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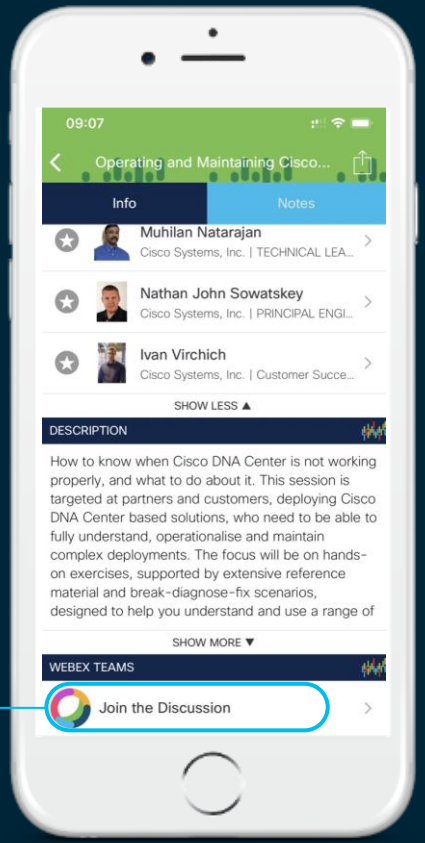

Network Service Fabric Architecture

Powered by EVPN

Thierry Couture
dax@cisco.com

BRKSPG-2322

cisco Live!
Barcelona | January 27-31, 2020

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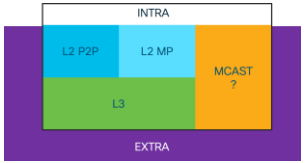
Agenda

- Welcome to Planet EVPN!
- Network Service Fabric
- Stitched vs Integrated Fabric
- EVPN Multi-Homing
- Eco-System / Toolkit
- Access Use Cases
- Legacy Network Migration
- Conclusion

Fabric Decision Matrix

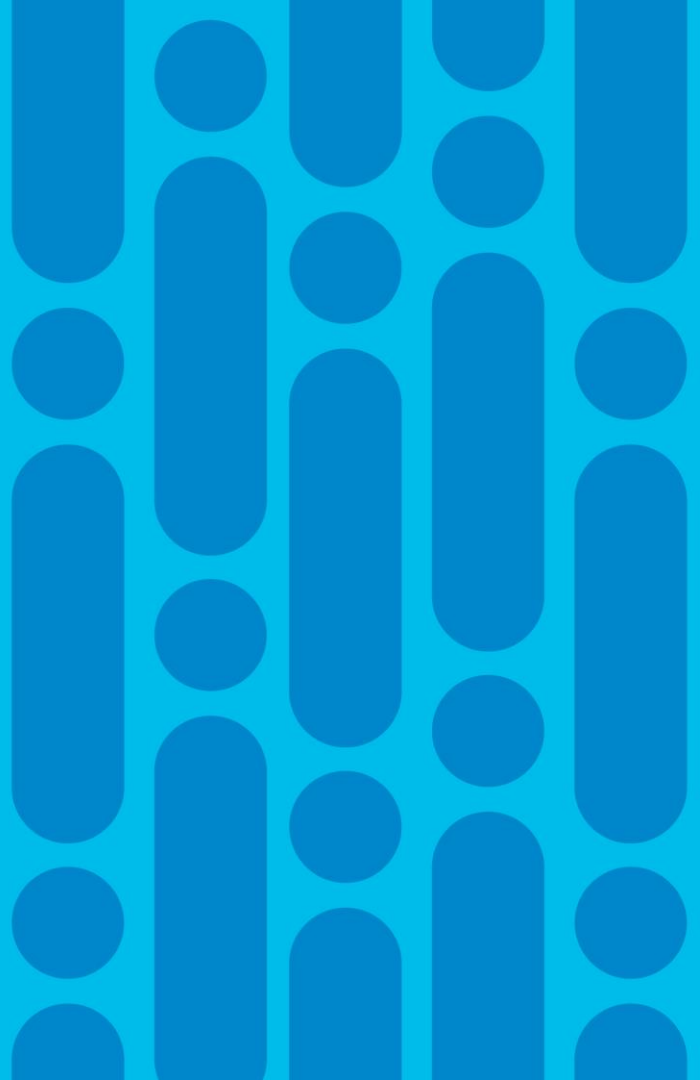
Typical Cisco Problem: Too many choices; what to pick?



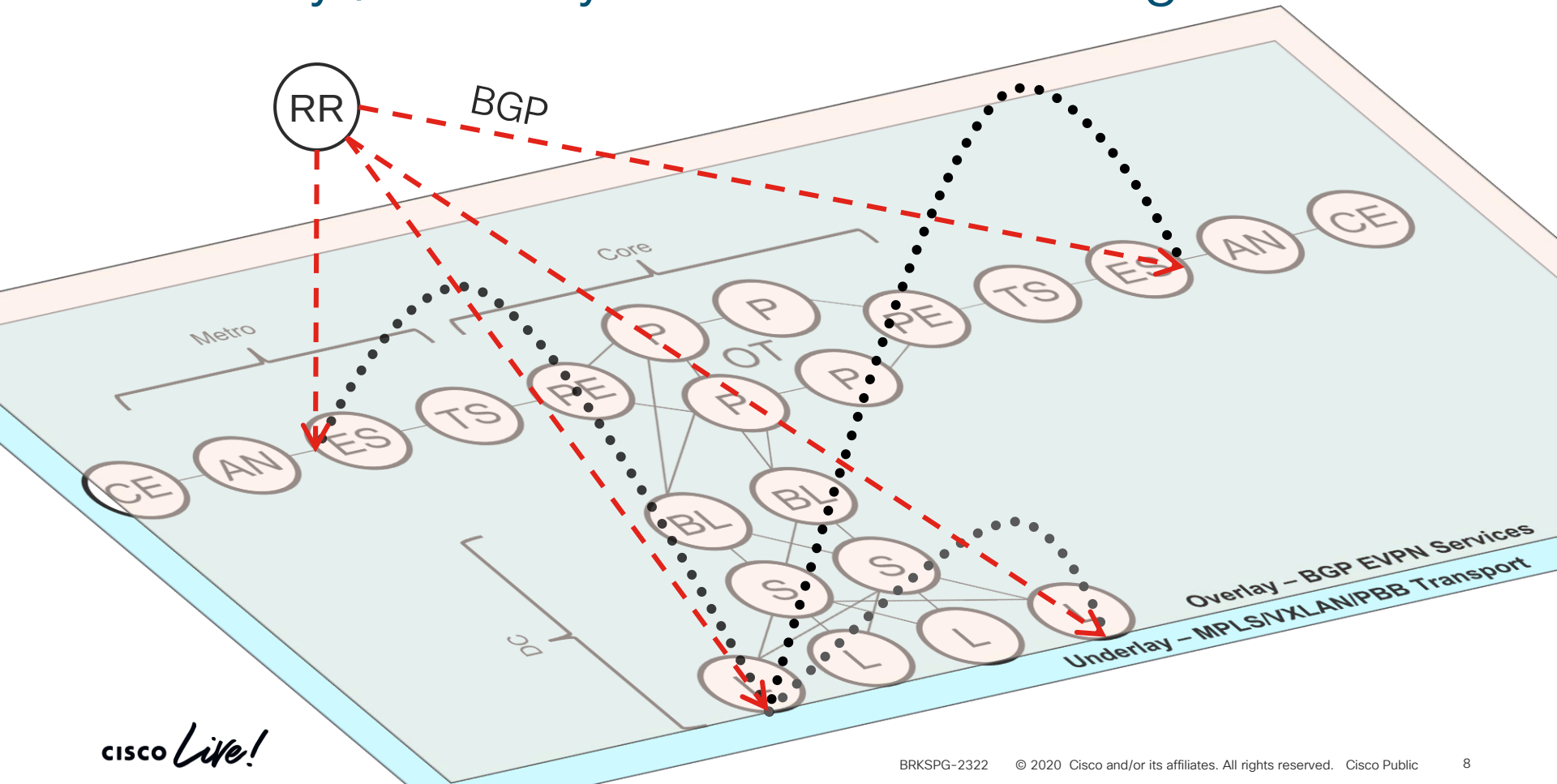
Item		Description	Possibility
Services Primitives		Use Cases with: L3, L3VPN, L2P2P, L2MP, L2VPWS, multicast, IPv4, IPv6, etc.	
Features	U	Forwarding Plane	IPv4, **MPLS**, IPv6, VXLAN, ACI, PBB, LISP, GRE, MPLSoGRE, PPP, Geneve, etc.
		Control Plane	OSPF, ISIS, BGP, SR, LDP, T-LDP, RSVP-TE, etc.
	O	Service Plane	L2VPN, L3VPN, BGP-VPLS, LDP-VPLS, **EVPN**, L2TPv3, GRE, PPP, OTV, LISP, NSH, etc.
		Management Plane	CLI, SNMP, SSH, Telnet, Syslog, NetFlow, BMP, RCMD, Netconf, YANG, OpenConfig, gRPC, GPB, etc.
Software		Products	**XR**, IOS, NxOS, NSO, SR-PCE, ODL, WAE, VTS, APIC, etc.
Hardware		Products	8000, ASR 9000, ASR 9900, NCS 5500, NCS 5000, Nexus 9000, Nexus 7000, XRv9000, CSR1Kv, VPP, UCS Servers, etc.
Others			White Box, Gray Box, Black Box, Rainbow box… Open Source, Closed Source, HGPOC, 3rd Party…

TODAY

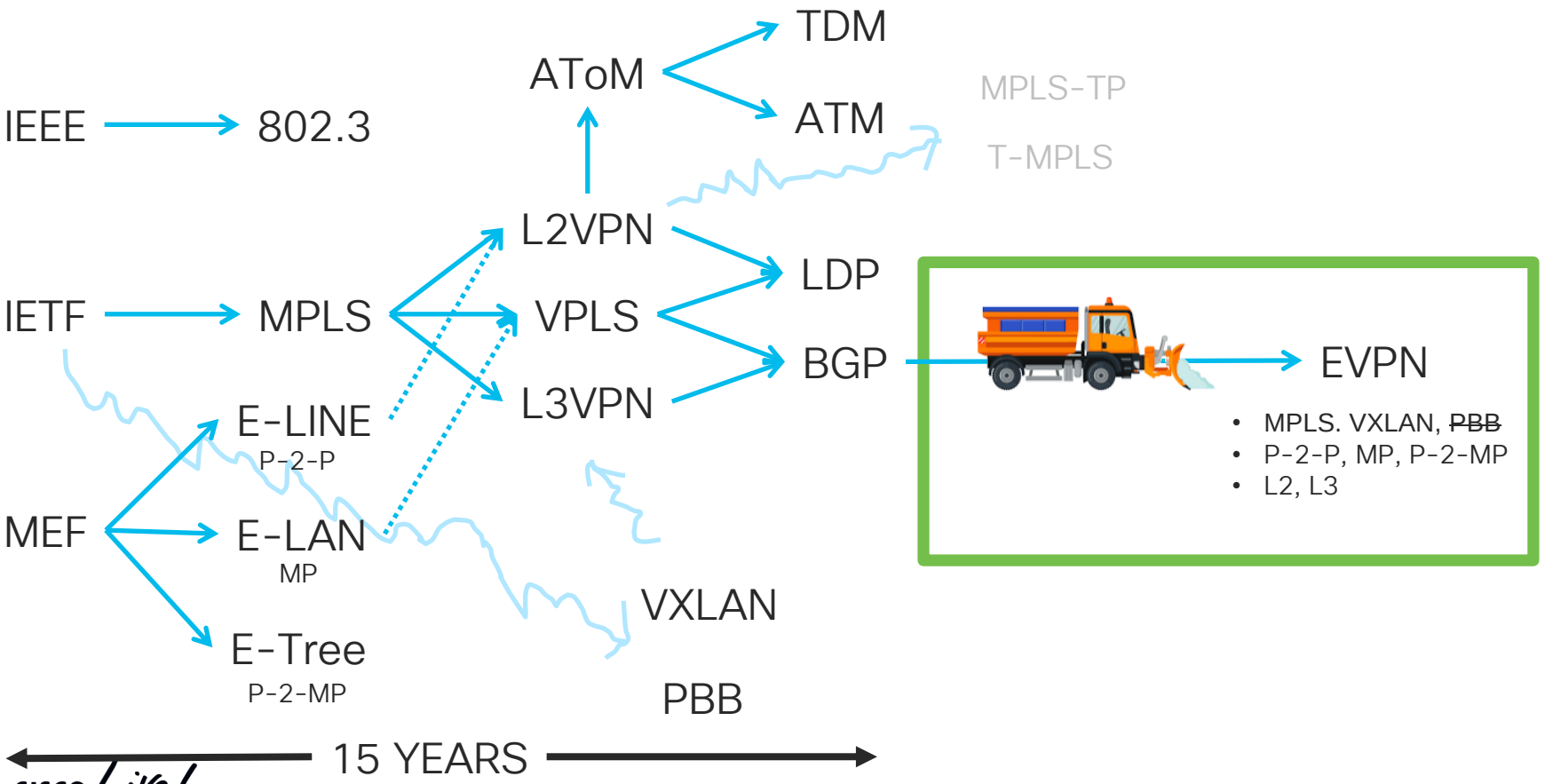
Welcome to Planet EVPN!



Underlay / Overlay 101 – EVPN for Beginners



EVPN Historical Perspective



EVPN: Value Proposition

Create New Revenue Streams

- Stateless SFC and NFV
- E-LAN, E-LINE, E-TREE, L3, IRB Services

Deploy with Ease

- Seamless Brownfield Integration
- Same principles and operational experience as IP VPNs

Protect Investments

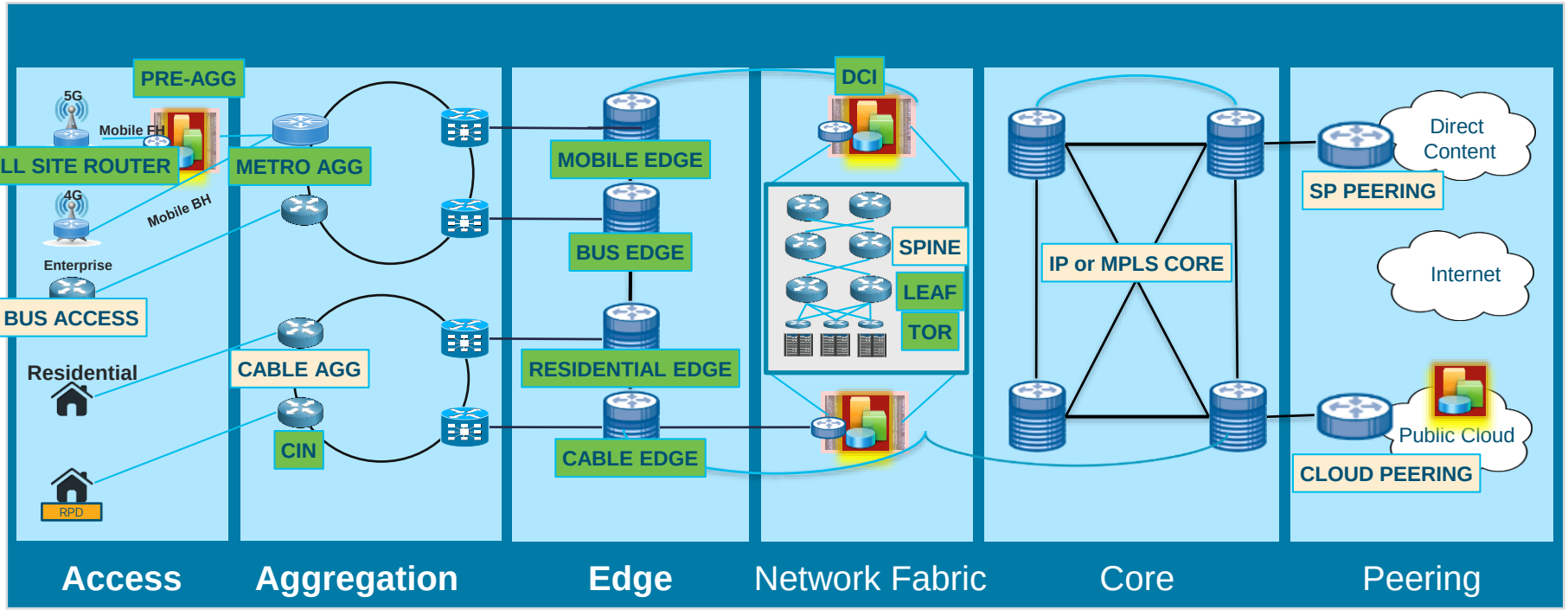
- Unified Networks on single overlay
- Simplify protocols and operations
- Industry adoption and standardization

Increase Availability

- Workload Mobility
- Optimal forwarding
- All-Active Redundancy with Fast Convergence

Fast, Resilient, Flexible Unified Services

SP Routing Use Case Representation
EVPN Applicability



Use EVPN Here

Why EVPN for Access?

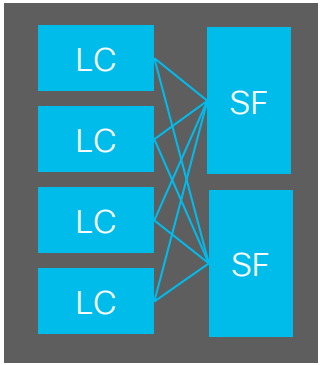
= RAS, DSLAM, OLT, Switch, Radio, etc.

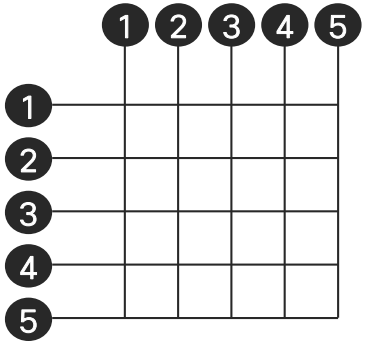
Access Challenges	EVPN Benefits
Low Cost / Low Features / Low Resources	Keep “intelligence” on aggregation devices
Often “in the field” and hard to upgrade	Keep “intelligence” on aggregation devices
1,000’s of them, little uniformity	Scale
L1, L2, if you are lucky, L3, you’re pushing it, MPLS, don’t even think about it…	It’s not you, it’s me!
Varous Topologies (star, hub/spoke, ring, stack, whatever)	Yes…
Single / Multi-Homed	Yess…
Optimized for both N/S and E/W	Yesss…

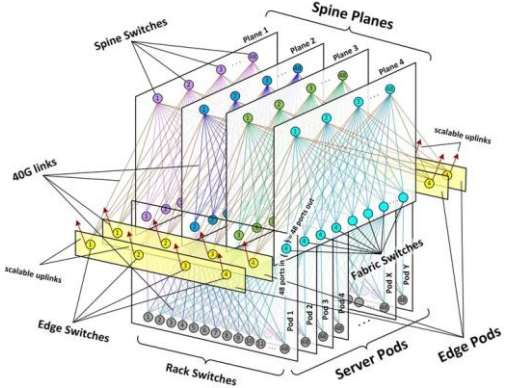
Network Service Fabric (Why EVPN for the Access)

SP Fabric Demystification

- Fabric > DC “Thing”
- Fabric != “NEW”
- Fabric (DC) = Constrained (Centralized), Mostly Symmetrical (multi-homing, distance, oversubscription, cost)
- Fabric (SP) <> Fabric (DC)

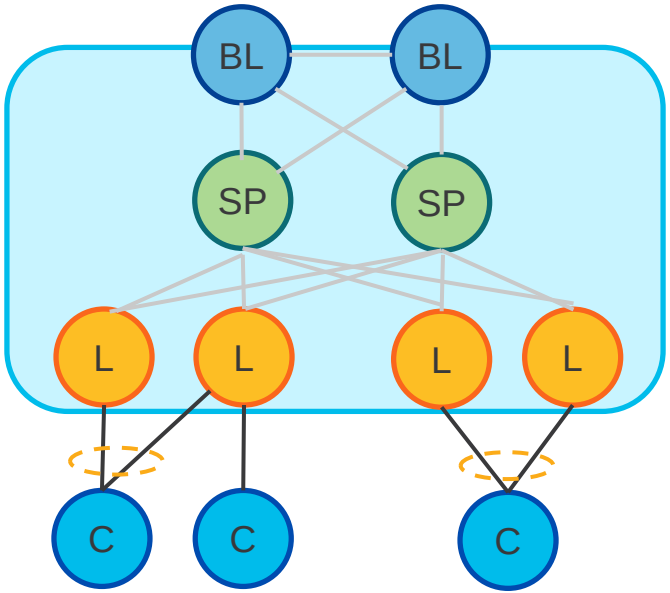






SP Fabric Demystification

Network Service Fabric



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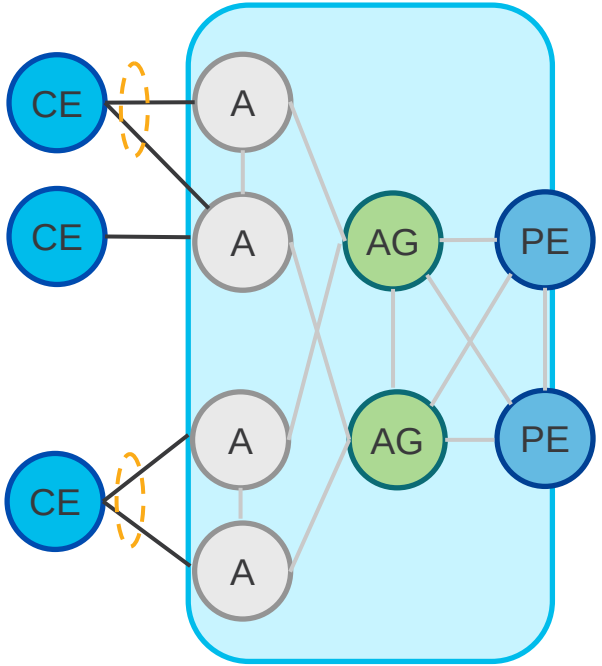
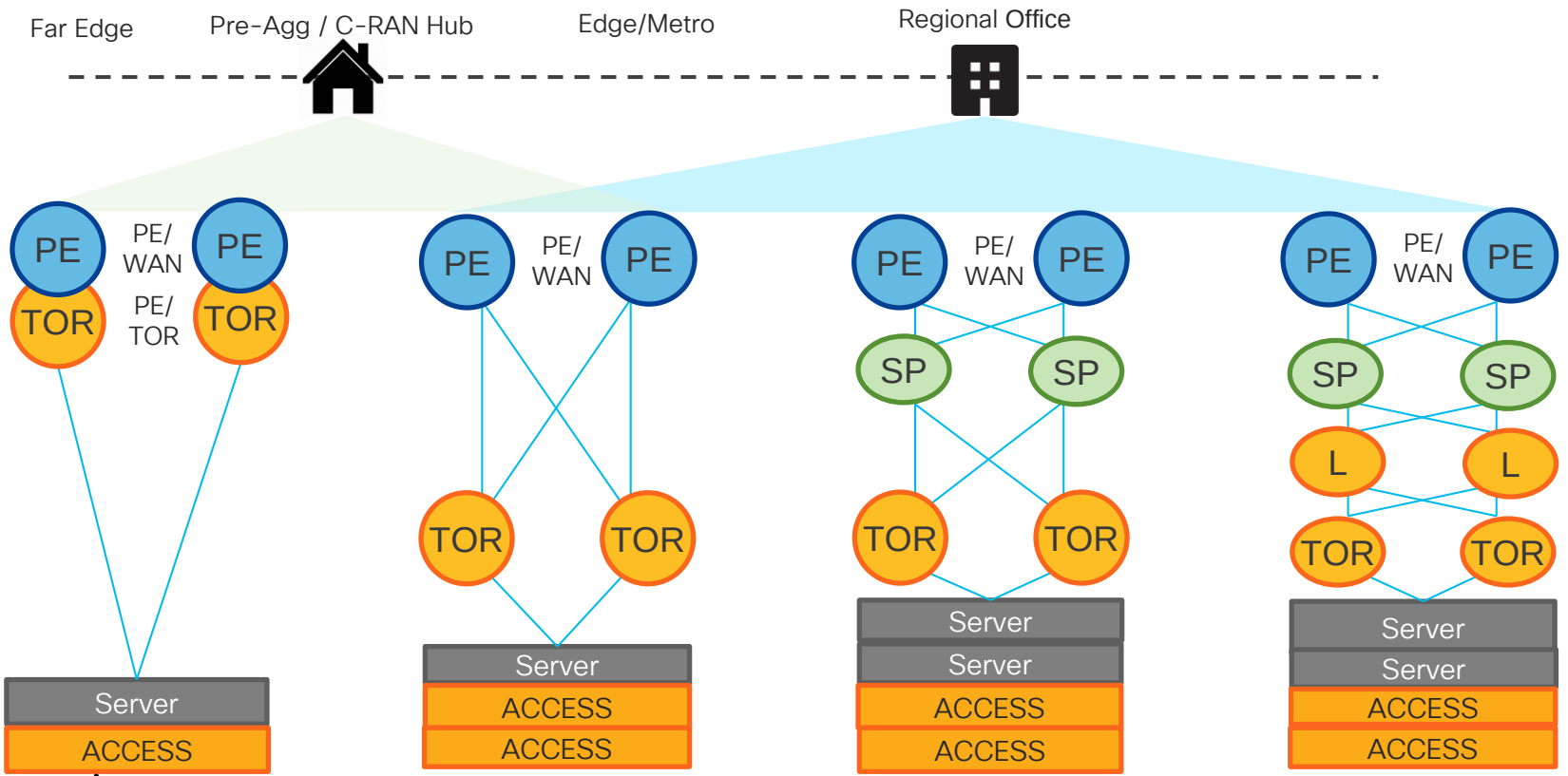
SP Metro Topology



