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The bridge to possible

Converged SDN Architecture for Programmable Transport with SR-EVPN Fabric

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BRKSPG-2701



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Converged SDN Transport Architecture

Key Building blocks



Consumer
Services

Mobility

IoT

Enterprise VPNs (B2B) Residential Services (B2C)



Orchestration
& Control

Cisco Crosswork and Segment Routing PCE



Network
Services

Ethernet VPN (EVPN) and L3VPN



Programmable
Transport

Programmable SR Fabric

Segment Routing (SR MPLS / SRv6) & SR PM

Why Programmable Transport with SR/EVPN?

Building the Next Gen Transport Fabric

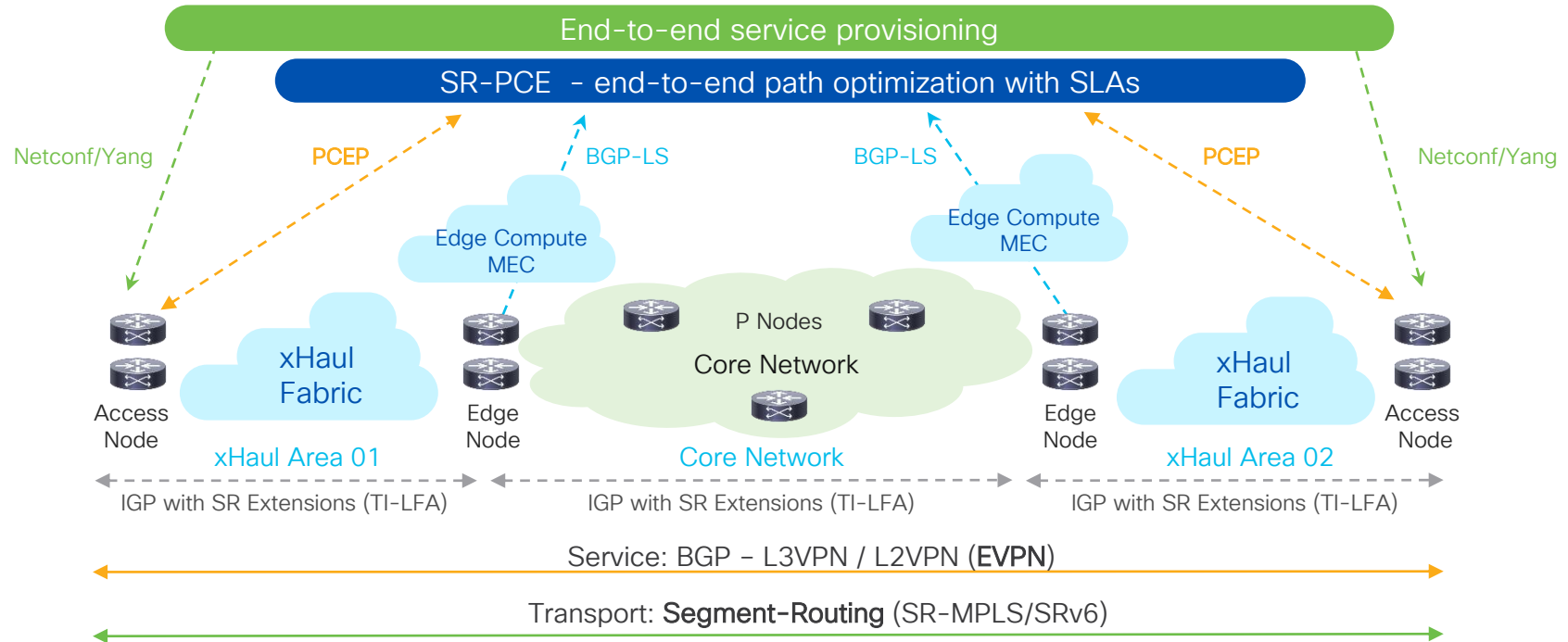
Segment Routing Underlay

- Transport Simplification
- Programmability with Source Routing
- SDN based Control
- SLA Based Traffic Steering (SRTE, Flex-Algo) with Performance Monitoring
- Topology independent Fast Re-route

EVPN Overlay

- Unified Service Control Plane with BGP
- Integrated Layer 2 & Layer 3 VPN Services
- L3VPN like principles and operational experience for scale & control
- Unified Service Plane across domains – Transport & Datacenter
- Efficiency with Optimized Broadcast & Unknown-unicast

Converged SDN Transport Architecture





Agenda

- SR-EVPN Basics
- SR-EVPN Fabric Design Considerations
- Case Study : Legacy MPLS to SR-EVPN Fabric
- Key Takeaways

SR-EVPN Basics



Transport Fabric Evolution

Centralized Management, Leaner & Highly Scalable

Unified MPLS



Services

Transport

MP-BGP
LDP
BGP-L3
RSVP
LDP
IGP
MPLS

- Operational complexity
- Integrated HW & SW
- Limited data plane scaling

MPLS SR with controller



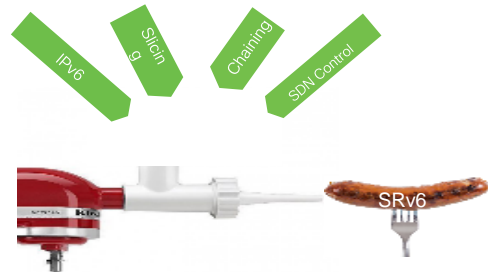
Services

Transport

MP-BGP	SDN
IGP/SR	
MPLS	

- Leaner & optimised routing
- Centralised orchestration
- Distributed control plane
- Limited data plane scaling

SRv6



Services

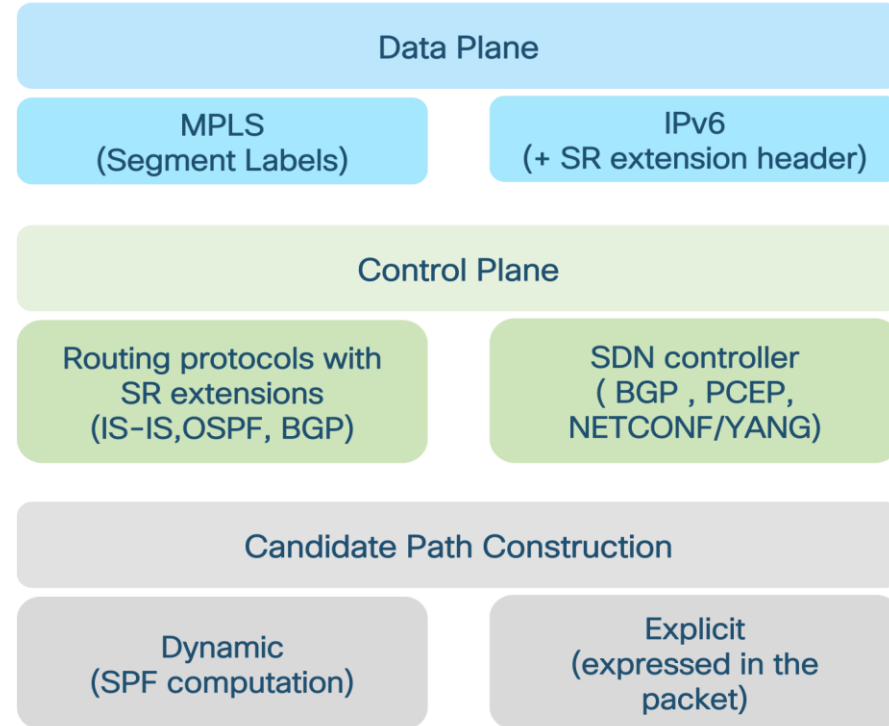
Transport

MP-BGP	SDN
IGP/SR	
IPv6	

- All of SR-MPLS features plus
- Massive data plane scaling
- Programmable control plane
- Service chaining

