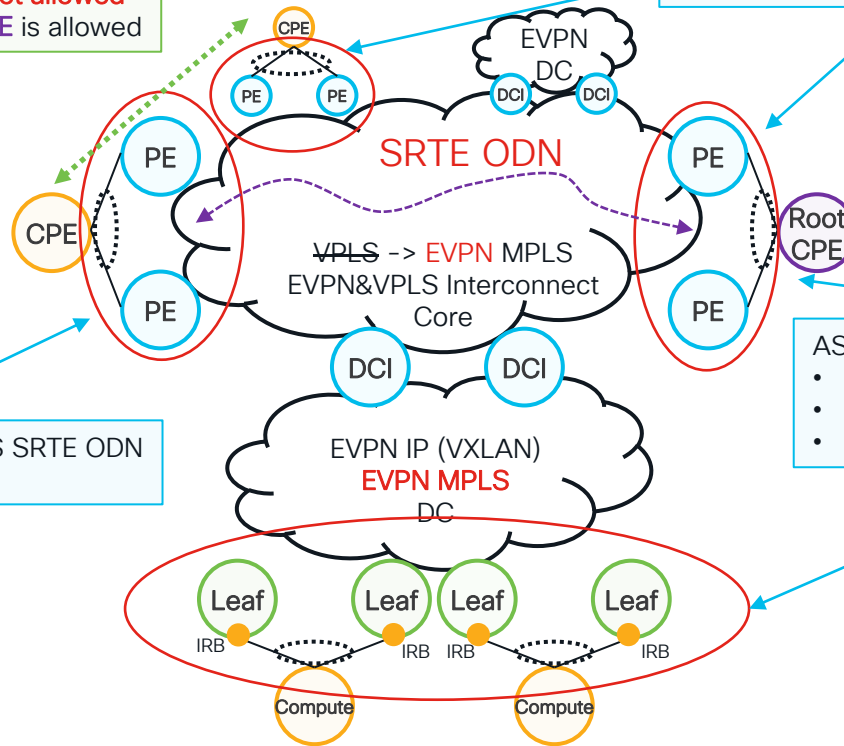
# What is ETREE?

- Host connected to Leaf can talk **ONLY** to device connected to Root
- H1, H2, H3 can talk to H4
- **H1, H2, H3 CANNOT** talk to each other



ETREE  
 CPE <-> CPE is **not allowed**  
 CPE <-> **Root CPE** is allowed

ASR9k/NCS EVPN ETREE Scenario 1

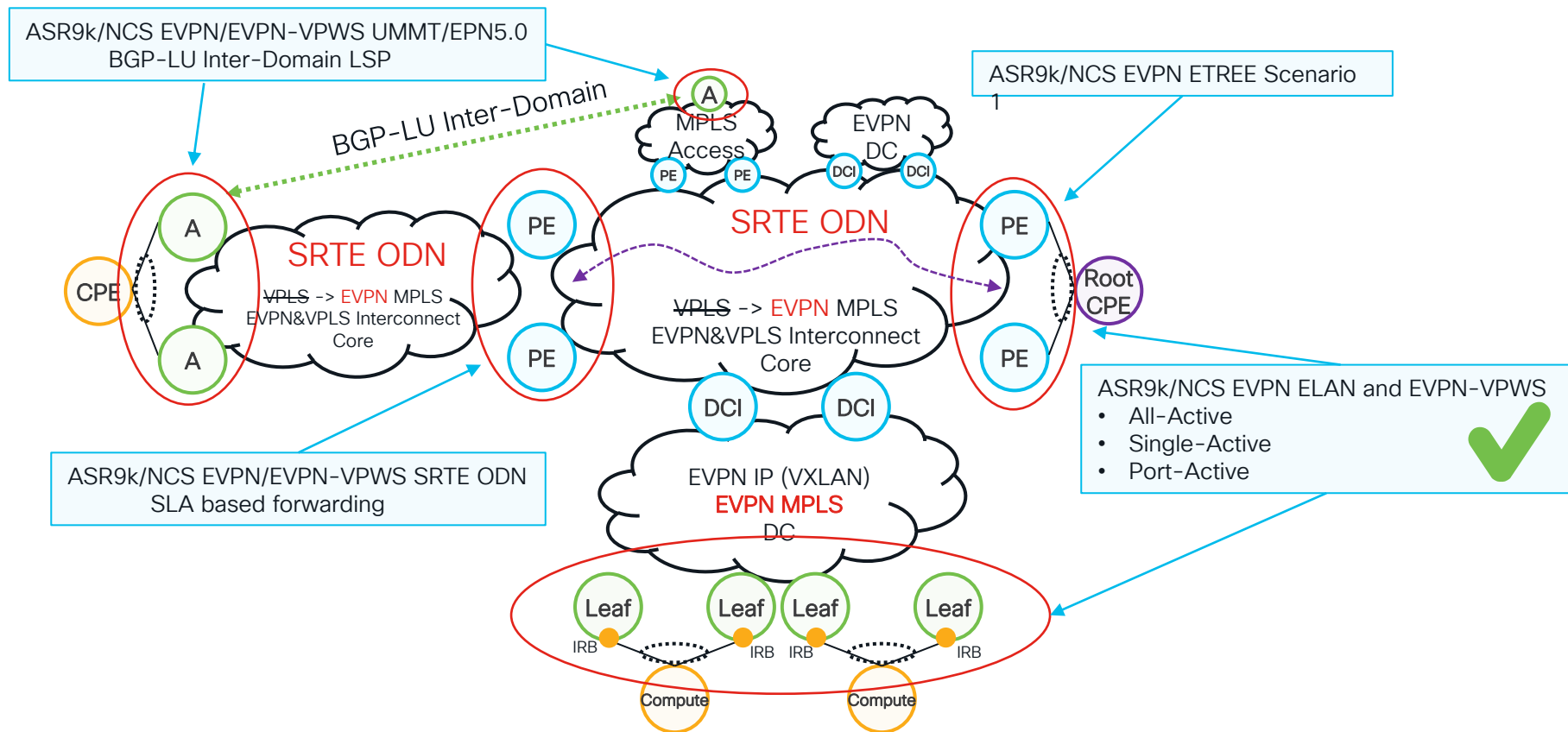


ASR9k/NCS EVPN ELAN and EVPN-VPWS

- All-Active
- Single-Active
- Port-Active

✓

ASR9k/NCS EVPN/EVPN-VPWS SRTE ODN  
 SLA based forwarding

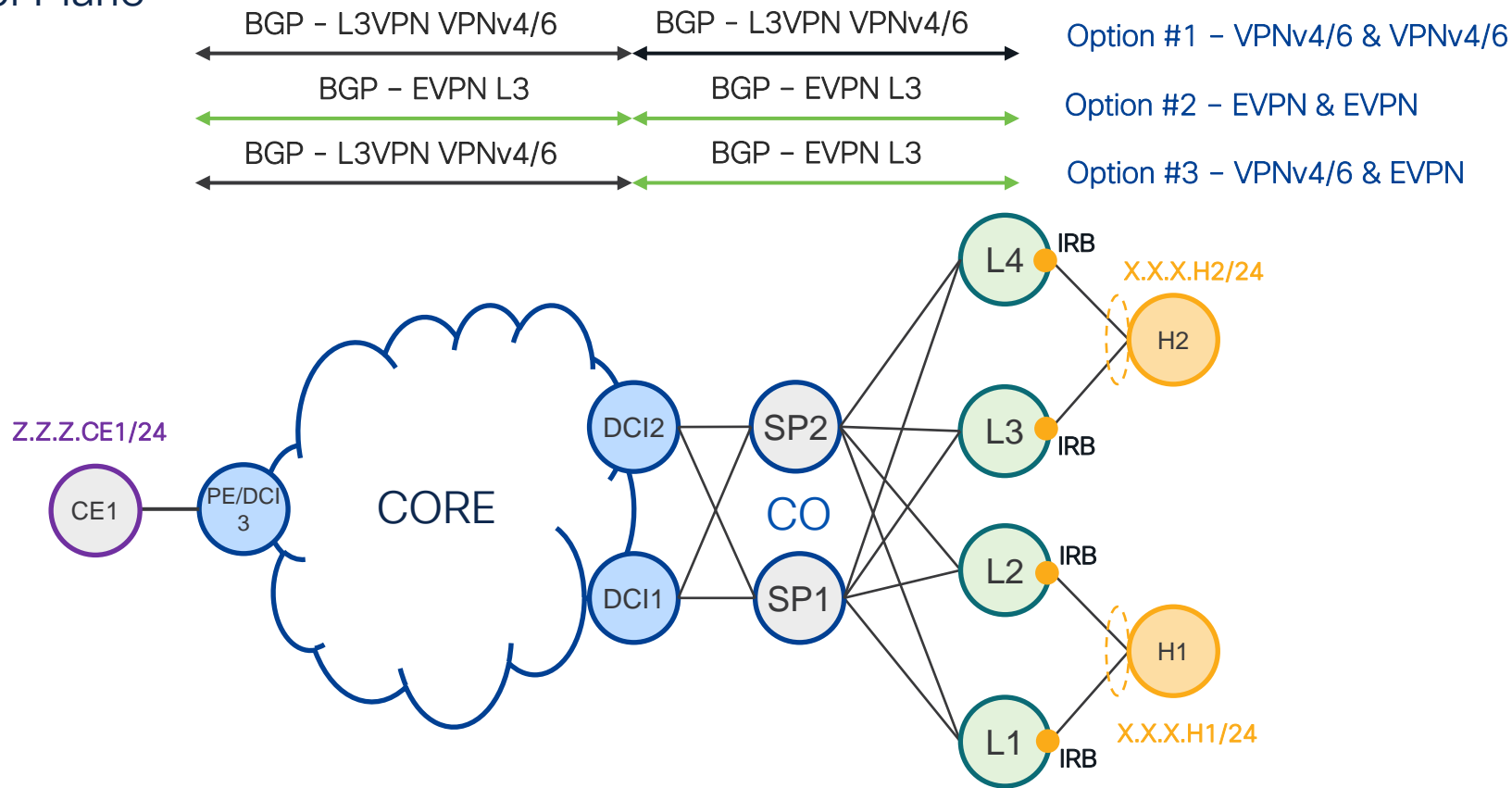


# L3VPN Signaling EVPN vs VPNv4/6



# BGP Layer3 Interconnect

## Control Plane





# BGP Layer3 Interconnect

## Control Plane Options Highlight

- Option #1 – VPNv4/6 & VPNv4/6

- + VPNv4/6 Industry proofed solution for Layer3 VPN
- + DCI doesn't need to understand BGP EVPN AF
- Leaf has to peer with Route-Reflector via both BGP EVPN and VPNv4/6 AF
  - EVPN AF to support L2 stretch (MAC advertisement) across DC/CO between Leaves
  - EVPN AF to sync ARP/ND for Multi-Homed All-Active
- DC/CO Route-Reflector has to support both BGP EVPN and VPNv4/6 AF
- Leaf has to advertise VM Host-Routes via VPNv4/6

