Introduction to SRv6 uSID Technology

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BRKMPL-2203

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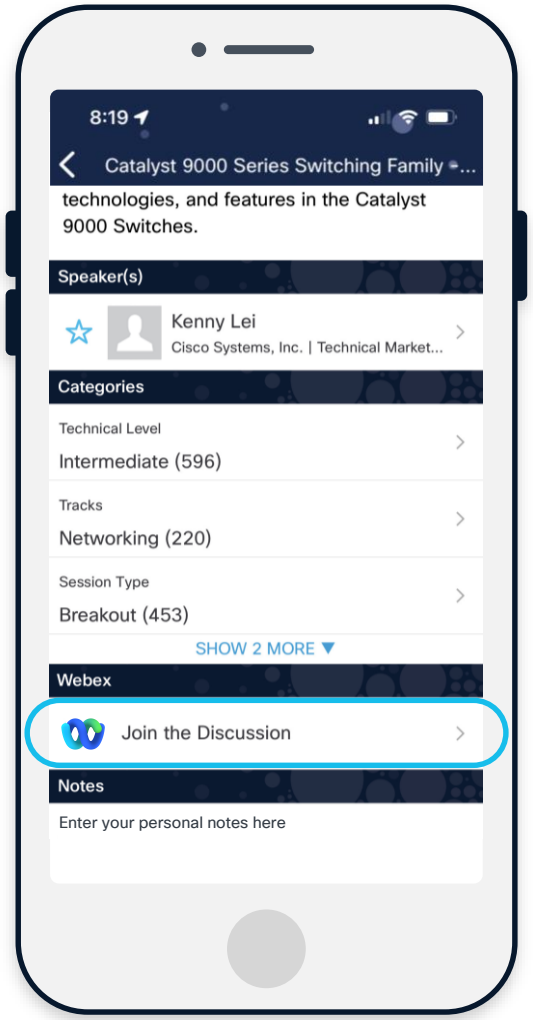

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Agenda

01 Introduction

02 SRv6 uSID Date Plane

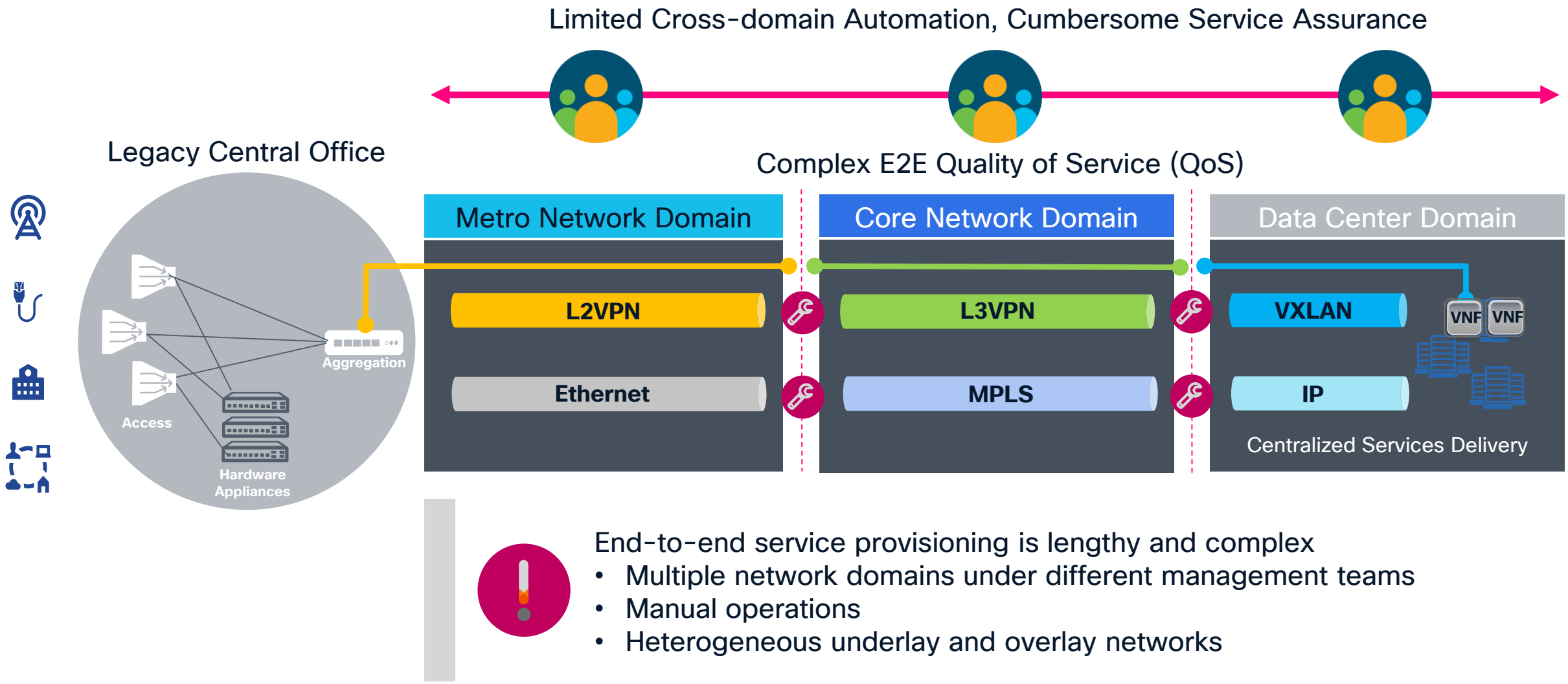
03 SRv6 uSID Control Plane

04 Migration to SRv6

05 Conclusion

Introduction

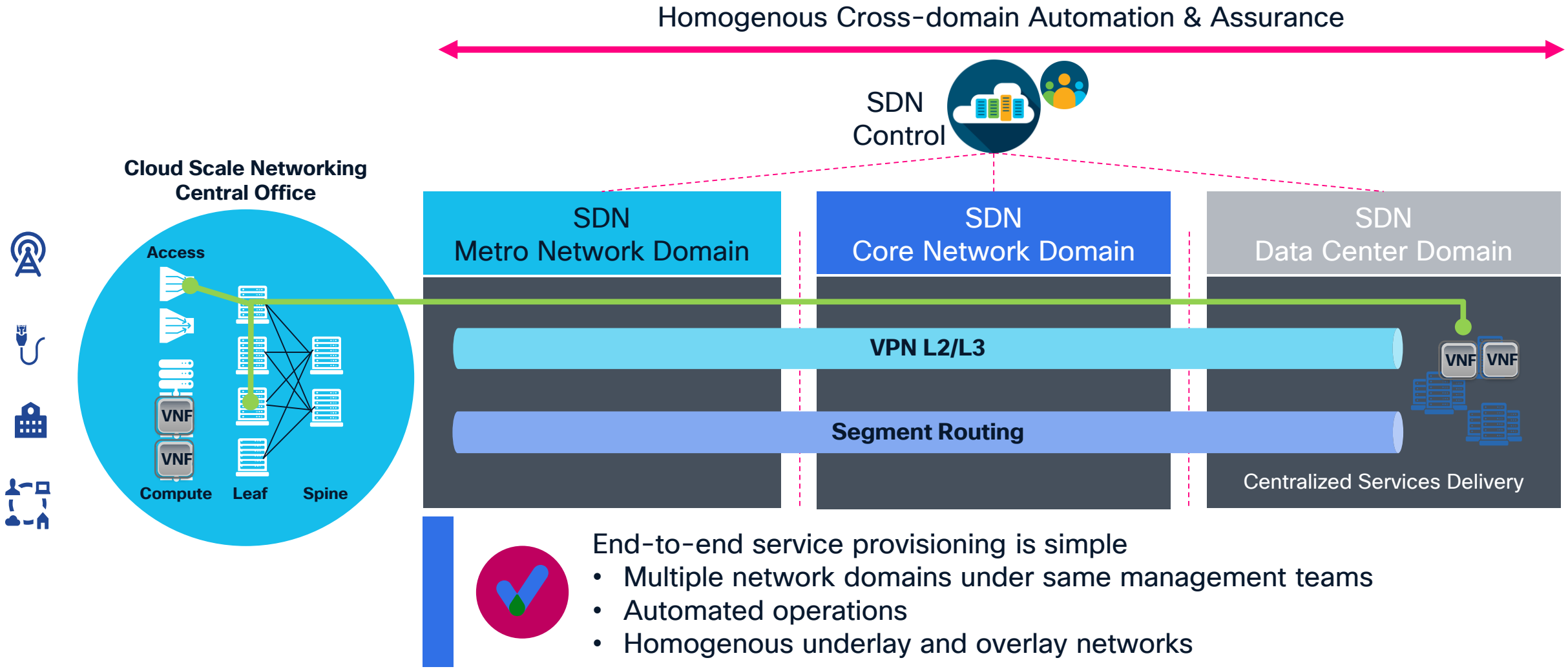
Understanding Today's Service Creation



End-to-end service provisioning is lengthy and complex

- Multiple network domains under different management teams
- Manual operations
- Heterogeneous underlay and overlay networks