Segment Routing Basics

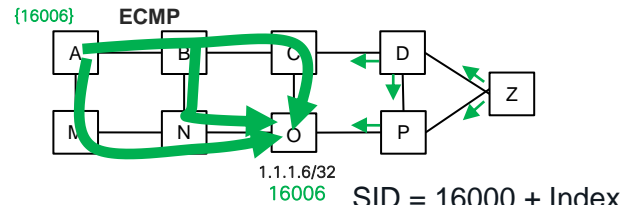
- **Source Routing**: the source chooses a path and encodes it in the packet header as an ordered list of segments
- **Segment**: an identifier for any type of instruction
 - Service
 - Context
 - Locator
 - **IGP-based forwarding construct**
 - BGP-based forwarding construct
 - Local value or Global Index



Segment Routing – Segments

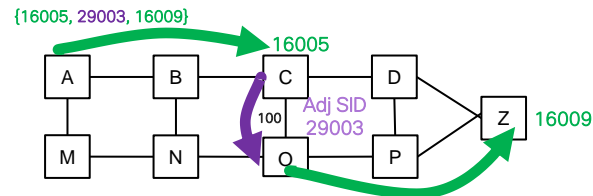
- IGP-Prefix Segment, Prefix SID

- IGP Prefix Segment depicts an ECMP-aware **path to an IGP Prefix**. Every router is identifiable by a unique Prefix SID in the network. **SID label value allocated from user-managed SR Global Block (SRGB – Default range: 16,000 – 23,999)**



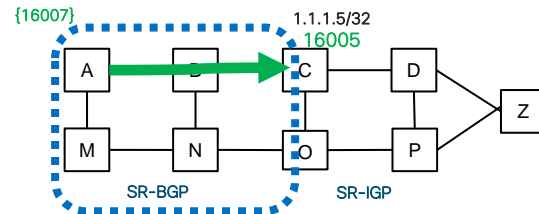
- IGP-Adjacency Segments, Adjacency SID

- IGP Adjacency Segment represents **a specific L3 adjacency on a router**, such as egress interface, to a neighbouring router. Steers the traffic to a specific adjacency



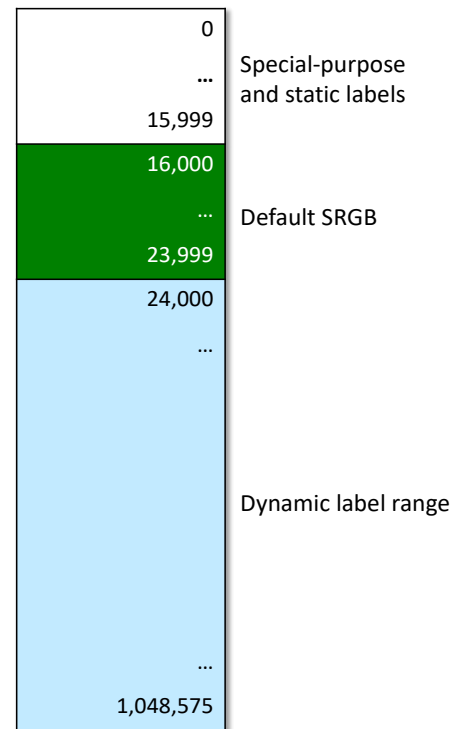
- BGP-Prefix Segment, BGP Prefix ID

- BGP Prefix Segment depicts a **path to a BGP Prefix**. It is unique within an SR domain. BGP has been extended to carry segment routing SID. It is an ECMP aware segment

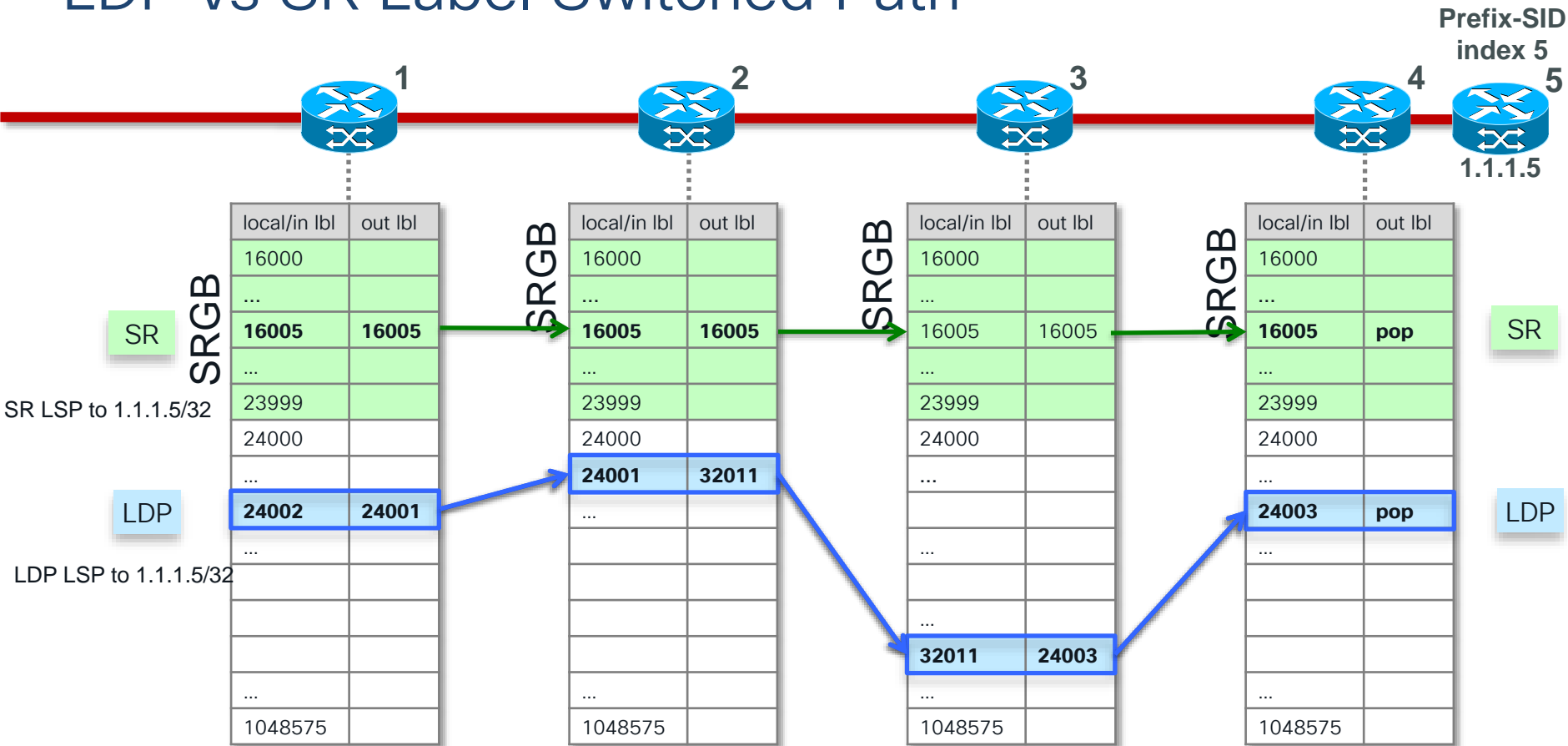


SR Global Block (SRGB) Allocation

- Global Segments always distributed as a label range (SRGB) + Index
- Index must be unique in Segment Routing Domain
- Default SRGB: 16,000 – 23,999
- Label space carving of [Segment Routing capable](#) software release (even if Segment Routing is not enabled) :
 - Label range [0-15] reserved for special-purposes
 - Label range [16-15,999] reserved for static MPLS labels
 - Label range [16,000-23,999] preserved for SRGB
 - Label range [24,000-max] used for dynamic label allocation