- Option #2 – EVPN & EVPN

- + Single BGP Address Family End-To-End in Network
- Existing L3 VPNv4/6 services has to to migrated to L3 EVPN
  - No technical benefit to migrate existing L3 VPNv4/6 to L3 EVPN

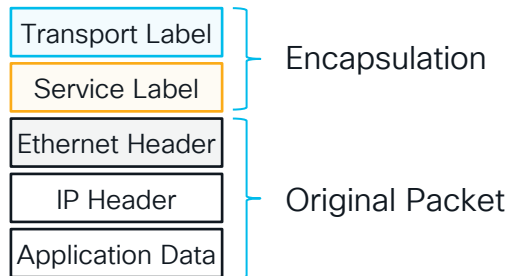
- Option #3 – VPNv4/6 & EVPN

- + Recommended solution which benefits from both Options #1 and #2
- + New DC/CO – Leaf, Route-Reflector use single BGP AF EVPN
- + Existing L3 VPNv4/6 services stay untouched

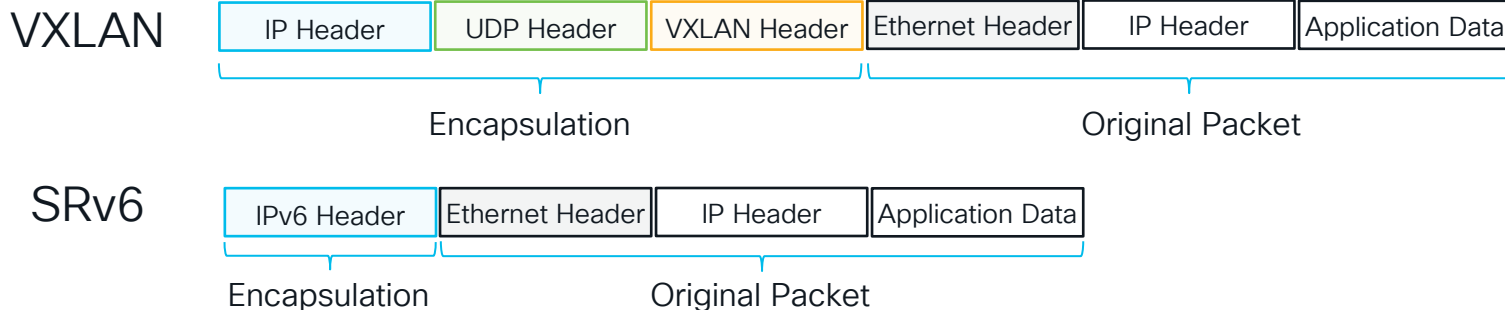
# MPLS and IP Data Plane

# L2VPN Services Overlay Encapsulation

## MPLS Data Plane

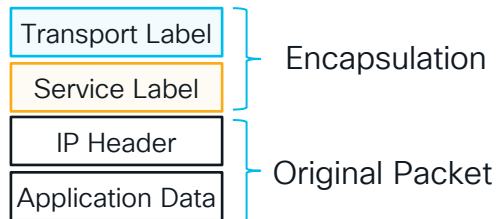


## IP Data Plane



# L3VPN Services Overlay Encapsulation

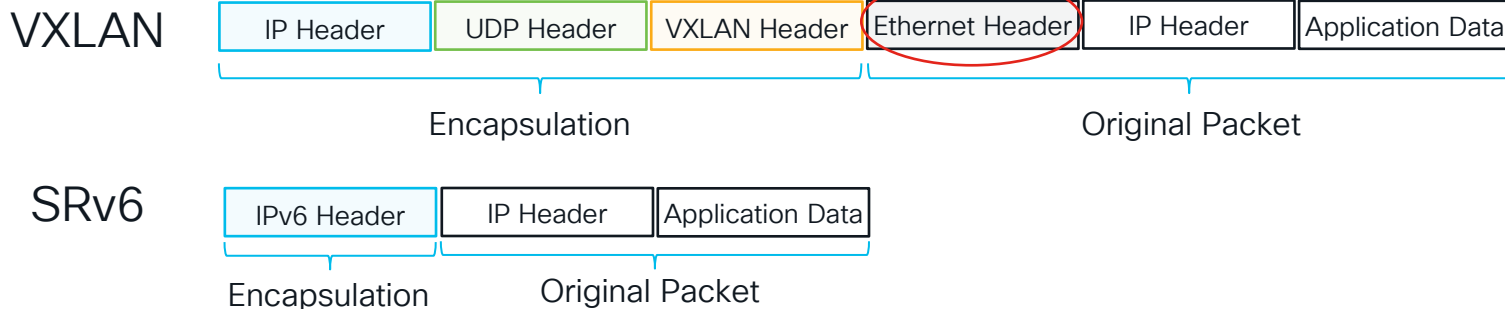
## MPLS Data Plane



## IP Data Plane

VXLAN RFC7348 - Requires Inner Ethernet

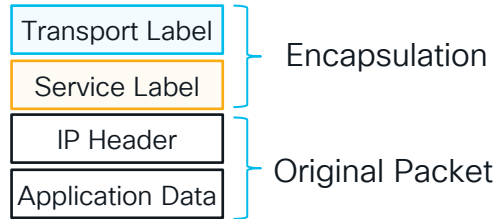
- Additional overhead for L3VPN / IP Forwarding



# MPLS Data Plane for Service Overlay

- + The packet structure is always identical, regardless of BGP VPNv4/6 or L3 EVPN Control Plane  
Less Complexity, Simple Troubleshooting
- + MPLS Load-Balancing (ECMP) by Inner IP Header Lookup for L3VPN or Flow Label (FAT) for L2VPN
- + Segment Routing provides Traffic Engineering and Fast Re-Reroute (FRR) capability

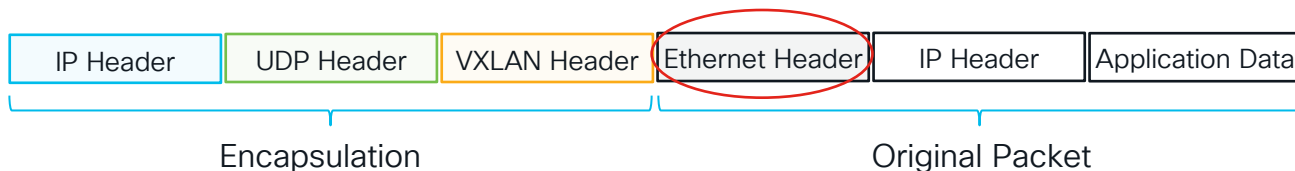
BGP L3 EVPN or VPNv4/6 signaled MPLS Packet (example for L3VPN)



# IP Data Plane for Service Overlay

## VXLAN

- EVPN Signaling only
- RFC7348 requires Inner Ethernet header even for L3VPN / IP Forwarding => Additional overhead



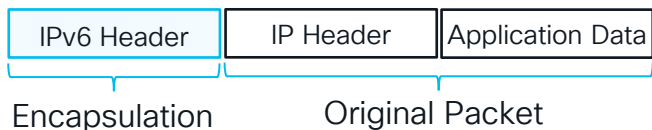
- Inner Ethernet Header encapsulation/decapsulation typically done by Integrated Routing and Bridging (IRB) Interface  
IRB requires Bridge-Domain  
DCI doesn't participate in L2 Forwarding => Bridge-Domain (BD) requires unnecessary HW resources
- + **VXLAN draft-ietf-nvo3-vxlan-gpe can simplify**

# IP Data Plane for Service Overlay

## SRv6

- + Transport and Service is integrated in service overlay encapsulation IPv6 Header
- + The packet structure is always identical, regardless of BGP VPNv4/6 or L3 EVPN Control Plane