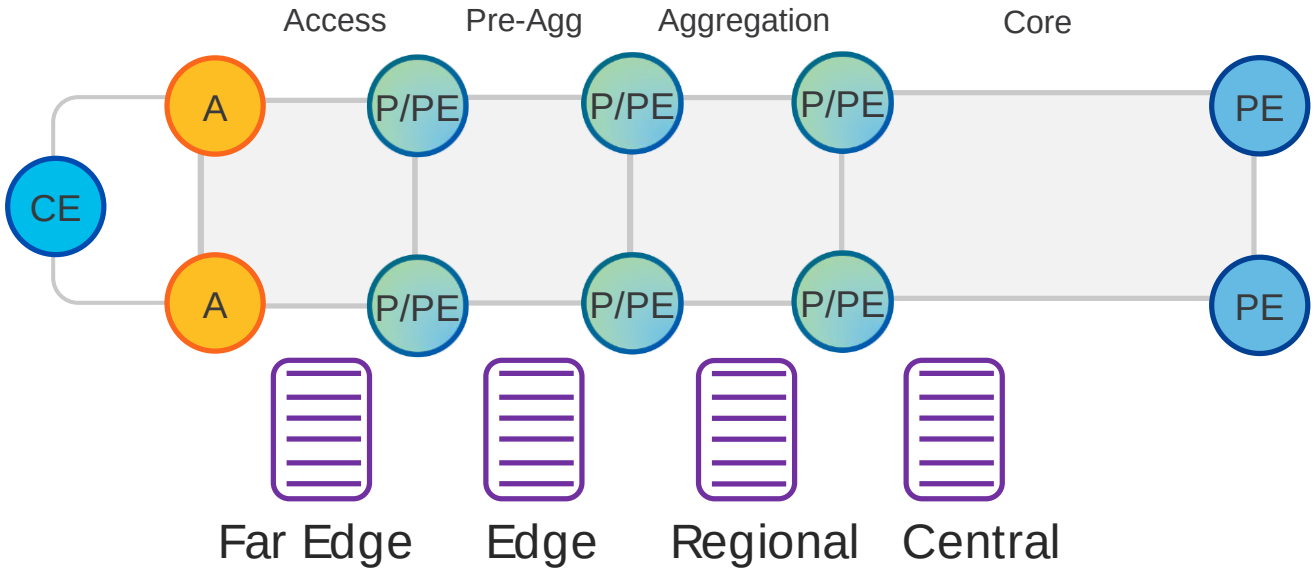
EVPN

*PE - Hierarchical Services

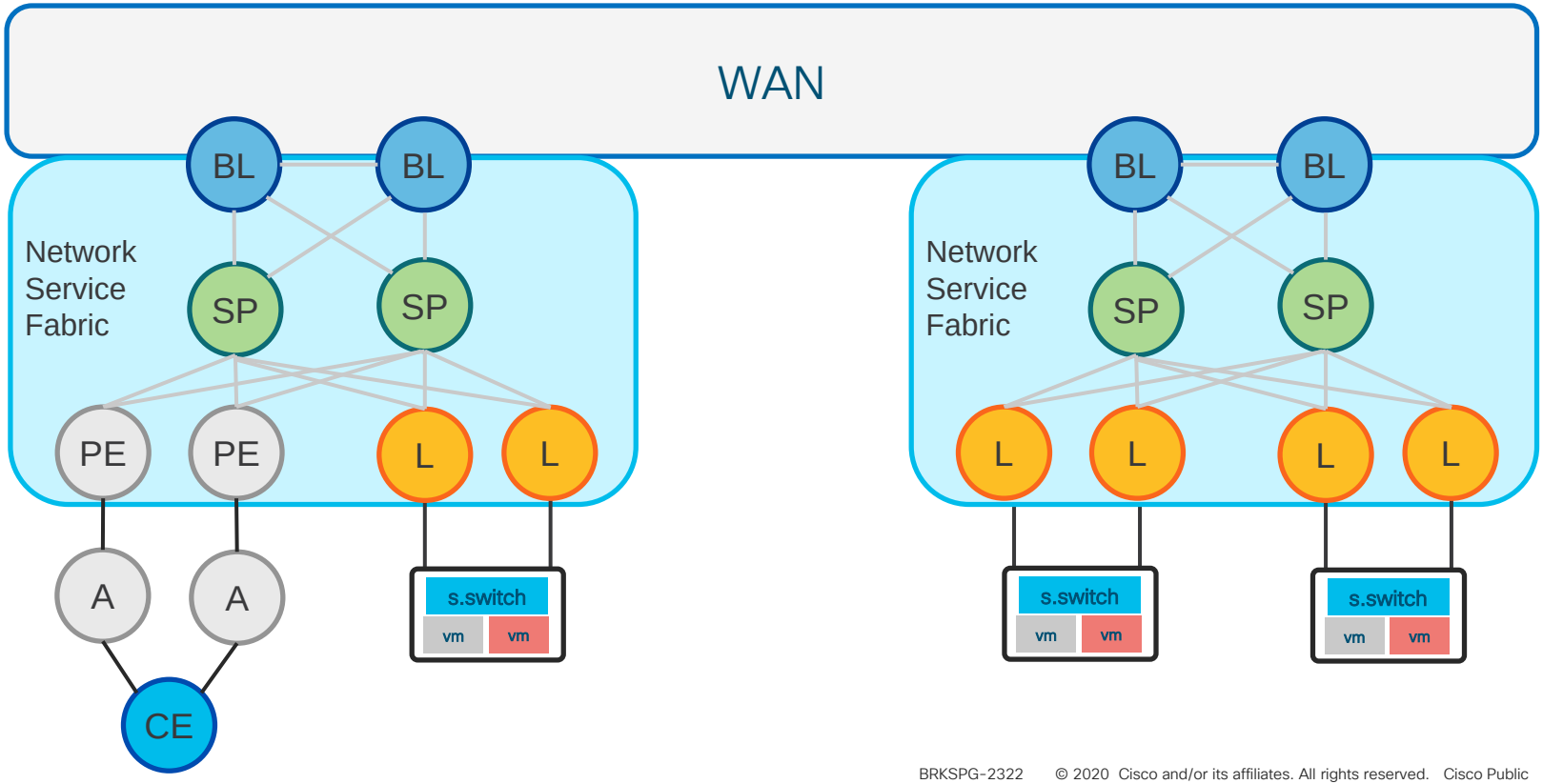
Network Service Fabric Design Options



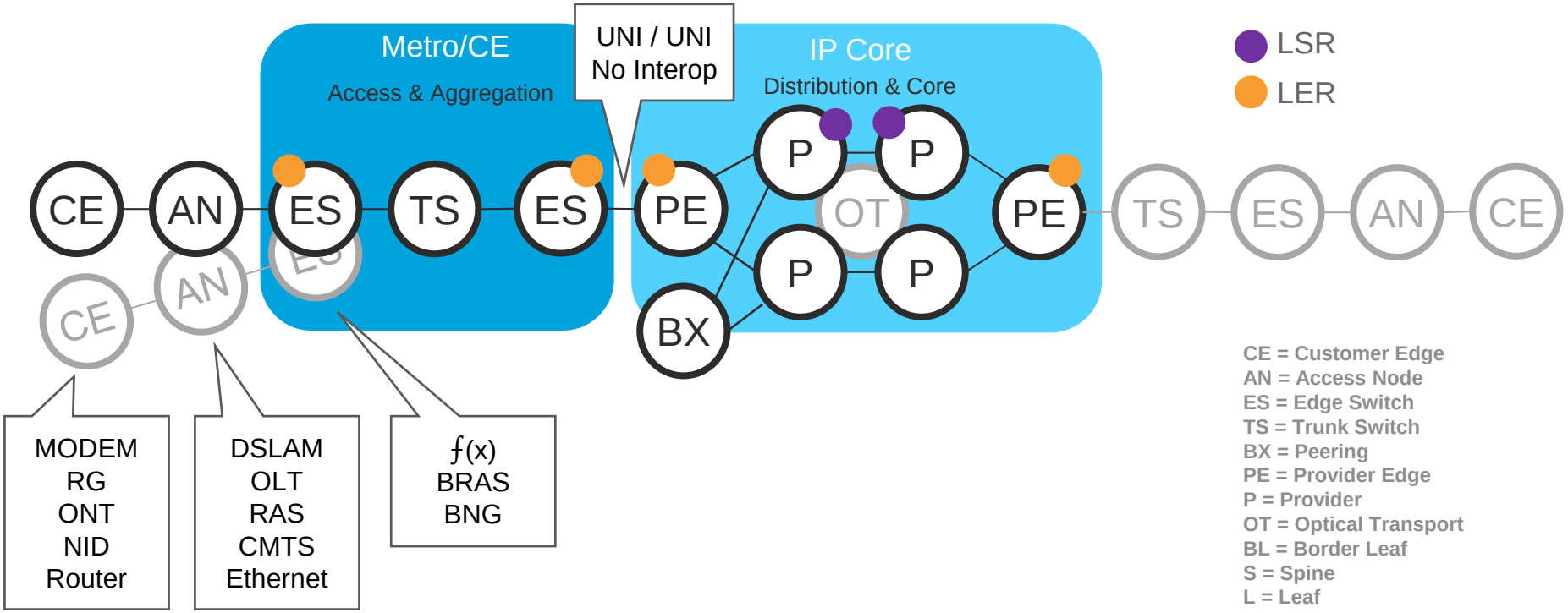
Service Provider Network



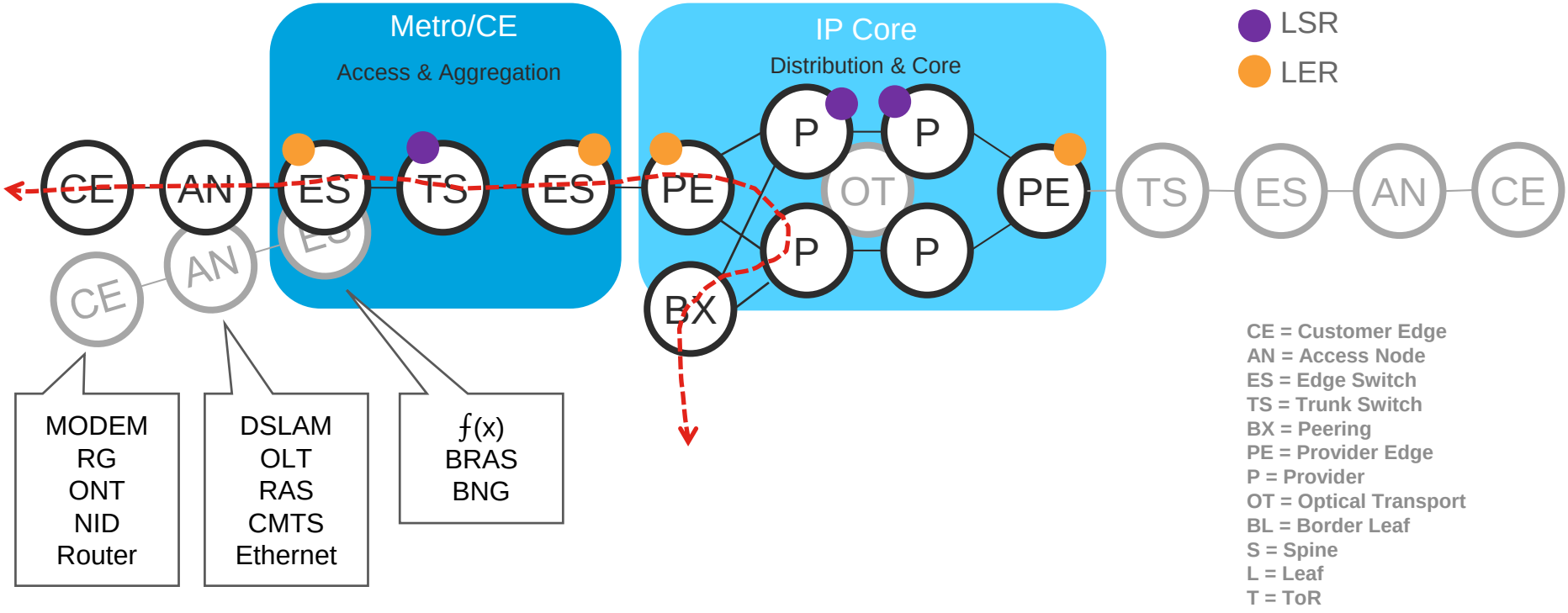
Network Service Fabric



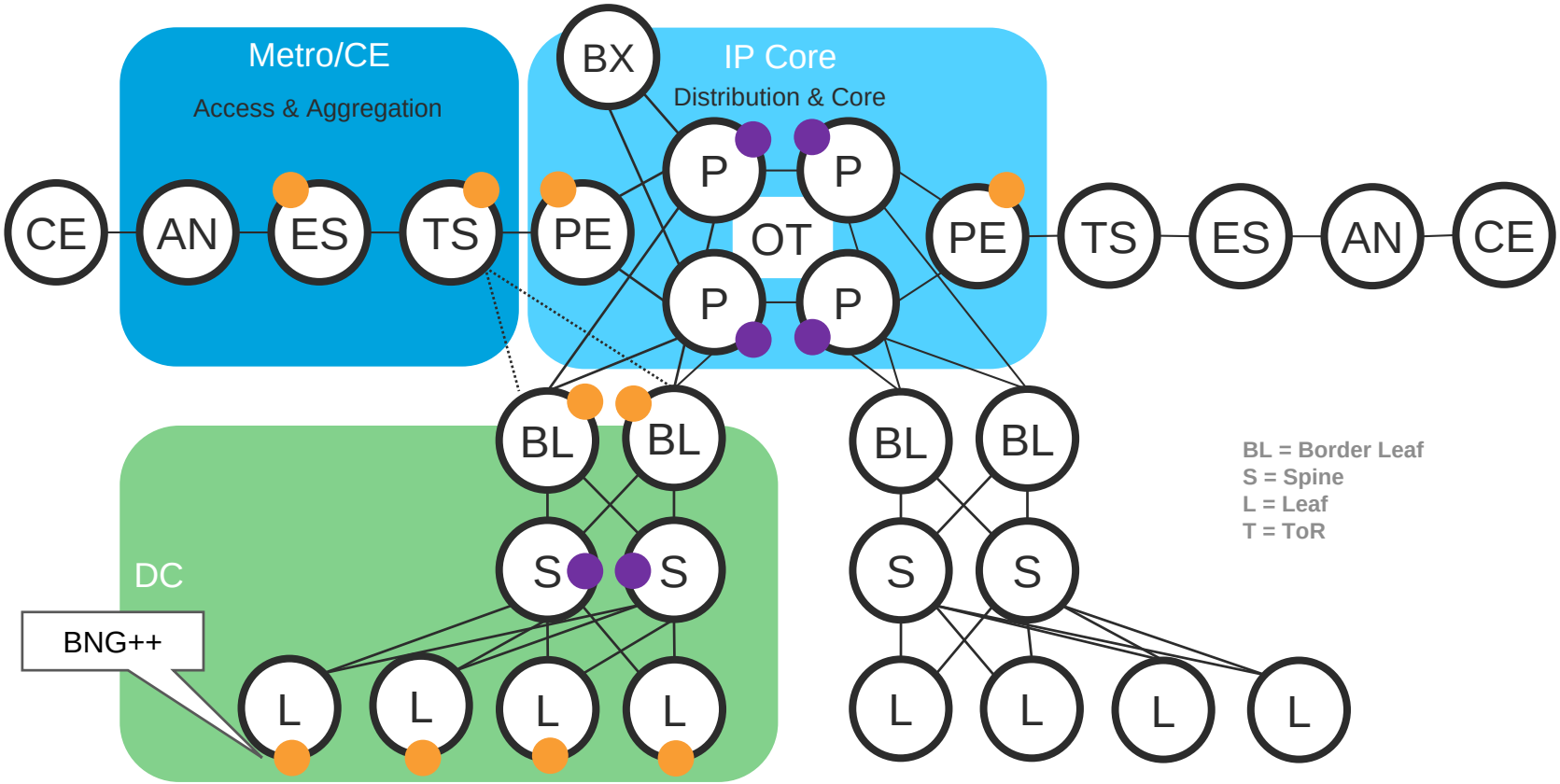
Classic SP Architecture



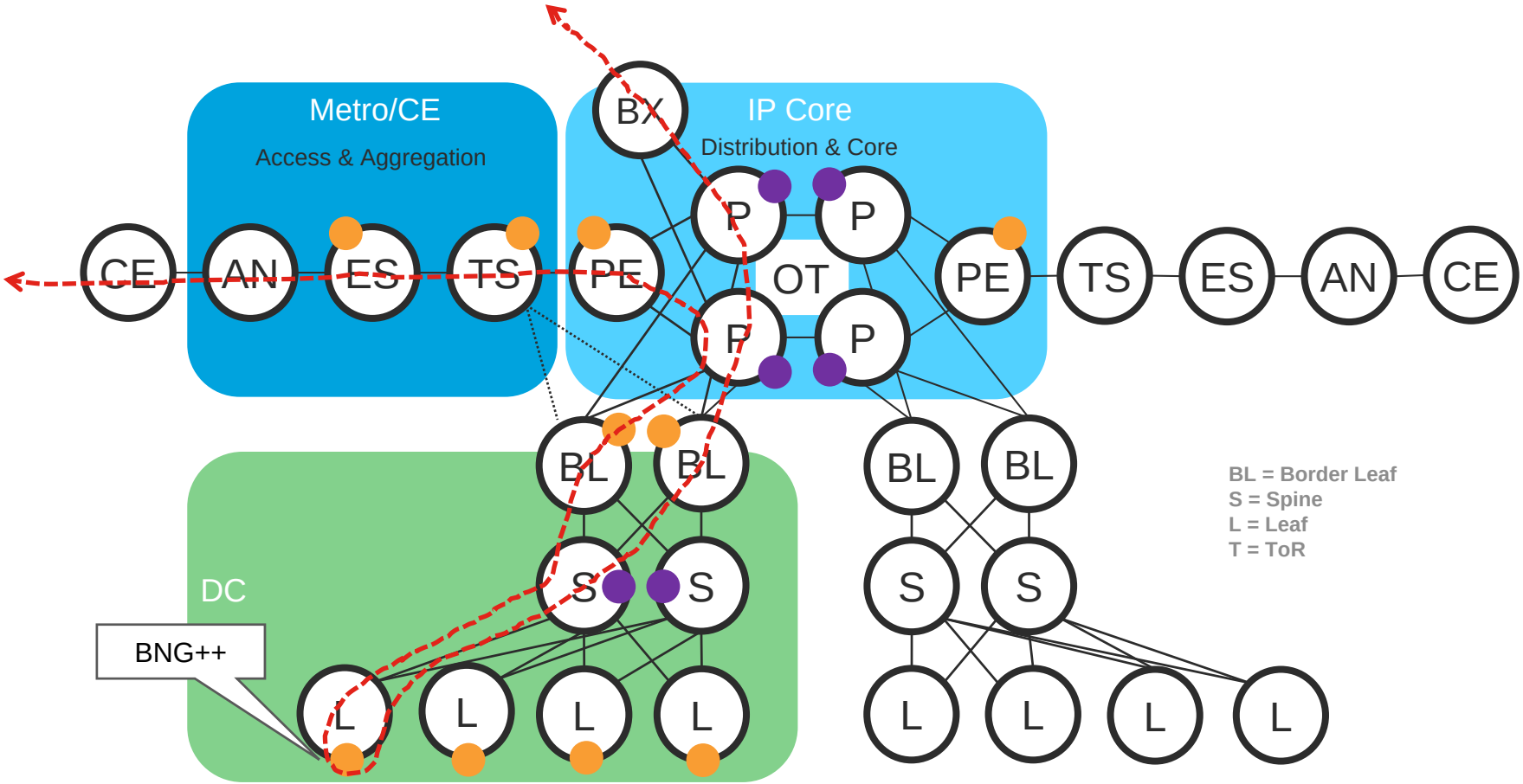
Classic SP Architecture



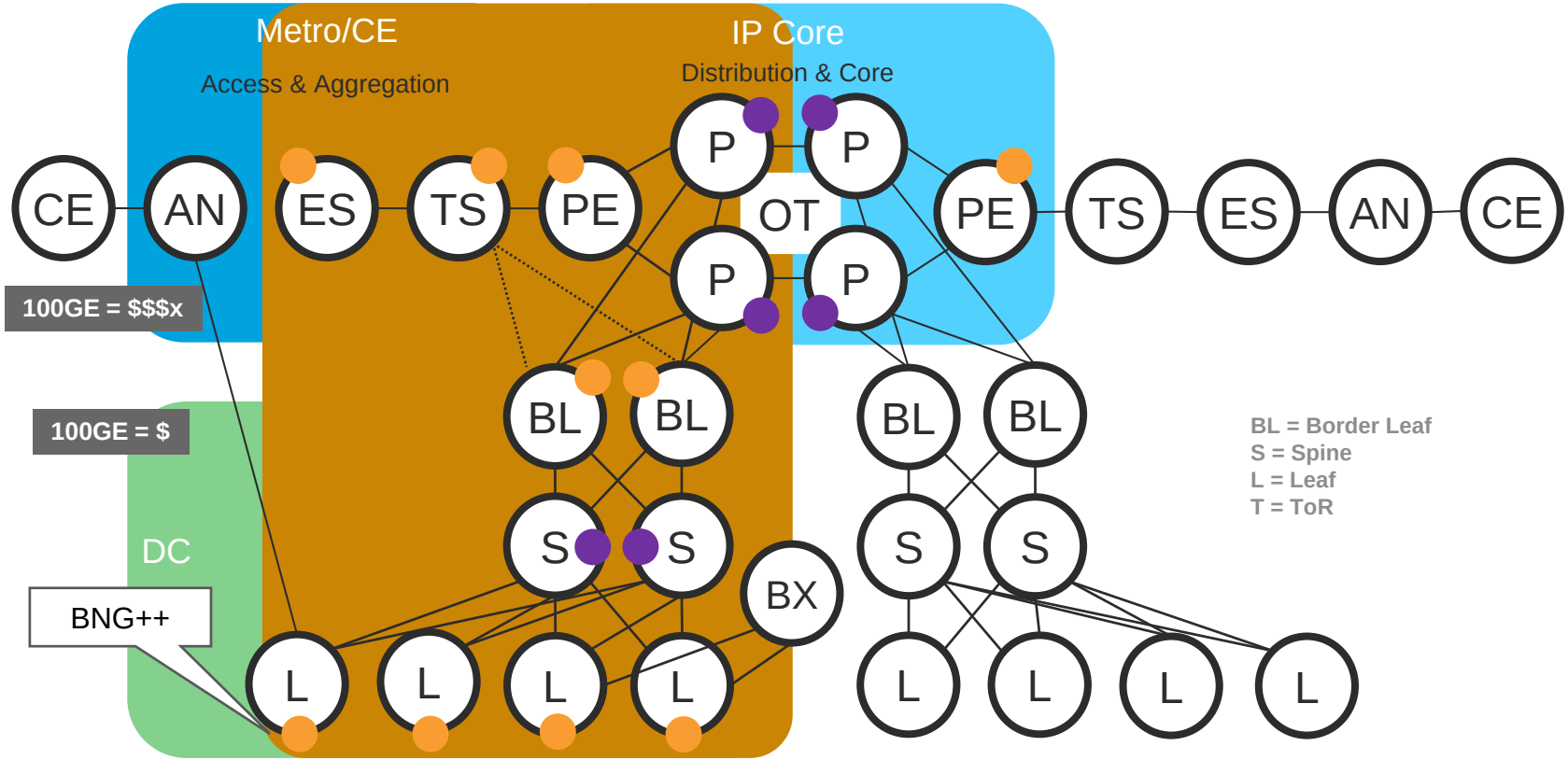
NFV SP Architecture



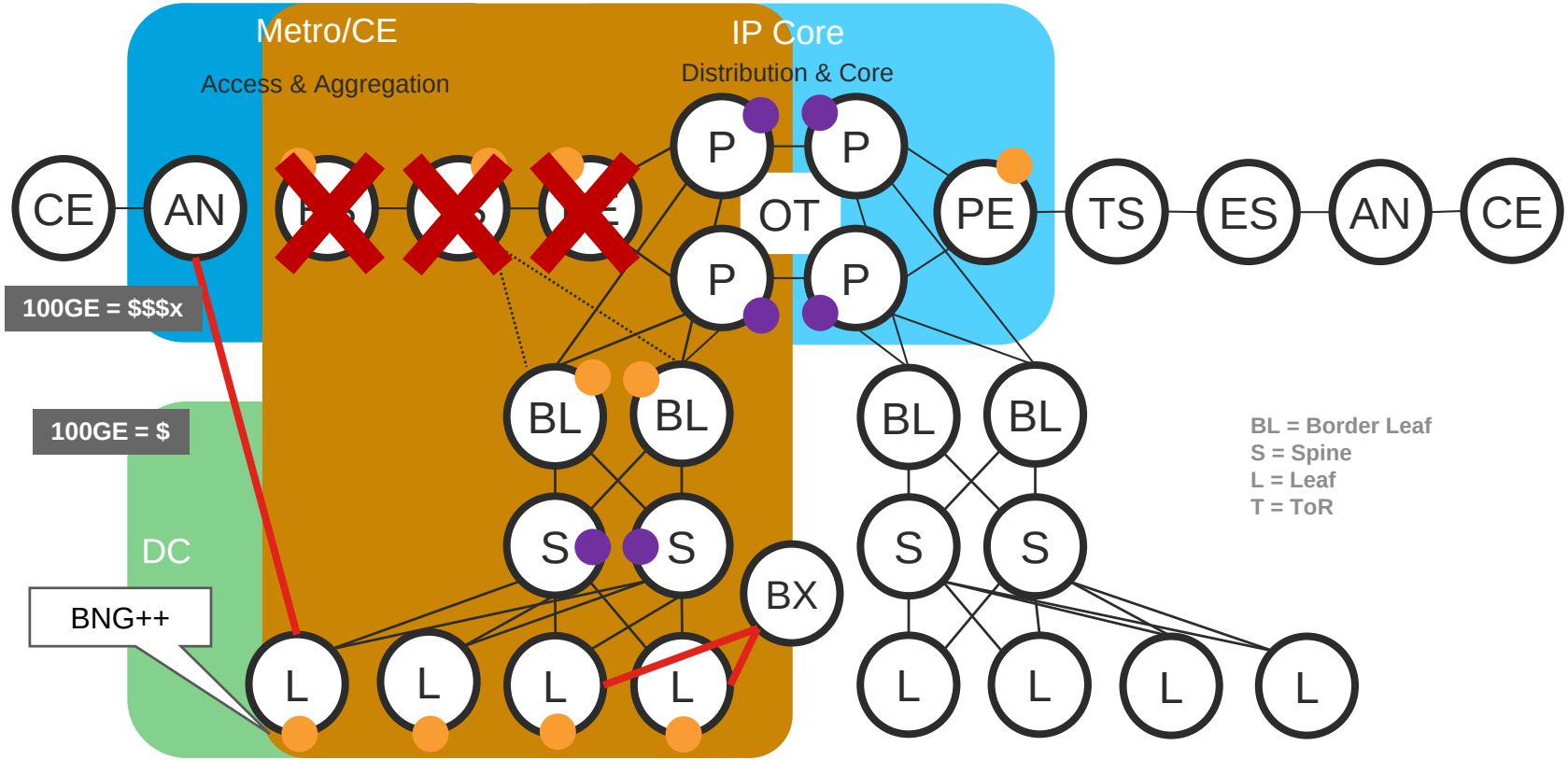
NFV SP Architecture



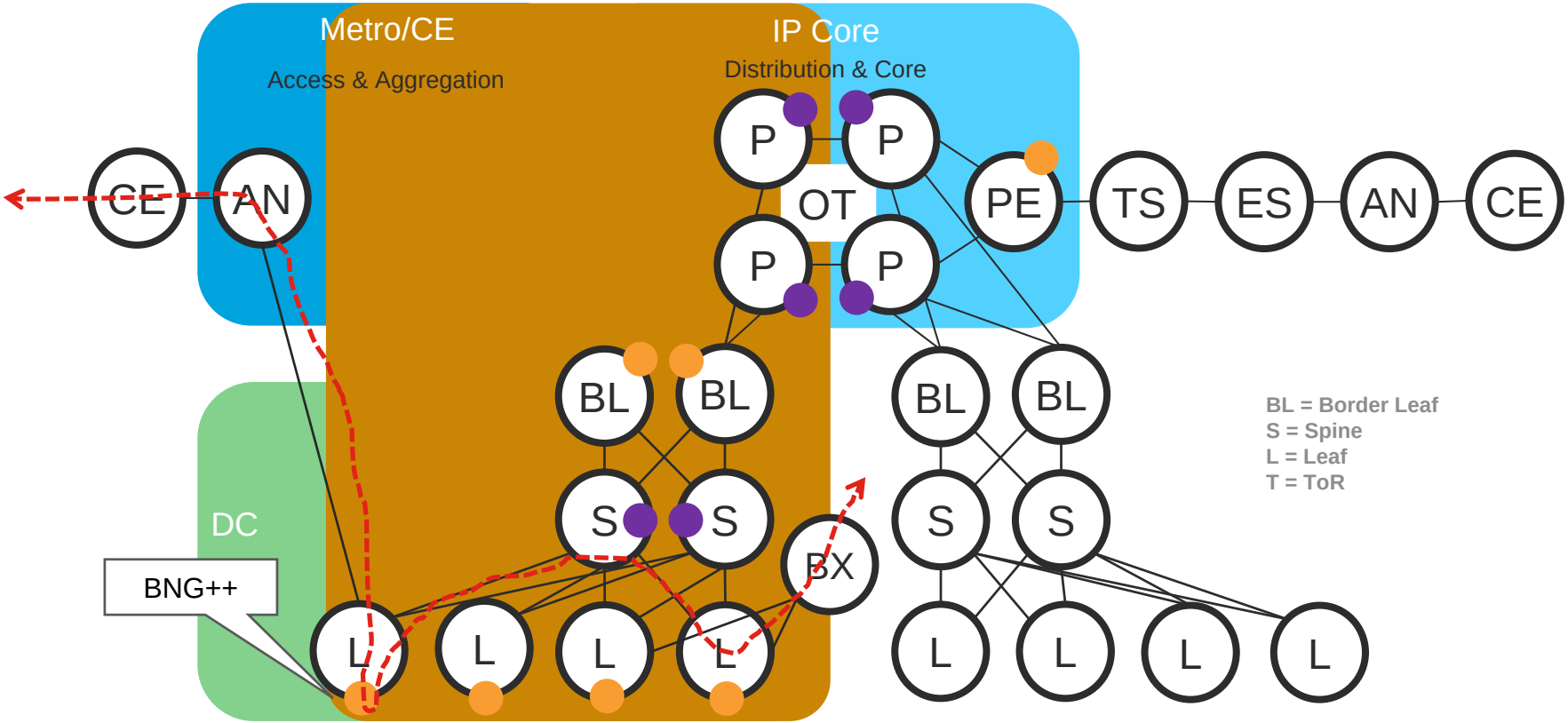
NFV SP Architecture Evolution



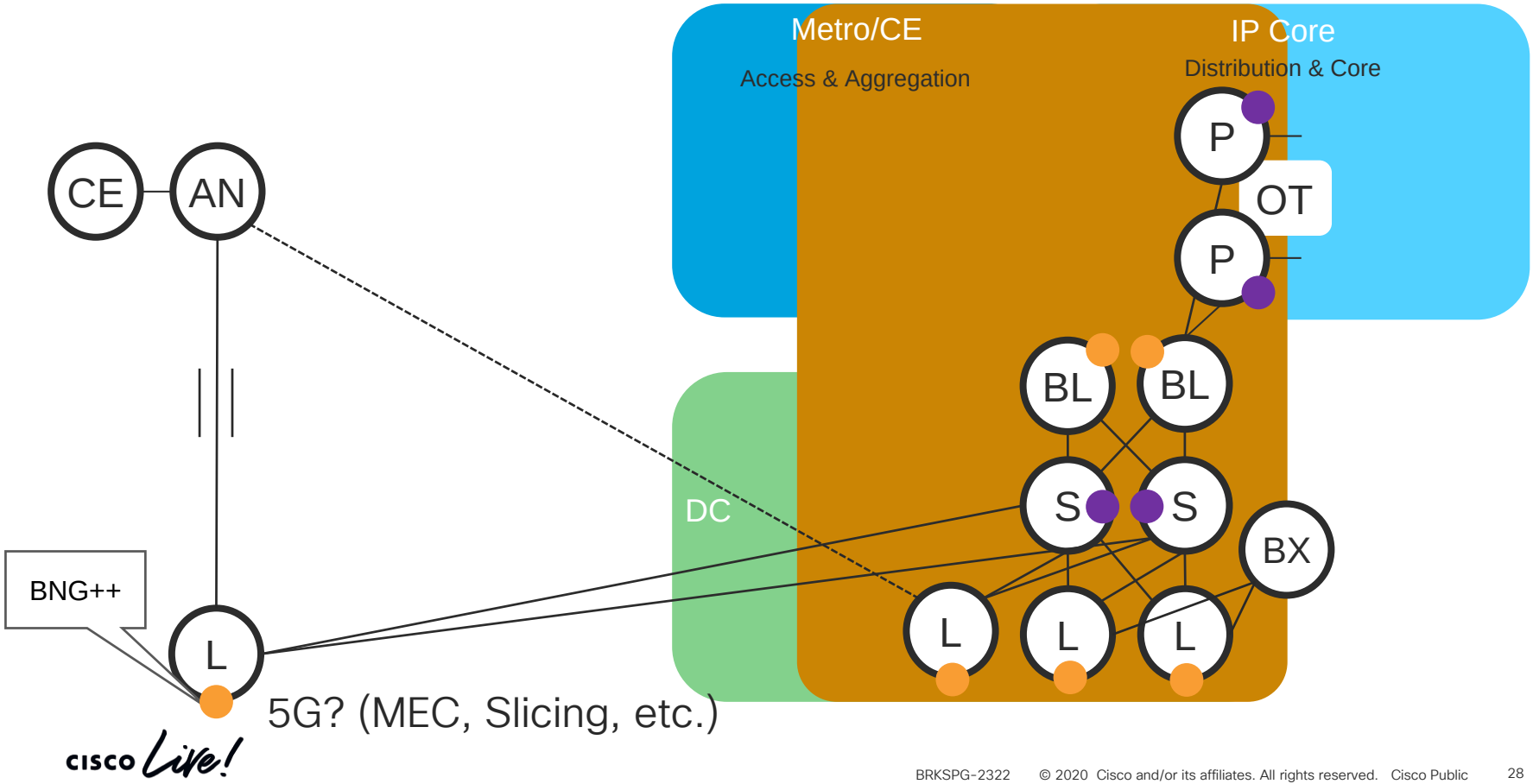
NFV SP Architecture Evolution



NFV SP Architecture Evolution



NFV SP Architecture Evolution

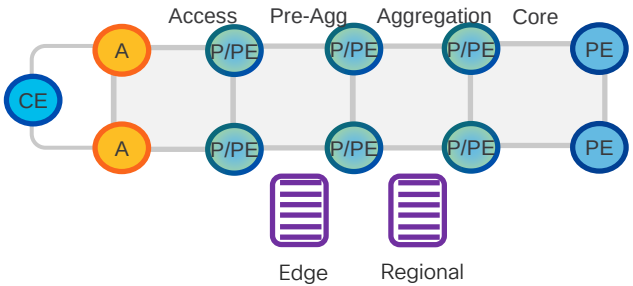


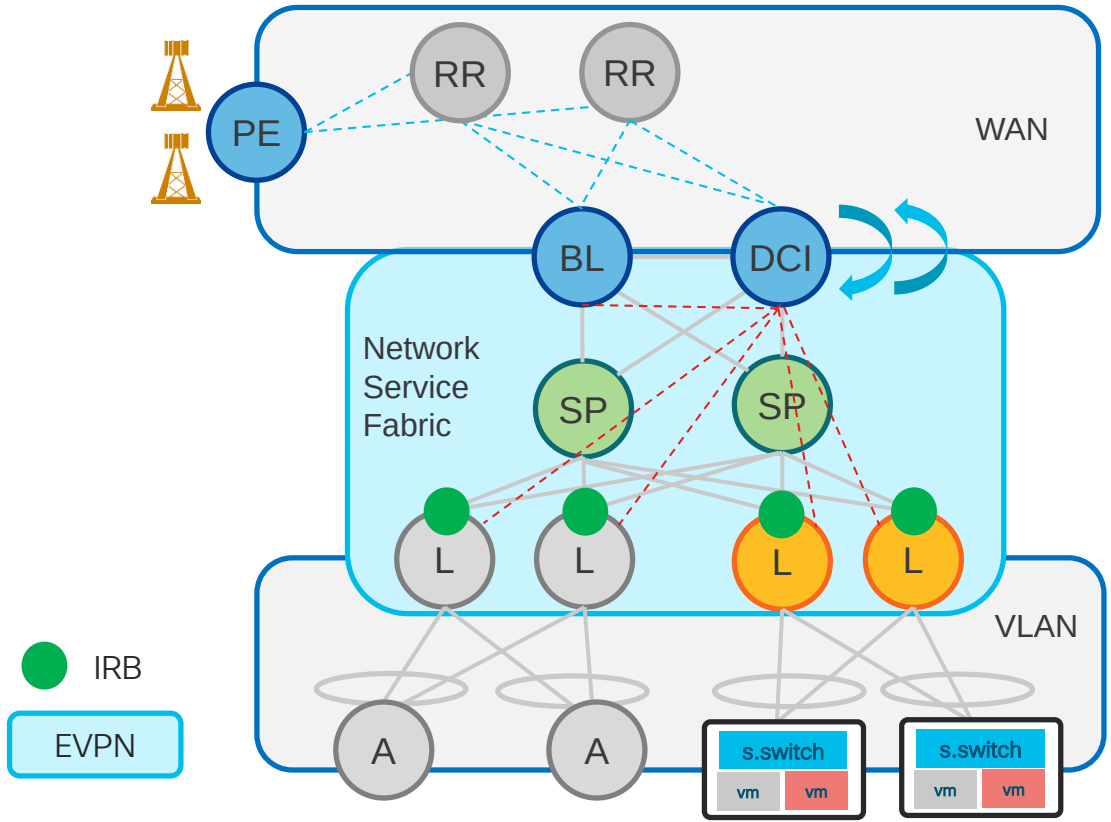
Corollary

- The Network and the Donut?
- What and Where is the Edge?

Stitched vs Integrated

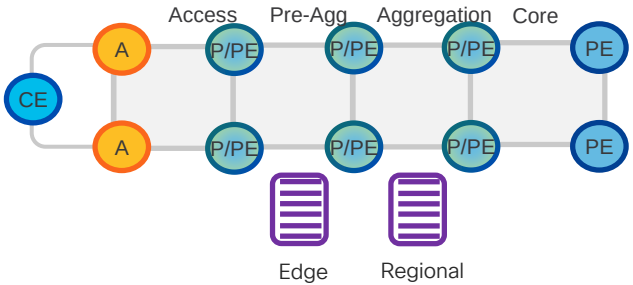
Stitched Fabric – Regional / Edge

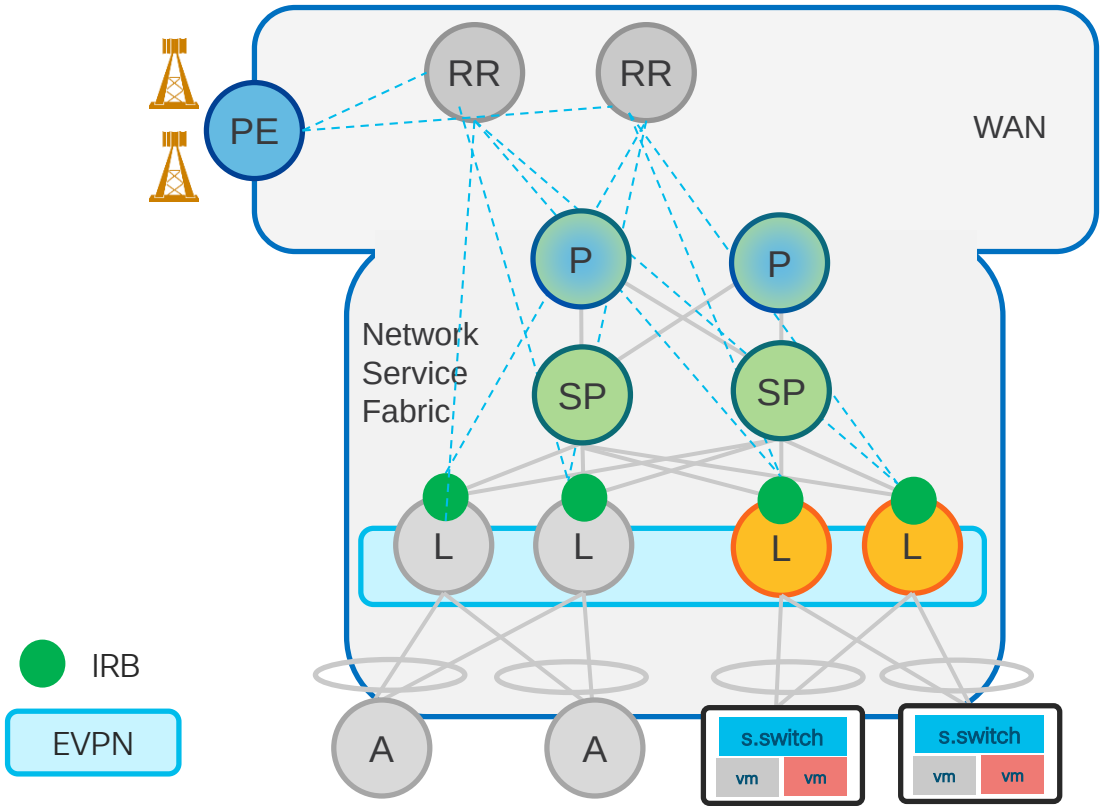




- Discrete IGP domain
- Packet rebuild / regenerated at BL
- Host routing within fabric
- Summarization at BL
- Services are always terminated at BL
- Separate orchestration
- Optimal Forwarding E-W, N-S

Integrated Fabric – Regional / Edge





- Underlay IP visible outside fabric
- Packets are untouched
- No protocol translation