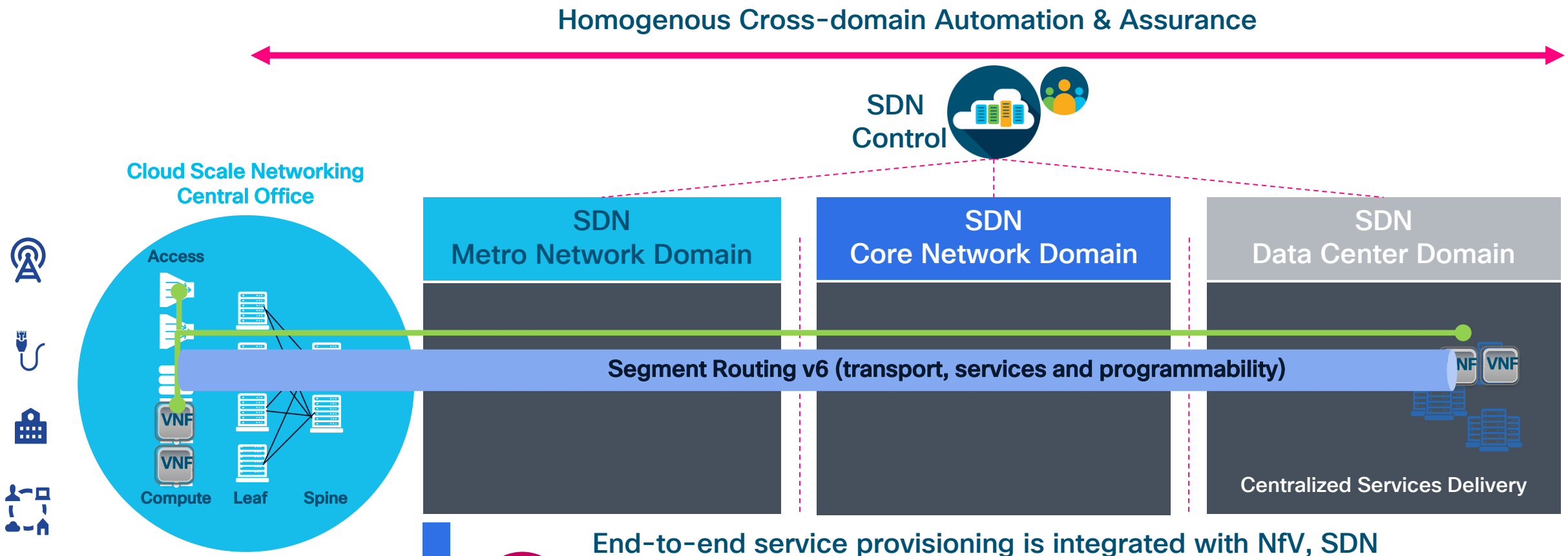
SR-MPLS: SDN ready
“Network as a Fabric” for Service Creation



End-to-end service provisioning is simple

- Multiple network domains under same management teams
- Automated operations
- Homogenous underlay and overlay networks

SRv6: SDN, NfV, 5G ready
“Network as an API” for Service Creation



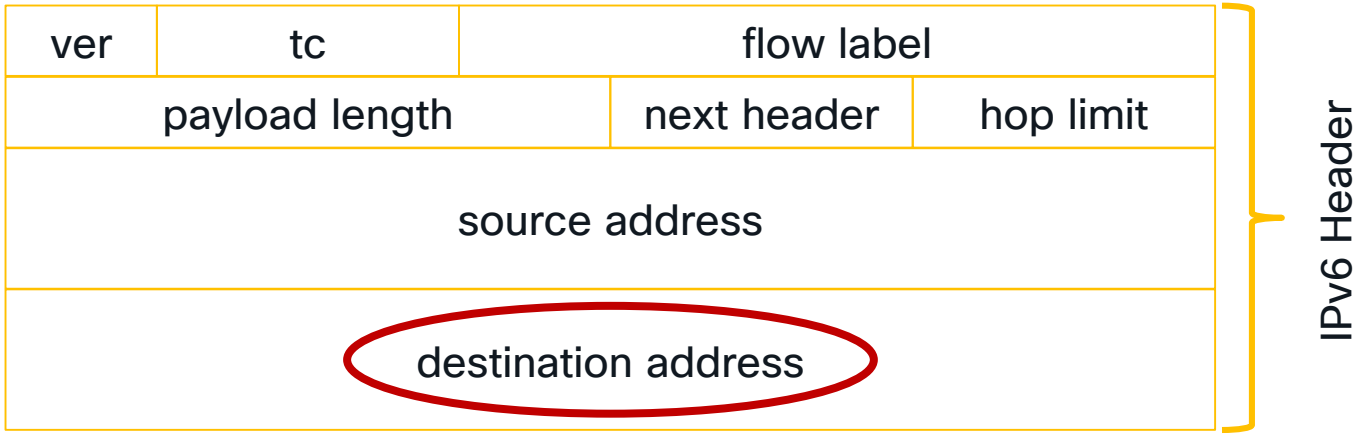
End-to-end service provisioning is integrated with NfV, SDN

- Multiple network domains under same management teams
- Automated operations
- Integrated underlay and overlay networks (NfV)
- Network as API (NfV)
- Hyper Scale (5G)