Less Complexity, Simple Troubleshooting

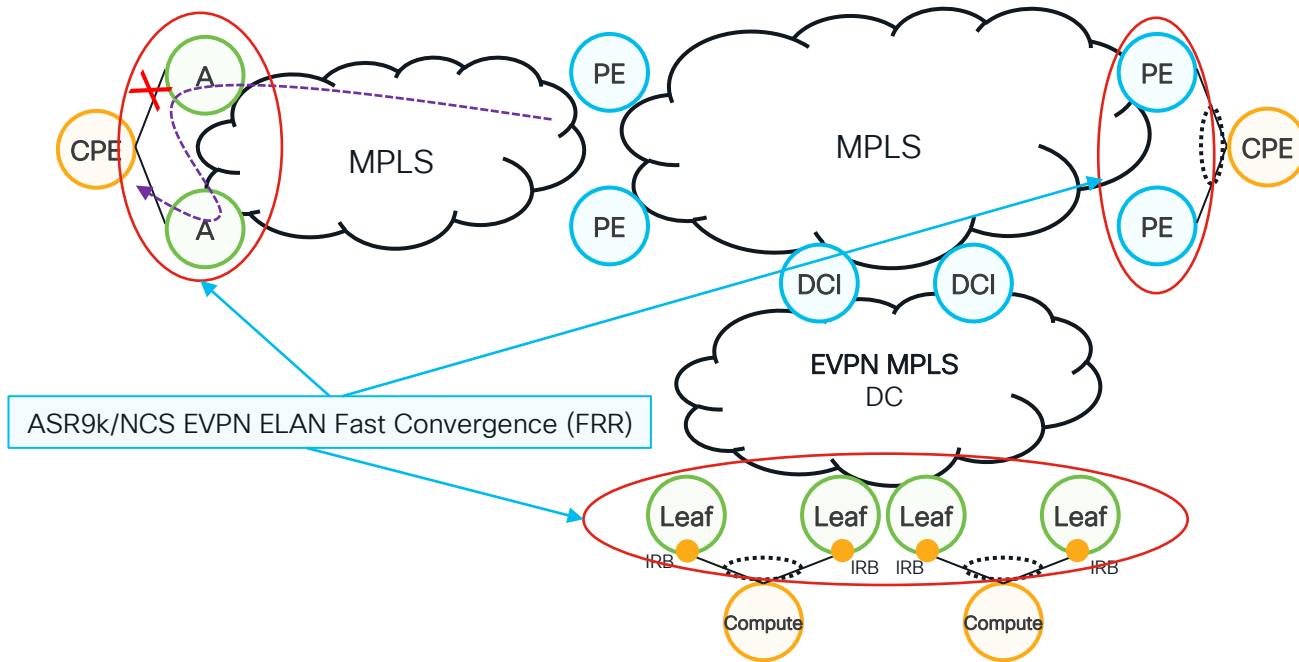


- + Load-Balancing (ECMP) by Flow-Label in service overlay IPv6 header
- + Doesn't require additional header compared to VXLAN
- + Same Principles as Segment Routing MPLS

Optional Segment Routing Header (SRH) can extend Traffic Engineering, Service Chaining and Fast Re-Reroute (FRR) capabilities

# Advanced Solutions





# FRR in Core by Underlay

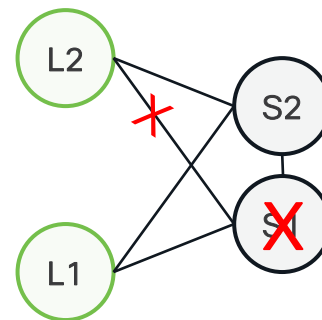
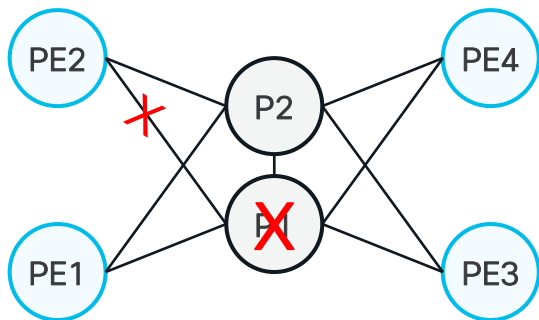
## Core Failure (Link/Node) – PIC Core

Technology: RSVP-TE/LFA/rLFA/TI-LFA

Transport: IGP -> MPLS, SRv6

Overlay Service: Service Independent

Device: P-Router, Spine



# L3VPN FRR

## Edge Failure (Link) – BGP PIC Edge

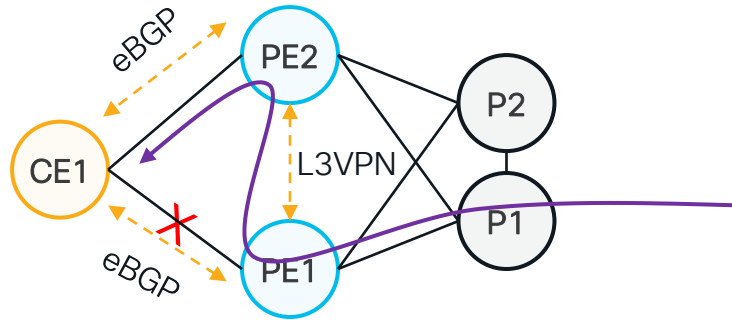
Technology: BGP PIC Edge

Transport: MPLS, SRv6 (Transport Independent)