- Host routing leaked to WAN (small fabric)
- Full WAN feature set at the leaf
- Ease of End to end OAM
- End-to-end service

EVPN Eco-System / Toolkit

Network Service Fabric Requirements

Co-location

Full Mesh

Latency

Legacy Features

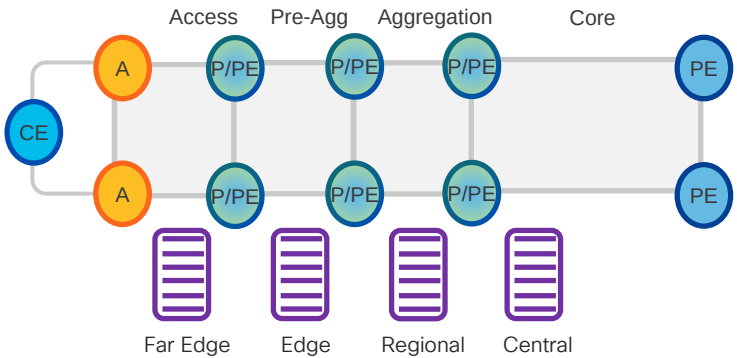
Convergence

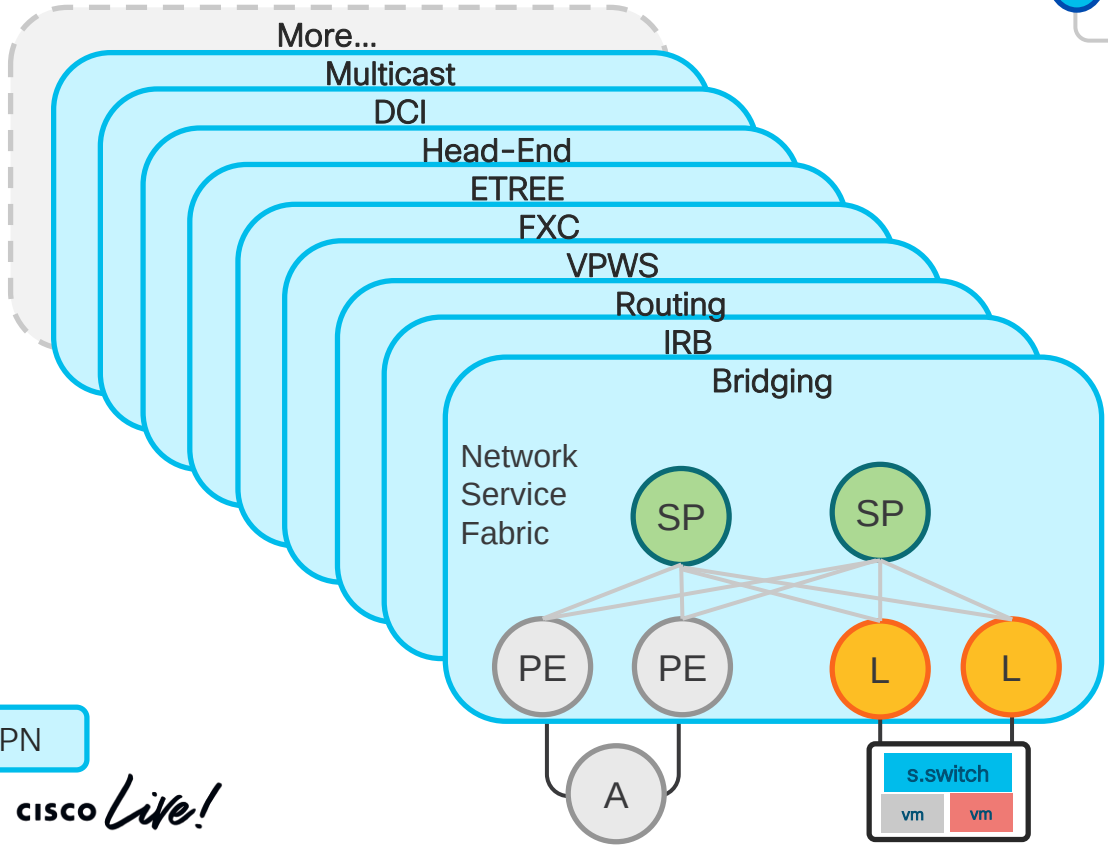
Virtualization

Optimal Forwarding

Flexible Eco-System

Eco-System / Toolkit





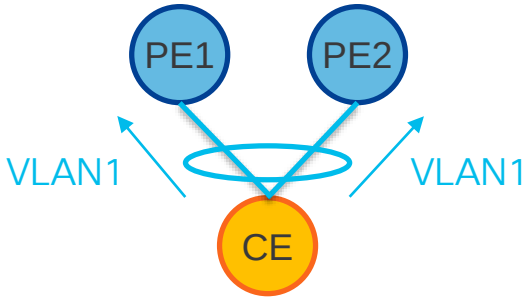
Telemetry

EVPN

cisco Live!

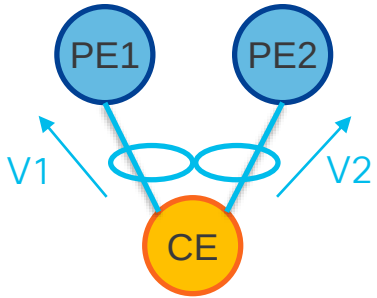
EVPN – Load-Balancing Modes

All-Active (per flow)



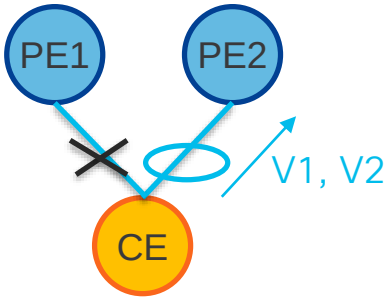
Single LAG at the CE
VLAN goes to both PE
Traffic hashed per flow
Benefits: Bandwidth, Convergence

Single-Active (per VLAN)



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

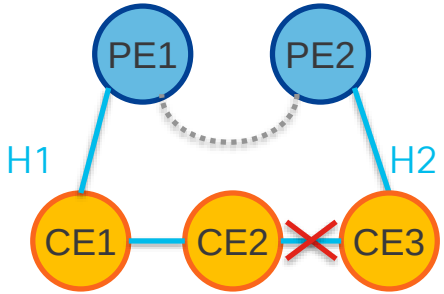
Port-Active (per port)



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

EVPN – Load-Balancing Modes

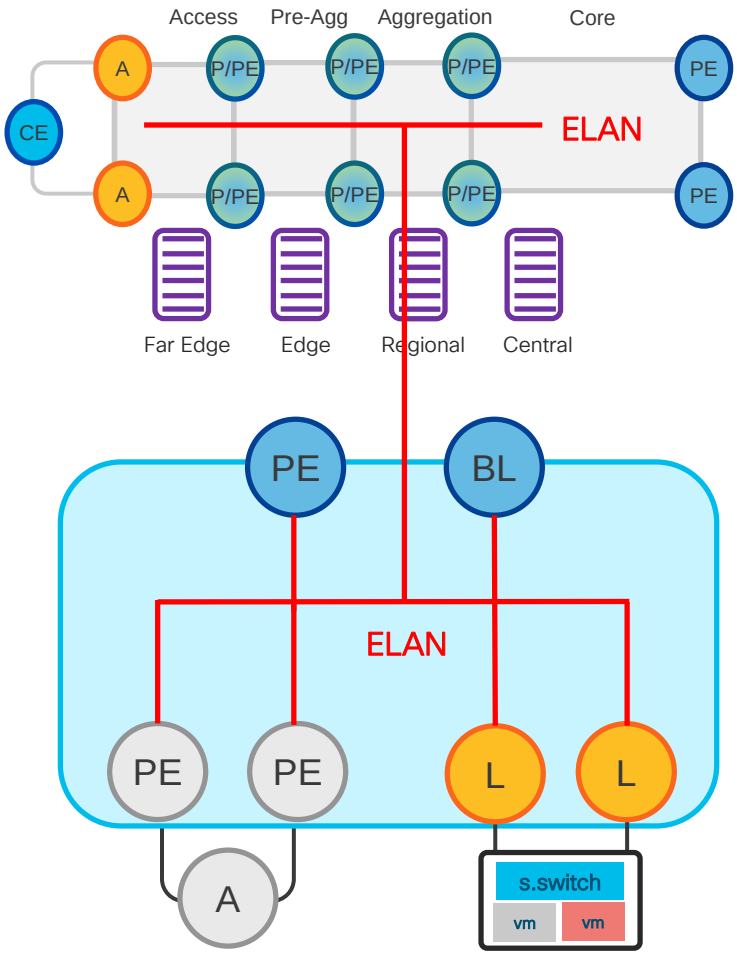
Single-Flow-Active (L2 access GW)



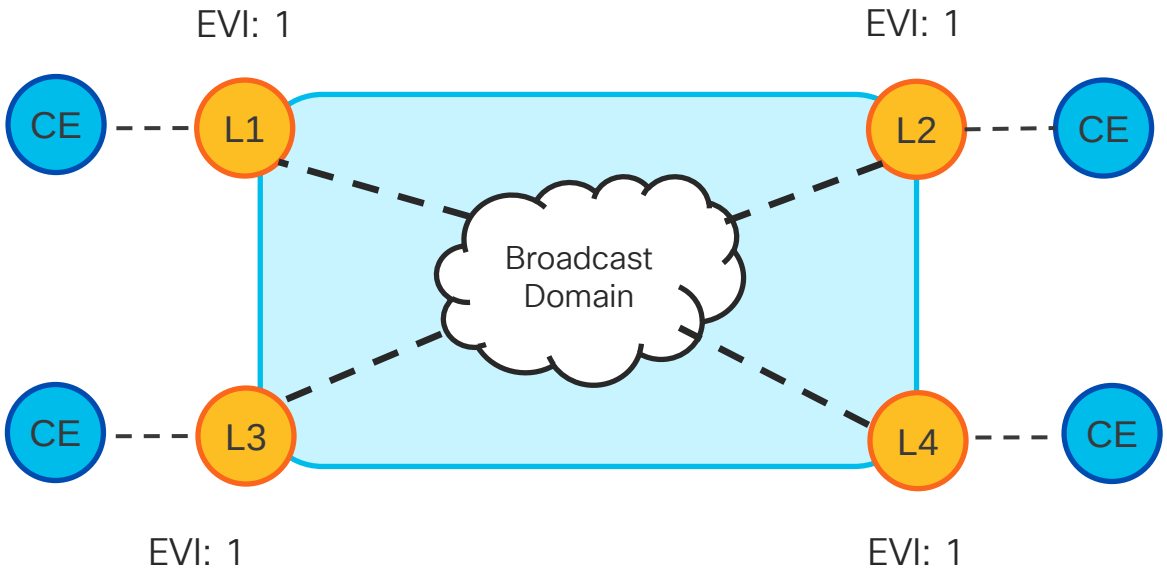
Single LAG at the CE
VLAN goes to both PE
Access takes care of L2 loop
Benefits: Legacy support for STP, REP, G.8032

EVPN – Bridging

- L2 E-LAN E2E Service
- East-West In Fabric
- MAC advertisement
- Multi-homing
- Legacy access protocols
- VPLS seamless interop
- MAC mobility
- On-Demand Nexthop
- Convergence