SRv6 uSID Data Plane

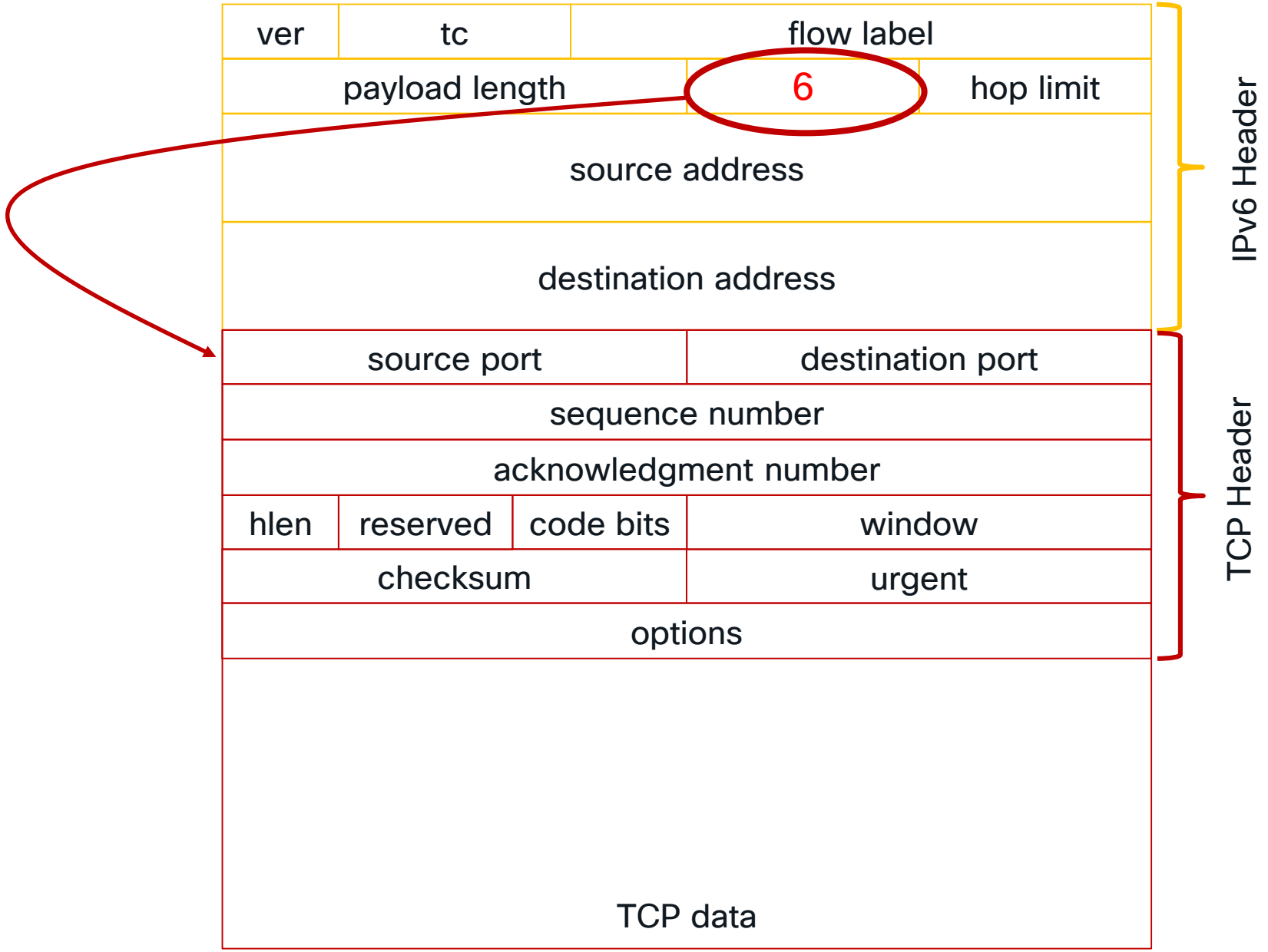
SRv6

- IPv6 Header
- Destination IP address



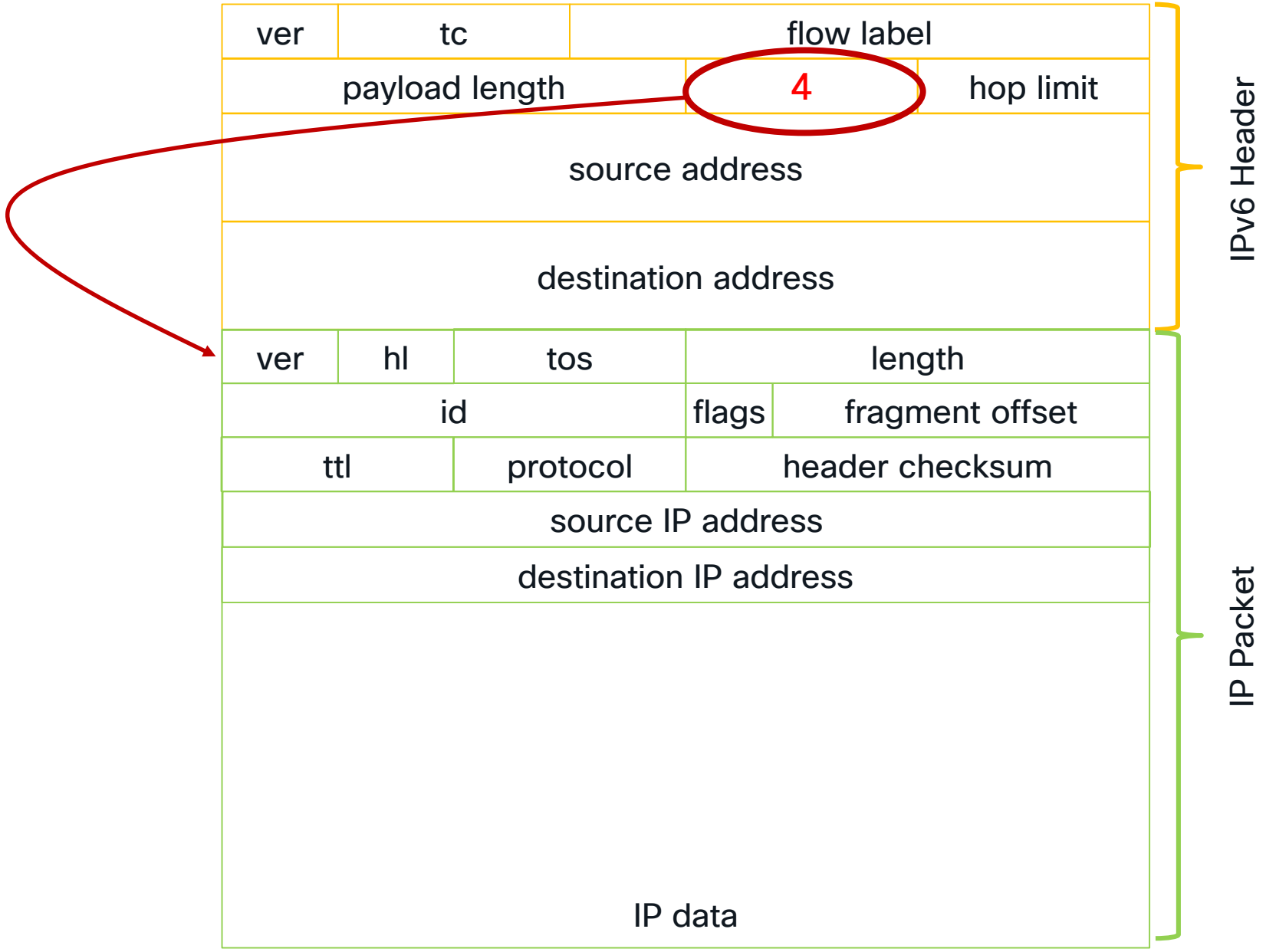
SRv6

- IPv6 Header
- Destination IP address
- Next header field:
  - TCP, UDP, ICMP....



SRv6

- IPv6 Header
- Destination IP address
- Next header field:
  - TCP, UDP, ICMP....
  - IPv4, IPv6



SRv6

- IPv6 Header
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- Next header field:
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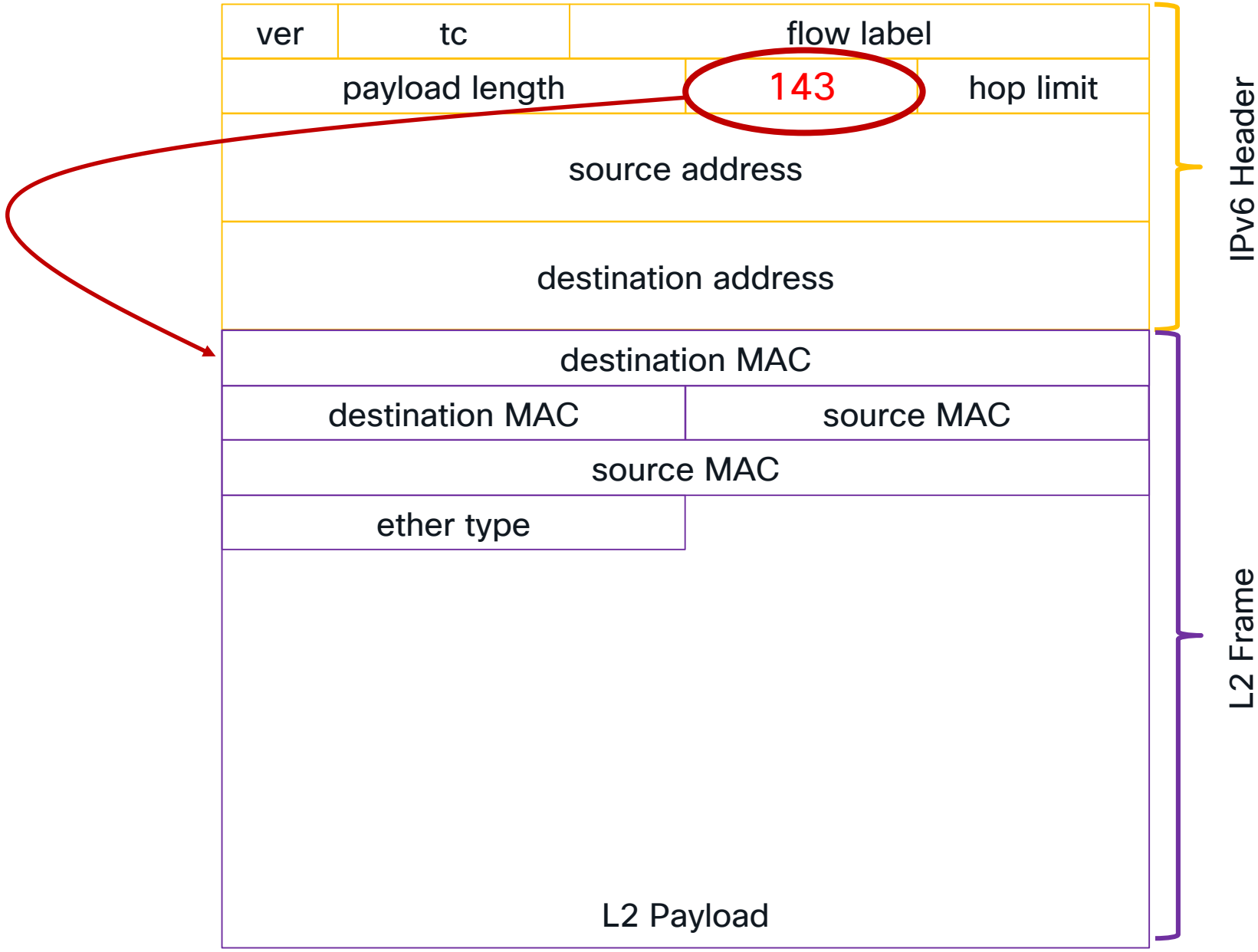
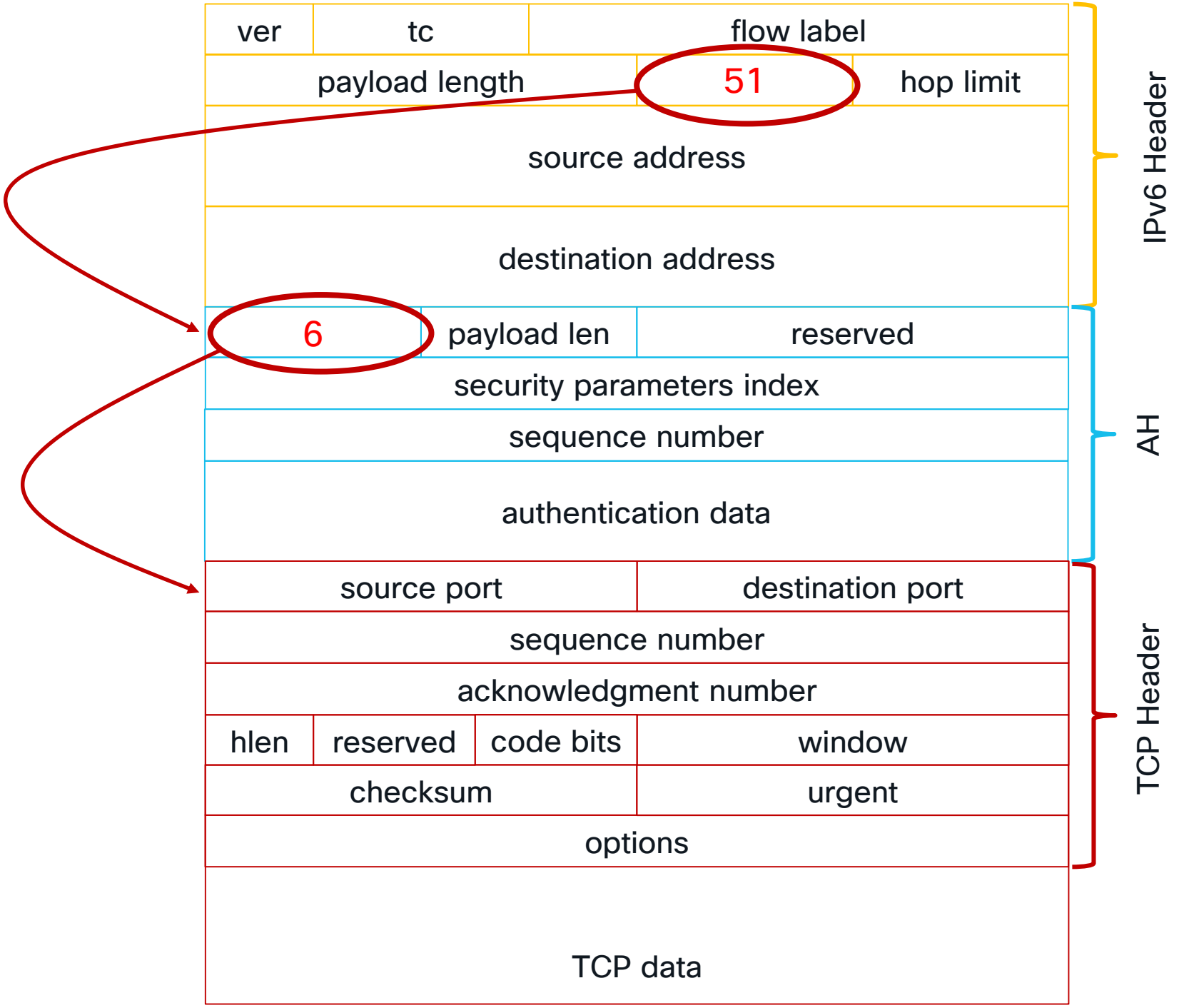
  - IPv4, IPv6, L2



SRv6

- IPv6 Header
- Destination IP address
- Next header field:
  - TCP, UDP, ICMP....
  - IPv4, IPv6, L2
  - Hop by Hop, Dest. Options, Fragmentation, Authentication Header ...