Overlay Service: L3VPN

Device: Access / DC

**BGP CE-PE is mandatory!!!**



# L2VPN - EVPN FRR

## Edge Failure (Link) - EVPN FRR

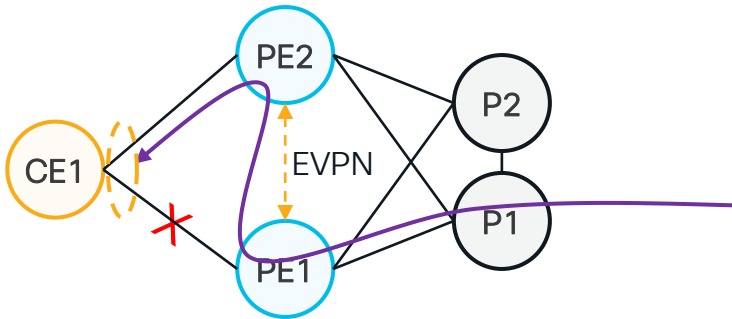
Technology: EVPN FRR

Transport: Transport Independent

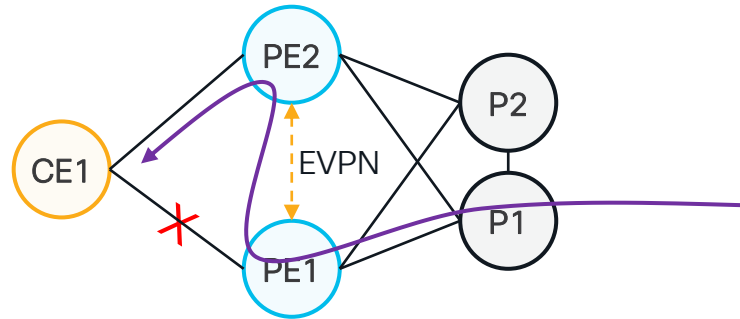
Overlay Service: EVPN

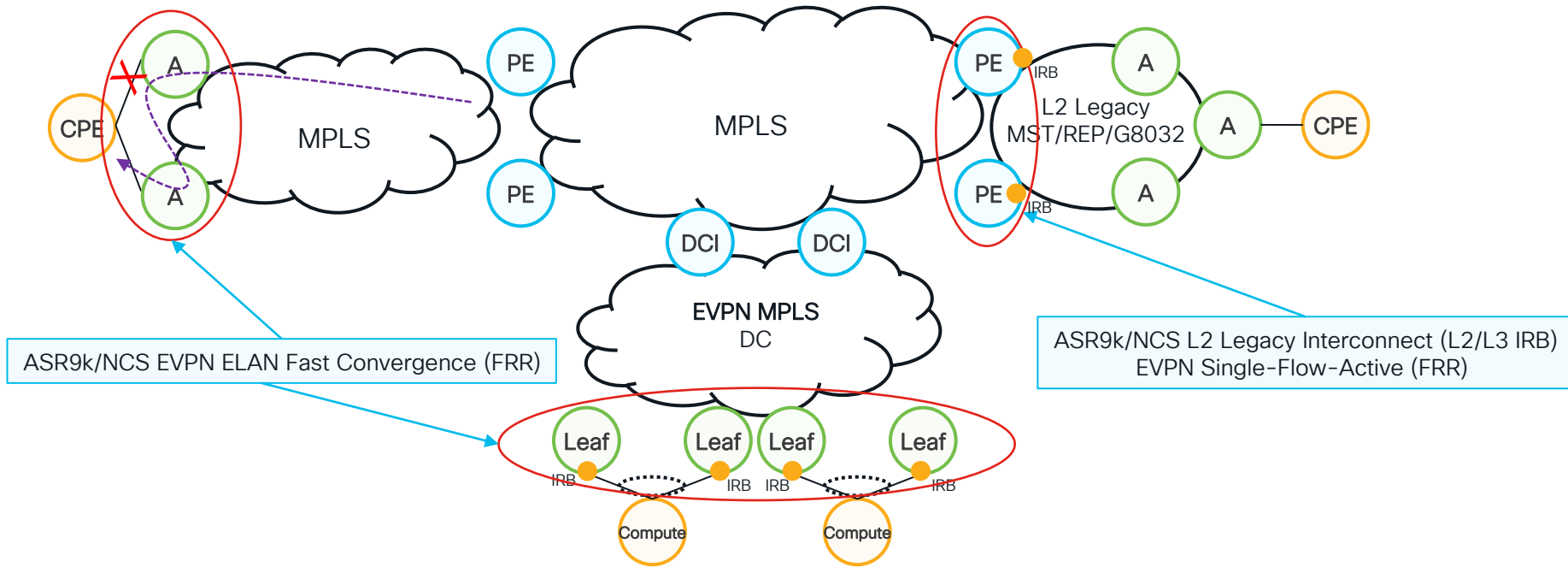
Device: Access / DC

### All-Active



### Single-Active

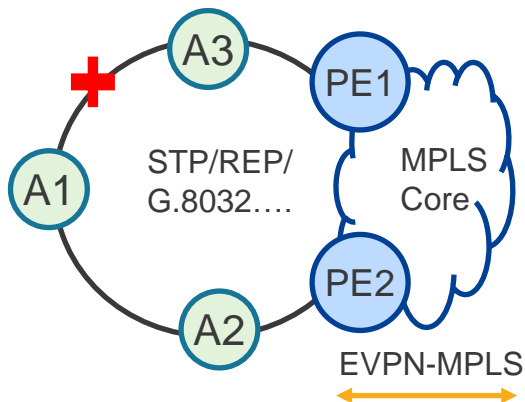




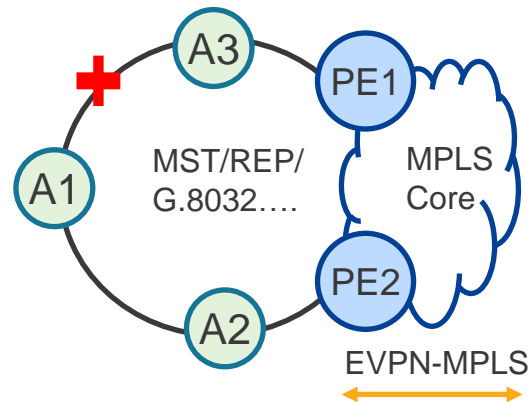
# EVPN Load-Balancing Modes

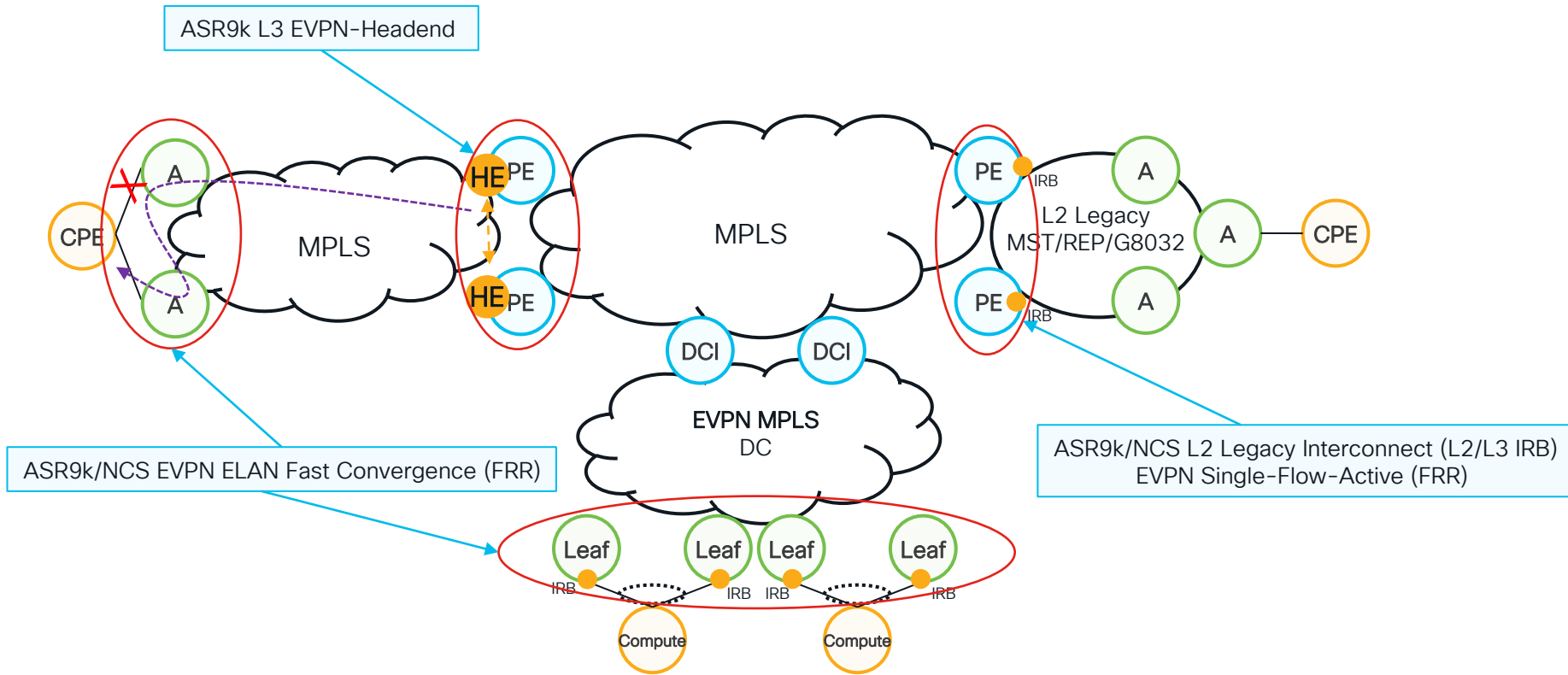
## Single-Flow-Active (SFA)