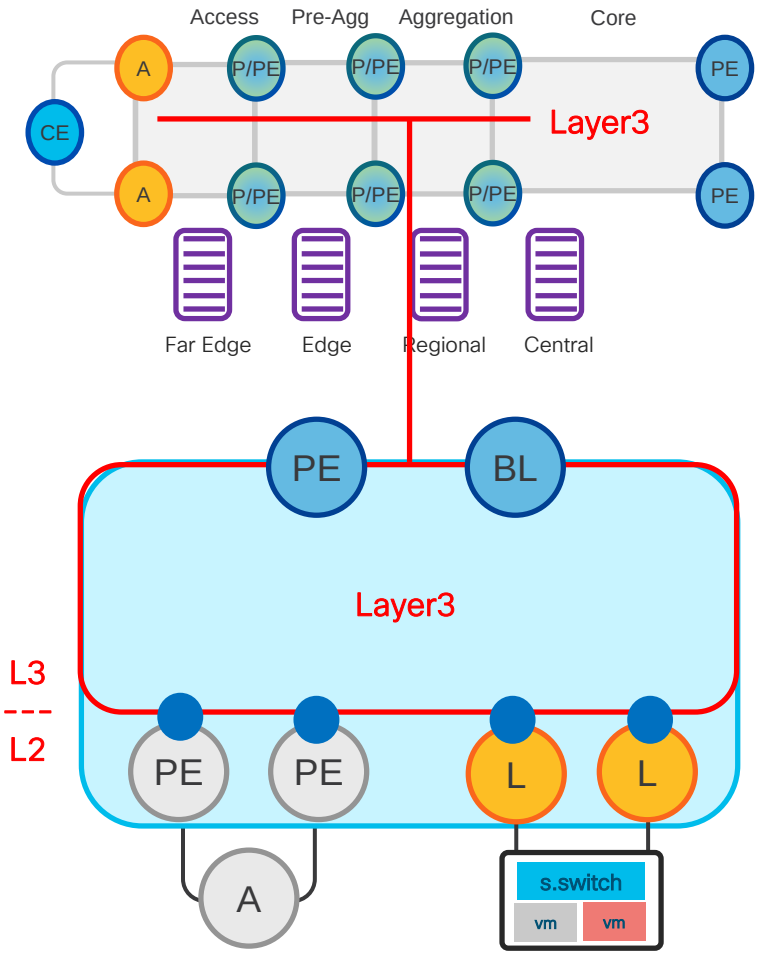
EVPN – Bridging
An Example



EVI = EVPN instance

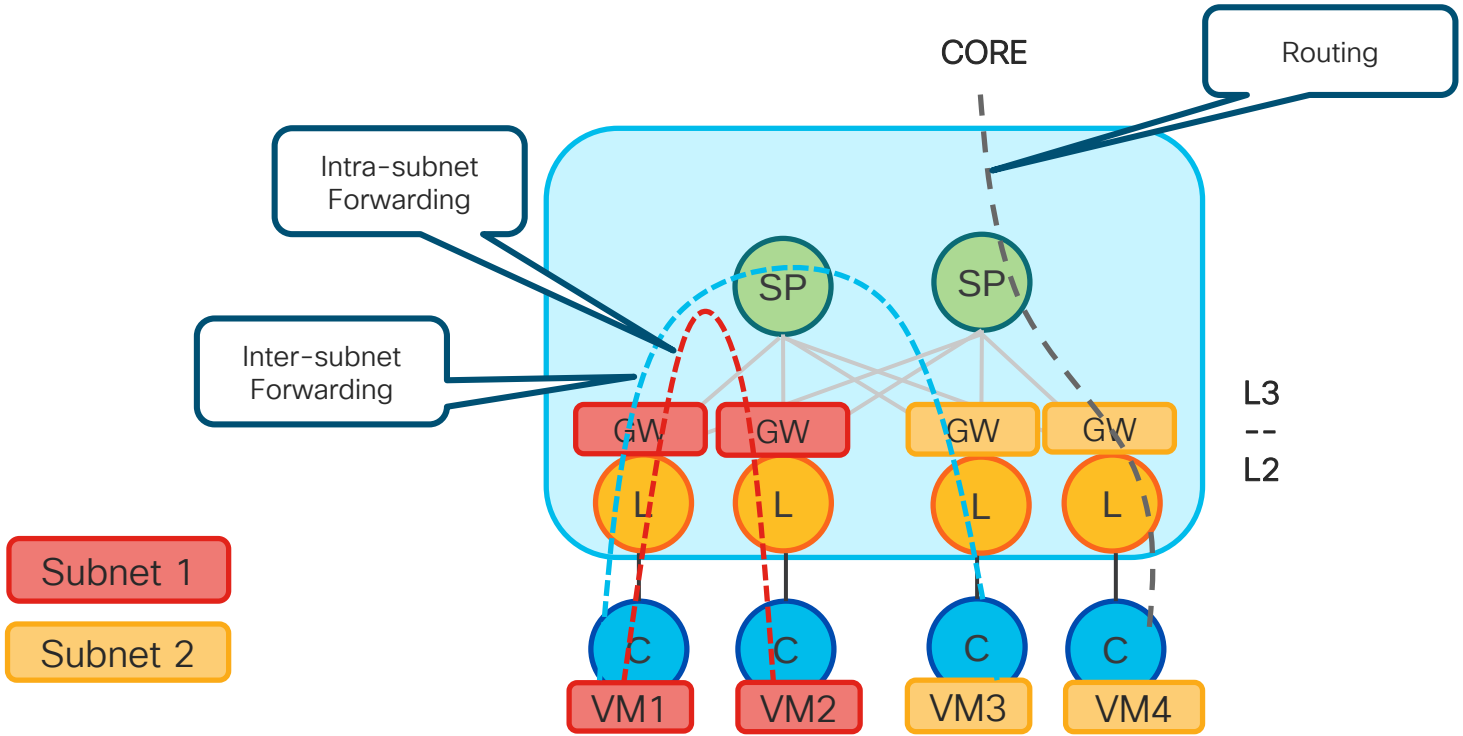
EVPN – IRB

- Virtualization and Compute
- L2 Legacy to L3VPN
- Distributed Anycast Gateway
- Symmetric IRB
- Multi-homing
- Host Routing & Mobility
- Optimal Forwarding
- Summarization
- L2 / L3 integration



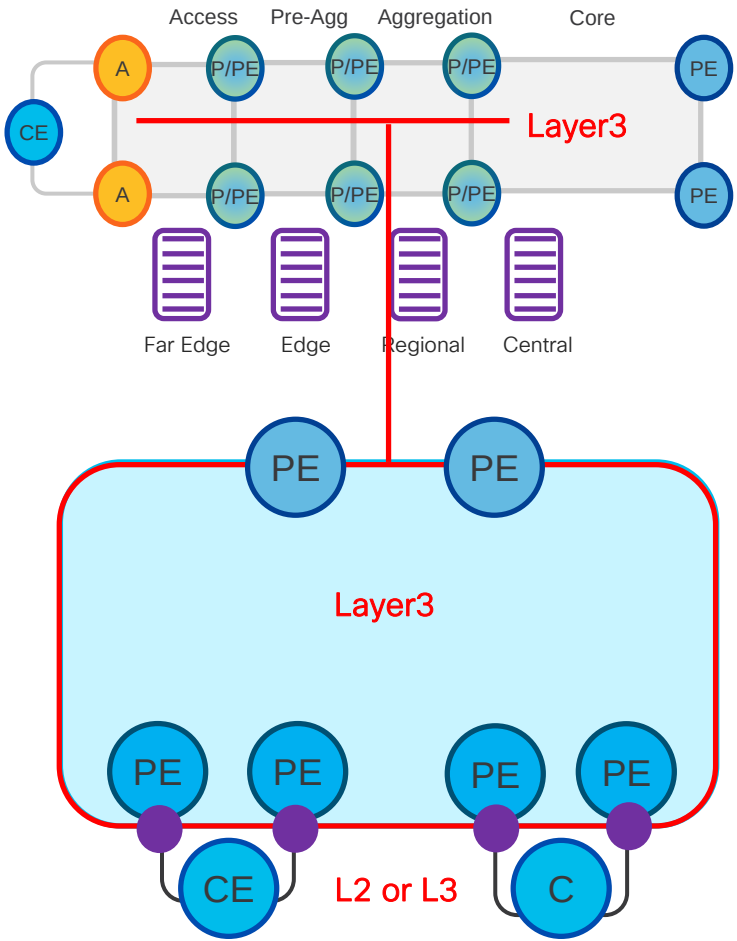
IRB

EVPN – IRB
An Example



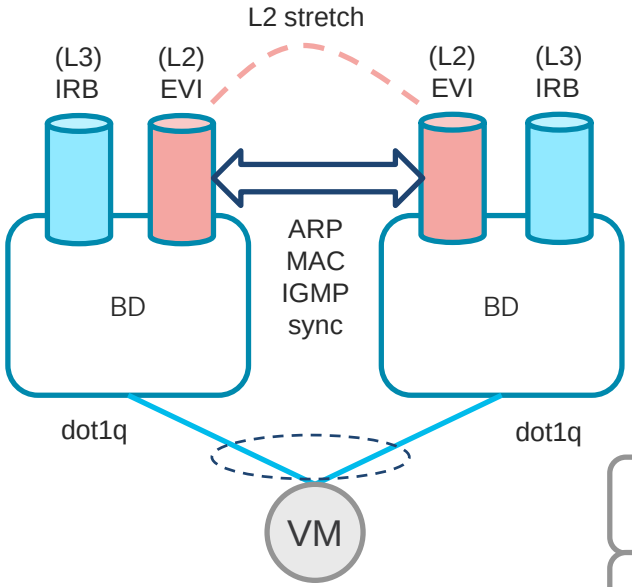
EVPN – Routing

- All-Active L3VPN Service
- VSS/vPC Equivalent
- Scalability
- v4 / v6
- VRF2VRF leaking
- IPVPN seamless interop
- RPL
- RT constraint
- IGMP/MLD sync



L3 Interface

EVPN – IP Gateway Multi-Homing



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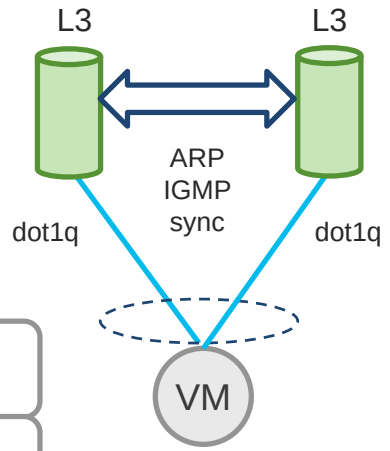
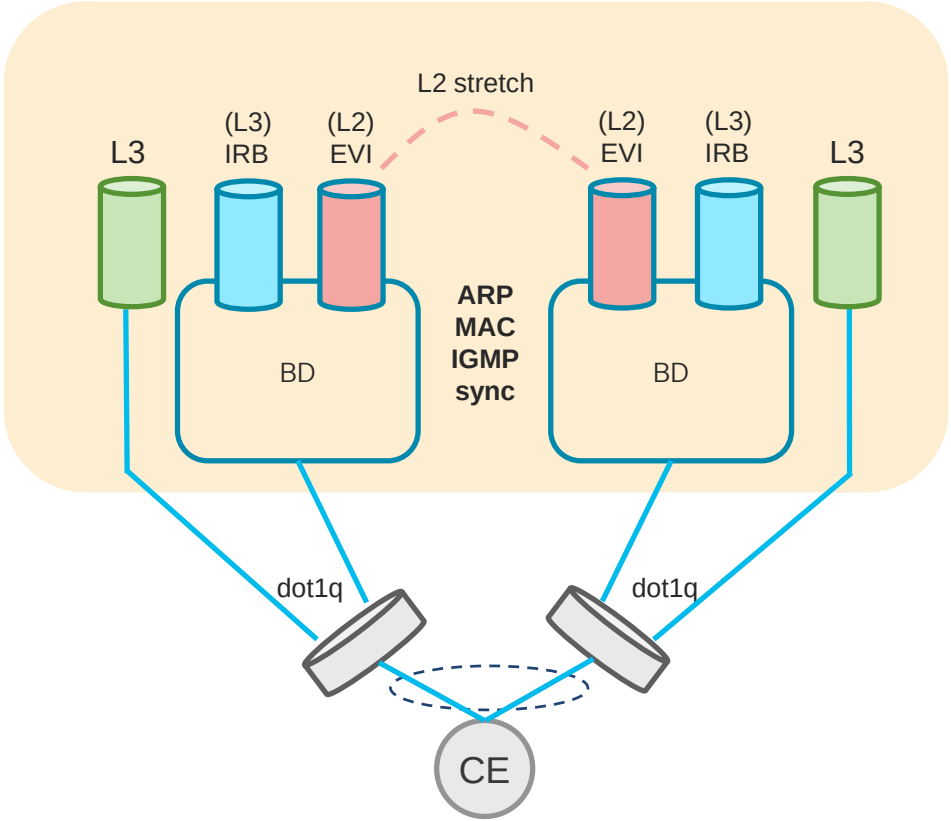


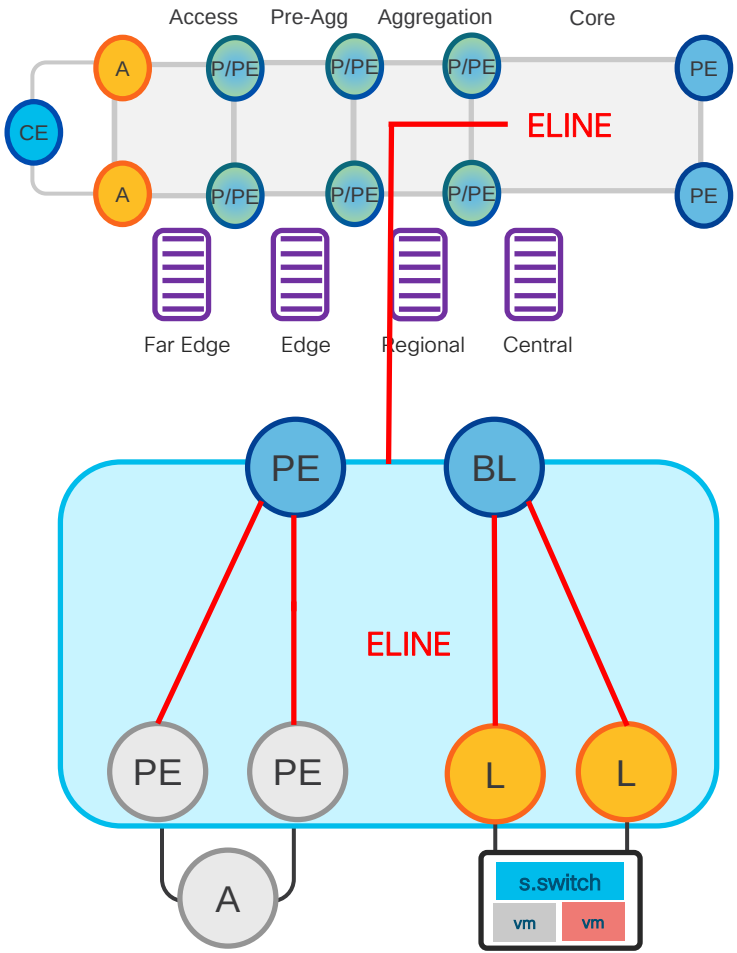
- No subnet stretch
- No VM mobility
- Higher scale

EVPN – Gateway Multi-Homing

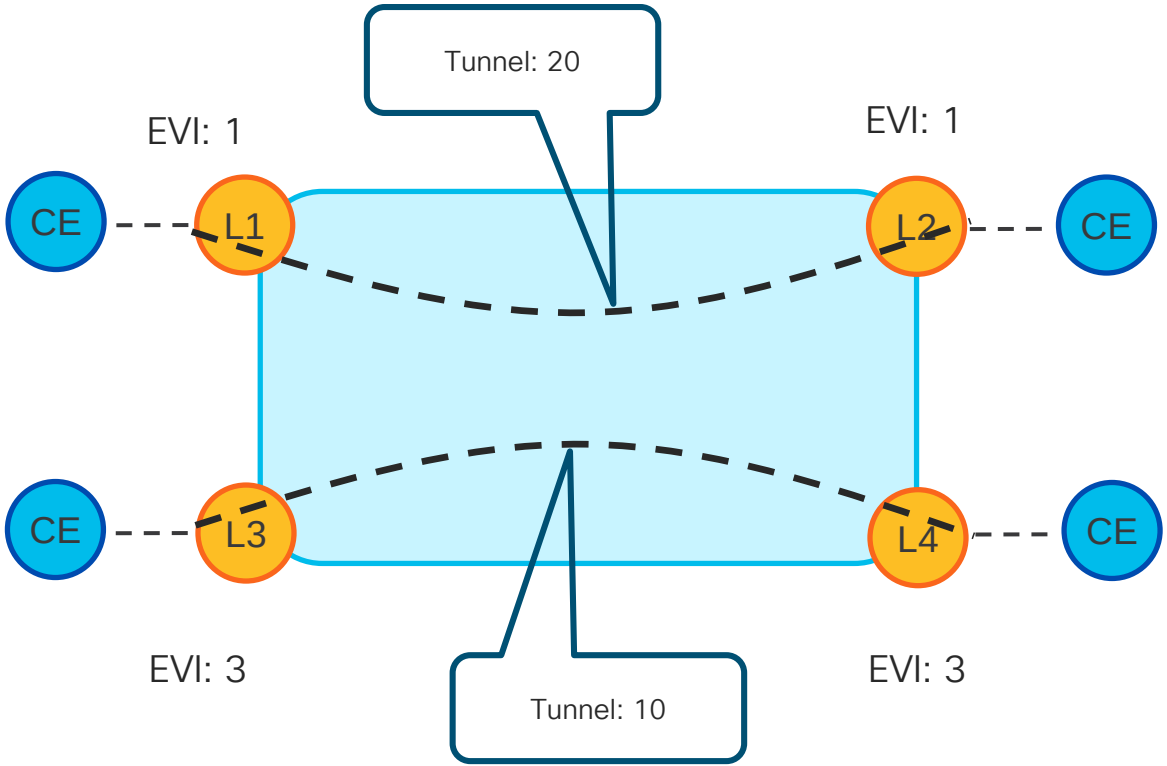


EVPN – VPWS

- L2 E-LINE E2E Service
- Access Services to Fabric
- VLAN-unaware
- MPLS / SRv6 dataplane
- Multi-homing
- On-Demand Nexthop



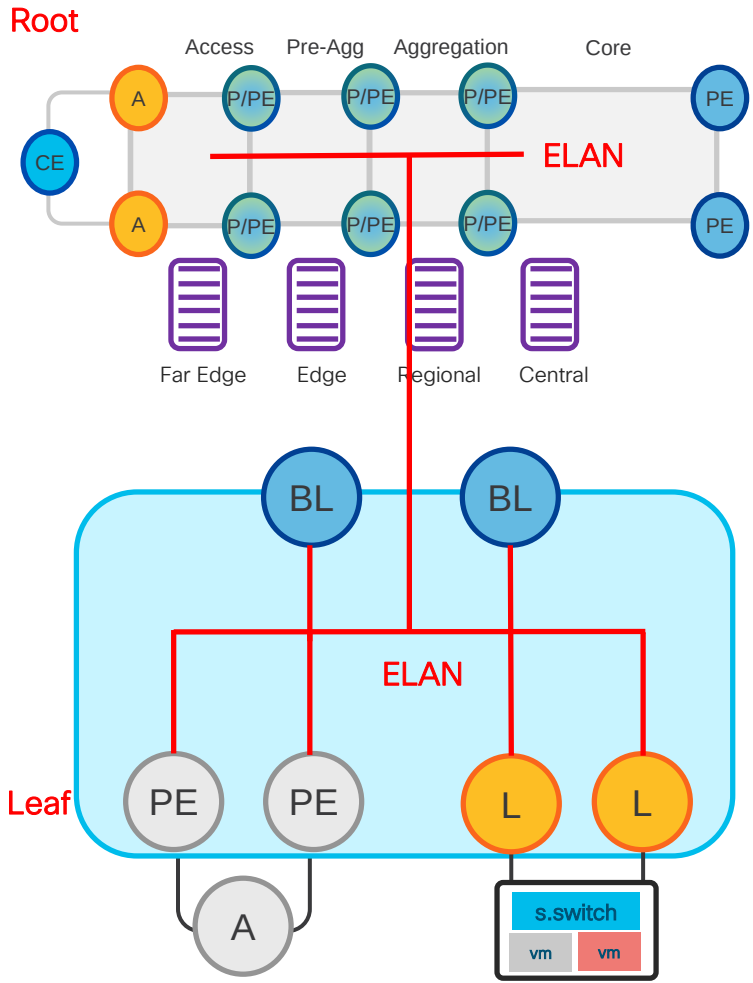
EVPN – VPWS
An example



EVI = EVPN instance

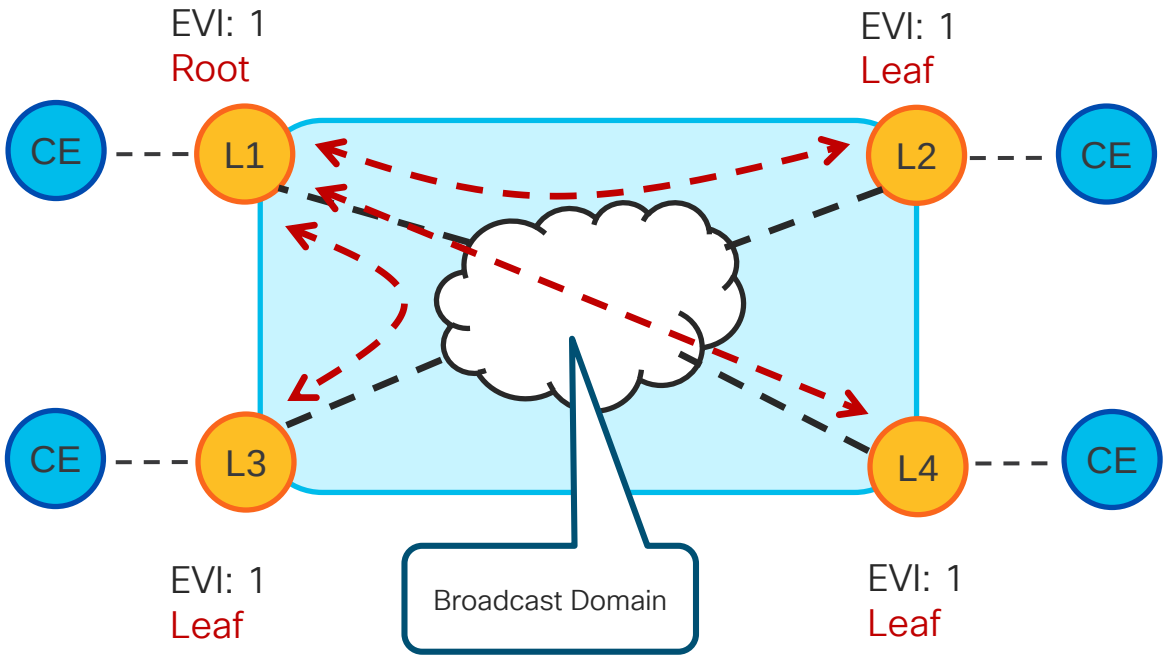
EVPN – ETREE

- Residential Services
- BNG applications
- Access Aggregator
- Root/Leaf per router
- Root/Leaf per Bridge Domain
- IRB (as root)
- Multi-homing
- VLAN segmentation



EVPN – ETREE
An Example

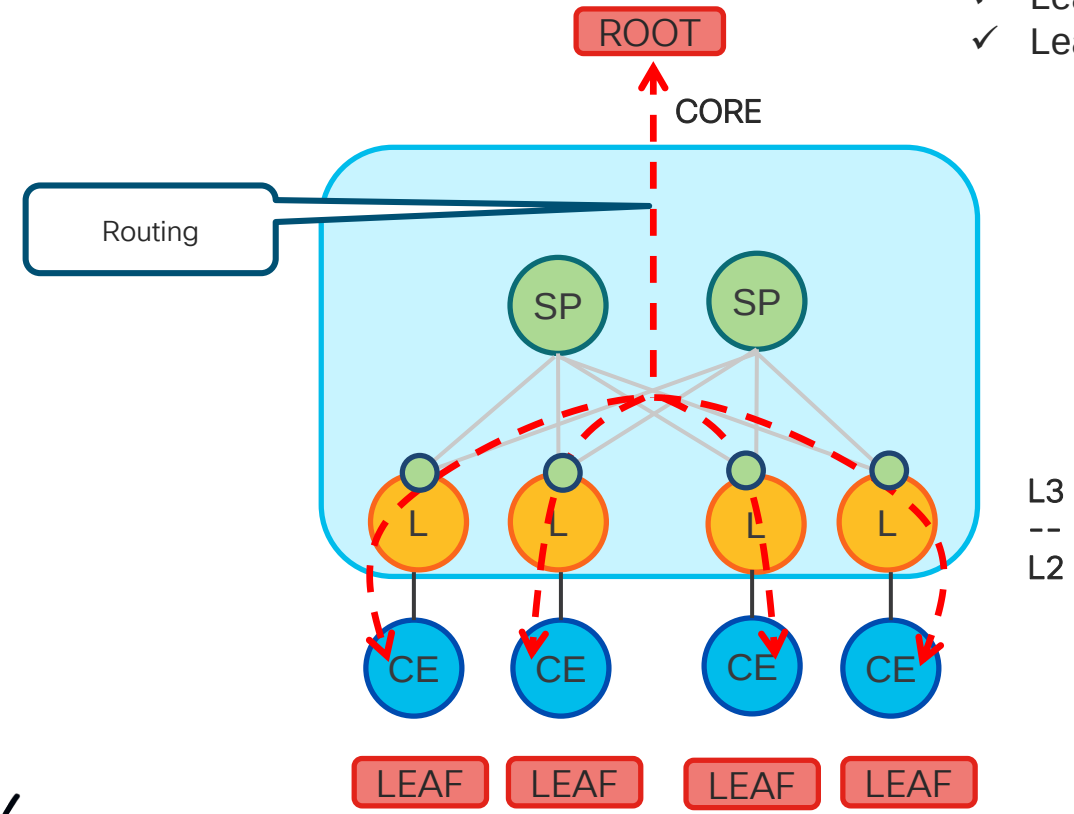
- ✓ Root to leaf
- ✓ Leaf to leaf prohibited