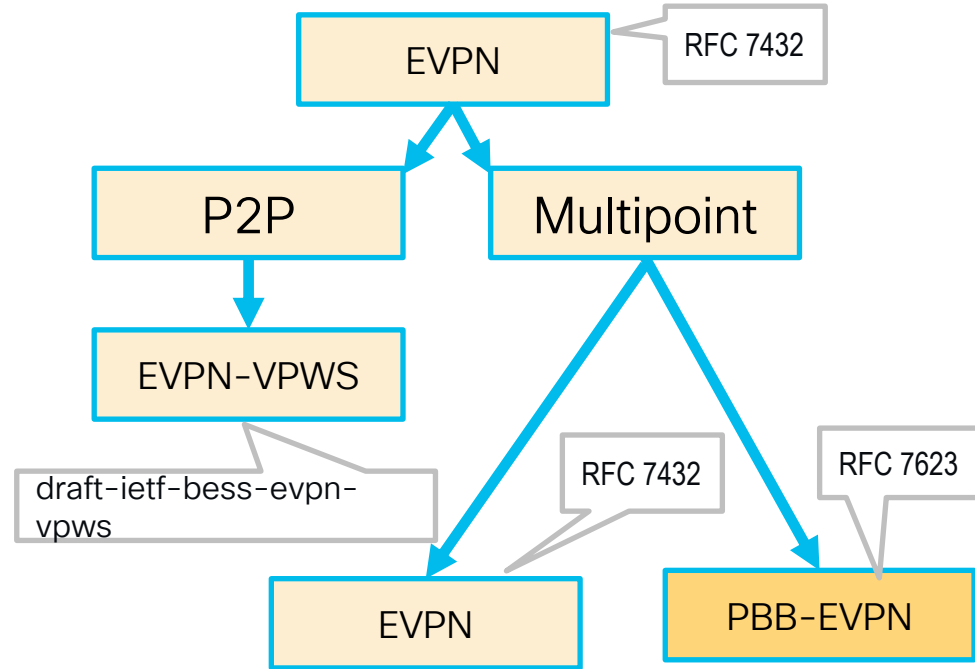


LDP vs SR Label Switched Path



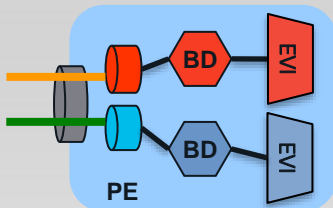
EVPN Basics

- Next generation solutions for Ethernet services
 - BGP control-plane for Ethernet Segment and MAC distribution and learning over MPLS core
 - Same principles and operational experience of IP VPNs
- No use of Pseudo wires
- Multi-Vendor Solution



EVPN Concepts

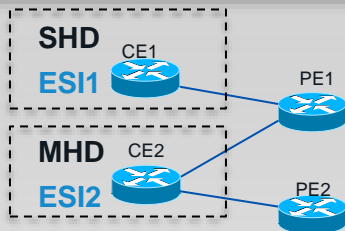
EVPN Instance (EVI)



- EVI identifies a VPN in the network
- Encompass one or more bridge-domains, depending on service interface type

Port-based
VLAN-based (shown above)
VLAN-bundling

Ethernet Segment



- Represents a 'site' connected to one or more PEs
- Uniquely identified by a 10-byte global Ethernet Segment Identifier (ESI)
- Could be a single device or an entire network

Single-Homed Device (SHD)
Multi-Homed Device (MHD)
Single-Homed Network (SHN)
Multi-Homed Network (MHN)

BGP Routes

Route Types
[1] Ethernet Auto-Discovery (AD) Route
[2] MAC/IP Advertisement Route
[3] Inclusive Multicast Route
[4] Ethernet Segment Route
[5] IP Prefix Advertisement Route

- **New SAFI [70]**
- **Routes serve control plane purposes, including:**
 - MAC address reachability
 - MAC mass withdrawal
 - Split-Horizon label adv.
 - Aliasing
 - Multicast endpoint discovery
 - Redundancy group discovery
 - Designated forwarder election
 - IP address reachability
 - L2/L3 Integration

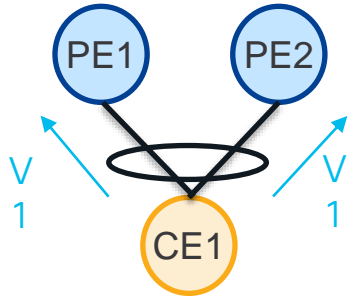
BGP Route Attributes

Extended Communities
ESI MPLS Label
ES-Import
MAC Mobility
Default Gateway
Encapsulation

- **New BGP extended communities defined**
- **Expand information carried in BGP routes, including:**
 - MAC address moves
 - Redundancy mode
 - MAC / IP bindings of a GW
 - Split-horizon label encoding
 - Data plane Encapsulation

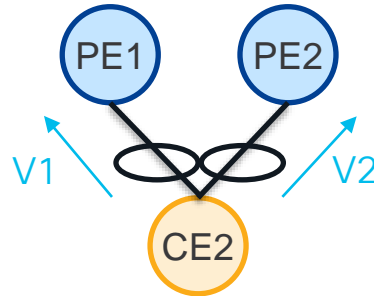
EVPN Topologies

All-Active
(per flow)



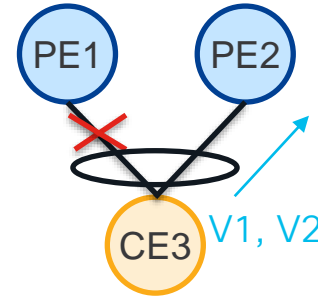
Single LAG at the CE
VLAN goes to both PE
Traffic hashed per flow
Benefits: Bandwidth,
Convergence

Single-Active
(per VLAN)



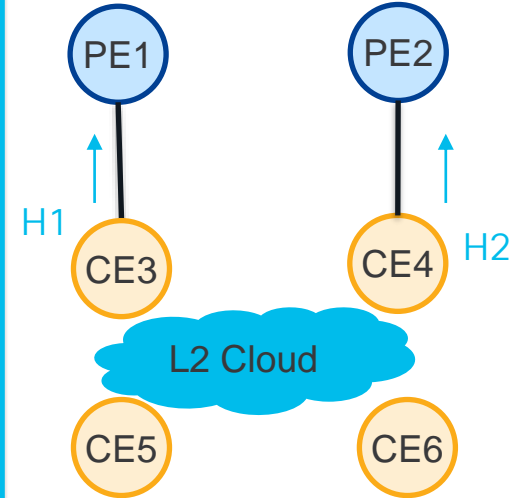
Multiple LAGs at the CE
VLAN active on single PE
Traffic hashed per VLAN
Benefits: Billing, Policing

Port-Active
(per port)



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

Single-Flow-Active
(access L2 Gateway)