Single-Homed  
STP/REP/G.8032 “break” L2 loop



Single-Flow-Active  
MST-AG/REP-AG/G.8032 “break” L2 loop

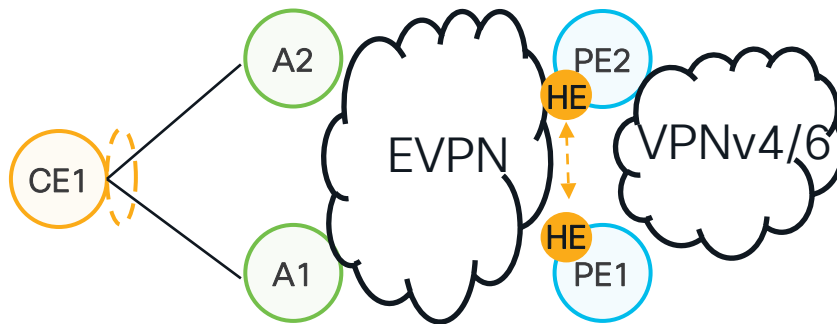




# L3 EVPN-Headend

## EVPN-Headend:

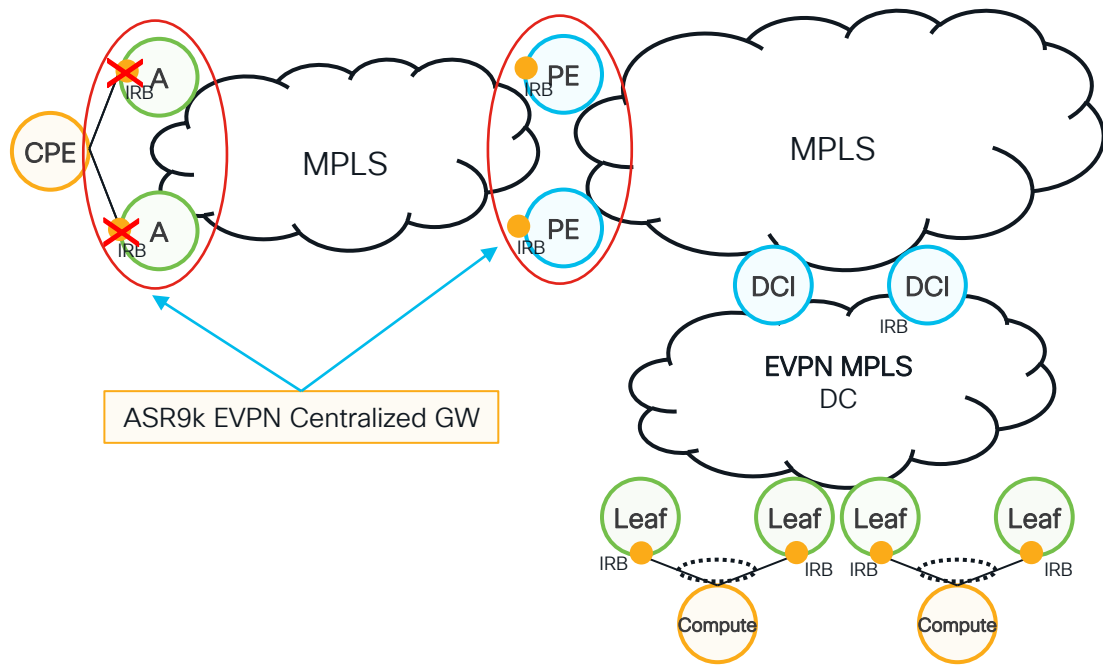
- IP termination
- QoS

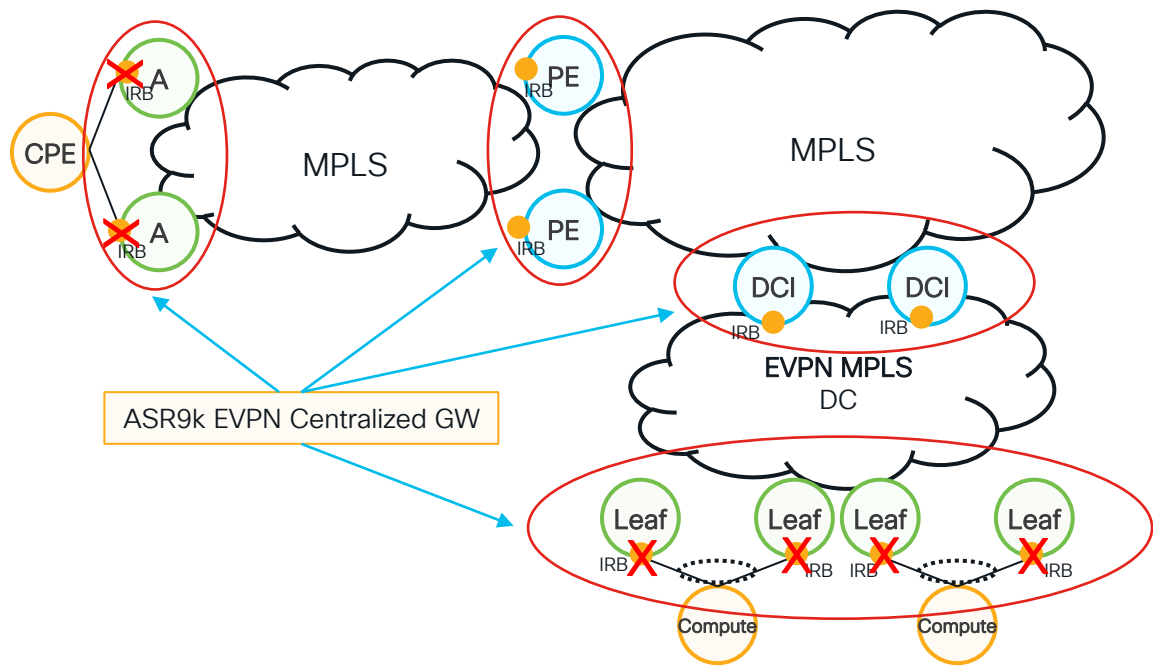


## Access Modes (A):

1. All-Active EVPN-VPWS
2. Port-Active EVPN-VPWS
3. Single-Active (main port only)

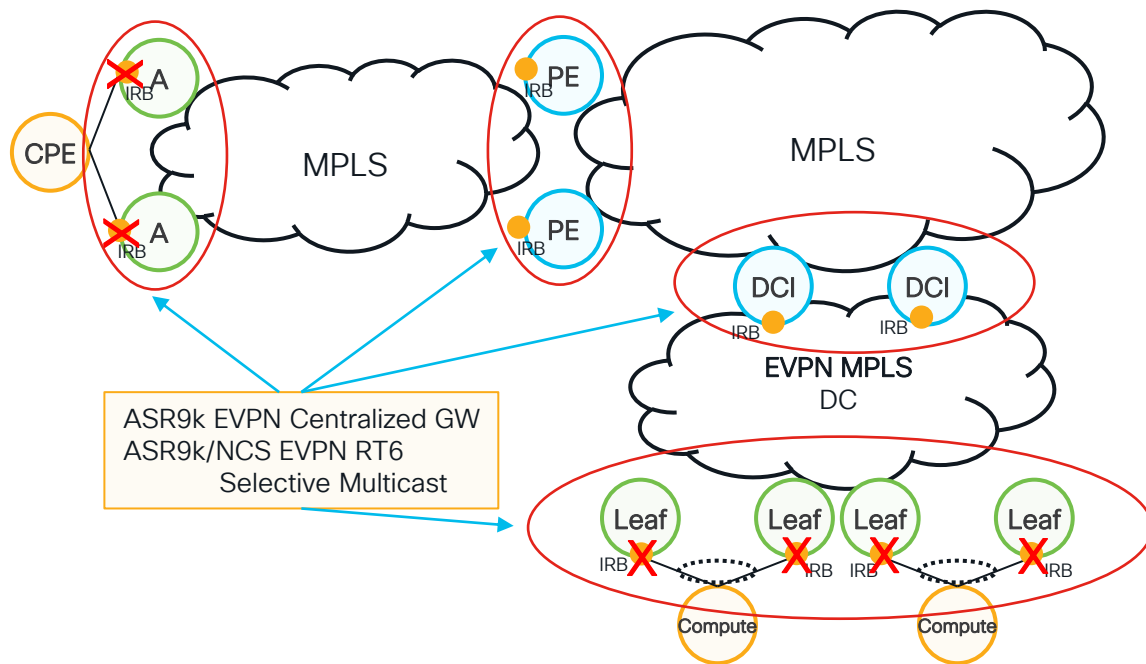




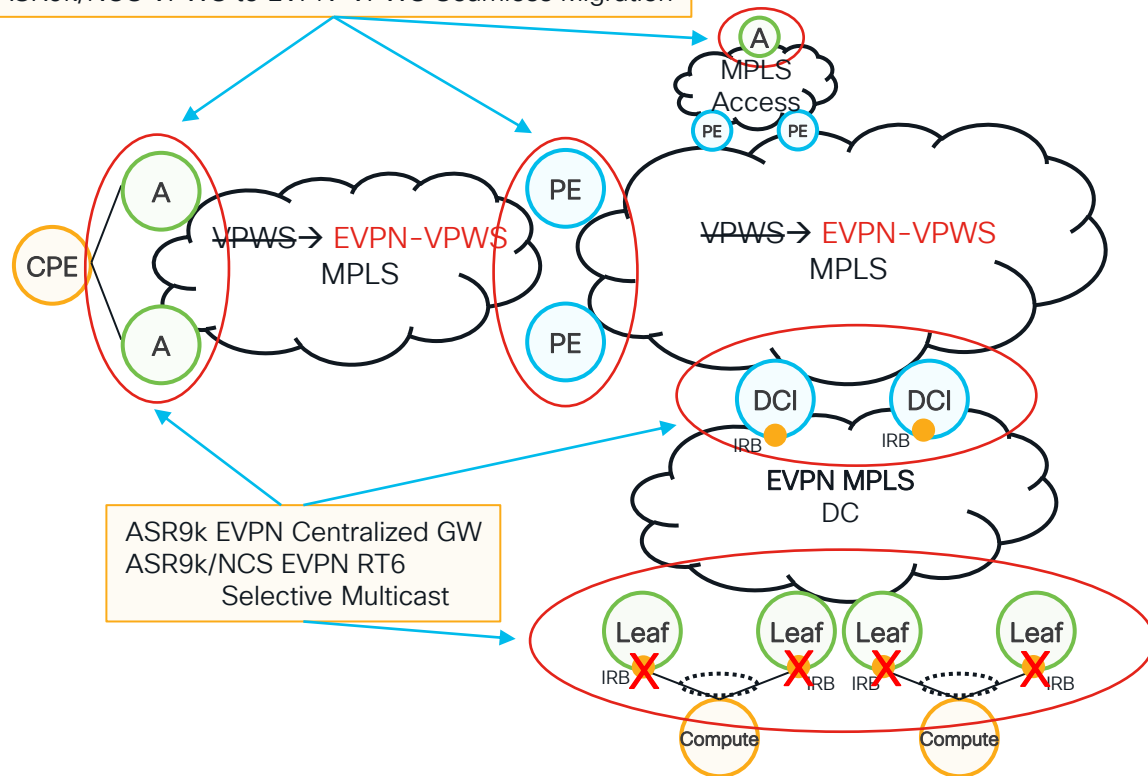


# Distributed vs Centralized Gateway

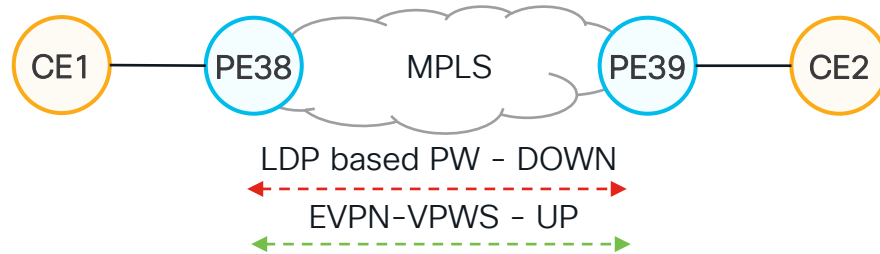
- Distributed Anycast Gateway is our priority!
  - Best Scalable solution
  - Optimal L2/L3 forwarding



# ASR9k/NCS VPWS to EVPN-VPWS Seamless Migration

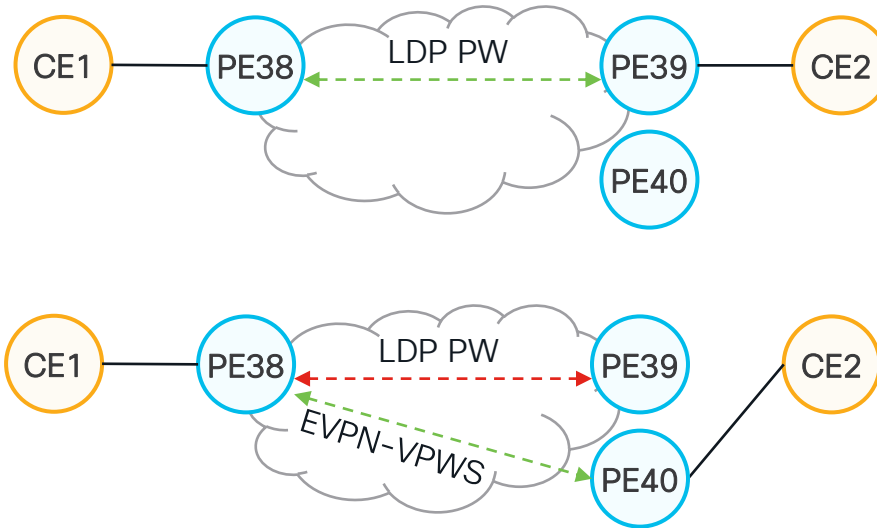


# EVPN-VPWS/Legacy-PW Seamless Migration



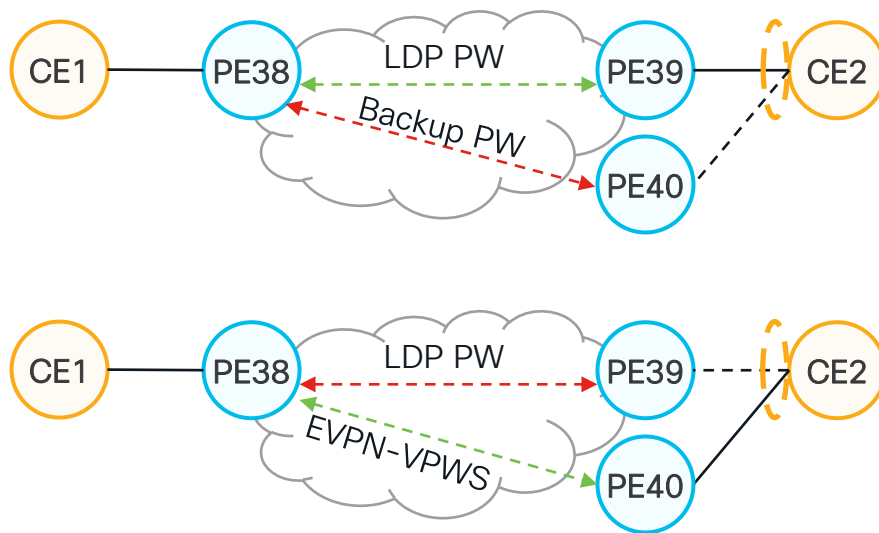
# EVPN-VPWS/Legacy-PW Seamless Migration Usecases