EVI = EVPN instance

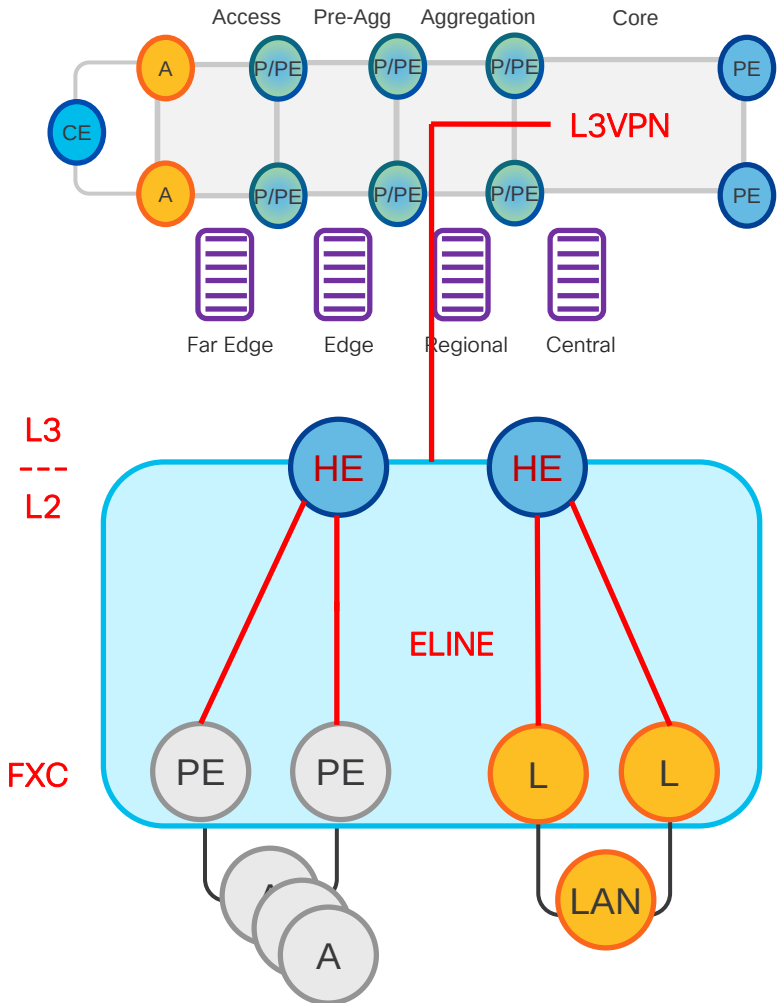
EVPN – ETREE
Another Example

- ✓ Root to leaf
- ✓ Leaf to leaf inter-subnet
- ✓ Leaf to leaf intra-subnet prohibited

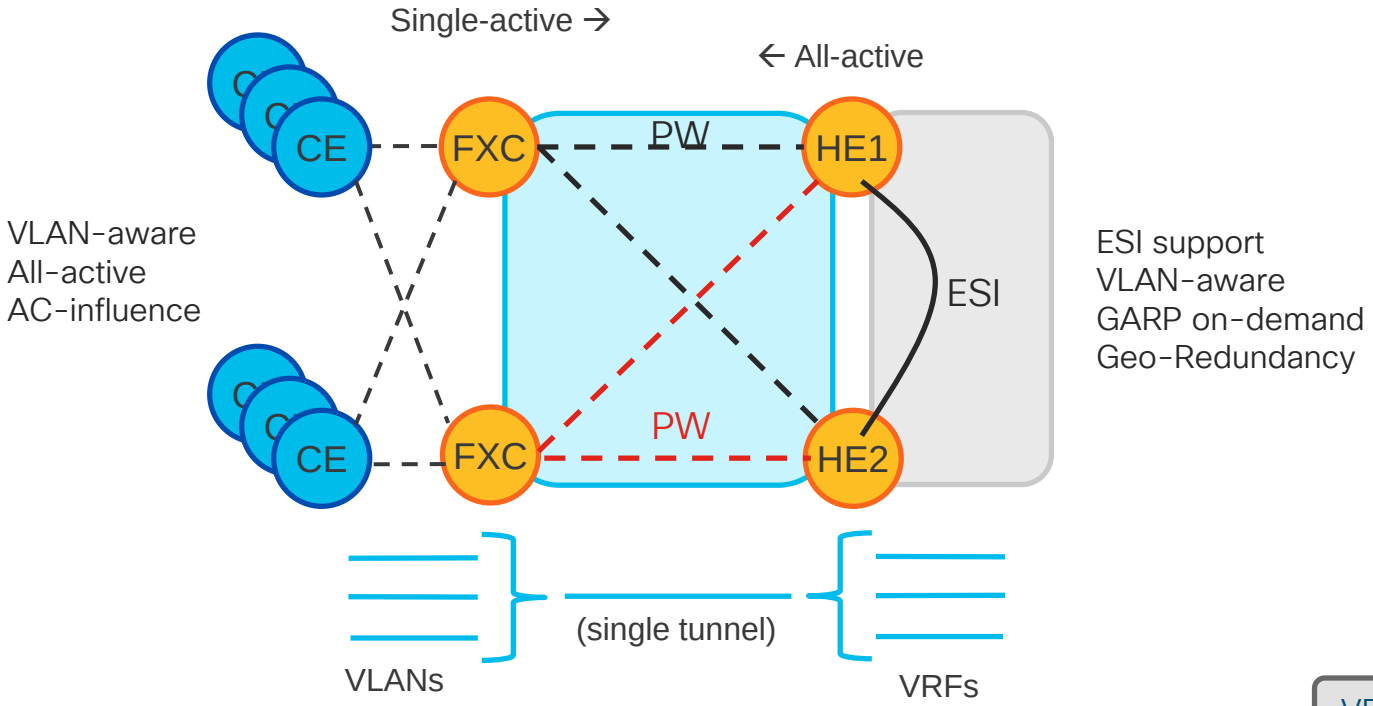


EVPN – Head End

- Hierarchical L3VPN Service
- Residential Service
- BNG application
- All-Active CoreToAccess
- Single-Active AccessToCore
- Service decoupling
- VLAN aware
- FXC as access service
- VPWS as access service



EVPN-Head End
An Example

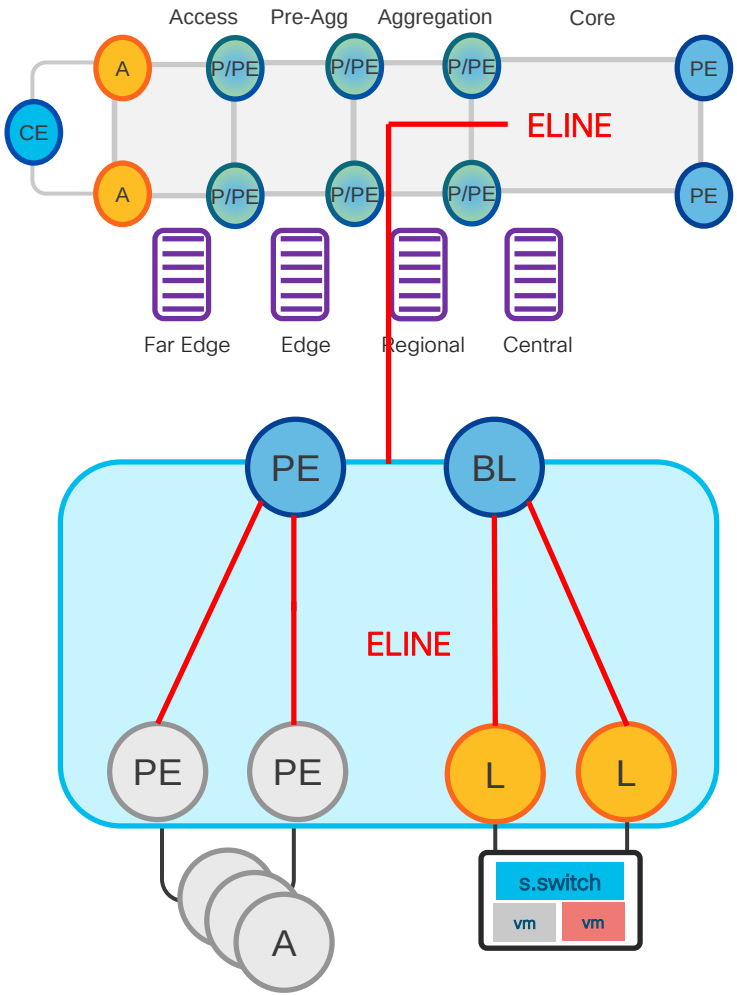


VPNv4/v6

EVPN

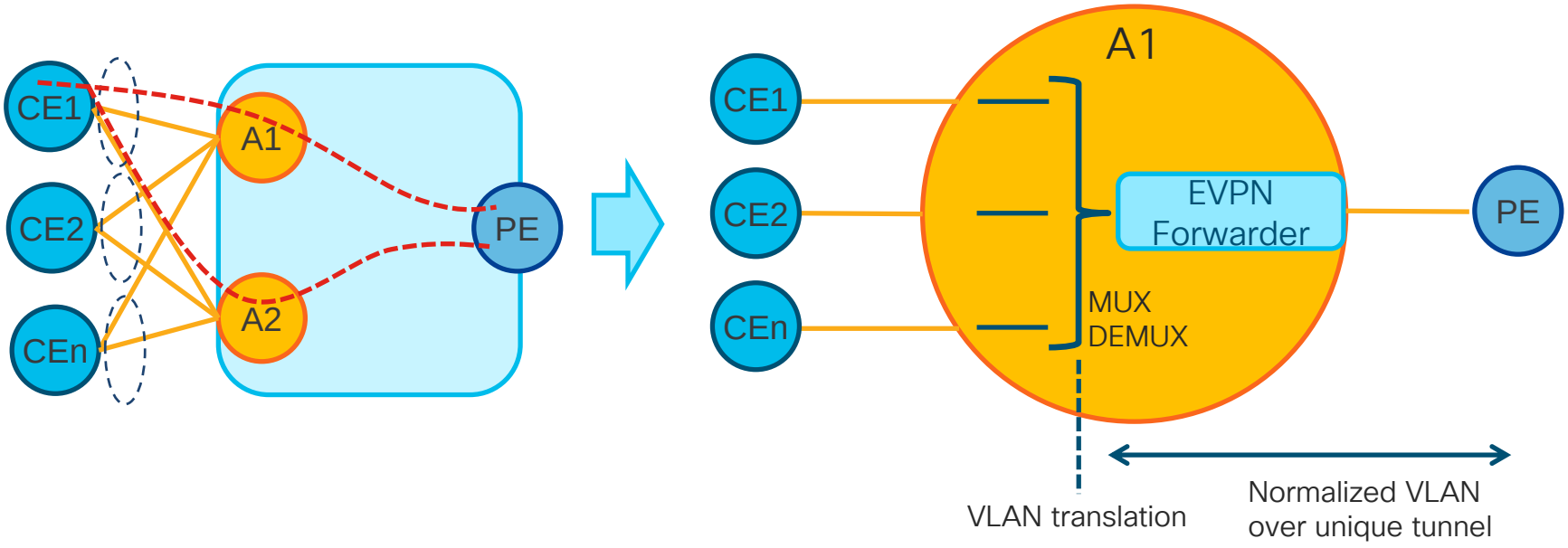
EVPN – Flexible XC Service

- L2 E-LINE E2E Service
- Access Services to Fabric
- Stateless SFC / NFV
- VLAN-aware
- Local Switching
- Multi-homing
- VLAN-unaware



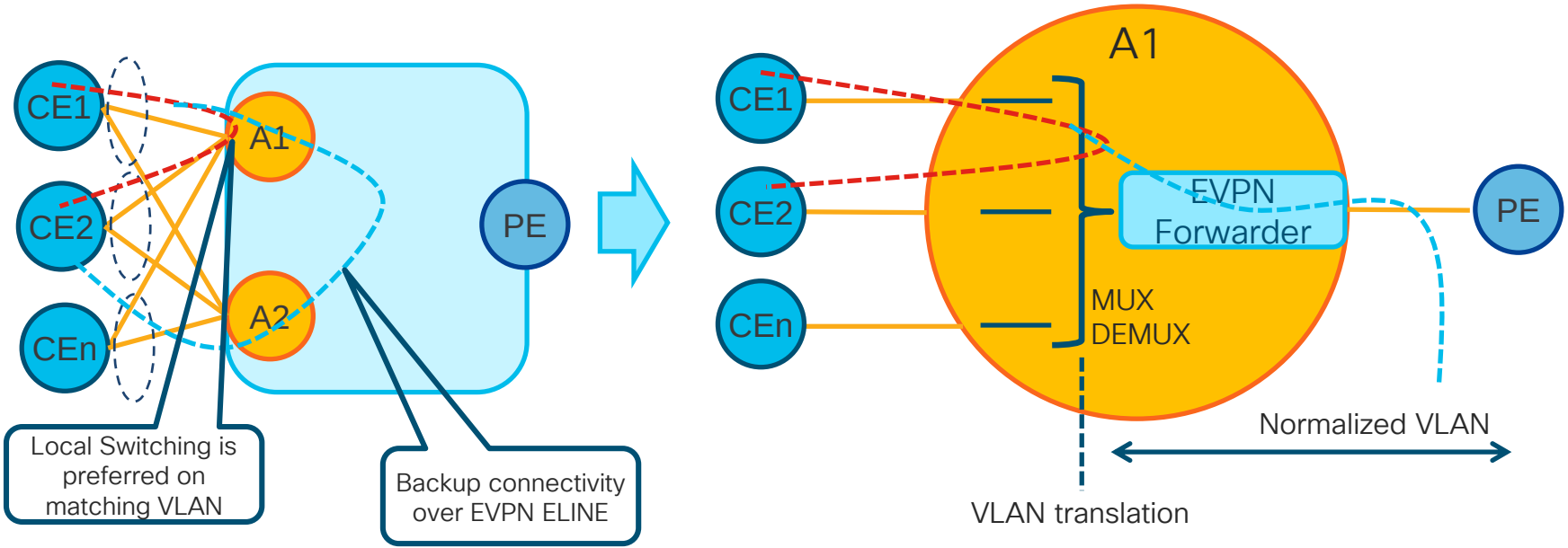
EVPN – Flexible Cross-Connect Service

Challenge:
How to bring multiple access services from different sources using a single EVPN E-LINE tunnel?



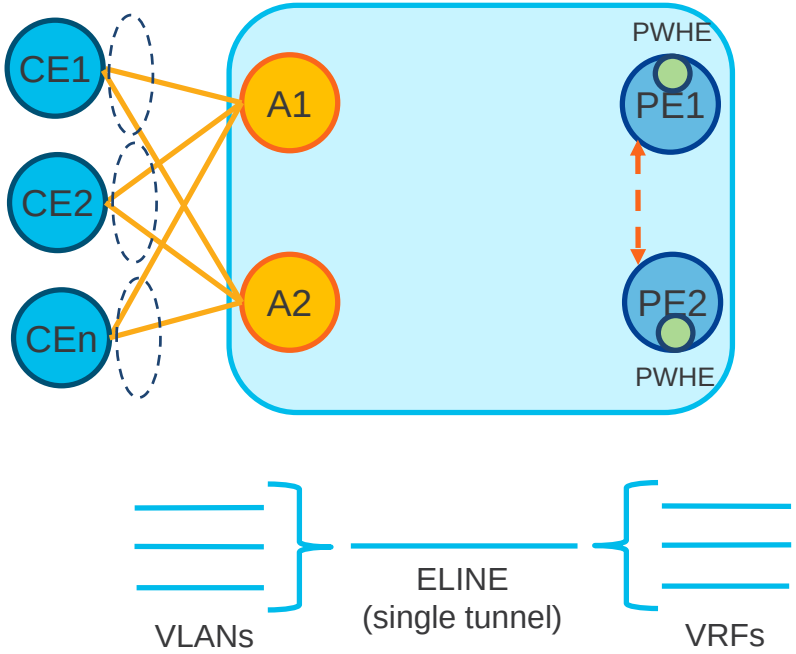
EVPN – Flexible Cross-Connect Service

Request:
Can local switching preferred over ELINE tunnel?



Flexible Cross-Connect Service: Head-End

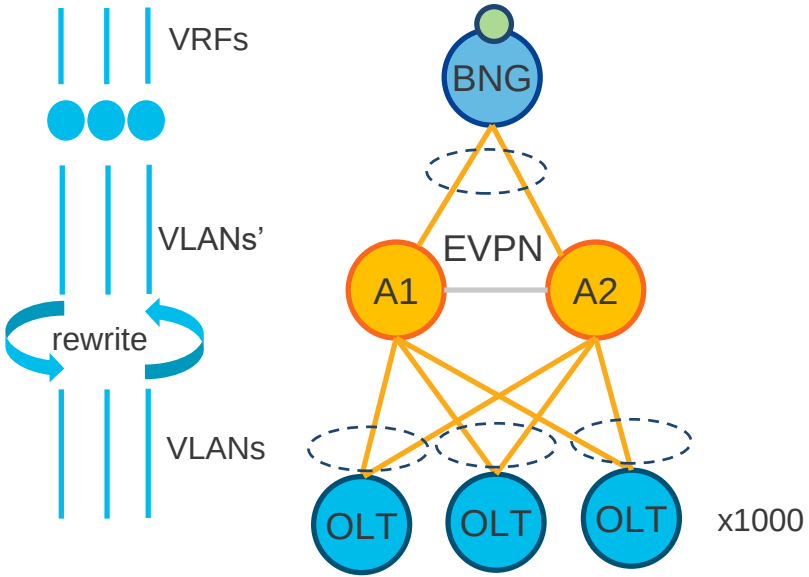
Purpose:
Bring multiple ELINE services into Pseudo-Wire Head-End termination



Flexible Cross-Connect Service: Local Switching

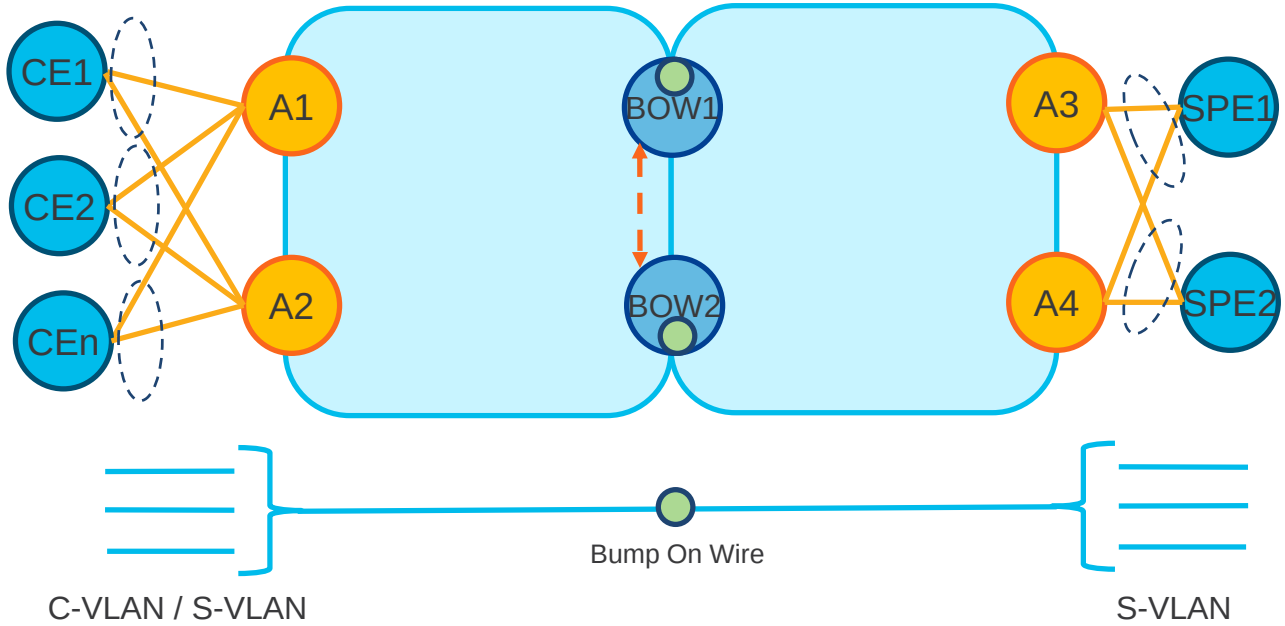
Purpose:

Bring access services (e.g OLT) into BNG with redundancy



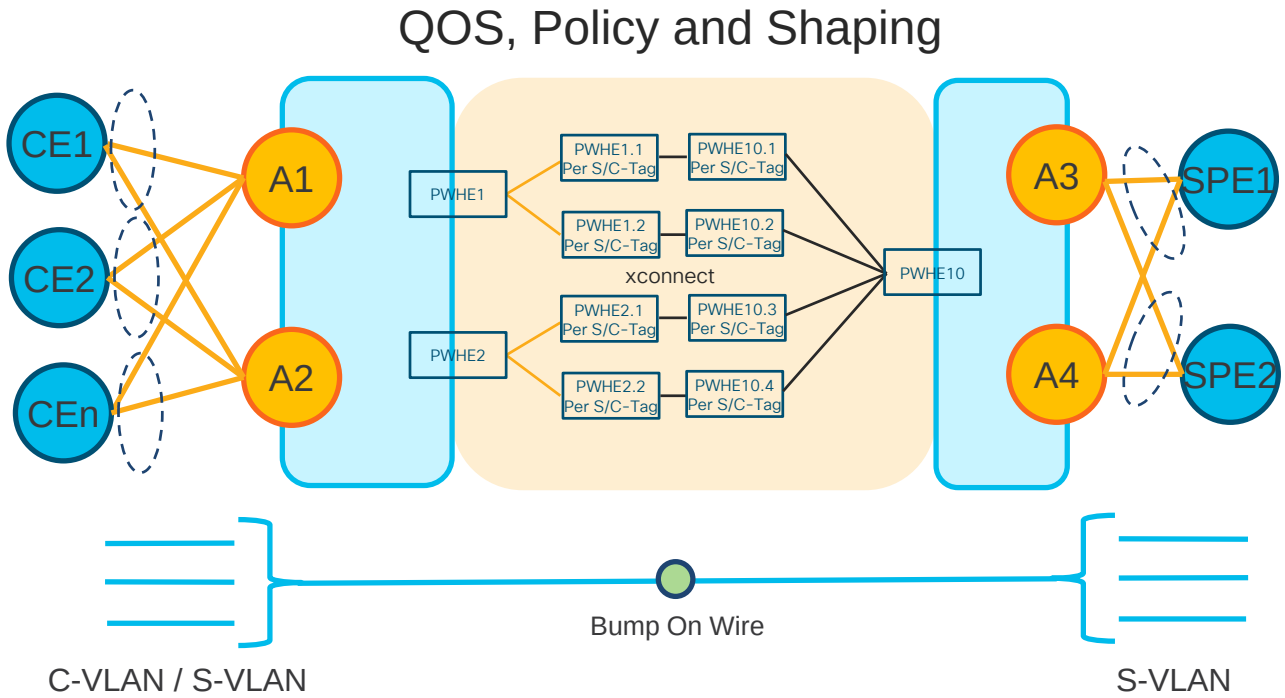
EVPN – ELBOW

Purpose:
Provide transparent QOS, Policy and Shaping with aggregation (MUX) capability



EVPN
ELINE

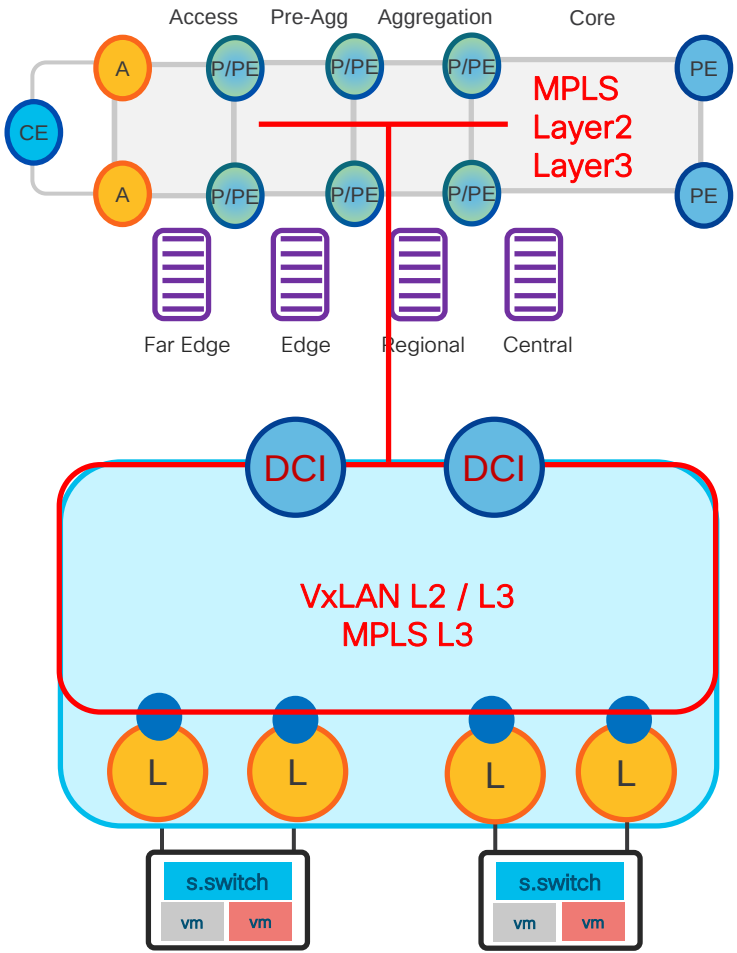
EVPN – ELBOW
An Example



EVPN
ELINE

EVPN – DCI

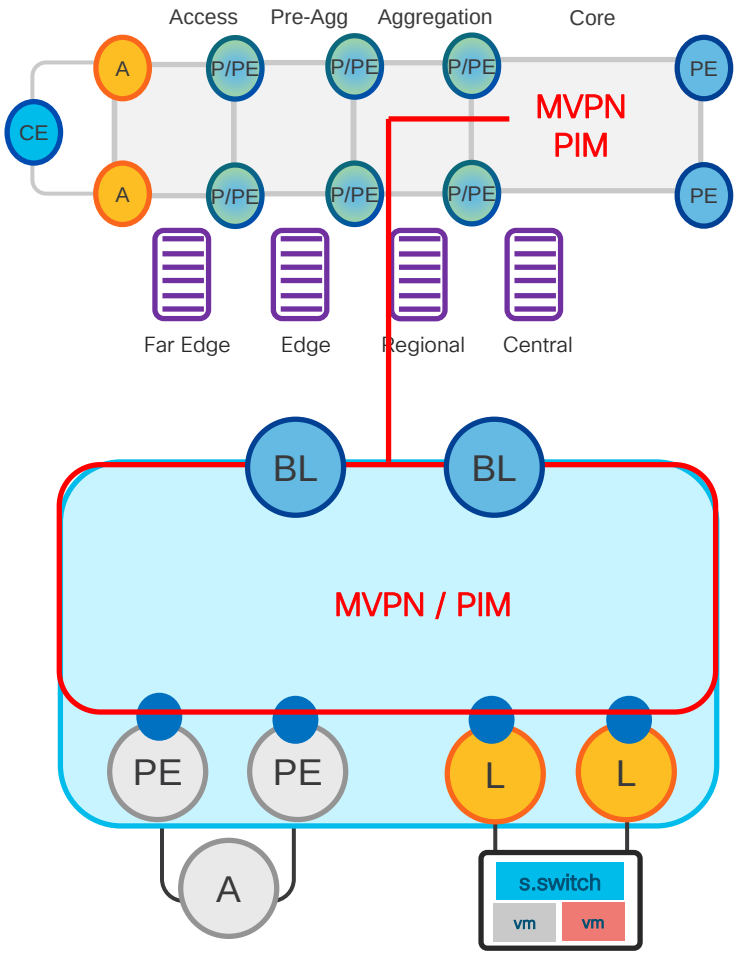
- Different data plane stitching
- Inter-DC communication
- L2/L3 to L2/L3 Interconnect
- EVPN enable Fabric
- Inter-Fabric Layer2
- Layer3
- Flood & Learn (VxLAN)