SRv6

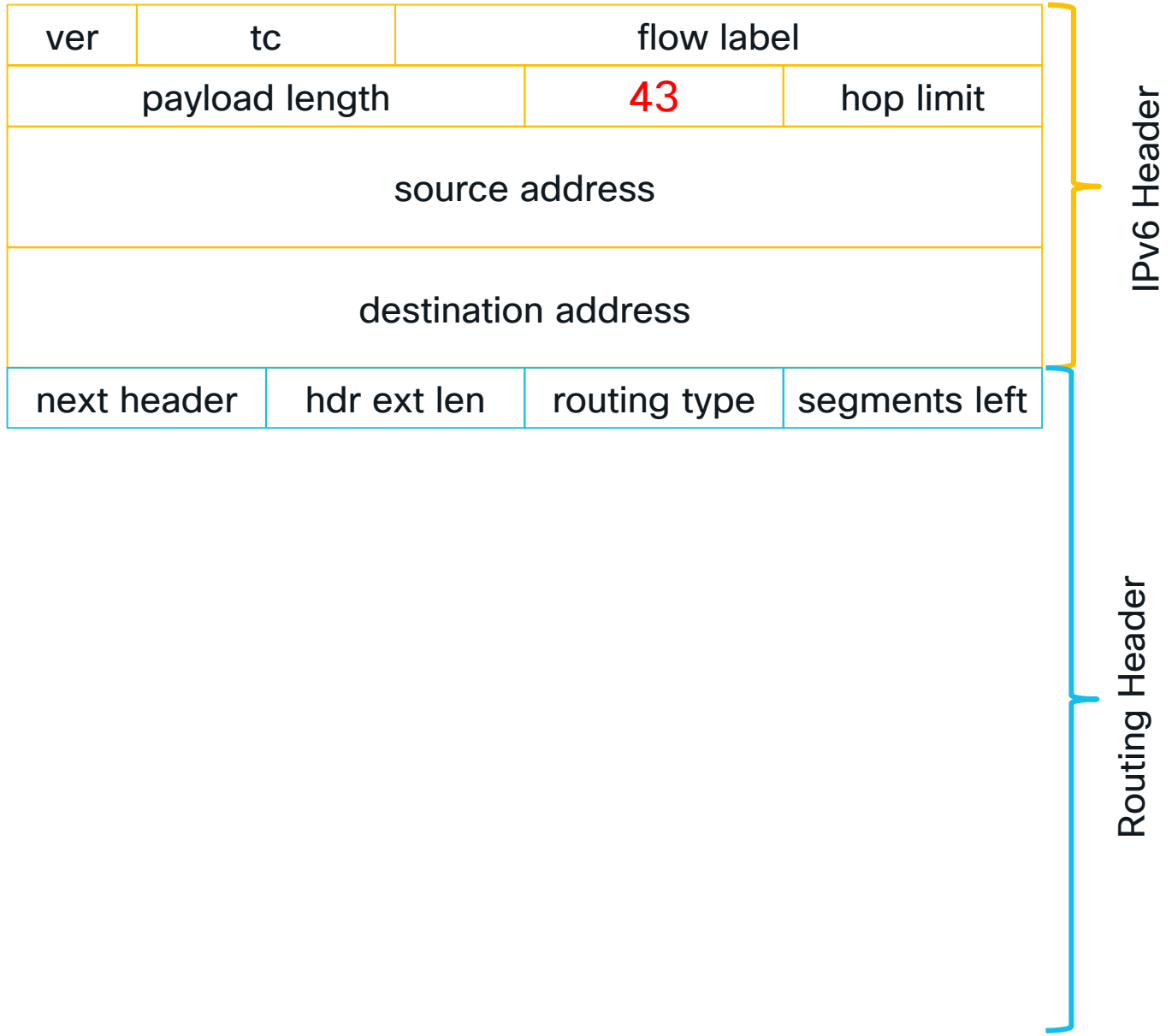
- IPv6 Header
- Destination IP address
- Next header field:
  - TCP, UDP, ICMP....
  - IPv4, IPv6, L2
  - Hop by Hop, Dest. Options, Fragmentation, Authentication Header ...
  - Routing Header

    0 Source Route (deprecated)

    1 Nimrod (deprecated)

    2 Type 2 (RFC 6275)

    3 RPL (RFC 6554)



SRv6

- IPv6 Header
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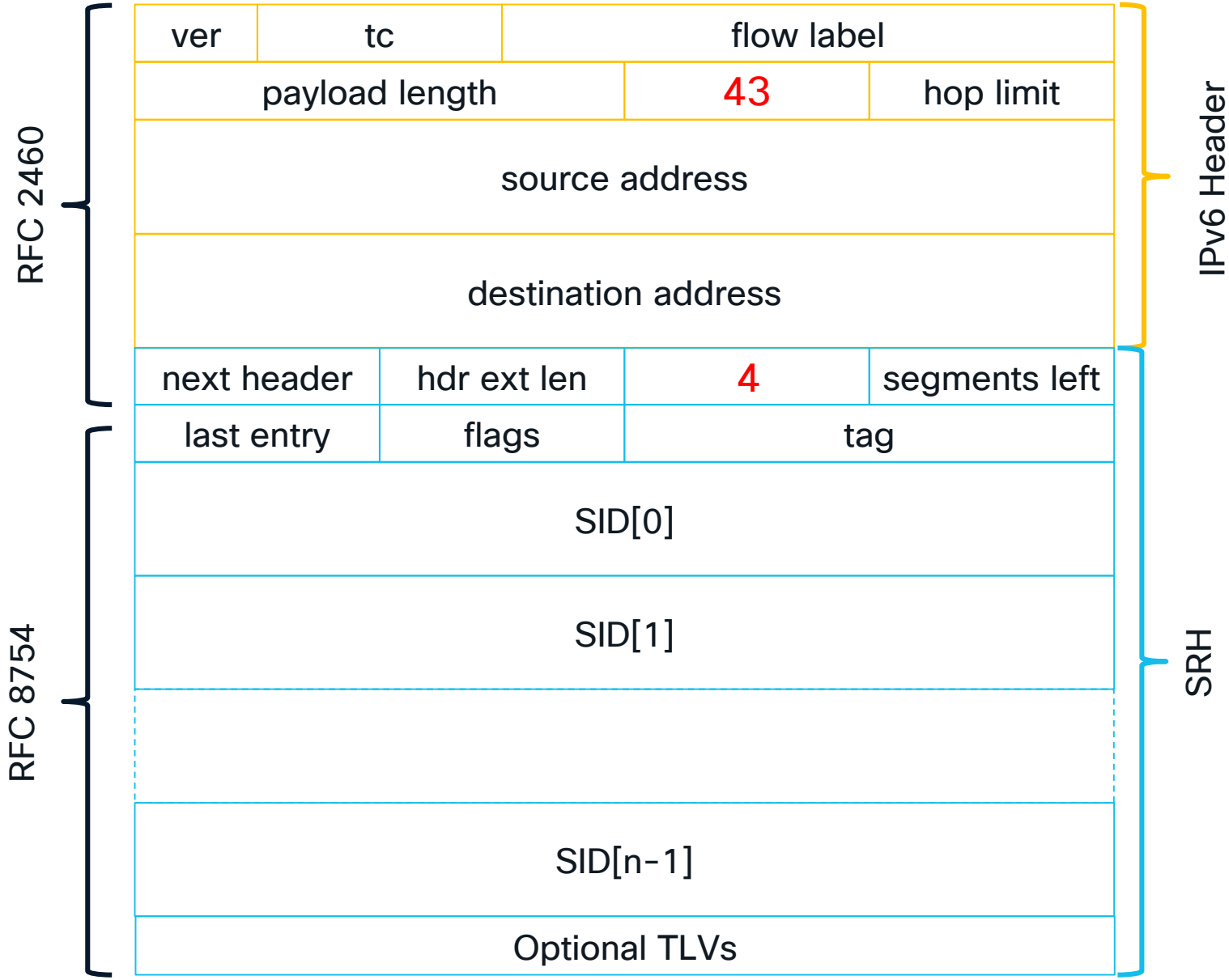
    2 Type 2 (RFC 6275)