## New Node (PE40) insertion/replacement



# EVPN-VPWS/Legacy-PW Seamless Migration Usecases

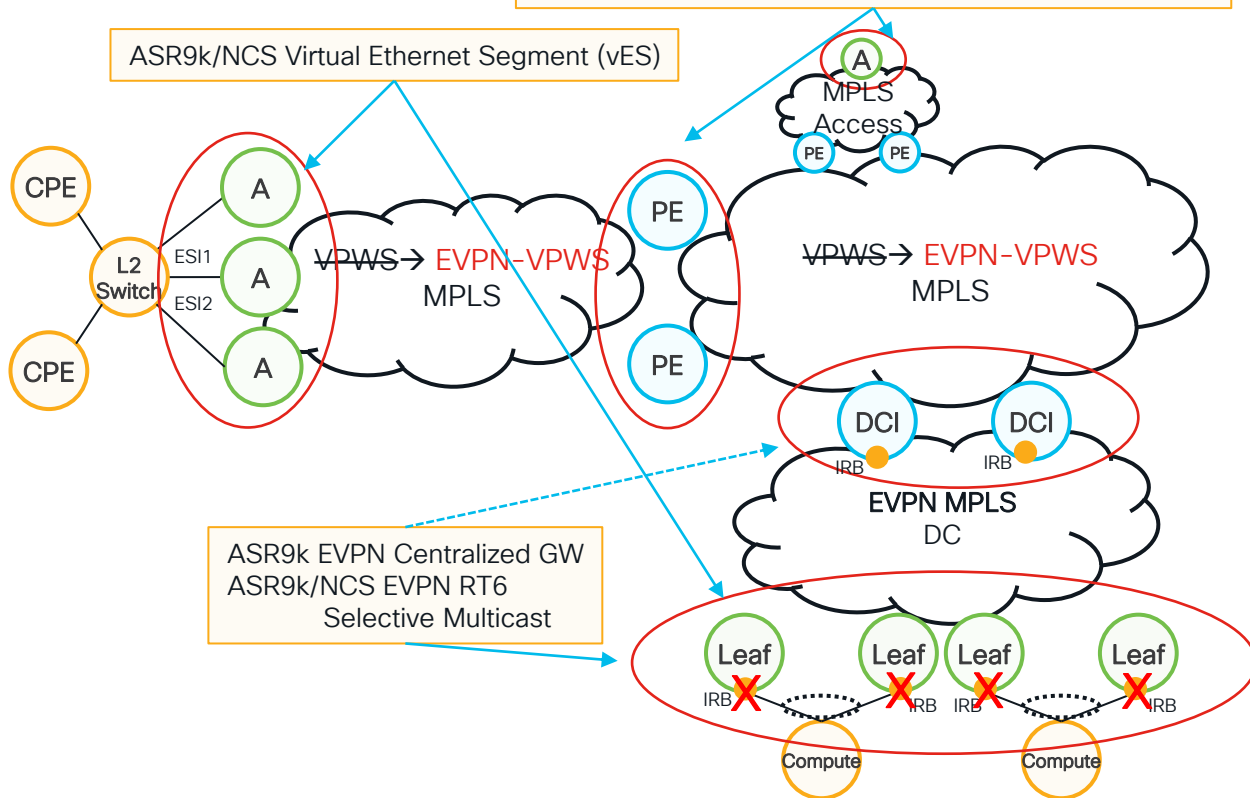
## Active/Backup PW – Multi-Homed CE



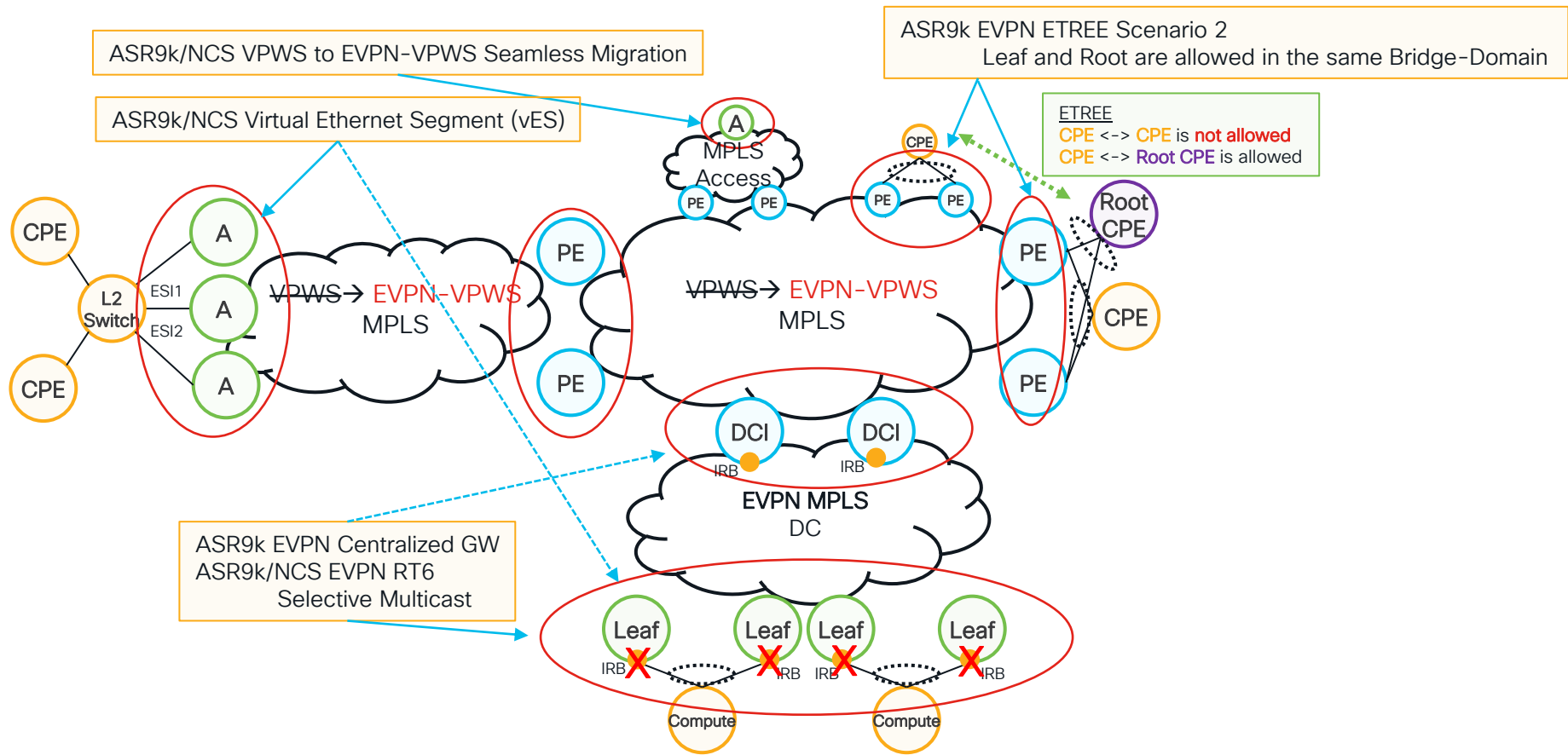


# ASR9k/NCS VPWS to EVPN-VPWS Seamless Migration

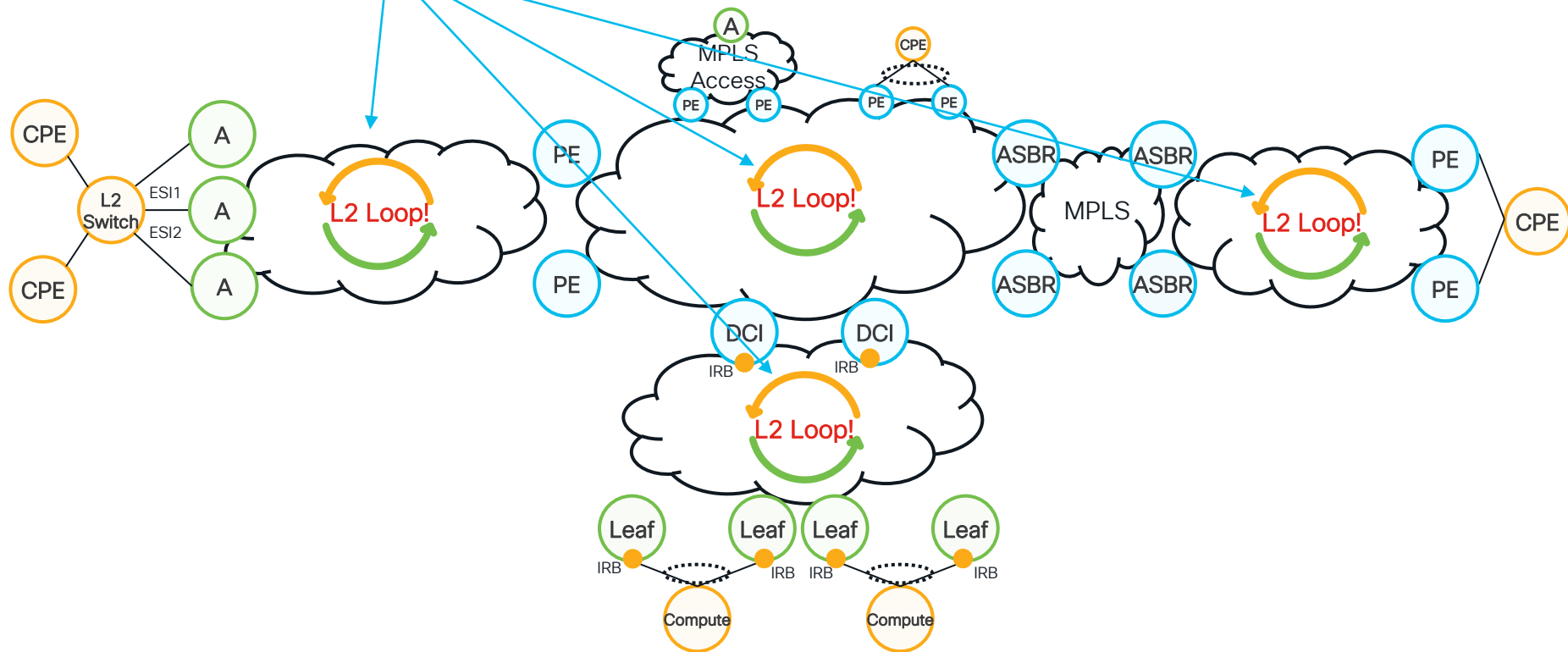
ASR9k/NCS Virtual Ethernet Segment (vES)