IRB

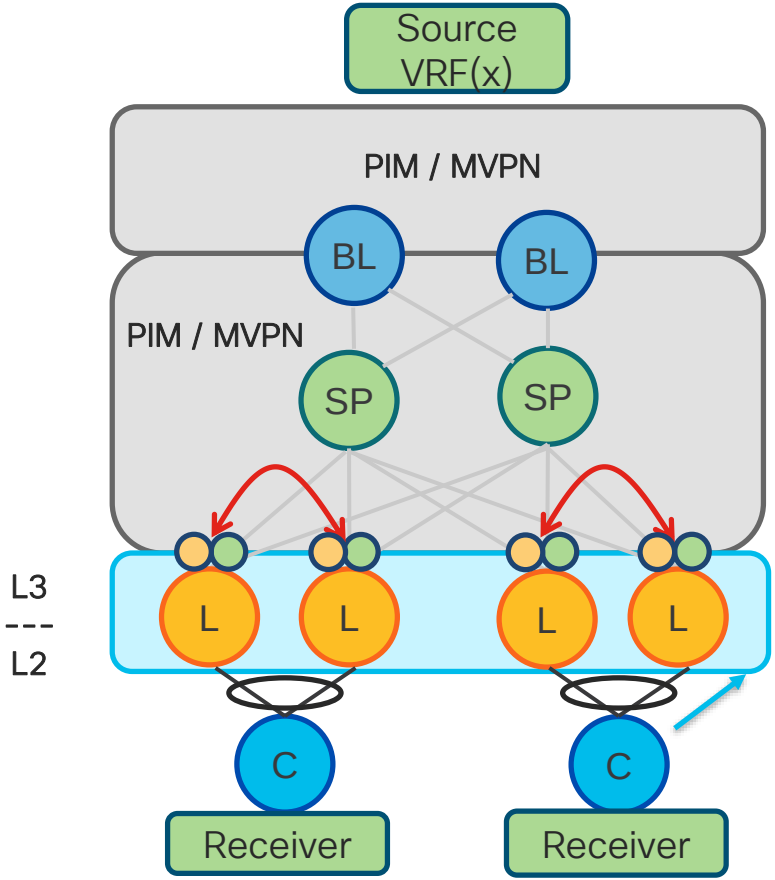
EVPN – Multicast

- Radio / Streaming Service
- Multicast Redundancy
- Multi-homing
- v4 / v6
- IGMP/MLD snooping sync
- IGMP/MLD sync
- Extranet
- “Intent-based” MVPN
  26 profiles



IRB

EVPN – Multicast
An Example



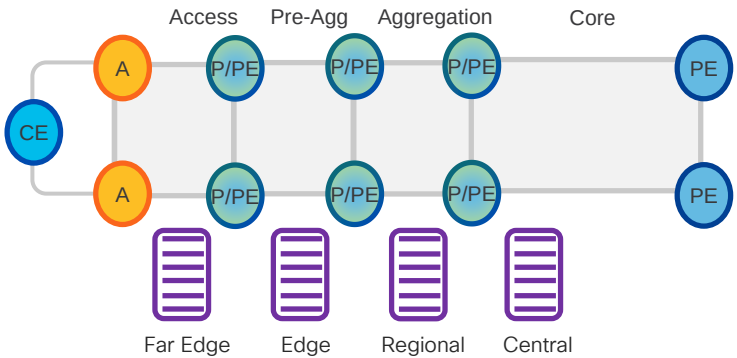
Join/Leave
Sync

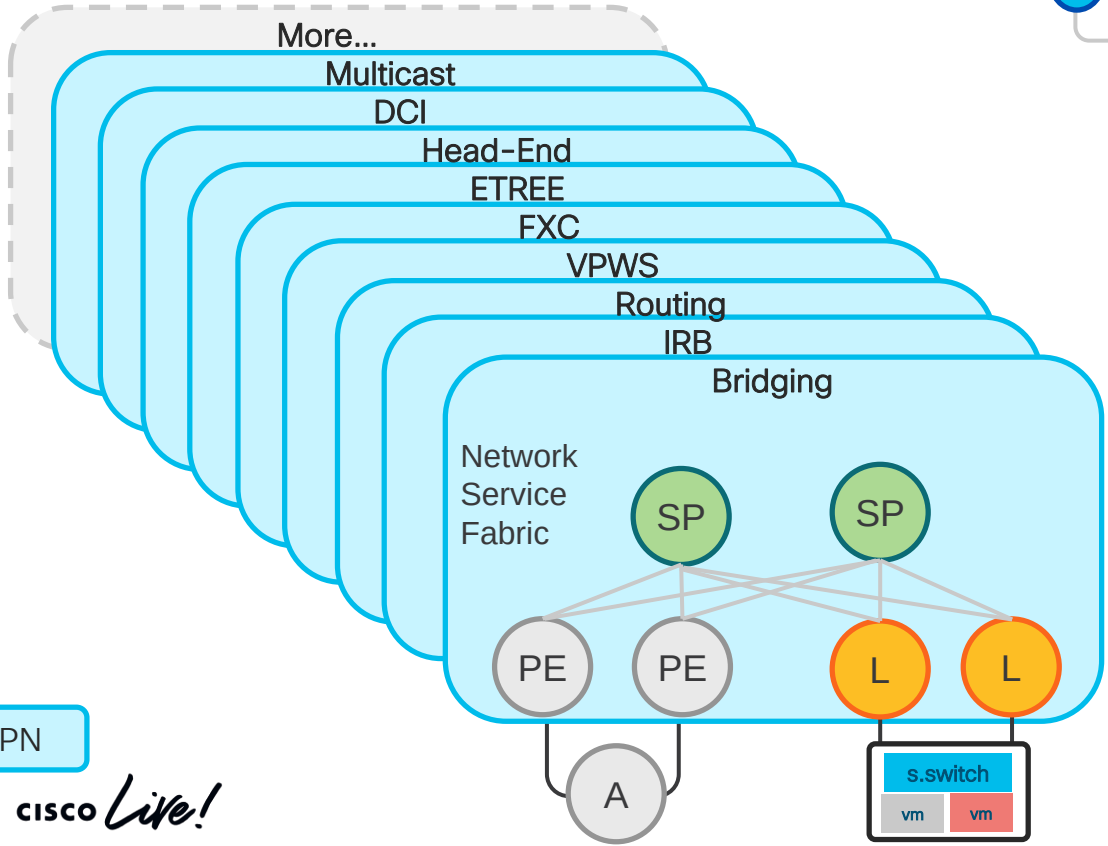
PIM / MVPN
EVPN

IRB-x
IRB-y

cisco Live!

Eco-System / Toolkit





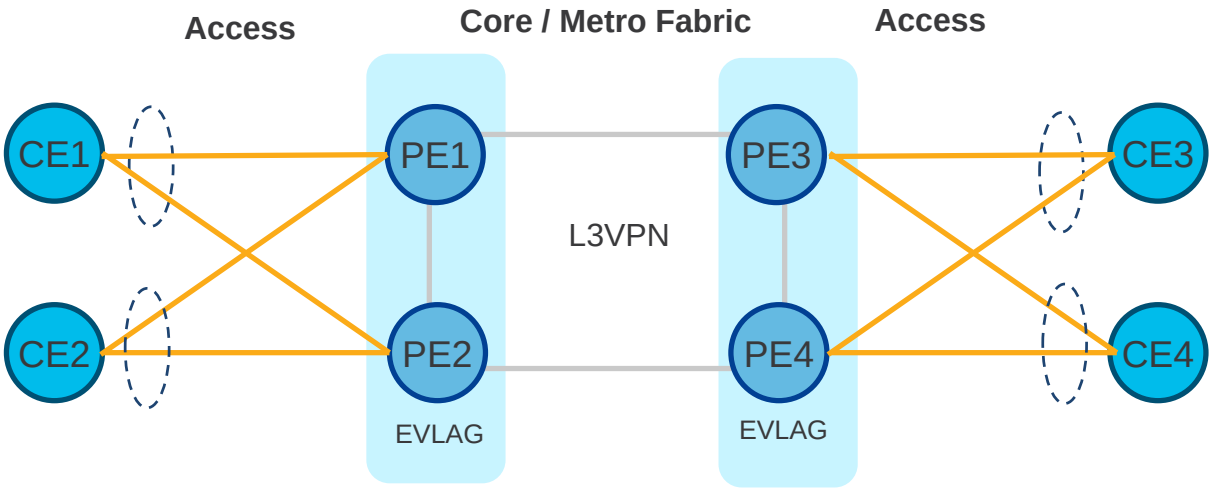
Telemetry

EVPN

cisco Live!