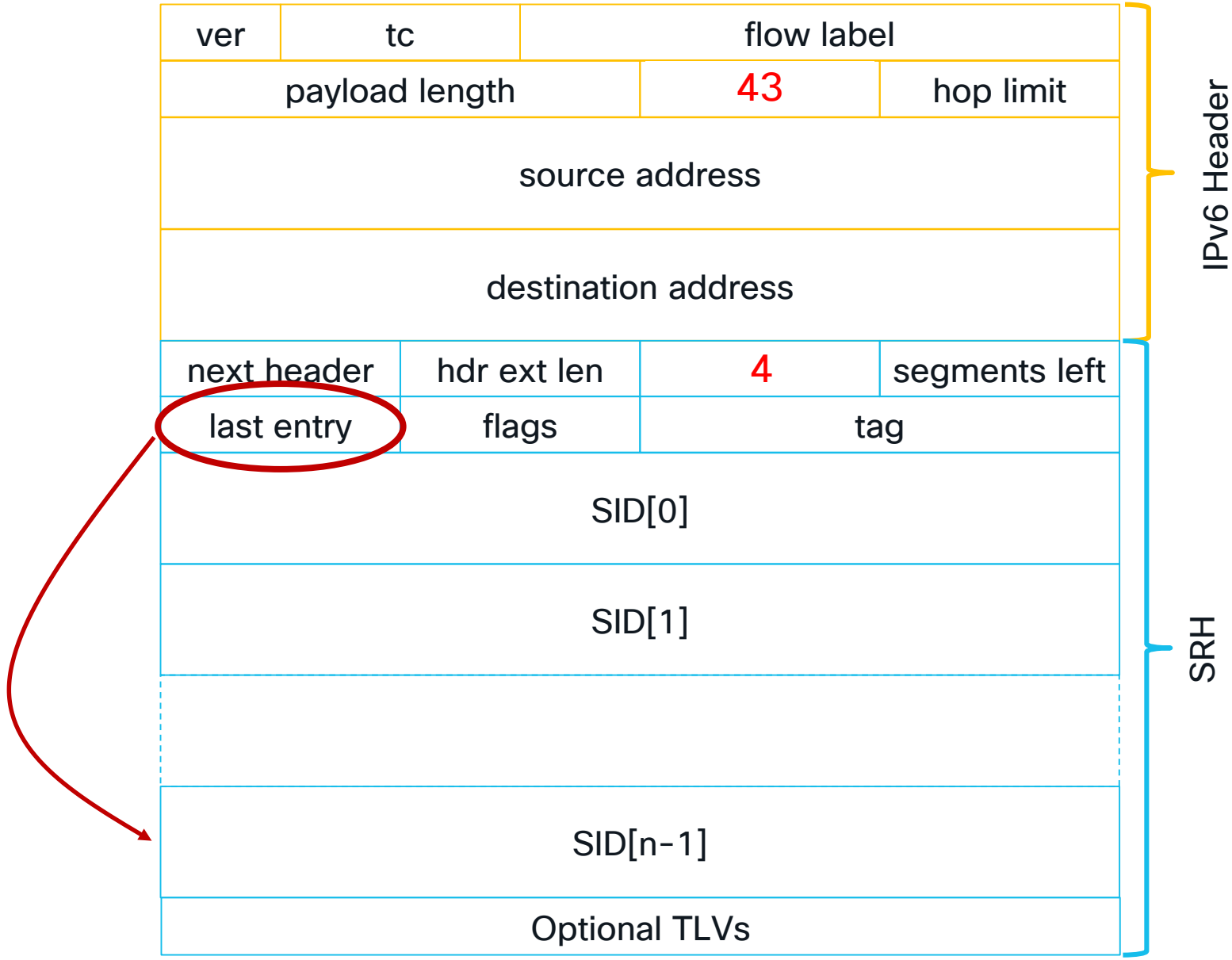
    3 RPL (RFC 6554)

    4 SRH (RFC 8754)



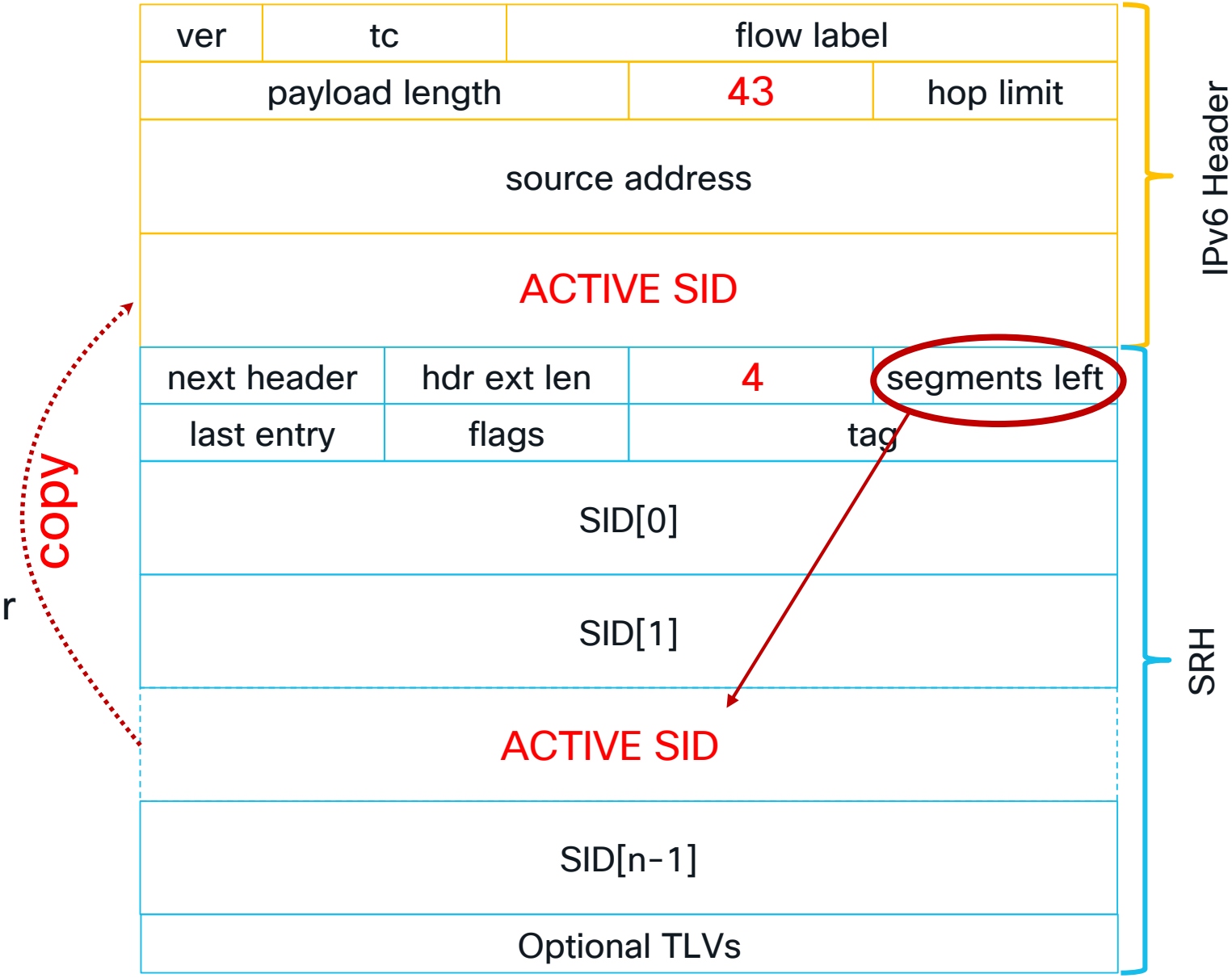
SRH

- Segment Routing Header
- First Segment
  - Pointer to very first SID



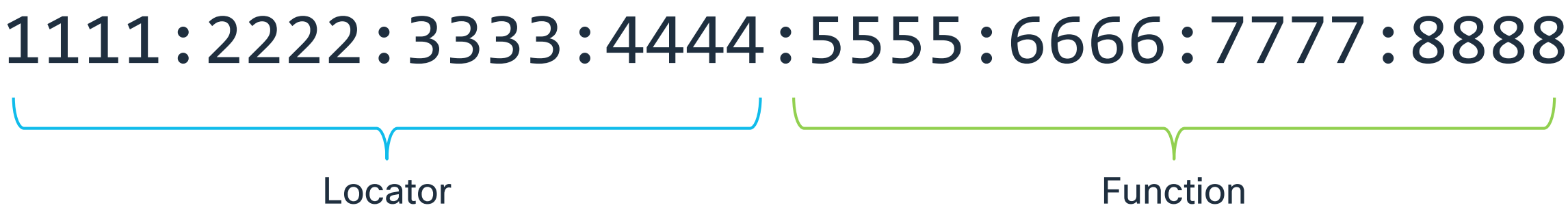
SRH

- Segment Routing Header
- First Segment
  - Pointer to very first SID
- Segments left
  - Pointer to Active SID
  - Active SID always in destination addr

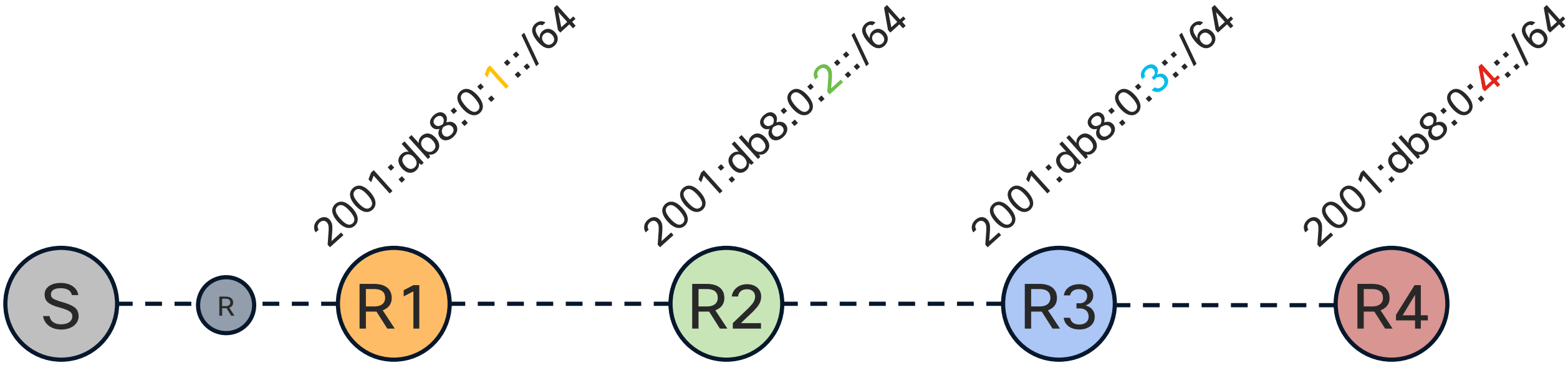


SID Structure –Locator

128 Bits Like IPv6 address but different semantics



SRv6 Full SID



BGP:2001:db8:0:4:eeee::