ASR9k EVPN Centralized GW  
ASR9k/NCS EVPN RT6  
Selective Multicast



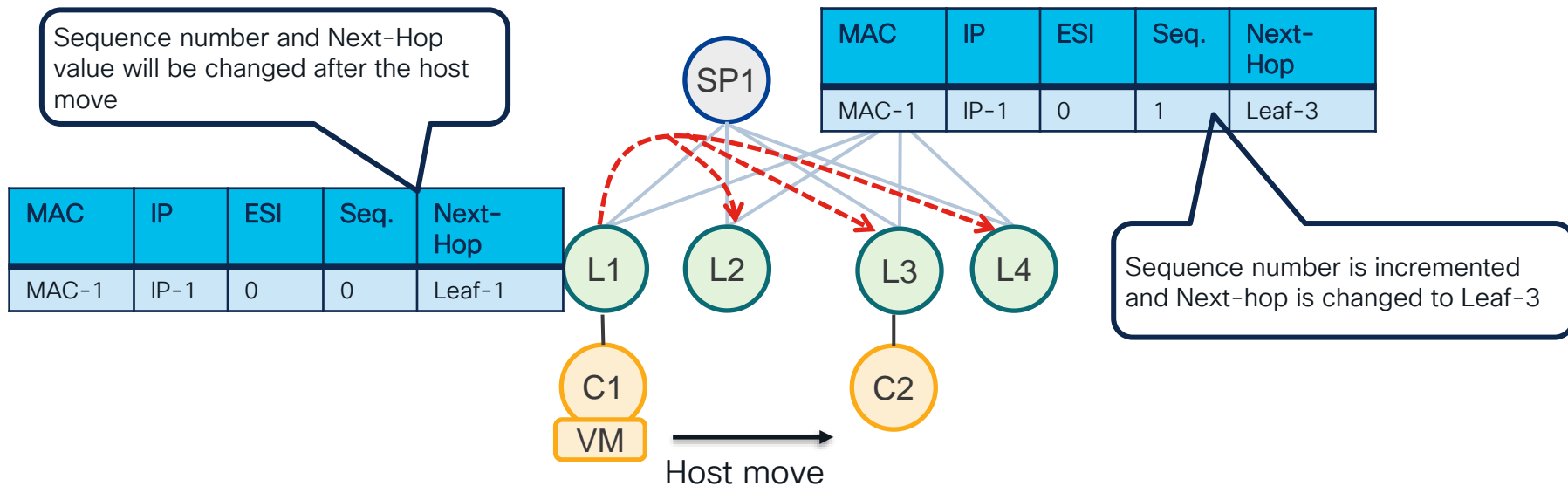
# ASR9k/NCS VPLS/EVPN L2 Loop Detection



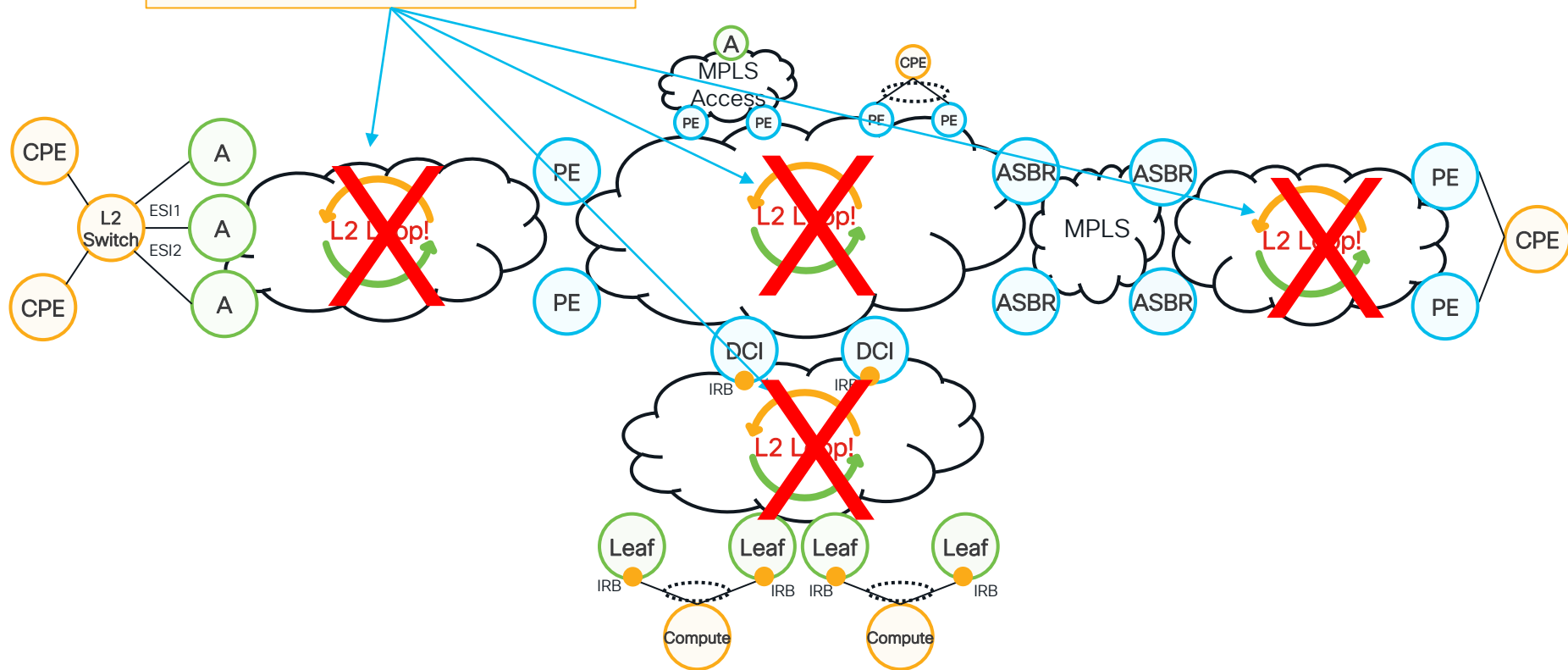
# EVPN – MAC Mobility

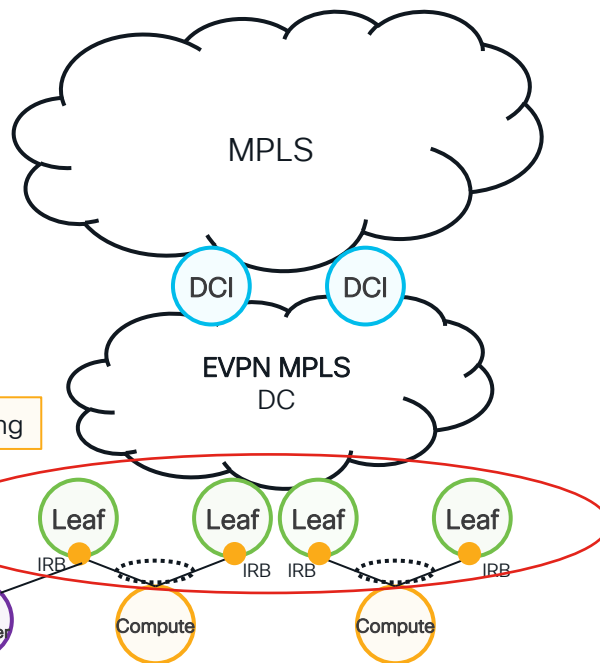
## Challenge:

How to detect the correct location of MAC after the movement of host from one Ethernet Segment to another also called “MAC move”?