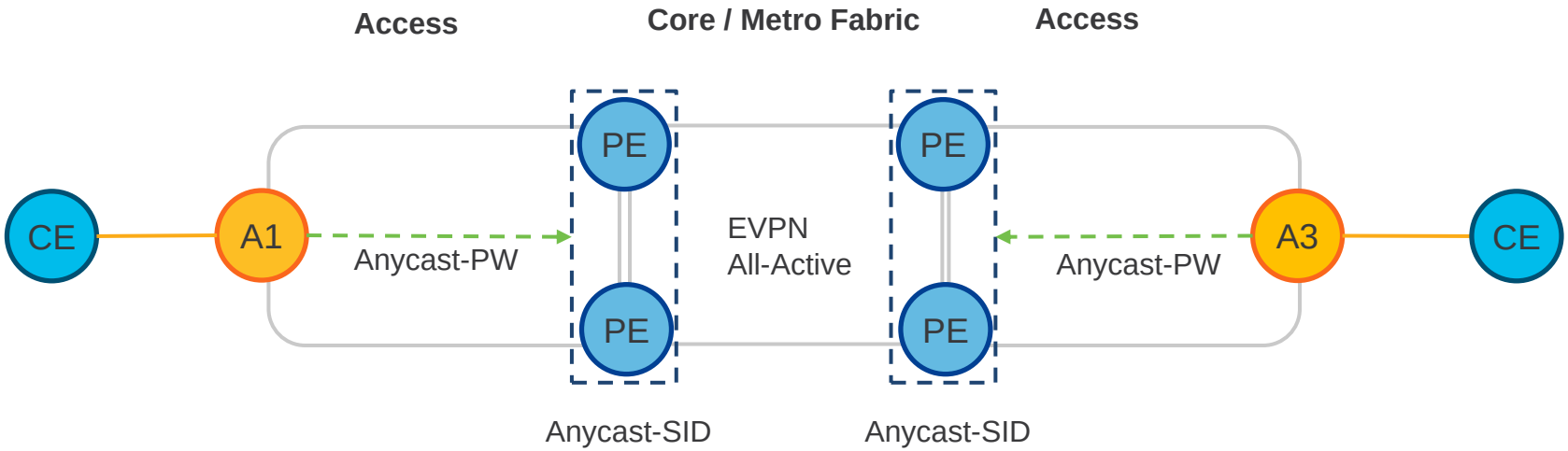
Access Use Cases

EVPN – L3 Multi-Homing using EVLAG

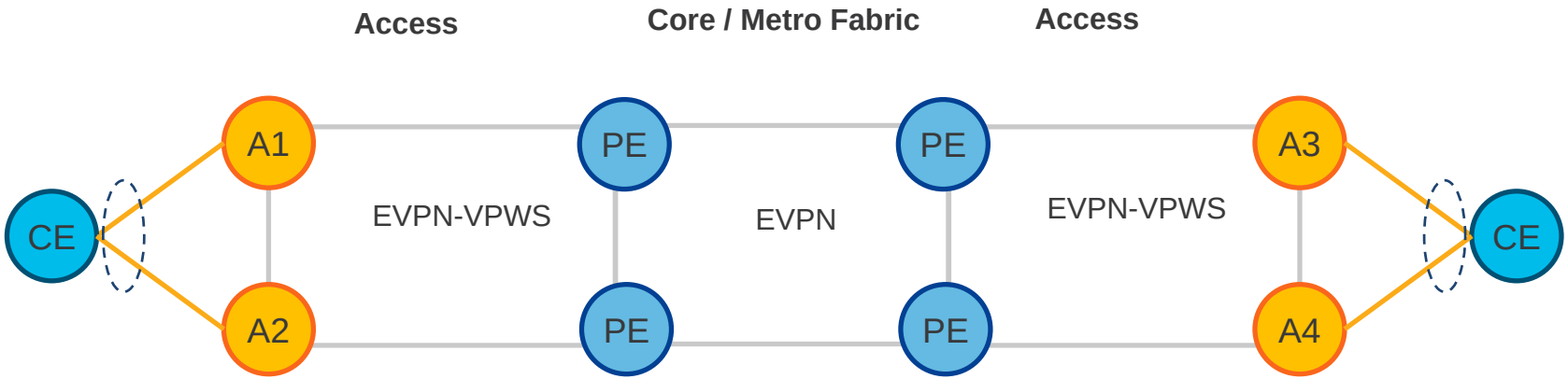


EVPN

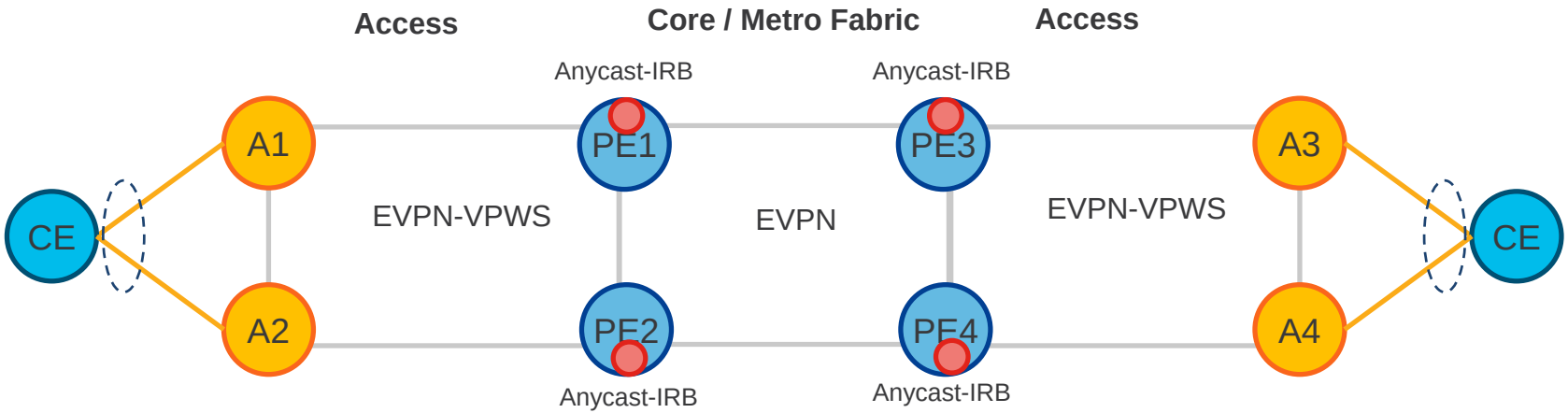
EVPN – Anycast-PW



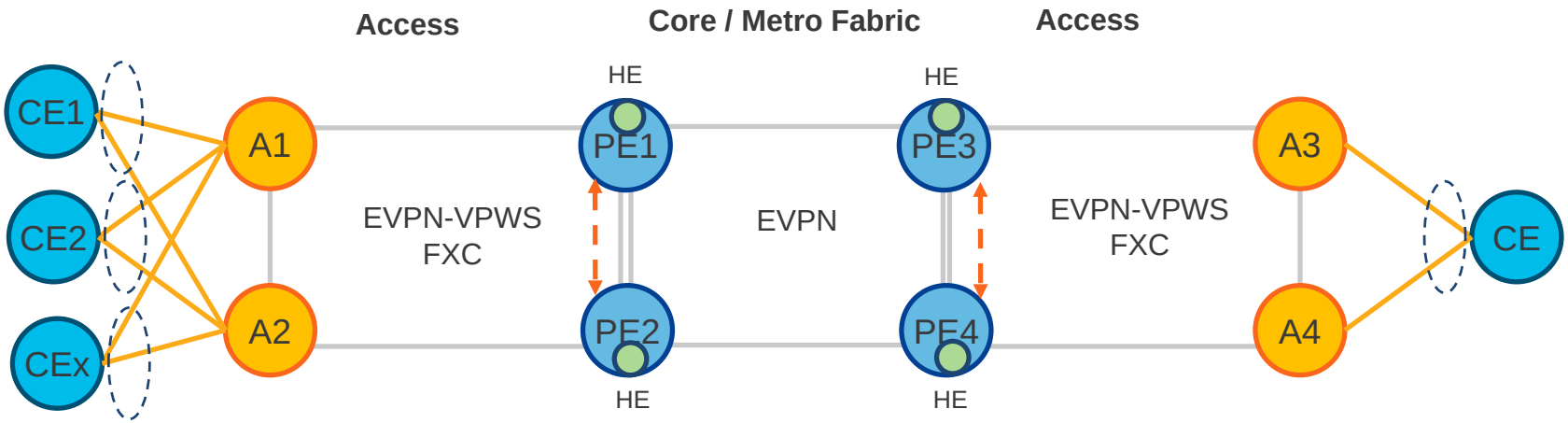
EVPN – Access VPWS



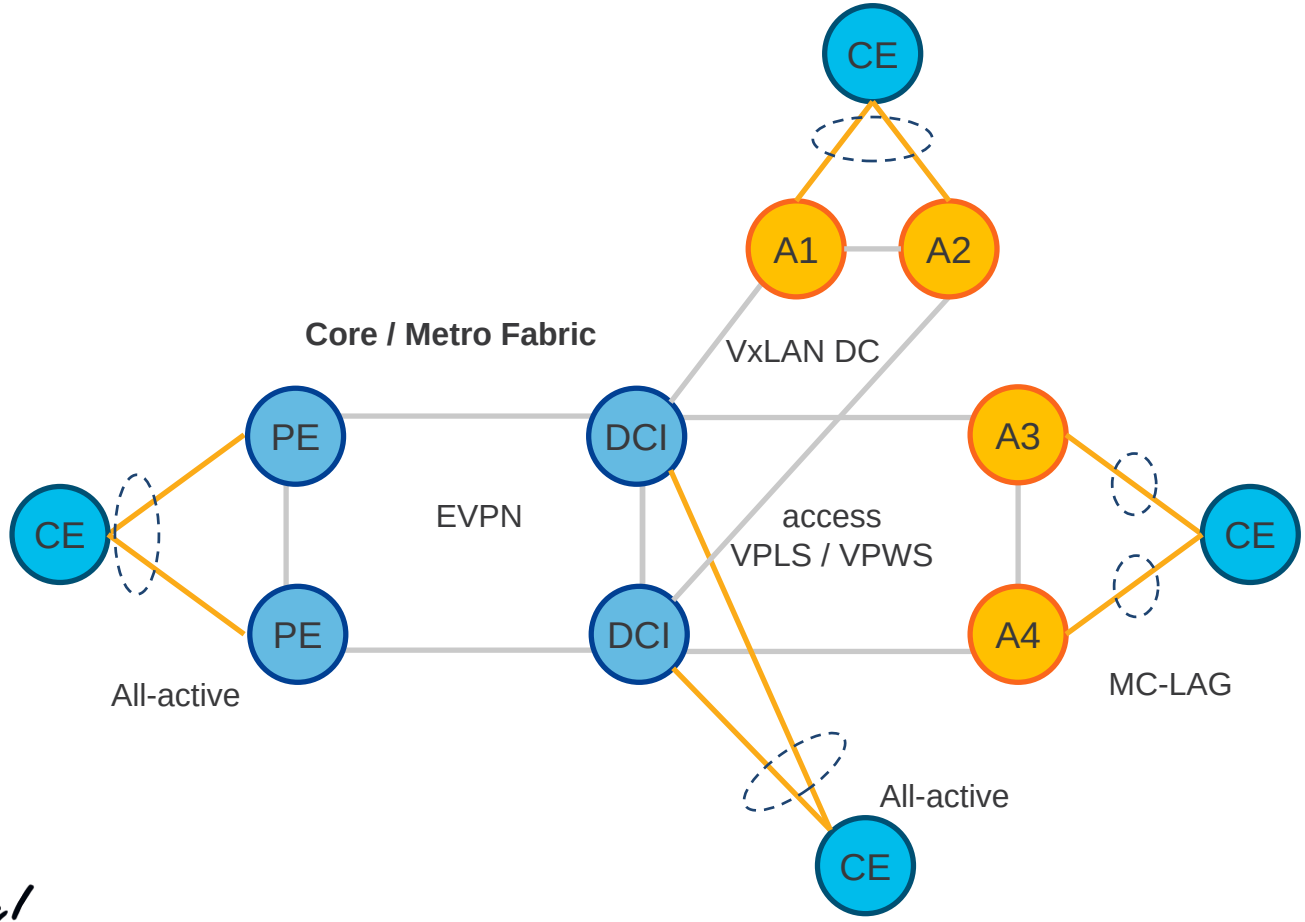
EVPN – IRB with Access VPWS



EVPN – HE with Access VPWS

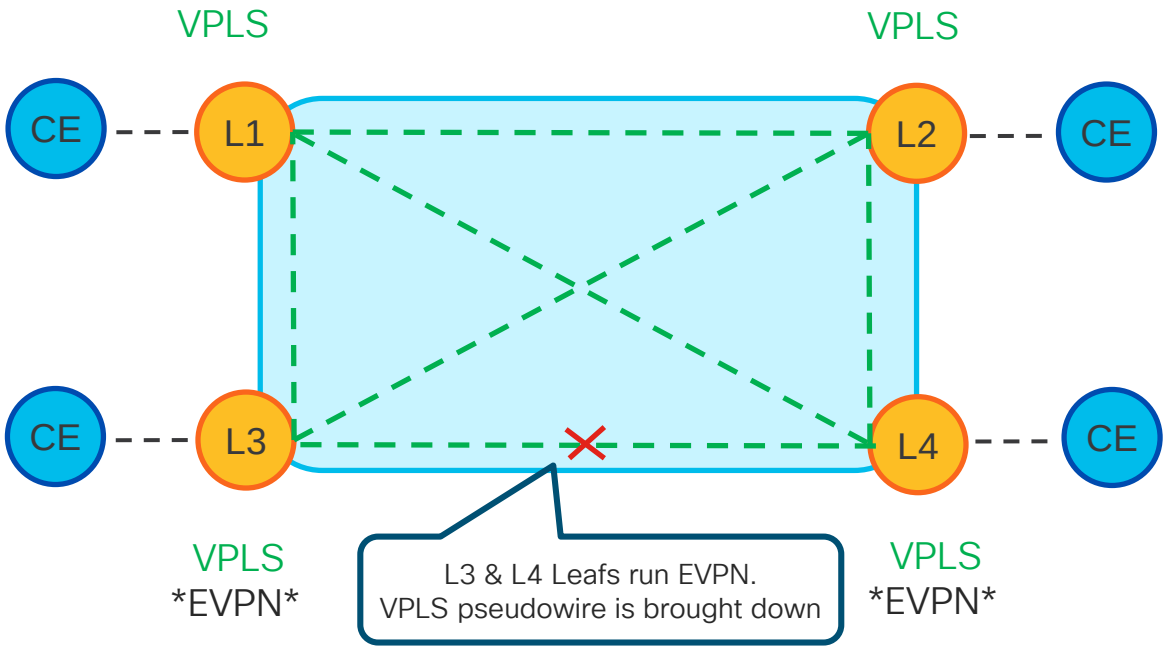


EVPN – Overlay Gateway

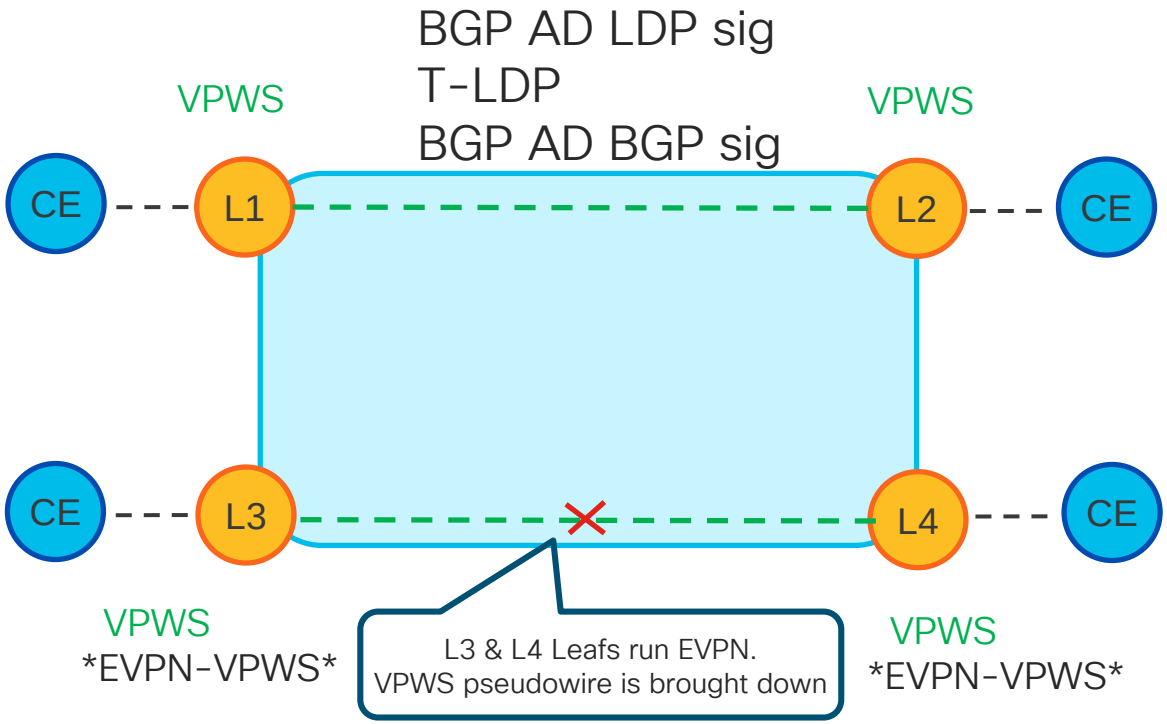


Legacy Network Migration

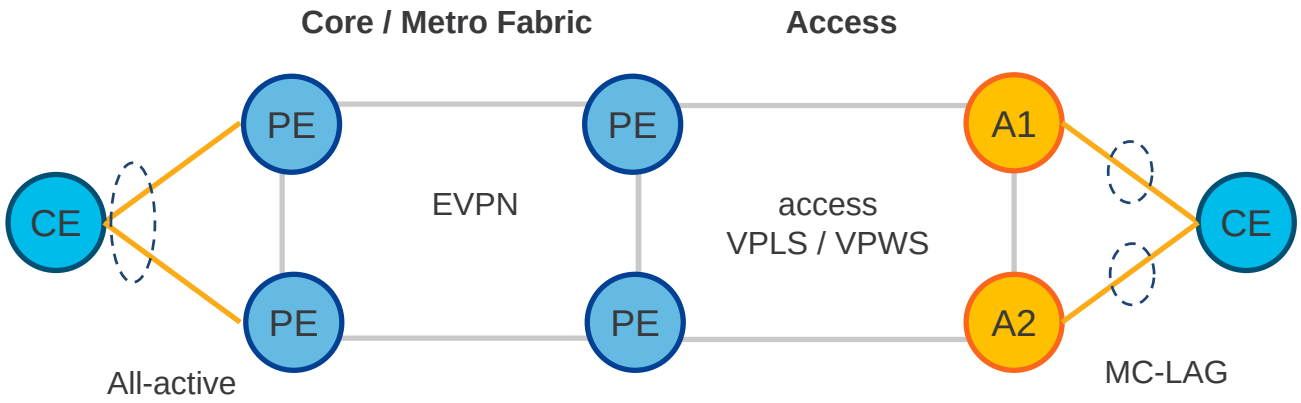
EVPN – VPLS Seamless Integration



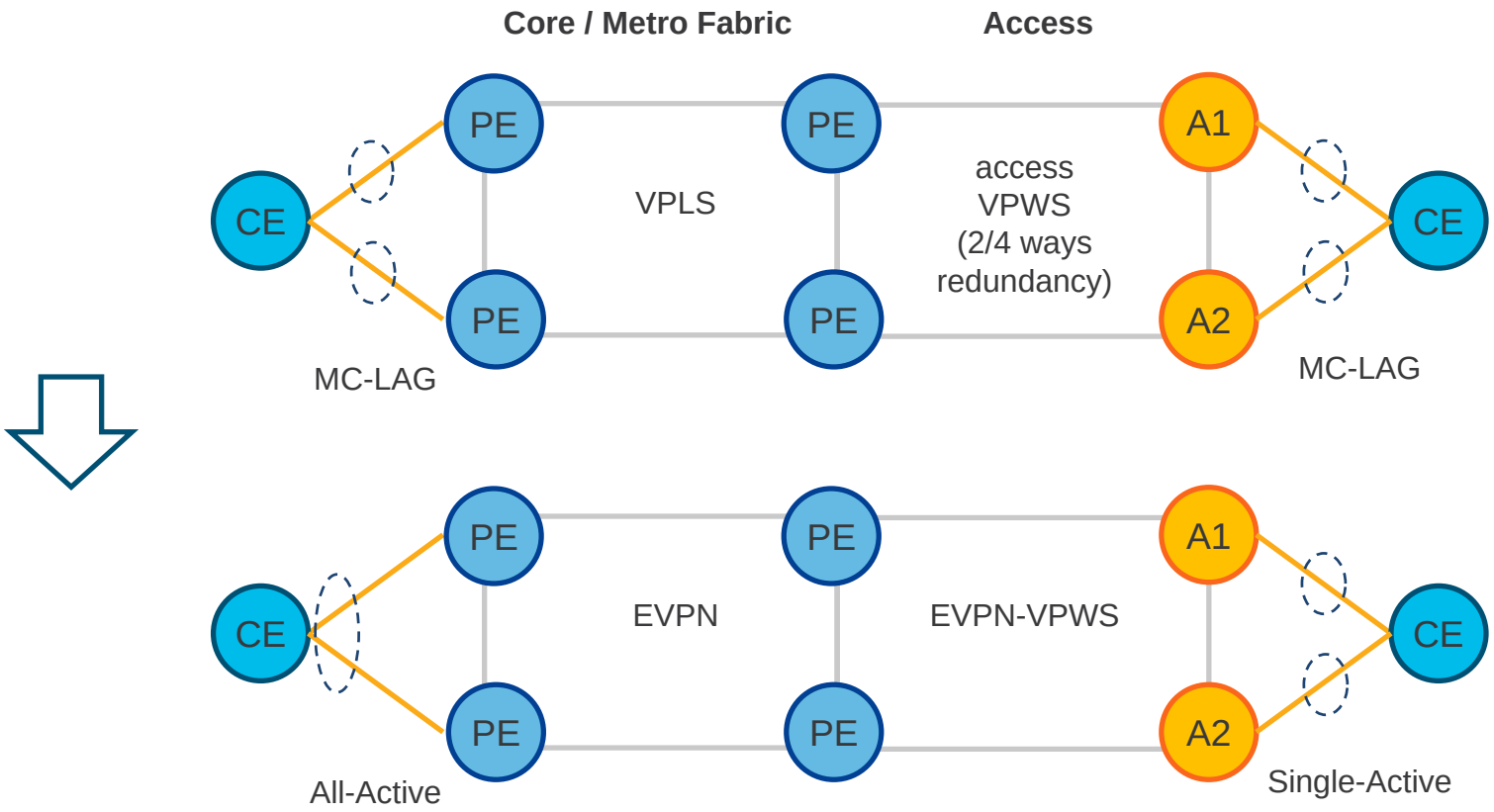
EVPN – VPWS seamless integration



EVPN – Access Legacy L2 to EVPN

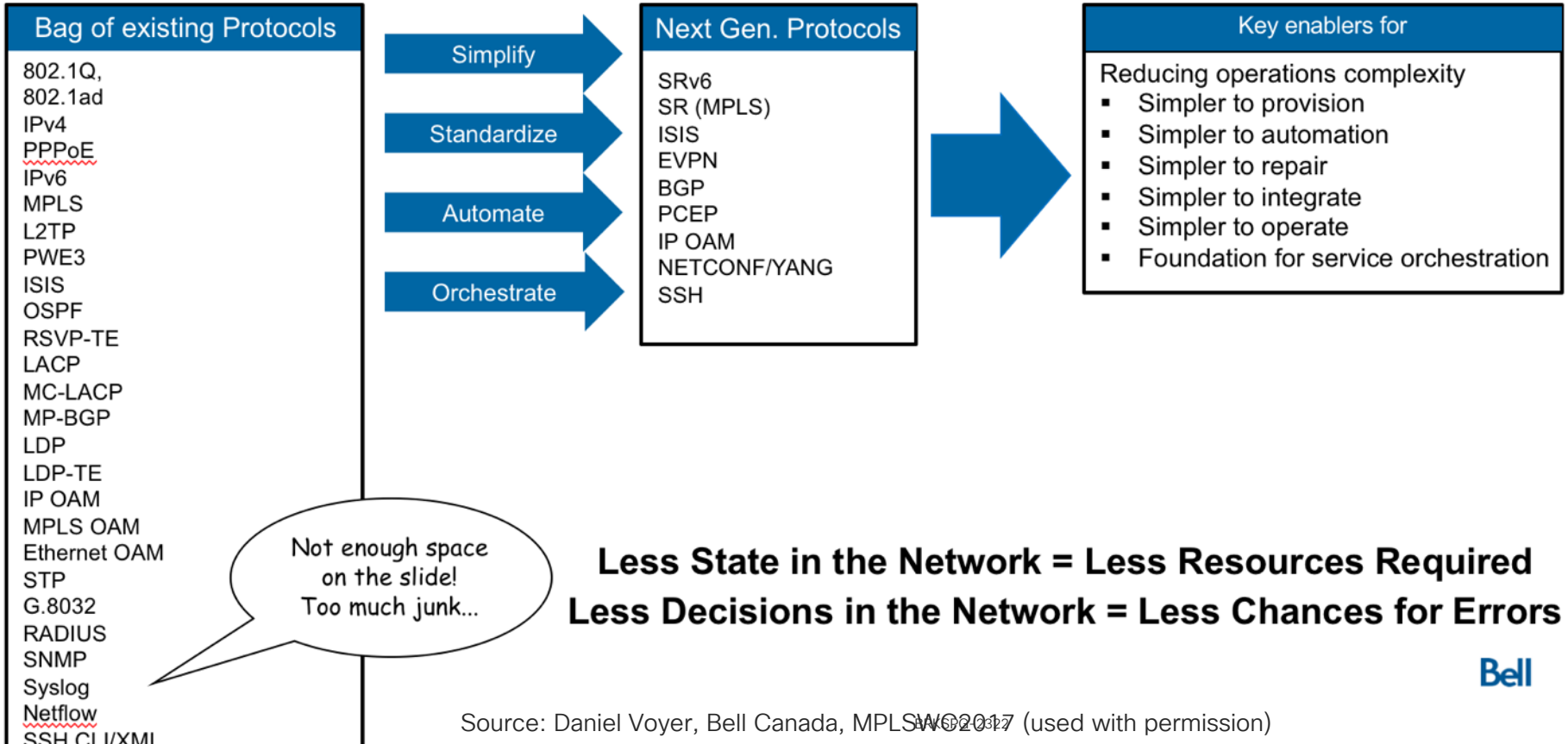


EVPN – Big Bang!



We believe in...

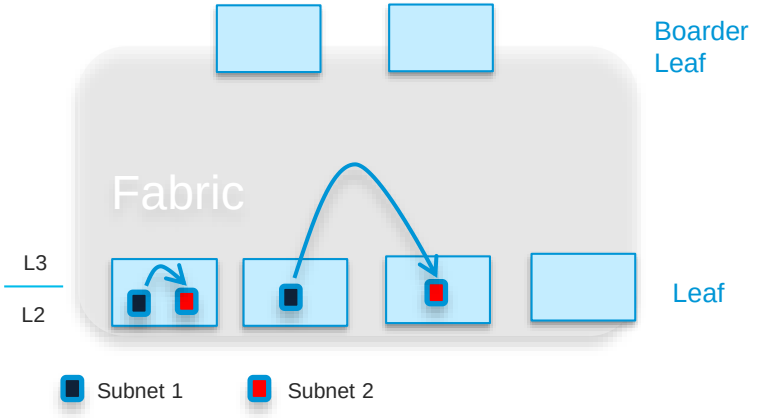
Architecture Change - Drastic Network Protocols Reduction @ Bell



Source: Daniel Voyer, Bell Canada, MPLS WG 2017 (used with permission)

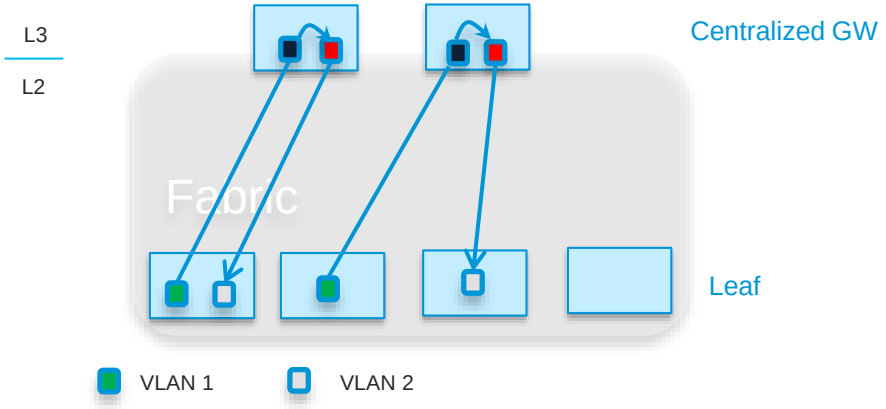
Centralized vs. Distributed Routing

Distributed Routing



- Optimized forwarding of east-west traffic
- ARP/MAC state localized to Leafs
- Helps with horizontal scaling of DC

Centralized Routing



- All east<->west routed traffic traverses to centralized gateways
- Centralized gateways have full ARP/MAC state in the DC
- Scale challenge

How to reach us?

dax@cisco.com
pbrisset@cisco.com
http://e-vpn.io

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You make **possible**

EXTRA

More Information (http://e-vpn.io)

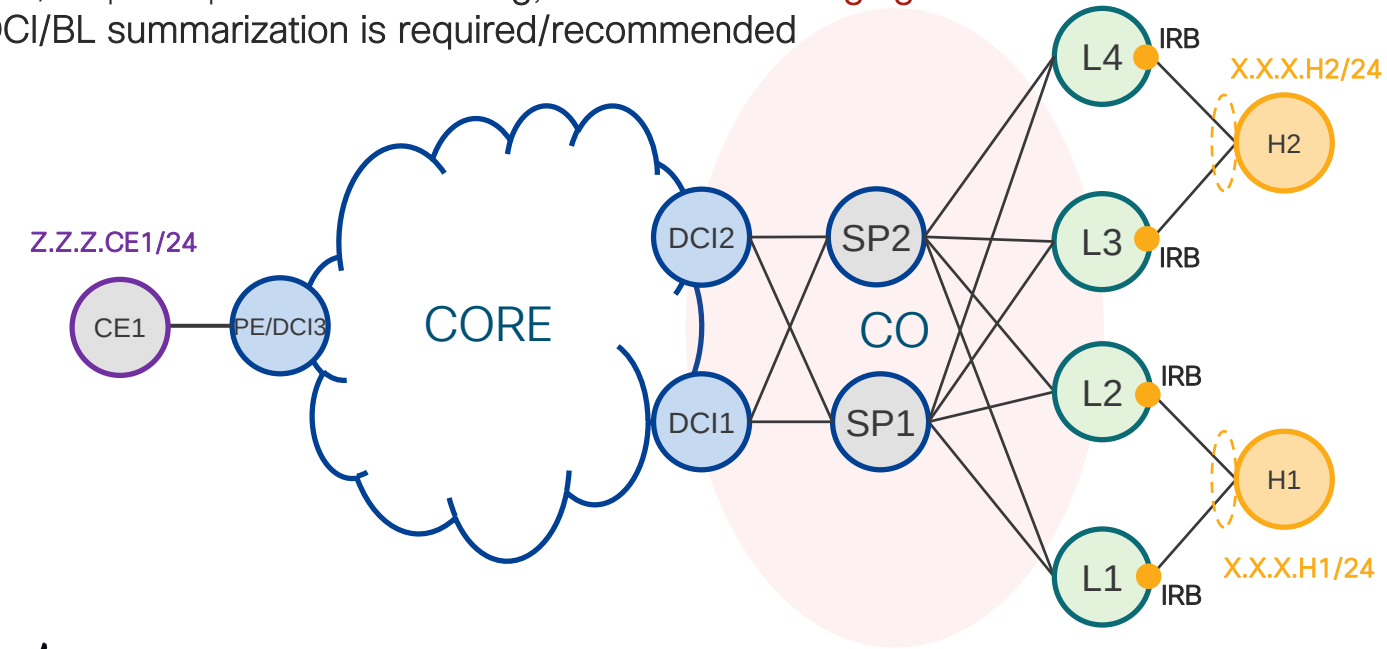
- RFC 7209: Requirements for Ethernet VPN
- RFC 7432: BGP MPLS-based Ethernet VPN
- RFC 8214: VPWS support in EVPN
- RFC 7623: PBB-EVPN
- RFC 8317: EVPN E-TREE
- draft-ietf-bess-evpn-overlay: NVO solutions for EVPN
- draft-ietf-bess-evpn-inter-subnet-forwarding: IRB in EVPN
- draft-ietf-bess-evpn-ip-prefix-advertisement: IP prefixes in EVPN

DCI and Network Fabric principles

BGP Layer3 Interconnect

Principles

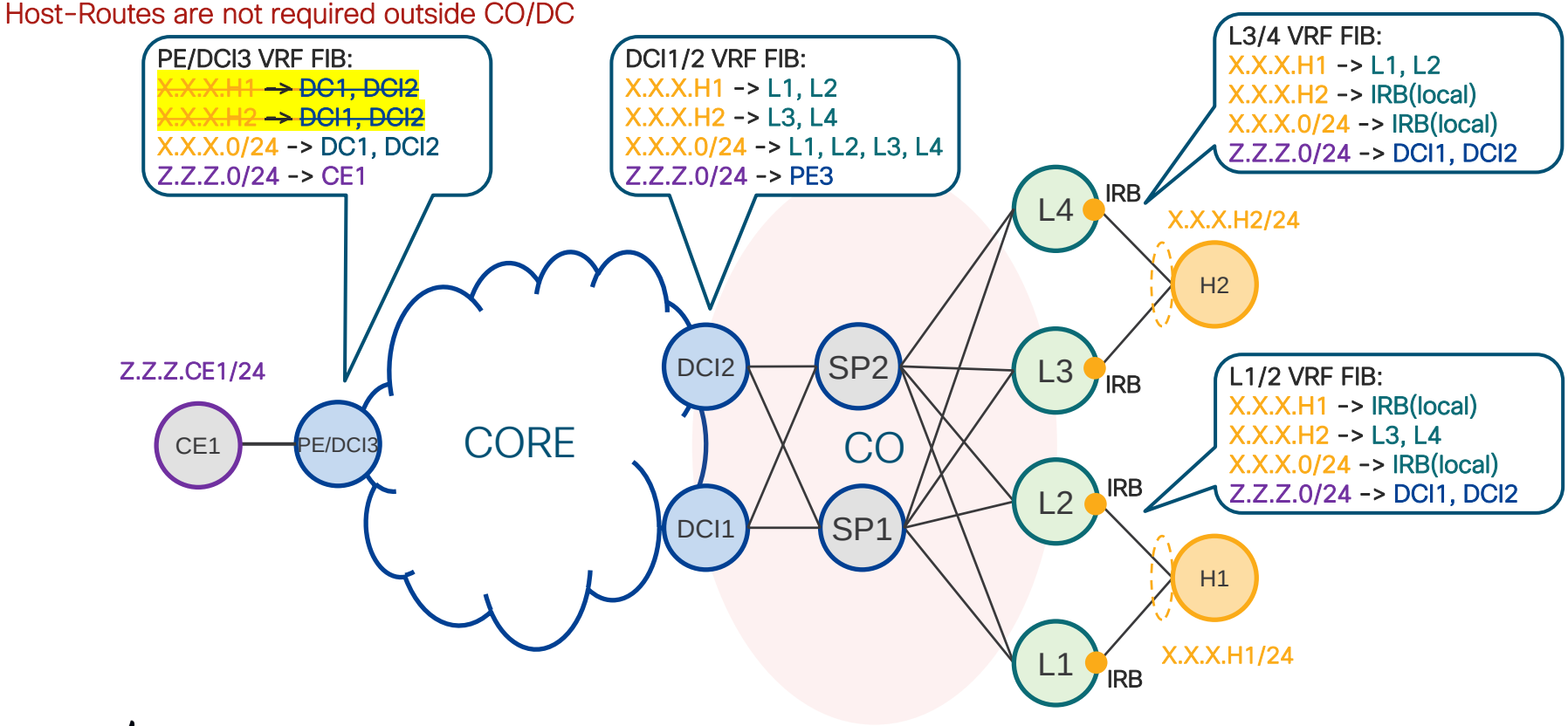
- DCI/BL provides Layer3 Interconnect
- DCI/BL participates in L3 Routing, but not in L2 Bridging
- DCI/BL summarization is required/recommended