SA:2001::1 DA:2001:db8:0:1:1:: NH:RH	SA:2001::1 DA:2001:db8:0:2:1:: NH:RH	SA:2001::1 DA:2001:db8:0:3:48:: NH:RH	**SA:2001::1 DA:2001:db8:0:4:eeee:: NH:IPv4**
Type:4(SRH) NH:IPv4|SL:3 Segment List: [0]:2001:db8:0:4:eeee:: [1]:2001:db8:0:3:48:: [2]:2001:db8:0:2:1:: [3]:2001:db8:0:1:1::	Type:4(SRH) NH:IPv4|SL:2 Segment List: [0]:2001:db8:0:4:eeee:: [1]:2001:db8:0:3:48:: [2]:2001:db8:0:2:1:: [3]:2001:db8:0:1:1::	Type:4(SRH) NH:IPv4|SL:1 Segment List: [0]:2001:db8:0:4:eeee:: [1]:2001:db8:0:3:48:: [2]:2001:db8:0:2:1:: [3]:2001:db8:0:1:1::	**Type:4(SRH) NH:IPv4|SL:0 Segment List: [0]:2001:db8:0:4:eeee:: [1]:2001:db8:0:3:48:: [2]:2001:db8:0:2:1:: [3]:2001:db8:0:1:1::**

SID Structure

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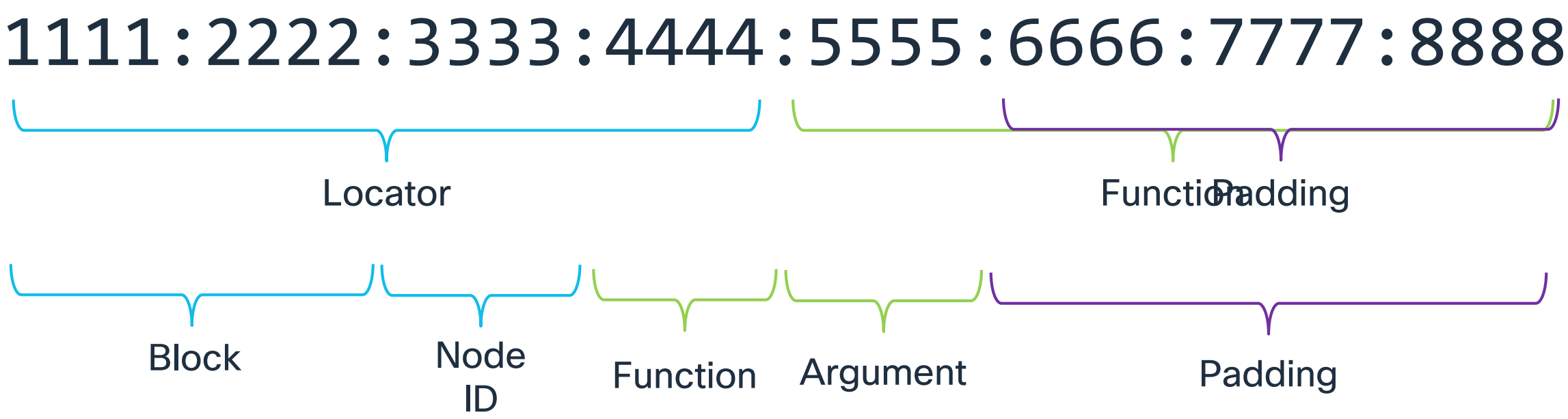
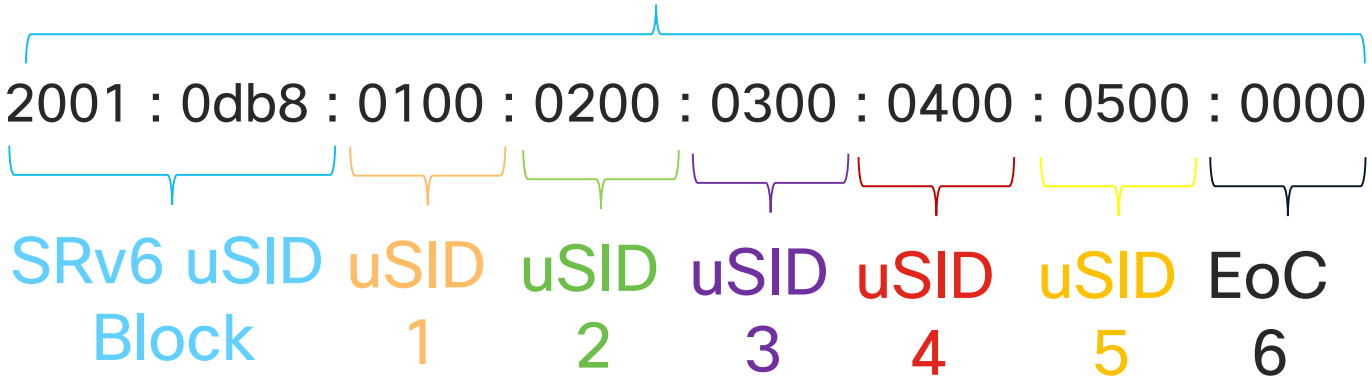


SRv6 uSID format

: 0100 : =SRV6 uSID

16 bits here, but can be anything

SRV6 uSID Container



32 bits here,
but can be anything

SRV6 Encapsulation

SA:2001::1
DA:2001:db8:0:4:1:0:0:0
NH:RH

Type:4(SRH)
NH:IPv4|SL:1
Segment List:
[0]: 2001:db8:0:5:45:0:0:0
[1]: 2001:db8:0:4:1:0:0:0
[2]: 2001:db8:0:3:48:0:0:0
[3]: 2001:db8:0:2:1:0:0:0
[4]: 2001:db8:0:1:42:0:0:0