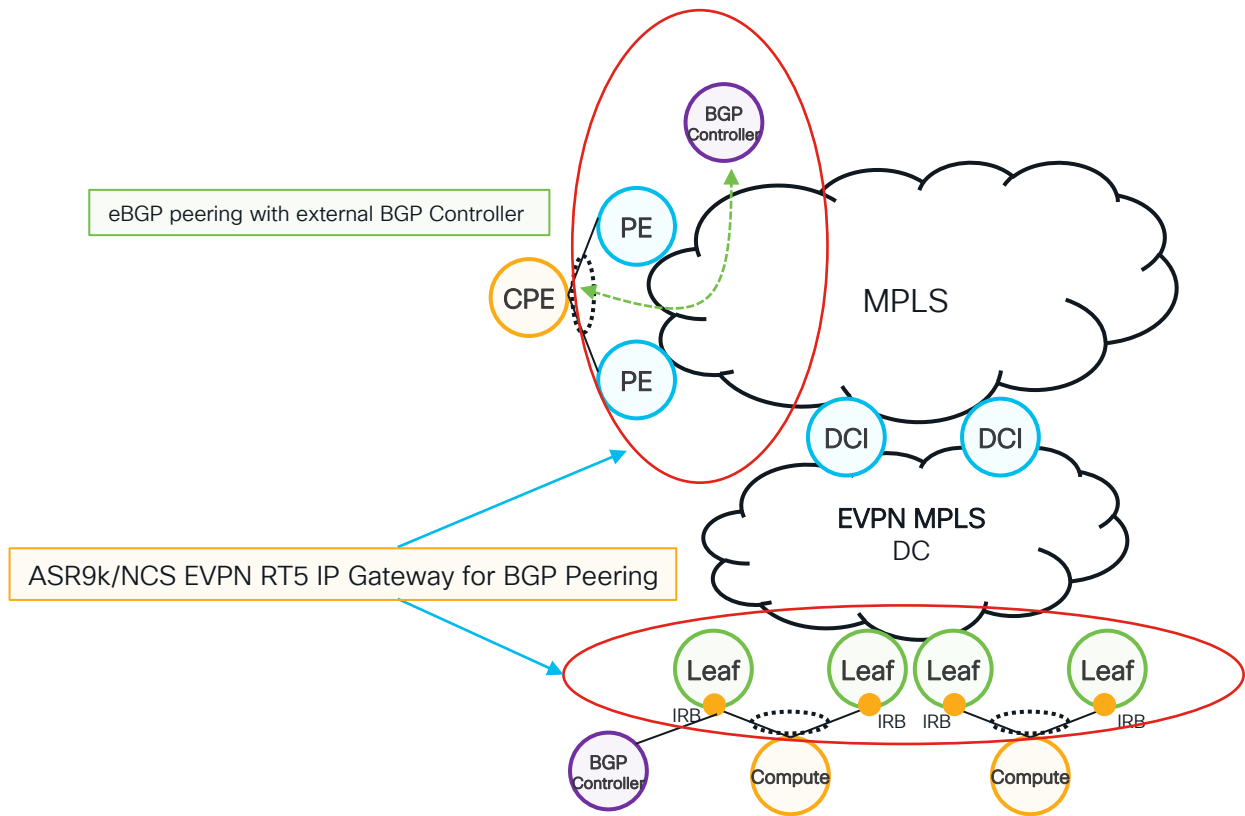


ASR9k/NCS VPLS/EVPN L2 Loop Detection  
ASR9k/NCS VPLS/EVPN L2 Loop **Protection**





ASR9k/NCS EVPN RT5 IP Gateway for BGP Peering



# Do you want to know more about EVPN in IOS XR?

## Service Overlay Cookbook - BRKSPG-2041

Jiri Chaloupka, Principal Technical Marketing Engineer, Cisco Systems, Inc. - **Distinguished Speaker**

Schedule

Monday, Jun 5 | 8:00 AM - 9:00 AM PDT | Level 3, South Seas C



## EVPN Deep Dive with IOS-XR Configuration examples for Service Provider Metro and Data Center - BRKMPL-2253

Jiri Chaloupka, Principal Technical Marketing Engineer, Cisco Systems, Inc. - **Distinguished Speaker**

Schedule

Wednesday, Jun 7 | 3:00 PM - 4:30 PM PDT | Level 2, Surf EF

## IOS XR EVPN Hands-On LAB - LTRSPG-2005

Jiri Chaloupka, Principal Technical Marketing Engineer, Cisco Systems, Inc. - **Distinguished Speaker**

David Jakl, Technical Marketing Engineer, Cisco Systems, Inc. - **Distinguished Speaker**

Schedule

Monday, Jun 5 | 1:00 PM - 5:00 PM PDT | Luxor - Level 1, Galleria DE

## Multicast with EVPN, Segment Routing & Traffic Engineering - BRKMPL-2123

Mankamana Mishra, Technical leader, Cisco Systems, Inc.

Schedule

Tuesday, Jun 6 | 10:30 AM - 12:00 PM PDT | Lower Level, Mariners AB

## Configure and Implement BGP-EVPN with Segment Routing using NCS 55xx/5xx platforms - LABSPG-3000

Tejas Lad, Technical Marketing Engineer, Technical Leader, Cisco Systems, Inc.

Paban Sarma, Technical Marketing Engineer, Cisco Systems, Inc.



# Summary

- EVPN is an very important complement to BGP based services
- BGP is Unified Services Control Plane across Network
- EVPN All-Active Multihomed Service with Distributed Anycast Gateway & Integration to L3VPN simplifies SPDC/NextGen-CO/WAN Integration
- EVPN is not strictly a replacement of “traditional” VPNv4/6
  - EVPN and VPNv4/6 can coexist
- Service Layer is Data Plane independent, but the right Data Plane (encapsulation) selection decreases complexity and provides additional capabilities
- Stay up to date <https://e-vpn.io/>

# Fill out your session surveys!



Attendees who fill out a minimum of four session surveys and the overall event survey will get **Cisco Live-branded socks** (while supplies last)!

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Attendees will also earn 100 points in the **Cisco Live Challenge** for every survey completed.



**These points** help you get on the leaderboard and increase your chances of winning daily and grand prizes

# Continue your education



- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Engineer meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at [www.CiscoLive.com/on-demand](https://www.CiscoLive.com/on-demand)

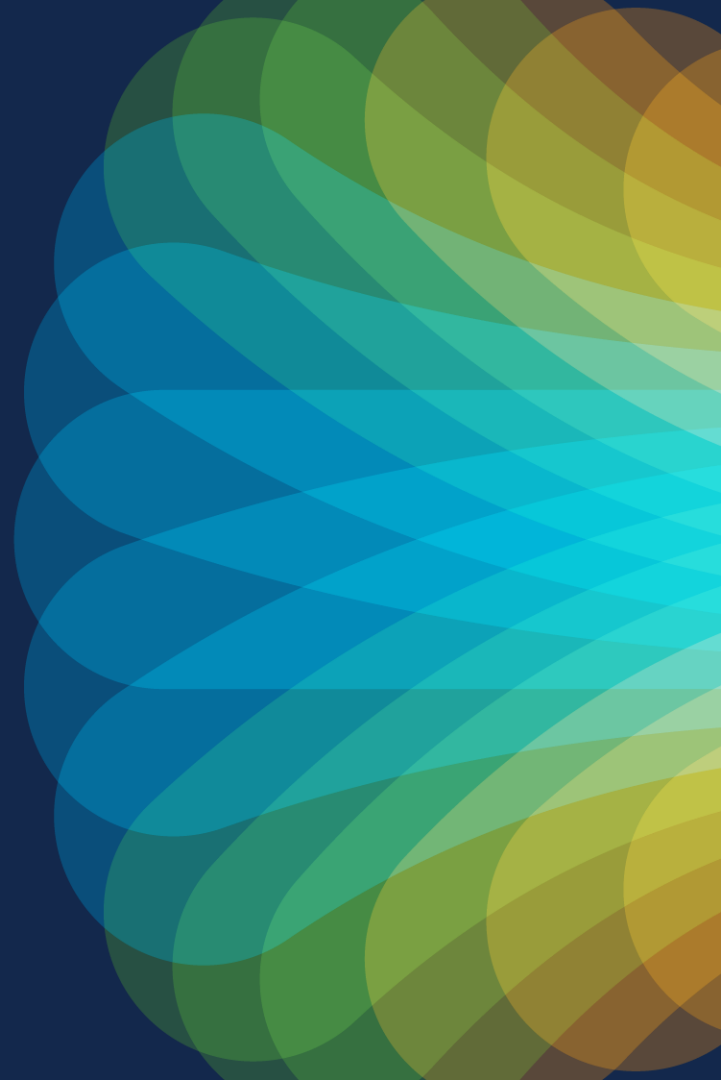


The bridge to possible

# Thank you

CISCO *Live!*

#CiscoLive

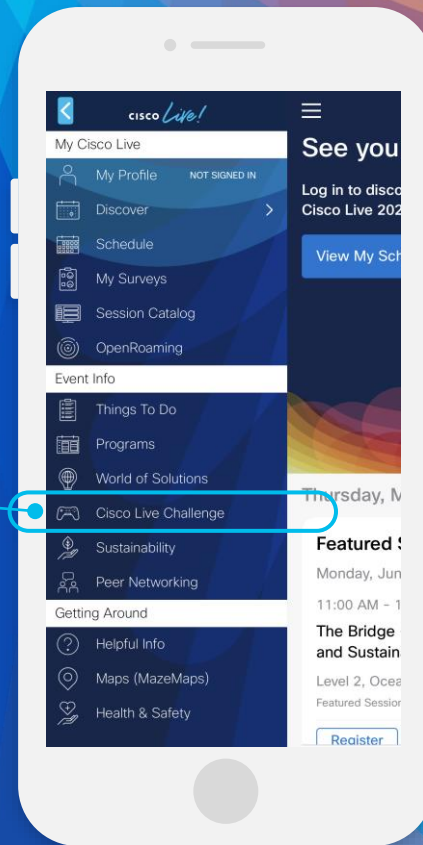


# Cisco Live Challenge

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## How:

- 1 Open the Cisco Events App.
- 2 Click on 'Cisco Live Challenge' in the side menu.
- 3 Click on View Your Badges at the top.
- 4 Click the + at the bottom of the screen and scan the QR code:



The background is a vibrant, abstract graphic. It features a central bright white light source from which numerous colorful rays emanate, creating a sunburst or starburst effect. The rays transition through a spectrum of colors including yellow, orange, red, and various shades of blue and green. Overlaid on this are several large, semi-transparent, wavy shapes in similar color tones, giving the overall image a sense of motion and energy.

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Let's go

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