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

SR-EVPN Fabric Design Considerations

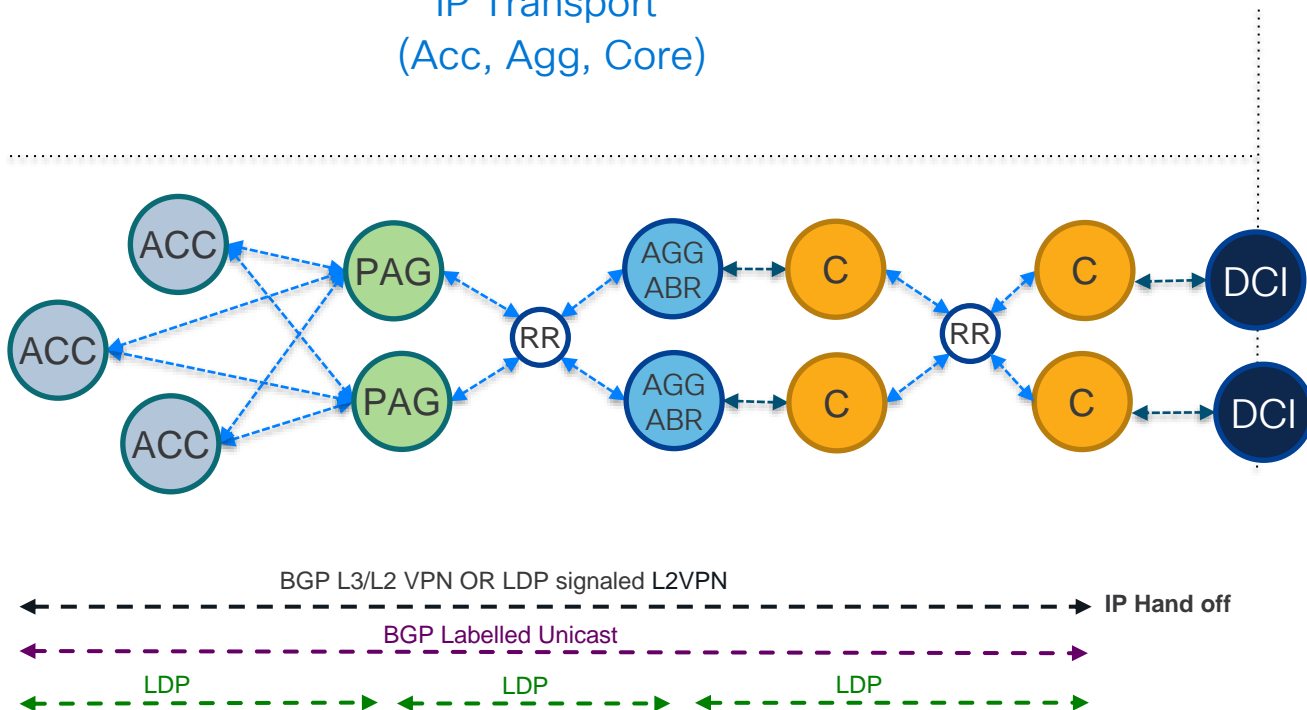


SR Design Considerations

- Hierarchical LSP (Unified MPLS) to SR-ODN Approach
- LDP & SR Interworking
- SRGB Planning Guidelines

Hierarchical LSP (Unified MPLS)

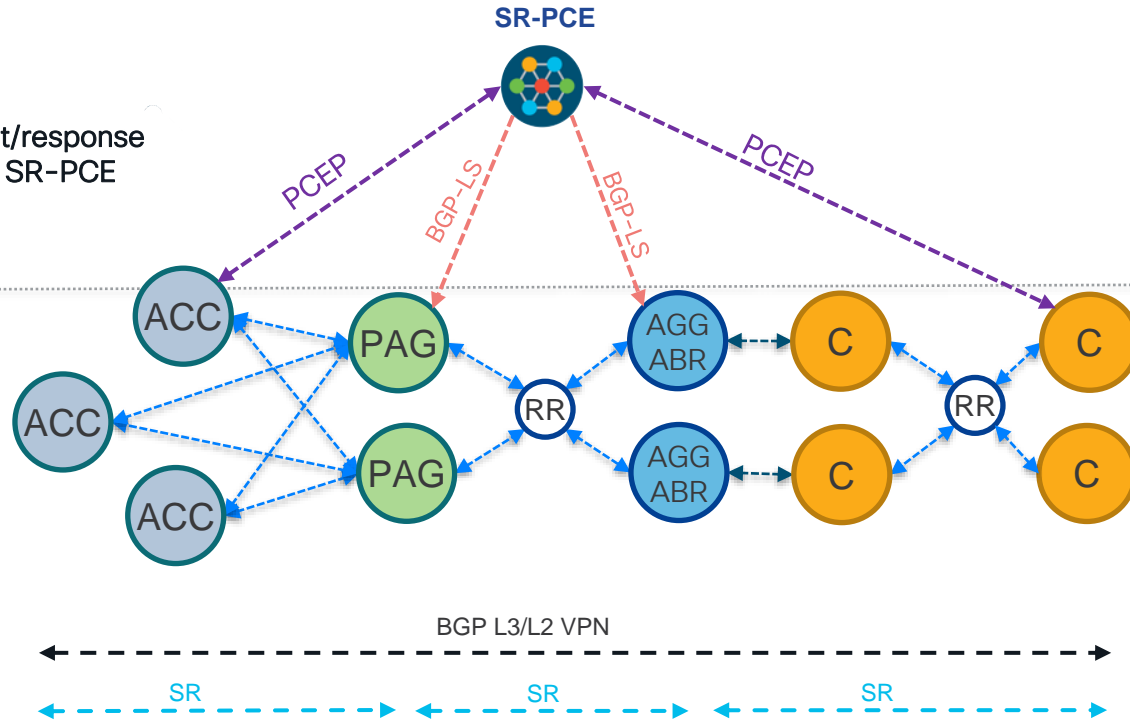
IP Transport
(Acc, Agg, Core)



SR-ODN Approach with SR-PCE

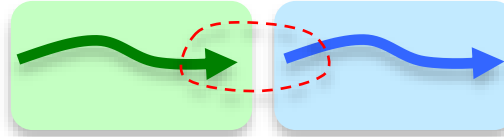
On demand Next Hop request/response exchange between PE and SR-PCE

IP
Transport



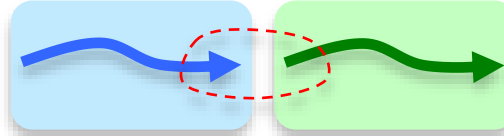
Interworking Deployment Model

SR to LDP



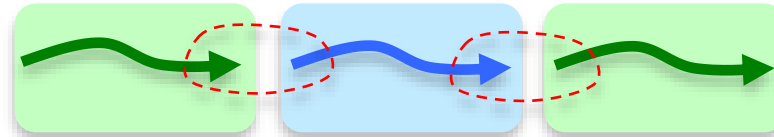
SR-Mapping Server
Required

LDP to SR



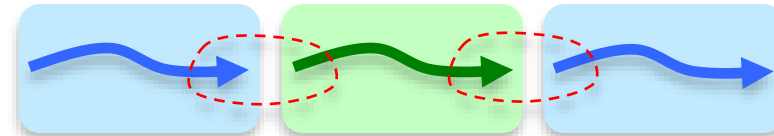
Automatic Copy the label

SR over LDP



SR-Mapping Server
Required

LDP over SR



SR-Mapping Server
Required

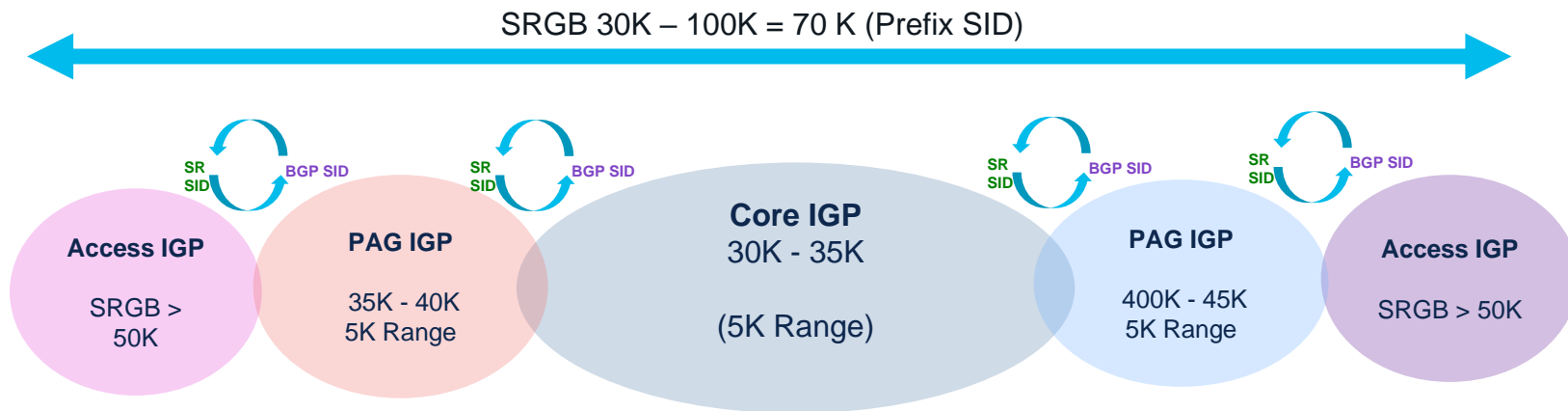
LDP

SR

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SR Global Block Planning - Example