SA:7.5.4.3
DA:11.6.19.71
Port:UDP

UDP Header/Data

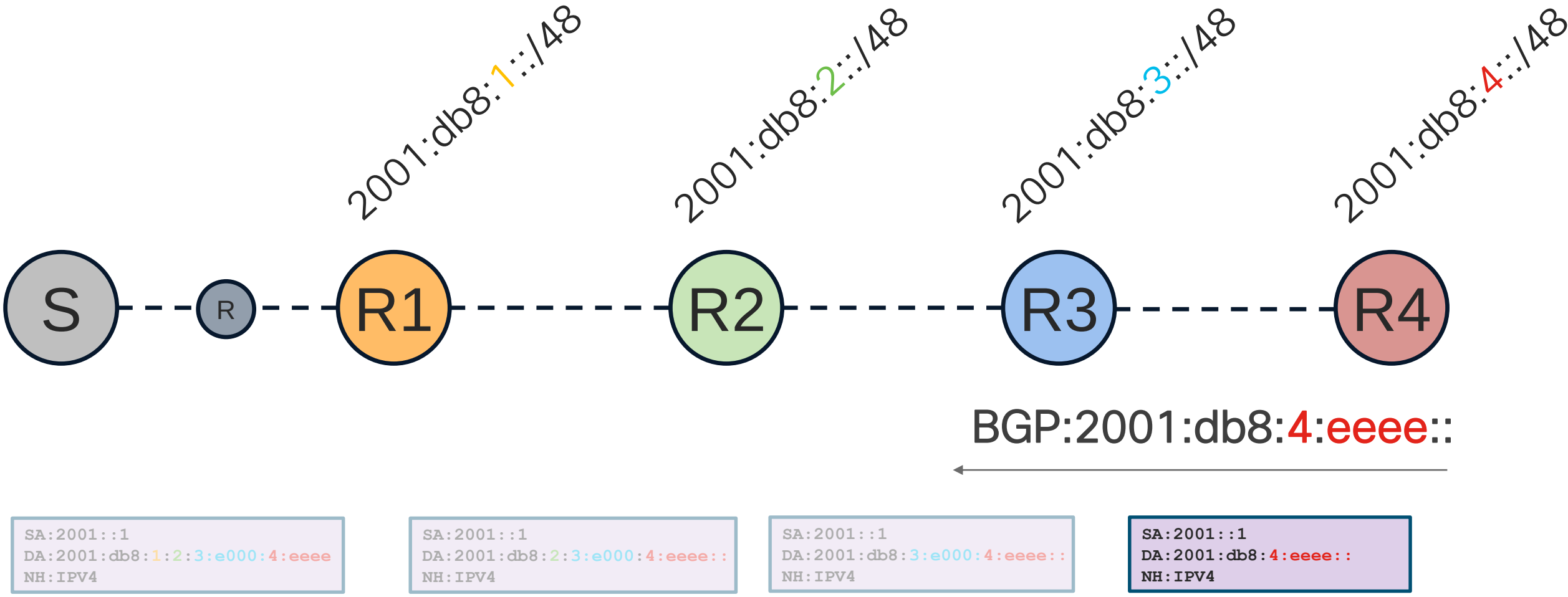
SRV6 uSID Encapsulation

SA:2001::1
DA:2001:db8:100:200:300:400:500::
NH:IPv4

SA:7.5.4.3
DA:11.6.19.71
Port:UDP

UDP Header/Data

SRv6 uSID F3216



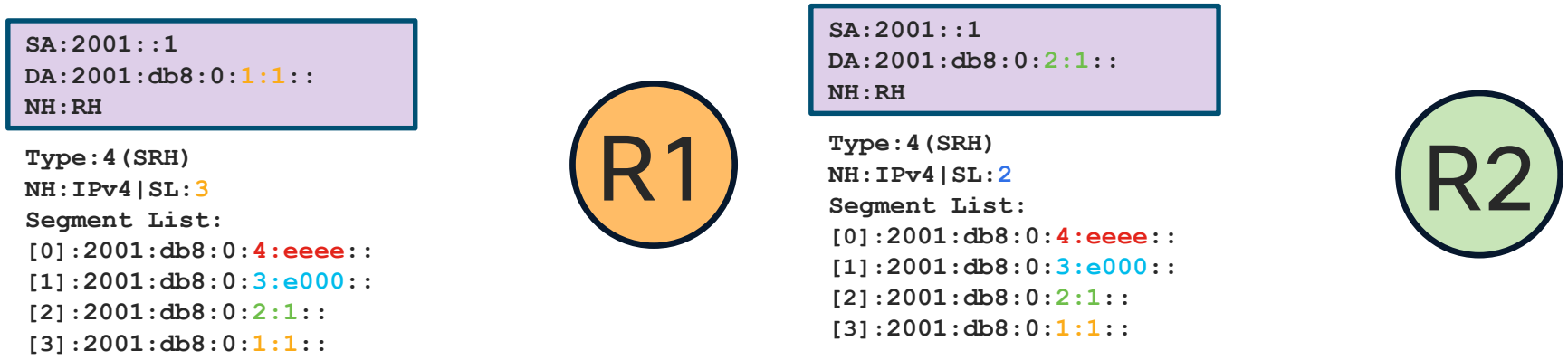
SRv6 uSID Control Plane

SRv6 functions: Steering and Services

Codename		Behavior	
End	uN	Endpoint	[Node SID]
End.X	uA	Endpoint with Layer-3 cross-connect	[Adj SID]
End.B6.Insert	uB6.Insert	Endpoint bound to an SRv6 policy	[BSID]
End.B6.Encap	uB6.Encaps	Endpoint bound to an SRv6 encapsulation policy	[BSID]
End.DX6	uDX6	Endpoint with decapsulation and IPv6 cross-connect	[L3VPN Per-CE]
End.DX4	uDX4	Endpoint with decapsulation and IPv4 cross-connect	[L3VPN Per-CE]
End.DT6	uDT6	Endpoint with decapsulation and specific IPv6 table lookup	[L3VPN Per-VRF]
End.DT4	uDT4	Endpoint with decapsulation and specific IPv4 table lookup	[L3VPN Per-VRF]
End.DT46	uDT46	Endpoint with decapsulation and specific IPv4&v6 table lookup	[L3VPN Per-VRF]
End.DX2	uDX2	Endpoint with decapsulation and L2 cross-connect	[E-LINE]
End.DT2U/M	uDT2U/M	Endpoint with decapsulation and L2 unicast lookup / flooding	[E-LAN]
End.DTM	uDTM	Endpoint with decapsulation and MPLS table lookup	[Interworking]
H.Insert / H.Encaps		Headend with Insertion / Encapsulation of / into an SRv6 policy	[TiLFA]
H. Encaps.L2		H.Encaps Applied to Received L2 Frames	[L2 Port Mode]
H.Encaps.M		H.Encaps Applied to MPLS Label Stack	[Interworking]

END- Default endpoint (Node SID)

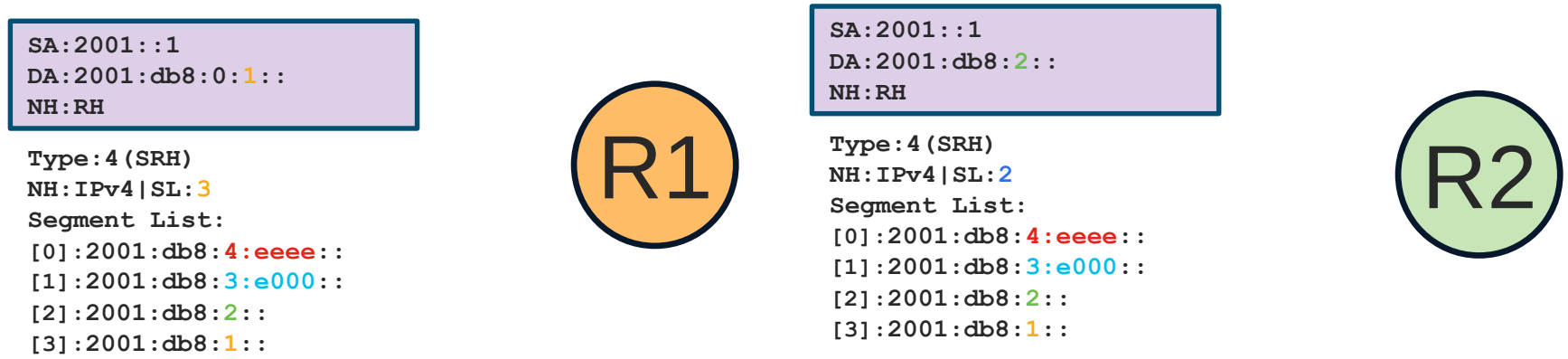
- *Decrement SL*
- *Copy Active SID*
- *Forward*



- Different Flavors:
  - End
  - End with PSP
  - End with USP
  - End with PSP & USP
  - End with USD
  - End with PSP & USD
  - End with USP & USD
  - End with PSP, USP & USD
  - End with **NEXT**-ONLY-CSID
  - End with **NEXT**-CSID
  - End with **NEXT**-CSID & PSP
  - End with **NEXT**-CSID & USP
  - End with **NEXT**-CSID, PSP & USP
  - End with **NEXT**-CSID & USD
  - End with **NEXT**-CSID, PSP & USD
  - End with **NEXT**-CSID, USP & USD
  - End with **NEXT**-CSID, PSP, USP & USD

uN=END with Next – Default endpoint (Node SID)

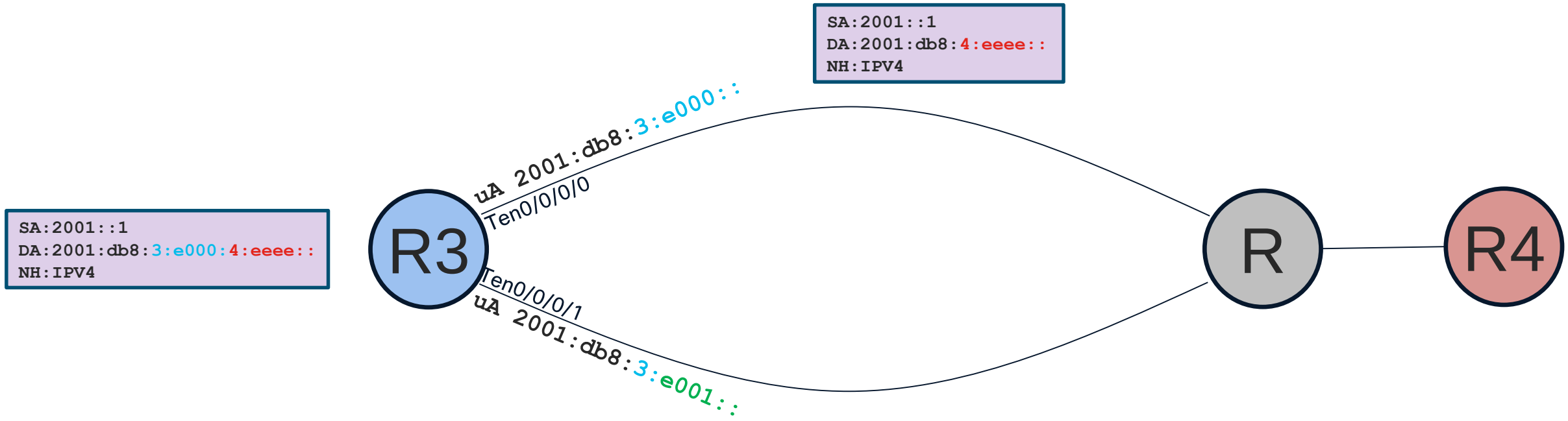
- *Decrement SL*
- *Copy Active SID*
- *Forward*



Better way:

- *Shift & Forward*

uA=END.X with Next – (Adjacency SID)



- *Shift & Forward to **SPECIFIC INTERFACE***

uDX4=END.DX4, uDX6=END.DX6, uDX2=END.DX2 Endpoint with Decapsulation and Xconnect

- *Decapsulate and Forward to **SPECIFIC INTERFACE***
- ***Same as Per CE Label Allocation***
- *Must be last function in SID list*

uDT4=END.DT4, uDT6=END.DT6 Endpoint with Decapsulation and Table Lookup

- *Decapsulate and Table Lookup* ***(VRF)***
- ***Same as Per VRF Label Allocation (aggregate label)***
- *Must be last function in SID list*

Functions might be signaled differently

Signalling	IGP	BGP-LS	BGP-IP/VPN
End, uN	Yes	Yes	
End.X, uA	Yes	Yes	
End.T	Yes	Yes	
End.DX4,uDX4		Yes	Yes
End.DX6,uDX6	Yes	Yes	Yes
End.DX2,uDX2		Yes	Yes
END.DT4,uDT4		Yes	Yes
End.DT6,uDT6	Yes	Yes	Yes
End.B		Yes	