BGP Layer3 Interconnect

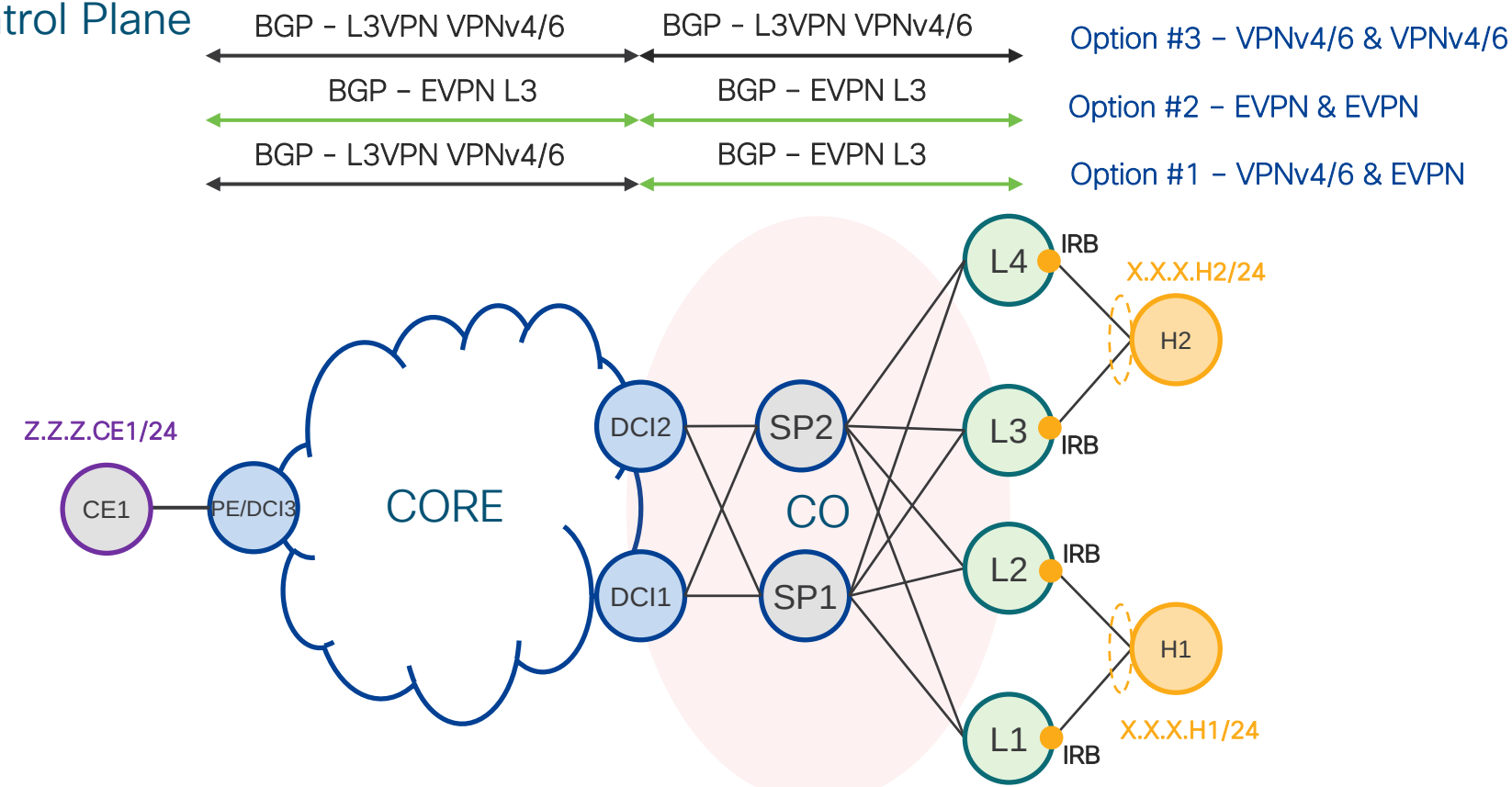
DCI/BL Summarization

Host-Routes are not required outside CO/DC



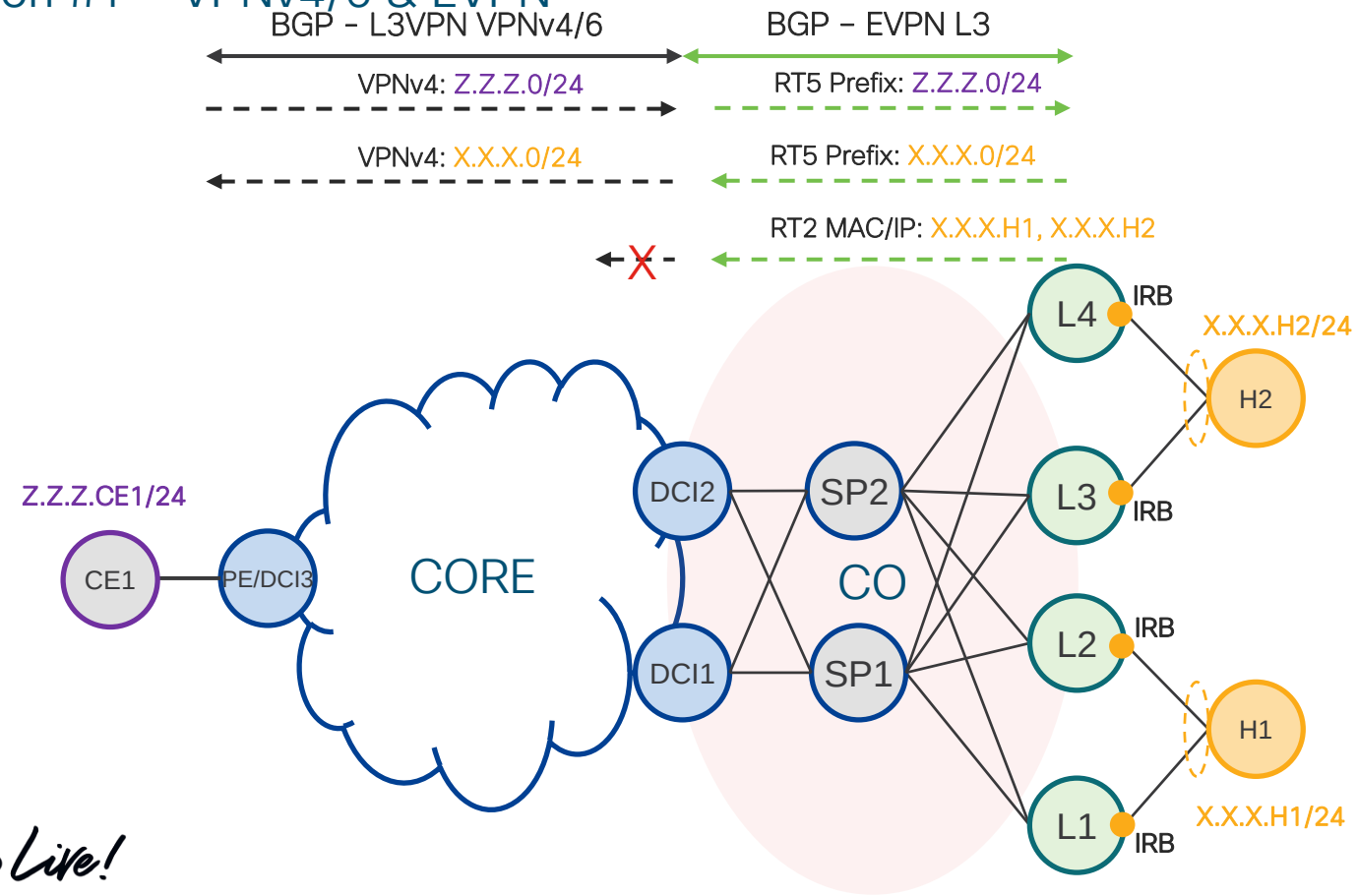
BGP Layer3 Interconnect

Control Plane



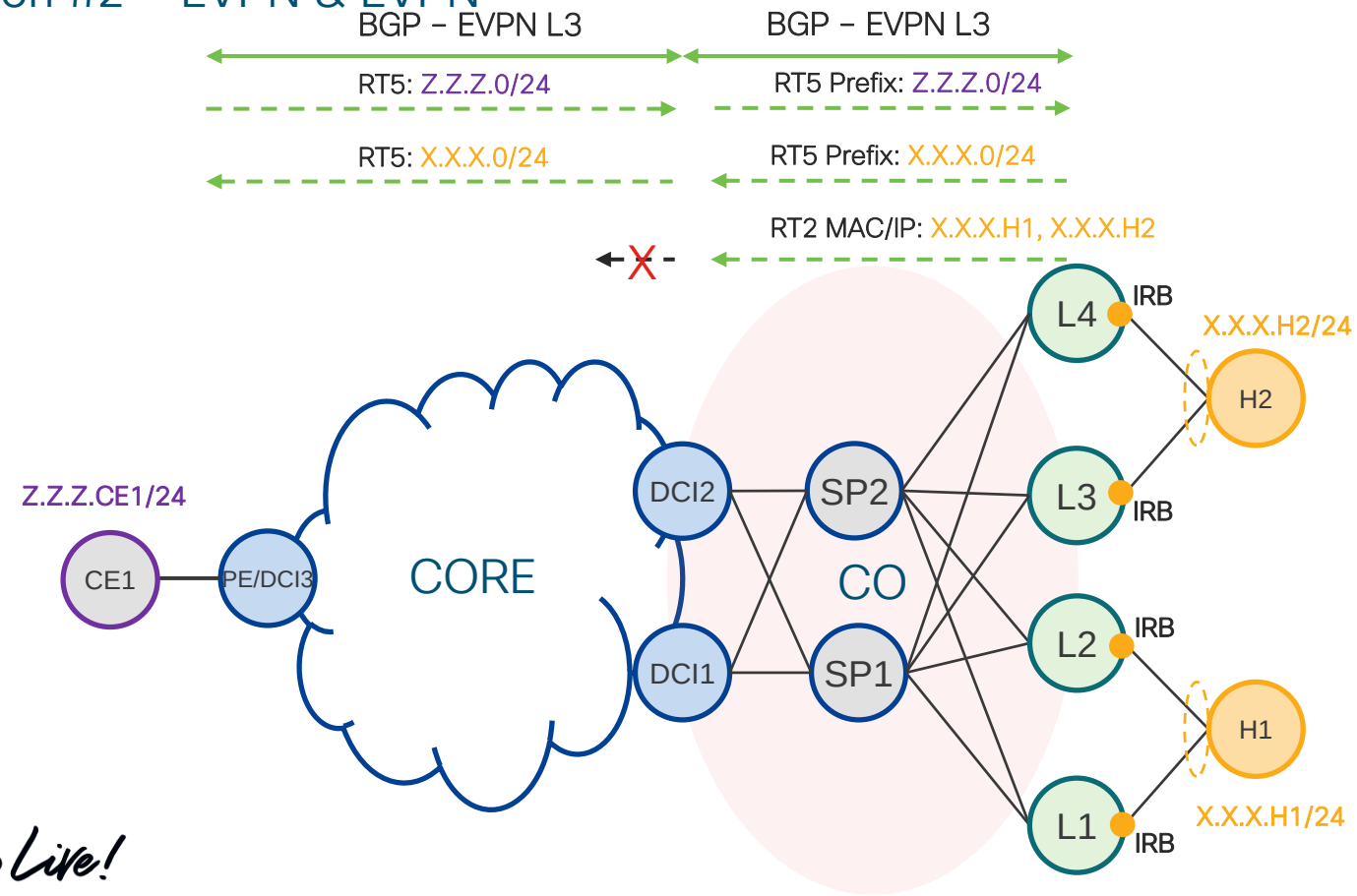
BGP Layer3 Interconnect

Option #1 – VPNv4/6 & EVPN



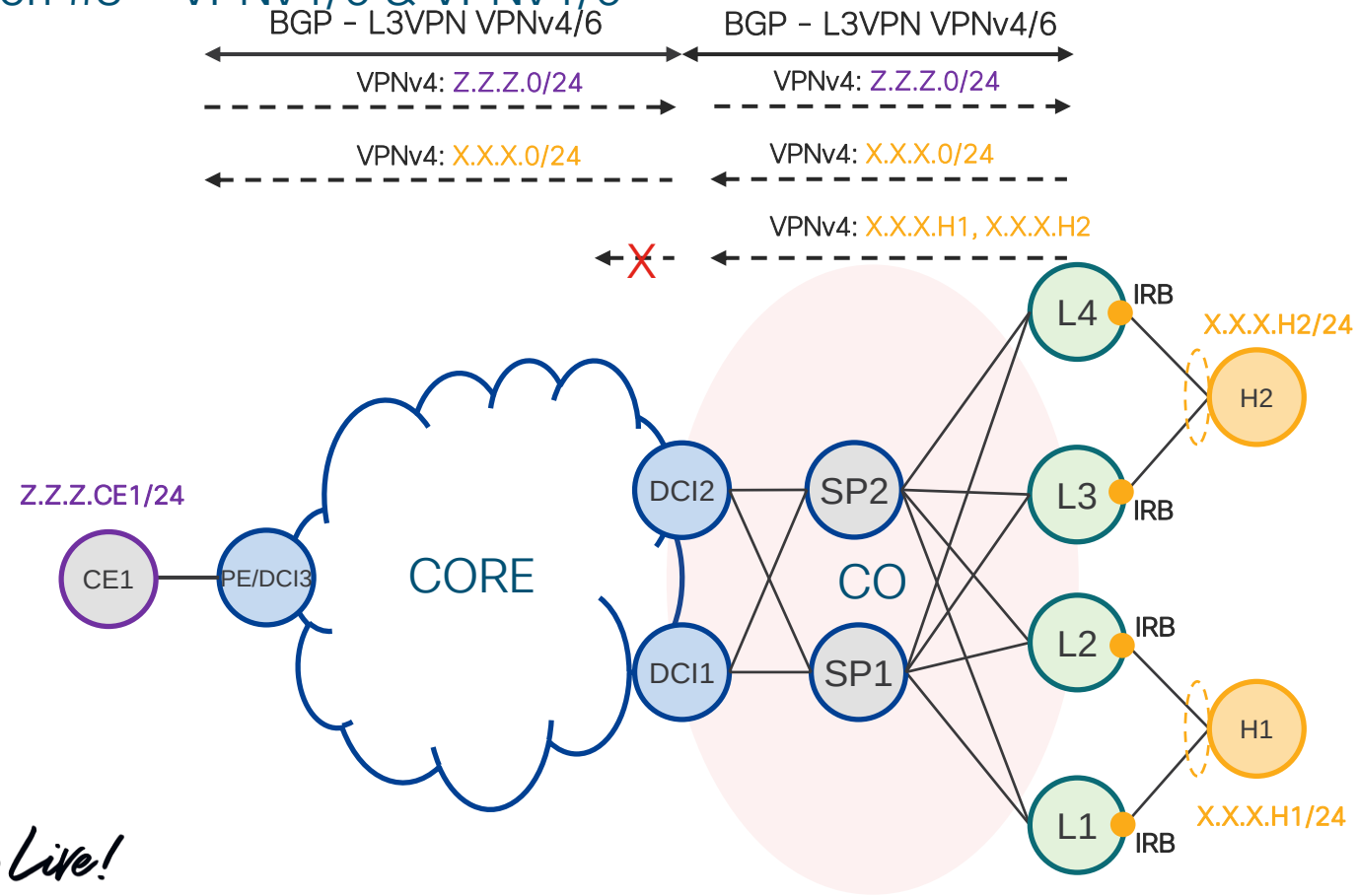
BGP Layer3 Interconnect

Option #2 – EVPN & EVPN



BGP Layer3 Interconnect

Option #3 – VPNv4/6 & VPNv4/6



BGP Layer3 Interconnect

Control Plane Options Highlight

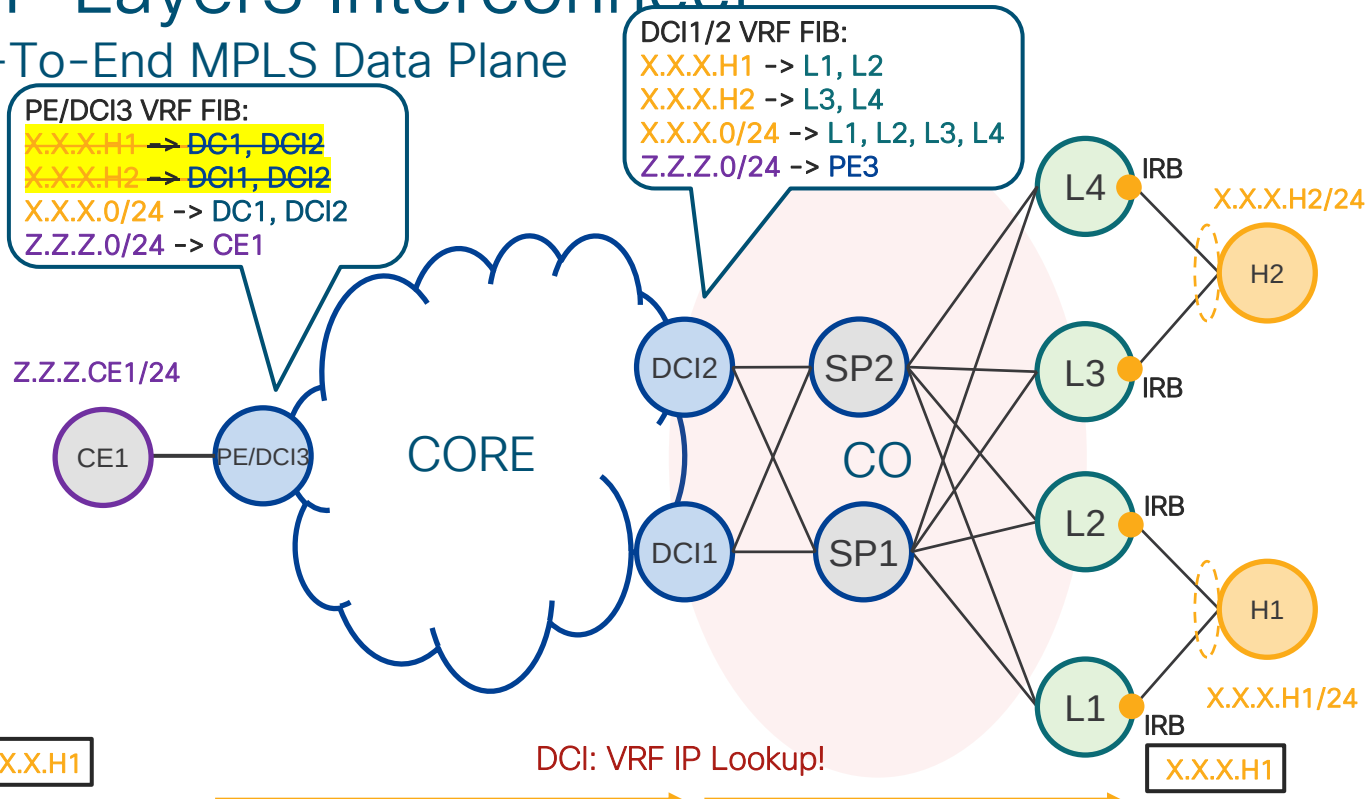
- Option #3 – VPNv4/6 & VPNv4/6
  - + VPNv4/6 Industry proofed solution for Layer3 VPN
  - + DCI doesn't need to understand BGP EVPN AF
  - - Leaf has to peer with Route-Reflector via both BGP EVPN and VPNv4/6 AF
    - EVPN AF to support L2 stretch (MAC advertisement) across DC/CO between Leaves
    - 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 #1 – VPNv4/6 & EVPN
  - + Recommended solution which benefits from both Options #2 and #3
  - + New DC/CO - Leaf, Route-Reflector use single BGP AF EVPN
  - + Existing L3 VPNv4/6 services stay untouched

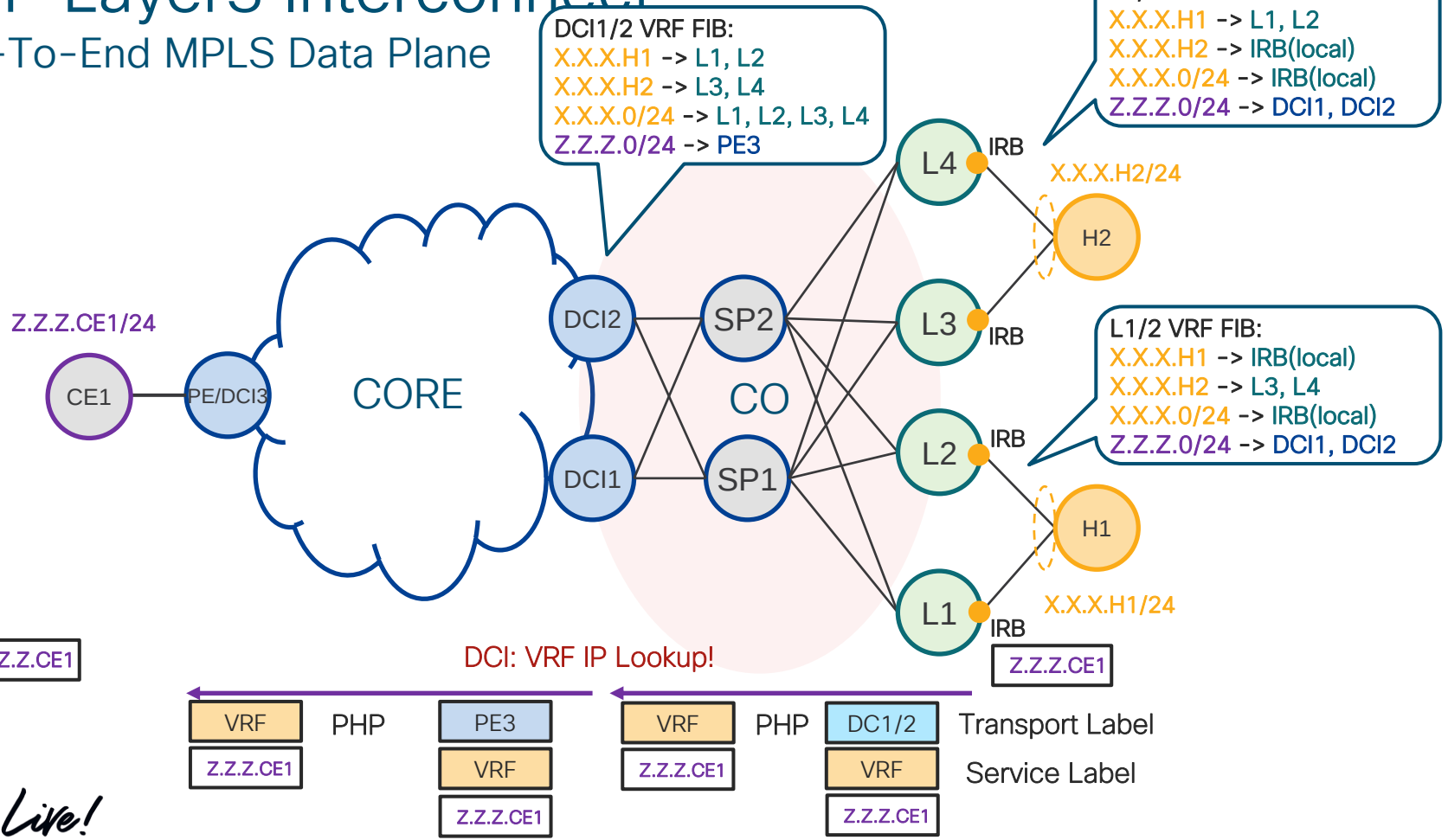
BGP Layer3 Interconnect

End-To-End MPLS Data Plane



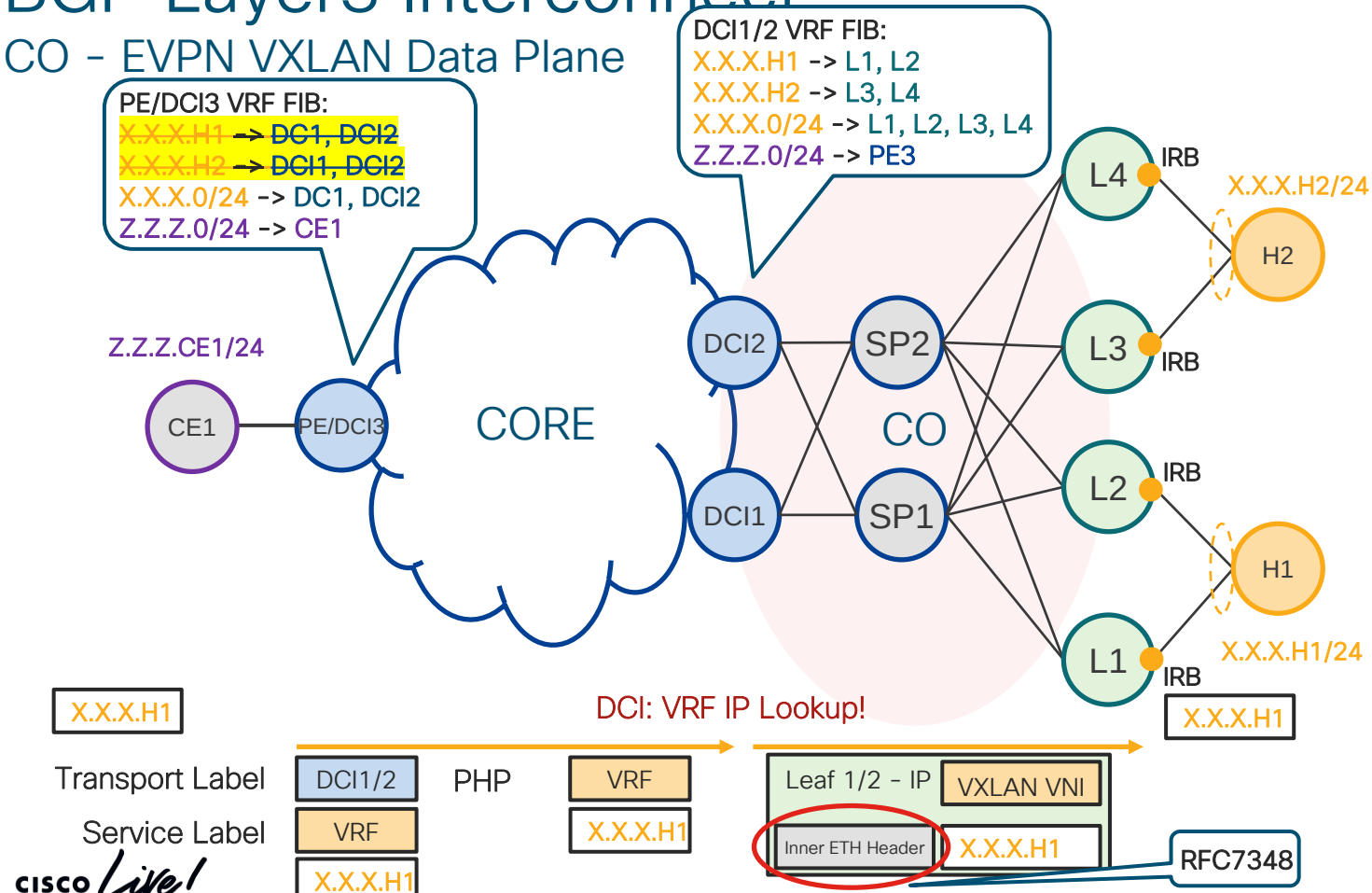
BGP Layer3 Interconnect

End-To-End MPLS Data Plane



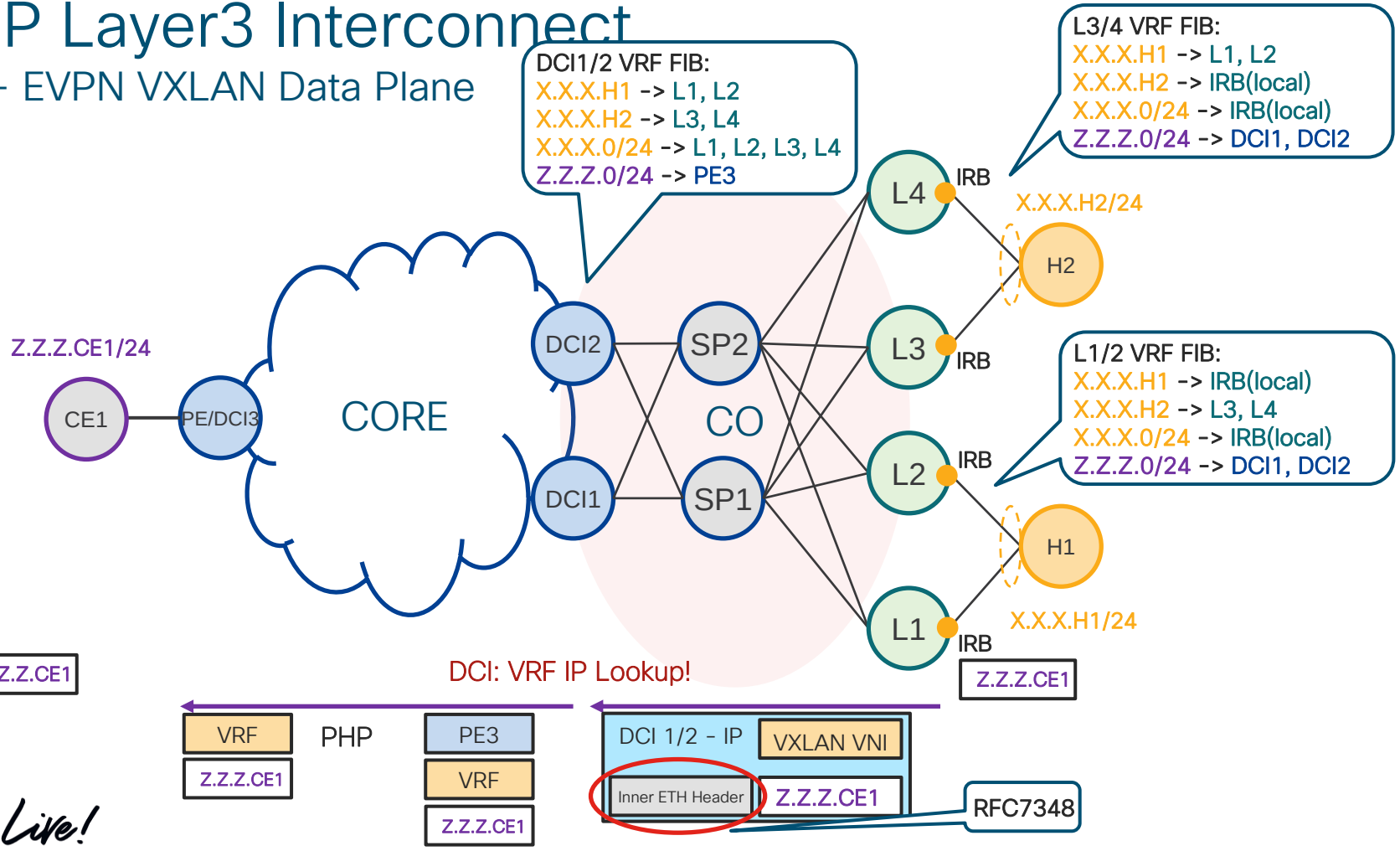
BGP Layer3 Interconnect

CO - EVPN VXLAN Data Plane



BGP Layer3 Interconnect

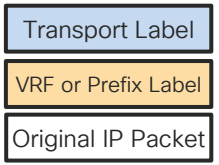
CO - EVPN VXLAN Data Plane



BGP Layer3 Interconnect

Data Plane Highlight

BGP L3 EVPN or VPNv4/6 MPLS Packet



- MPLS Data Plane
  - + Independent on BGP VPNv4/6 or EVPN Control Plane => Packet is identical
    - Less Complexity, Simple Troubleshooting
  - + MPLS Load-Balancing (ECMP) by Inner IP Header Lookup

- VXLAN Data Plane – RFC7348
  - - RFC7348 requires Inner Ethernet encapsulation => Unnecessary overhead for L3 Forwarding

  - - 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

You make **possible**