- Different color block implies for different IGP process in this example
- Default SRGB in IOS XR: 16,000 – 23,999 but it can be modified to as per network scale within LSDB space (1M)
- Different IGP domain can be “admiratively” assigned from the range for operational ease
- SR SID (IGP) and BGP SID should be assigned to all LB to keep labels in synch in multi-domain architecture
- Slicing block should be carved out as per number of slices requirement



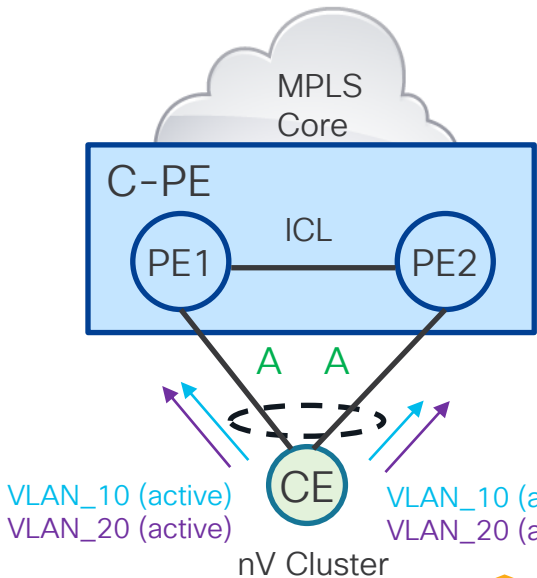
EVPN Design Considerations

- Multi-Home Device with EVPN
- Overcoming VPLS limitation with EVPN
- EVPN IRB for FHRP

Multi-Home Device – Legacy Design Options

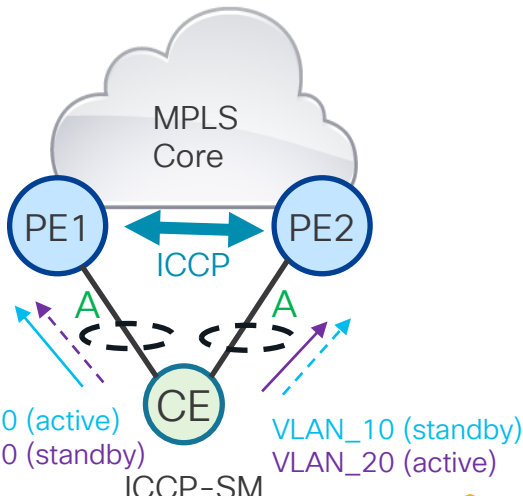
Legacy design options available before EVPN

1. nV Edge (Cluster)
2. ICCP-SM (ICCP based Service Multihoming or Pseudo MC-LAG)
3. MC-LAG

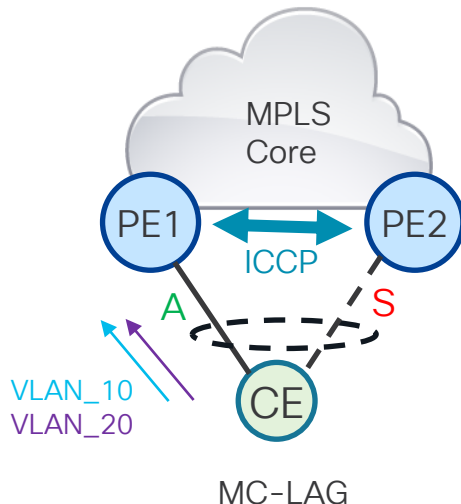


C-PE: Cluster PE

1

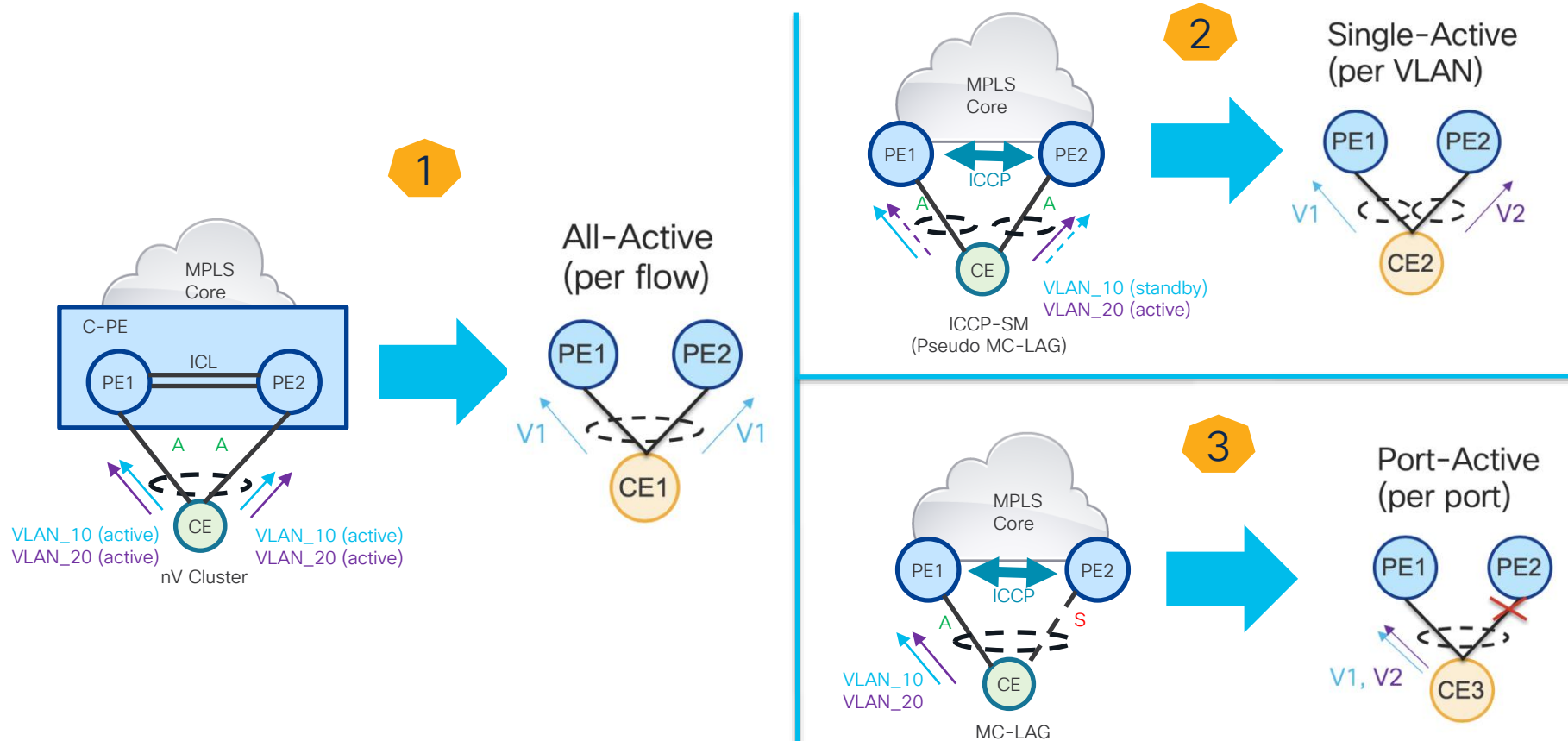


2



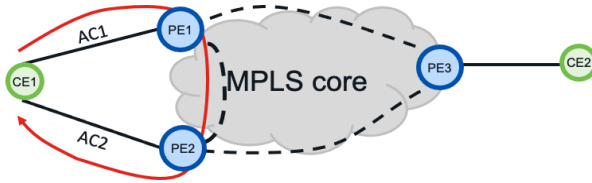
3

Multi-Home Device with EVPN



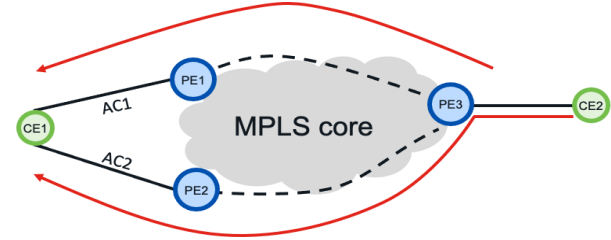
VPLS limitations – Legacy Design Options

1



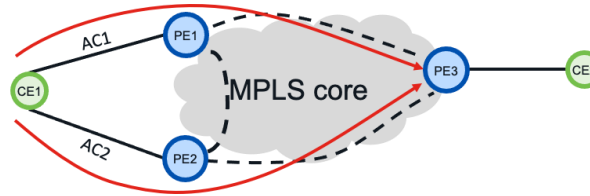
Forwarding Loops

2



Duplicate Frames

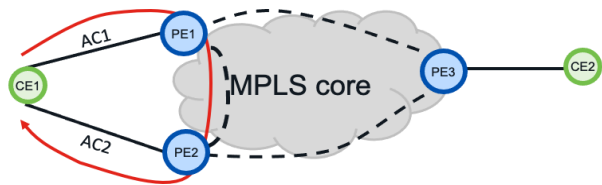
3



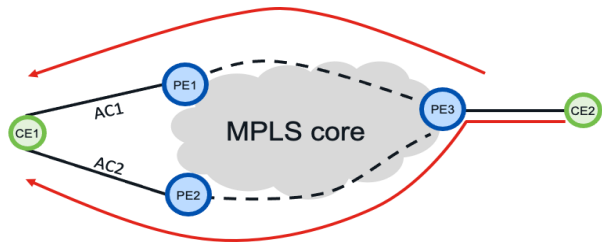
Instable Forwarding Table

Overcoming VPLS limitation with EVPN

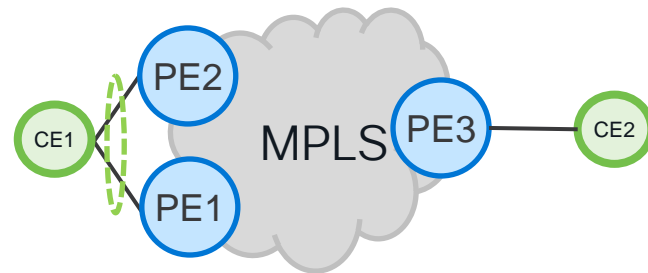
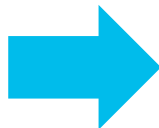
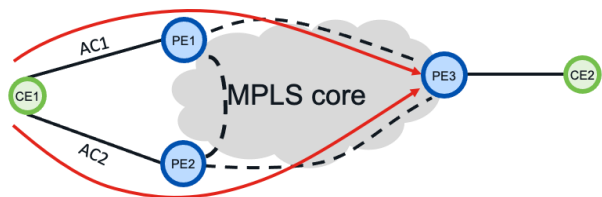
1



2

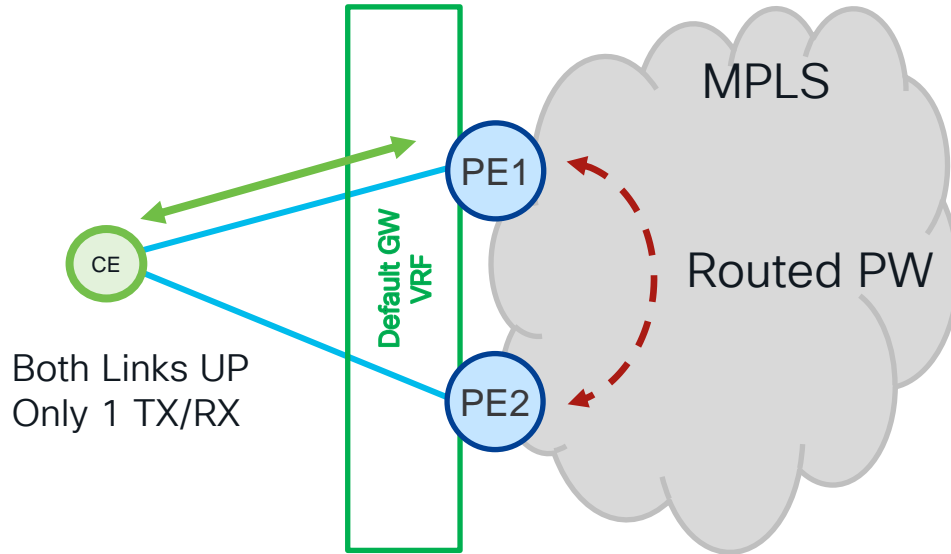


3



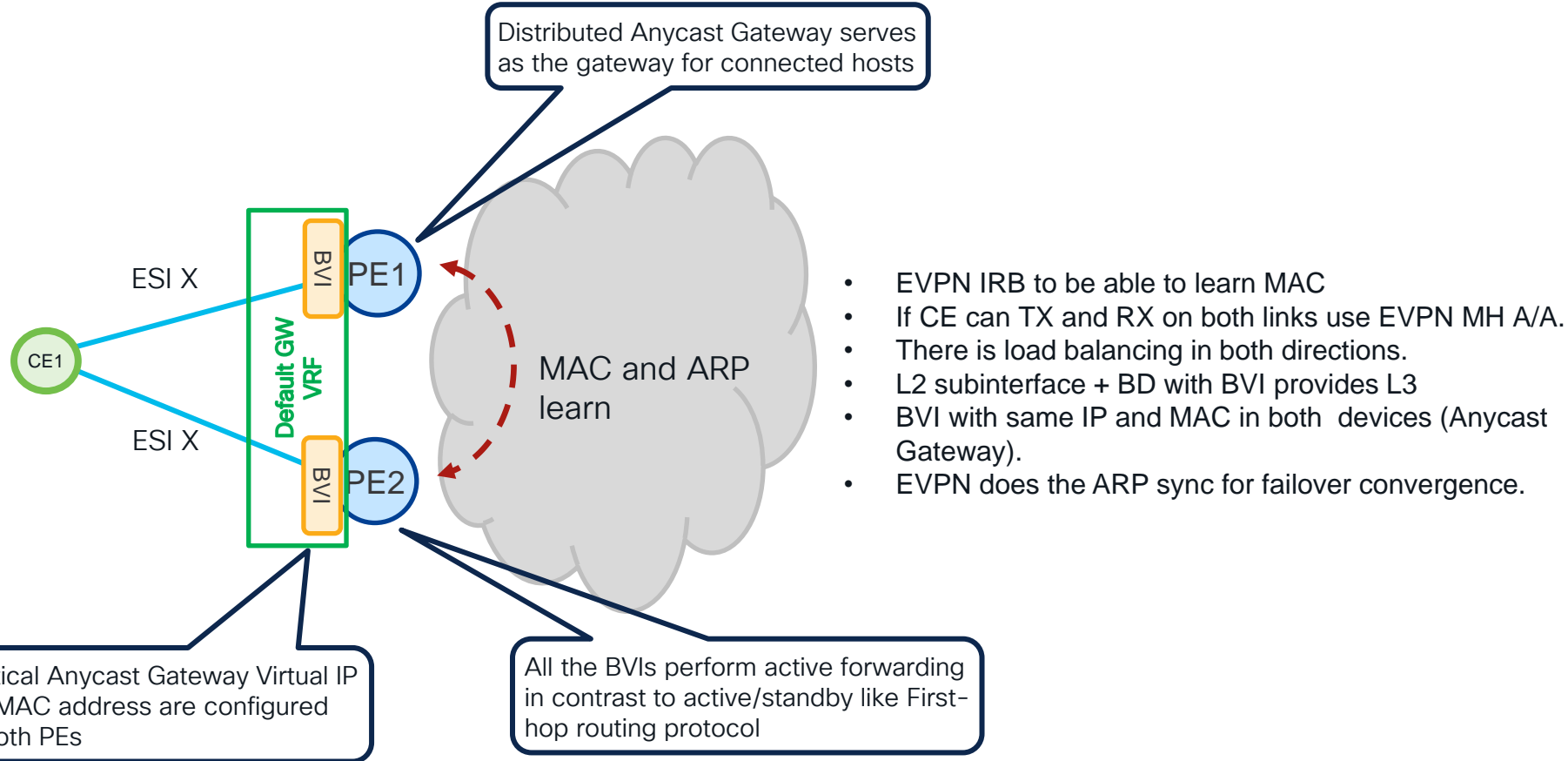
- Benefits of EVPN-VPWS/VPLS Multi-homed to L2 services
 - No signaling of PWs. Instead signals MP2P LSPs instead (ala L3VPN)
 - All-active CE multi-homing (per-flow LB)
 - Single-active CE multi-homing (per-service LB)
 - Port-active CE multi-homing (Active/standby)

FHRP with VRRP – Legacy Design Option



- VRRP as FHRP to provide gateway redundancy to CE
- Routed PW to be able to send and receive VRRP hellos
- Traffic in L3VPN.

EVPN IRB for FHRP



Case Study

Legacy MPLS to SR-EVPN Fabric



Mobile SP : Legacy MPLS to SR-EVPN Fabric



Challenge

- Large Scale cell site expansion
- MPLS-TP L2 access domain
- Complex capacity planning
- Redundancy Issues
- Legacy protocols



Solution

- SR-MPLS based underlay
- EVPN based overlay
- EVPN Active/Active IRB
- Single Flow Active Feature
- Active MAC-IP detection

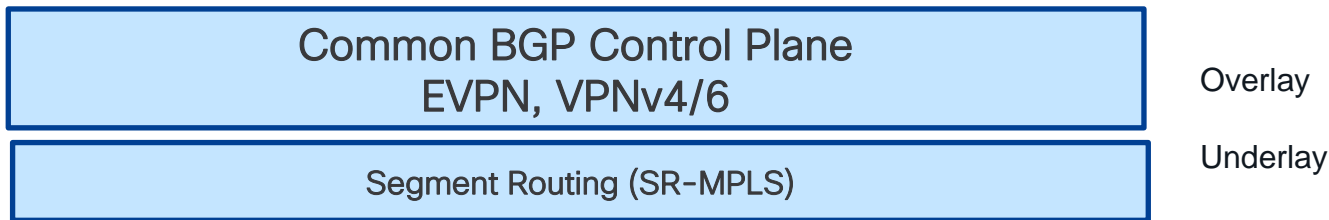


Outcomes

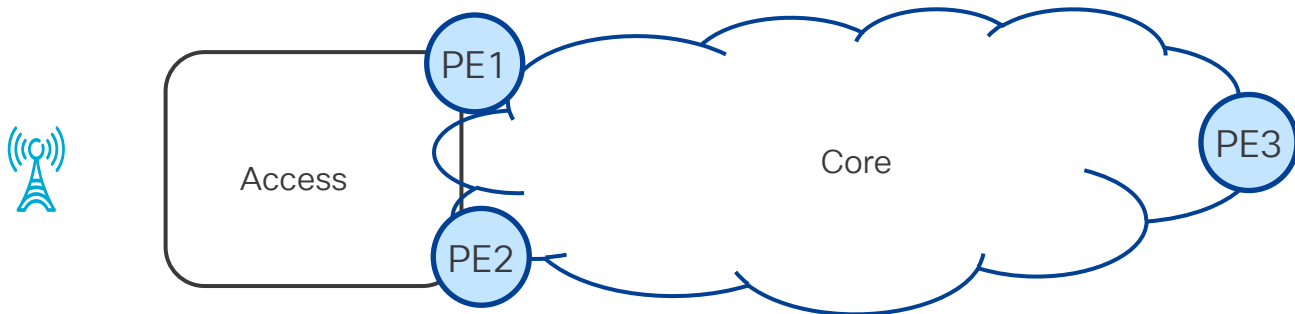
- Simpler protocol stack
- Unified BGP Services
- Improved convergence
- Layer 3 GW closer to cell sites
- Predictable capacity planning
- Seamless migration

Evolution from Legacy MPLS to SR-EVPN Fabric

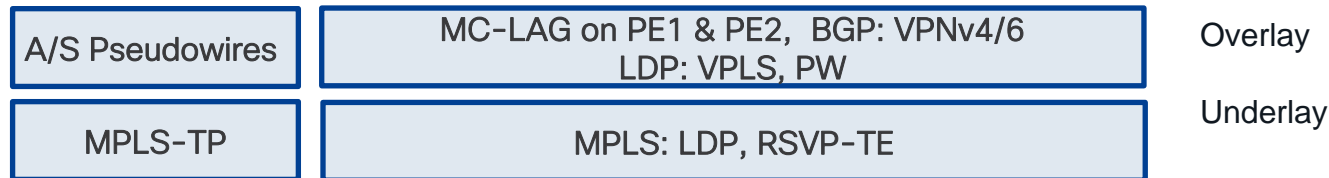
Evolution:



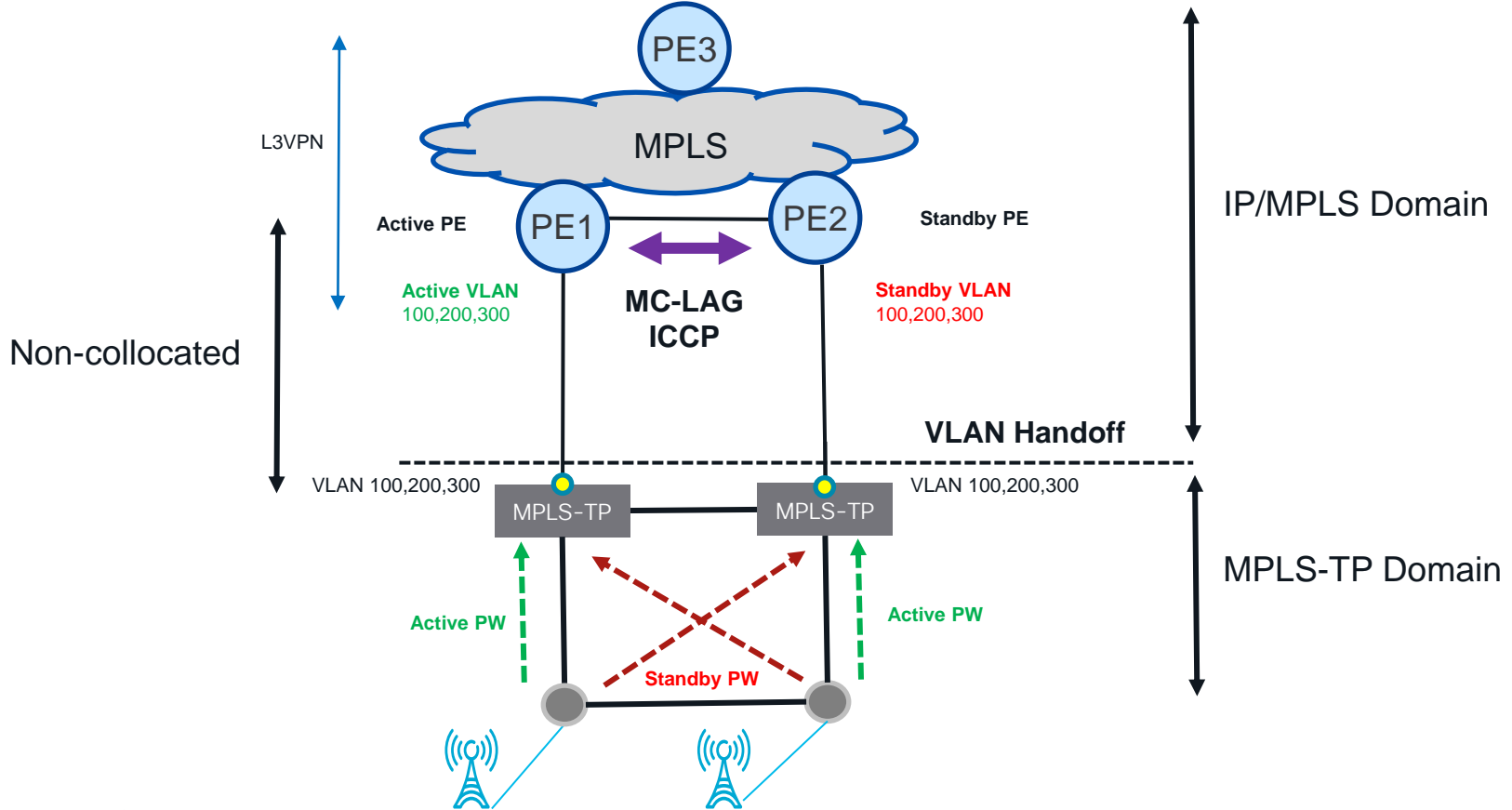
Service Provider Transport Network



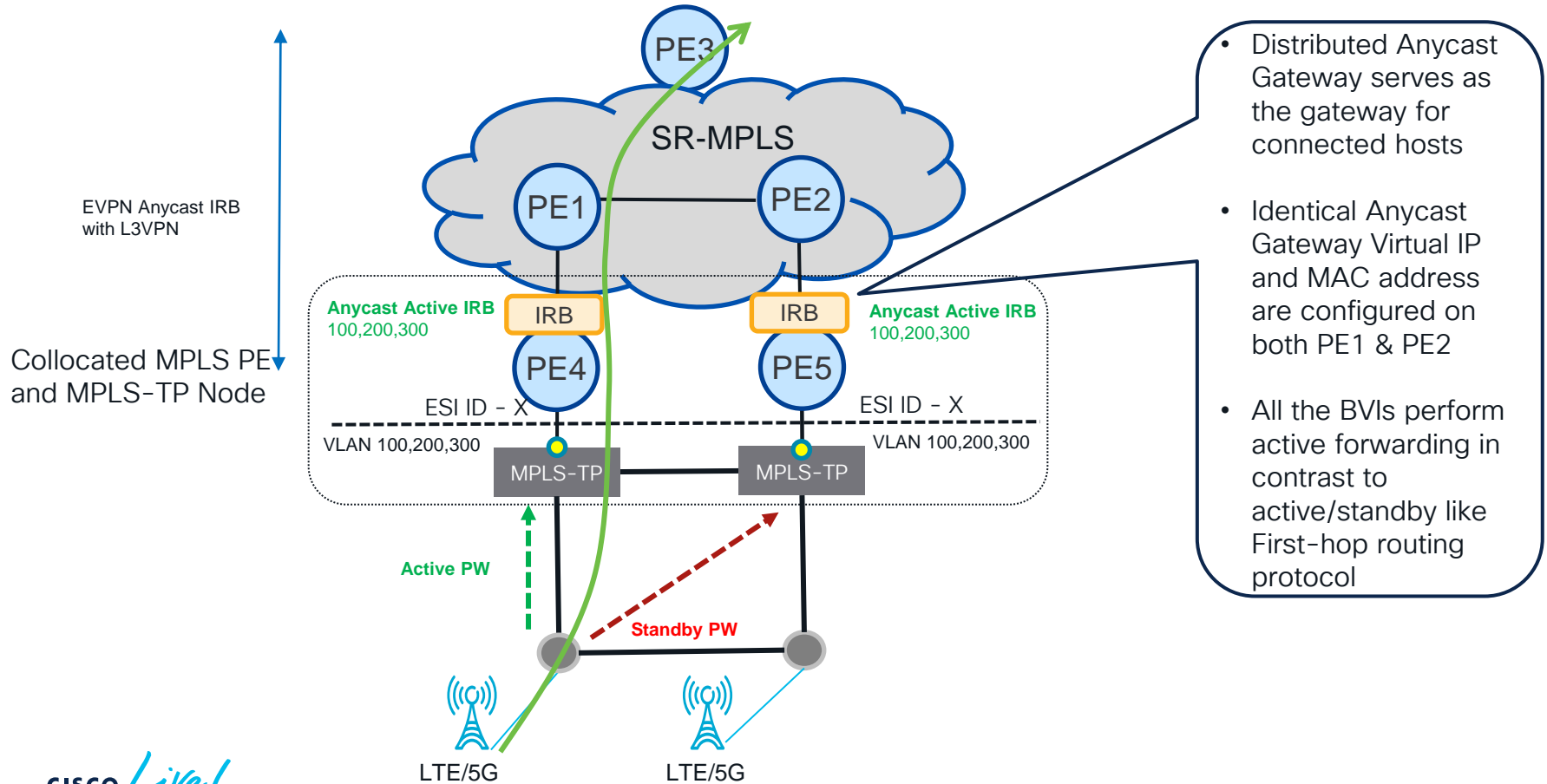
Existing Solution:



Initial State



Evolved State – EVPN All-Active IRB with SR-MPLS



Key Takeaways



SR-EVPN Fabric Advantages for Converged SDN Transport



Flexibility

- Choice of MPLS, VxLAN or SRv6 data plane encapsulation under EVPN Overlay Service
- Support existing and new services types (E-LAN, E-Line, E-TREE)



Network Efficiency

- Fully support IPv4 and IPv6 in the data plane and control plan
- All-active Multi-homing & PE load-balancing (ECMP)
- Fast convergence (Ti-LFA, link, node, MAC moves)

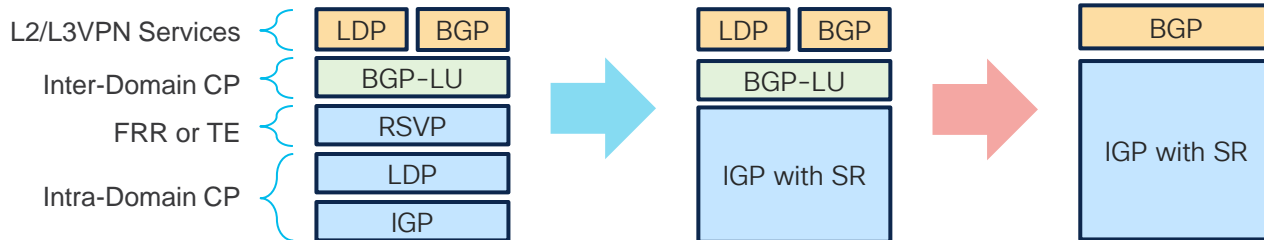


Investment Protection

- Control-Plane (BGP) learning. PWs are no longer used.
- Open-Standard and Multi-vendor support



Network Simplicity



Reference



<https://www.segment-routing.net>



<https://e-vpn.io>



Service Provider Programmable SDN solution
for the Metro Fabric, powered by Segment
Routing and EVPN - BRKSPG-2518

Technical Session Surveys

- Attendees who fill out a minimum of four session surveys and the overall event survey will get Cisco Live branded socks!
- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.
- These points help you get on the leaderboard and increase your chances of winning daily and grand prizes.



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The bridge to possible

Thank you

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