Signalling	IGP	BGP-LS	BGP-IP/VPN
H.insert		Yes	
H.Encap		Yes	

Locator – routing table

ISIS for SRv6

LSP (Link State Packet):

TLVs:

Hostname: r2

Interfaces: Hu0/0/0/0 uA:fcbb:0:2:e001::

Structure: BL=32;NL=16;FL=16;AL=0

Hu0/0/0/1 uA:fcbb:0:2:e002::

Structure: BL=32;NL=16;FL=16;AL=0

Lo0

Neighbors: r1

r3

IP addresses: fcbb:0:2::1/128

2001:12::2/64

Locator: fcbb:0:2::/48

uN:fcbb:0:2::

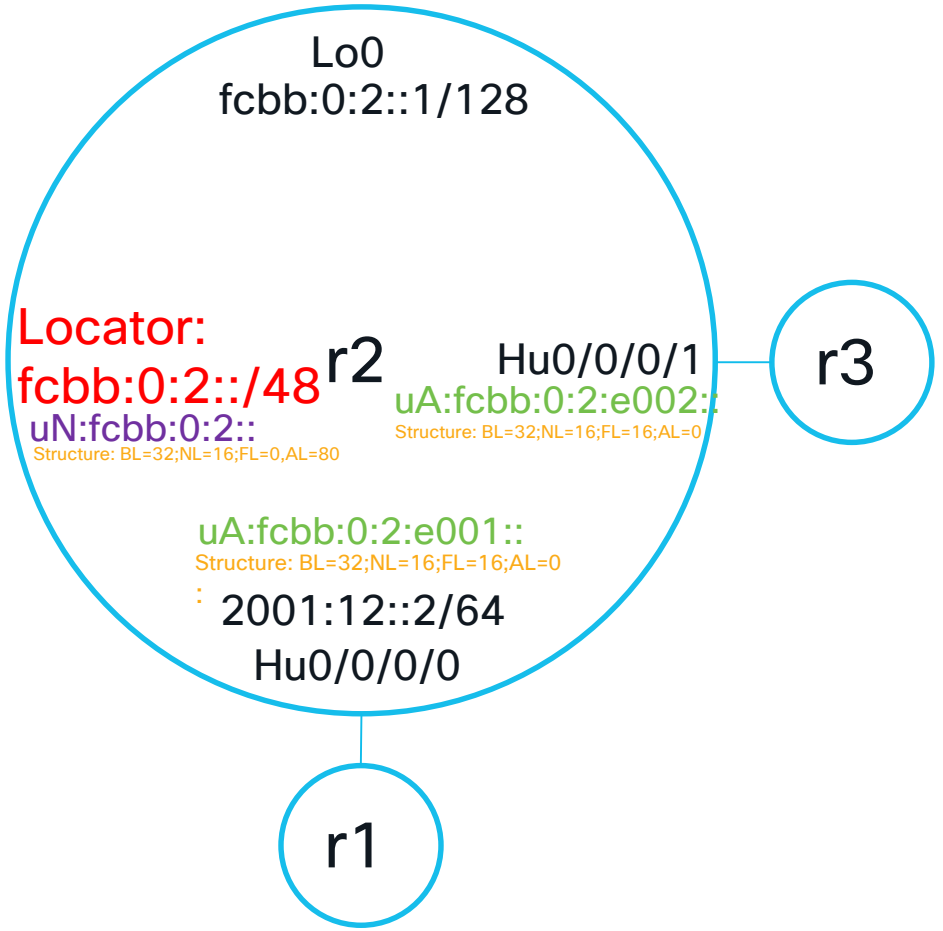
Structure: BL=32;NL=16;FL=0,AL=80

Capabilities: Algorithms .....

SIDs can insert

SIDs can decap

.....



ISIS LSP Example

```
IS-IS 1 (Level-2) Link State Database
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime/Rcvd  ATT/P/OL
r2.00-00              0x00000009   0x4f06        1145 /1200         0/0/0
  Area Address:   49
  NLPID:          0x8e
  Hostname:       r1
  IPv6 Address:   2001::2
  Metric: 10         MT (IPv6 Unicast) IPv6 fcbb:bb00:2::1/128
    Prefix Attribute Flags: X:0 R:0 N:1 E:0 A:0
  Metric: 1          MT (IPv6 Unicast) IPv6 fcbb:bb00:2::/48
    Prefix Attribute Flags: X:0 R:0 N:0 E:0 A:0
  MT:             IPv6 Unicast                                0/0/0
  SRv6 Locator:   MT (IPv6 Unicast) fcbb:bb00:2::/48 D:0 Metric: 0 Algorithm: 0
    Prefix Attribute Flags: X:0 R:0 N:0 E:0 A:0
    END SID: fcbb:bb00:2:: uN (PSP/USD)
      SID Structure:
        Block Length: 32, Node-ID Length: 16, Func-Length: 0, Args-Length: 0
  Router Cap:     0.0.0.0 D:0 S:0
    IPv6 Router ID: 2001::2
    SR Algorithm:
      Algorithm: 0
      Algorithm: 1
    SRv6: O:0
    Node Maximum SID Depth:
      SRH Max SL:       3
      SRH Max End Pop:  3
      SRH Max T.insert: 3
      SRH Max T.encaps: 4
      SRH Max End D:    4
  Metric: 10         MT (IPv6 Unicast) IS-Extended r1.00
    Local Interface ID: 6, Remote Interface ID: 6
    Interface IPv6 Address: 2001:12::2
    Neighbor IPv6 Address: 2001:12::1
    END.X SID: fcbb:bb00:2:e001:: B:0 S:0 P:0 uA (PSP/USD) Alg:0
      SID Structure:
        Block Length: 32, Node-ID Length: 16, Func-Length: 16, Args-Length: 0
Total Level-2 LSP count: 1     Local Level-2 LSP count: 0
```

Locator

Capabilities

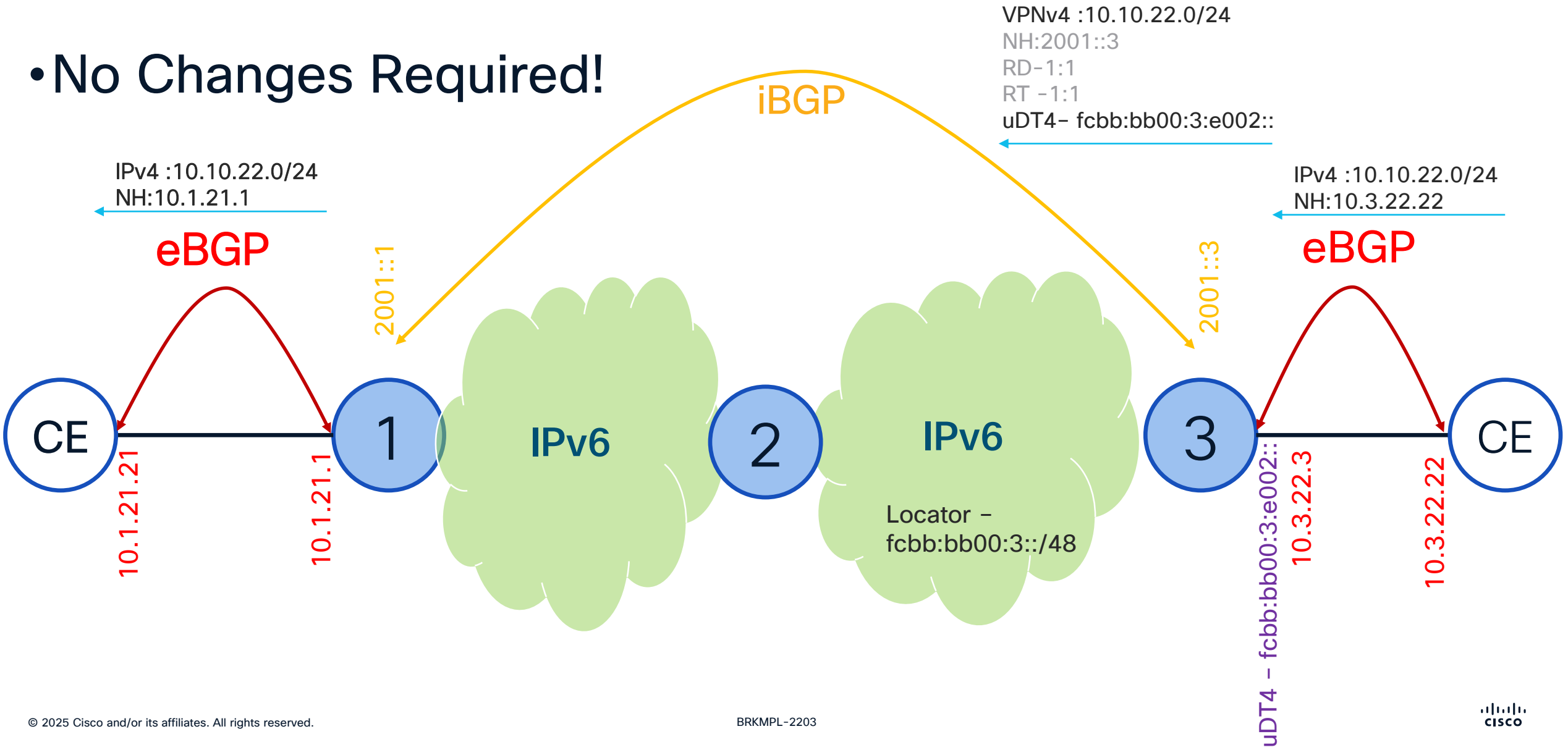
END

END.X

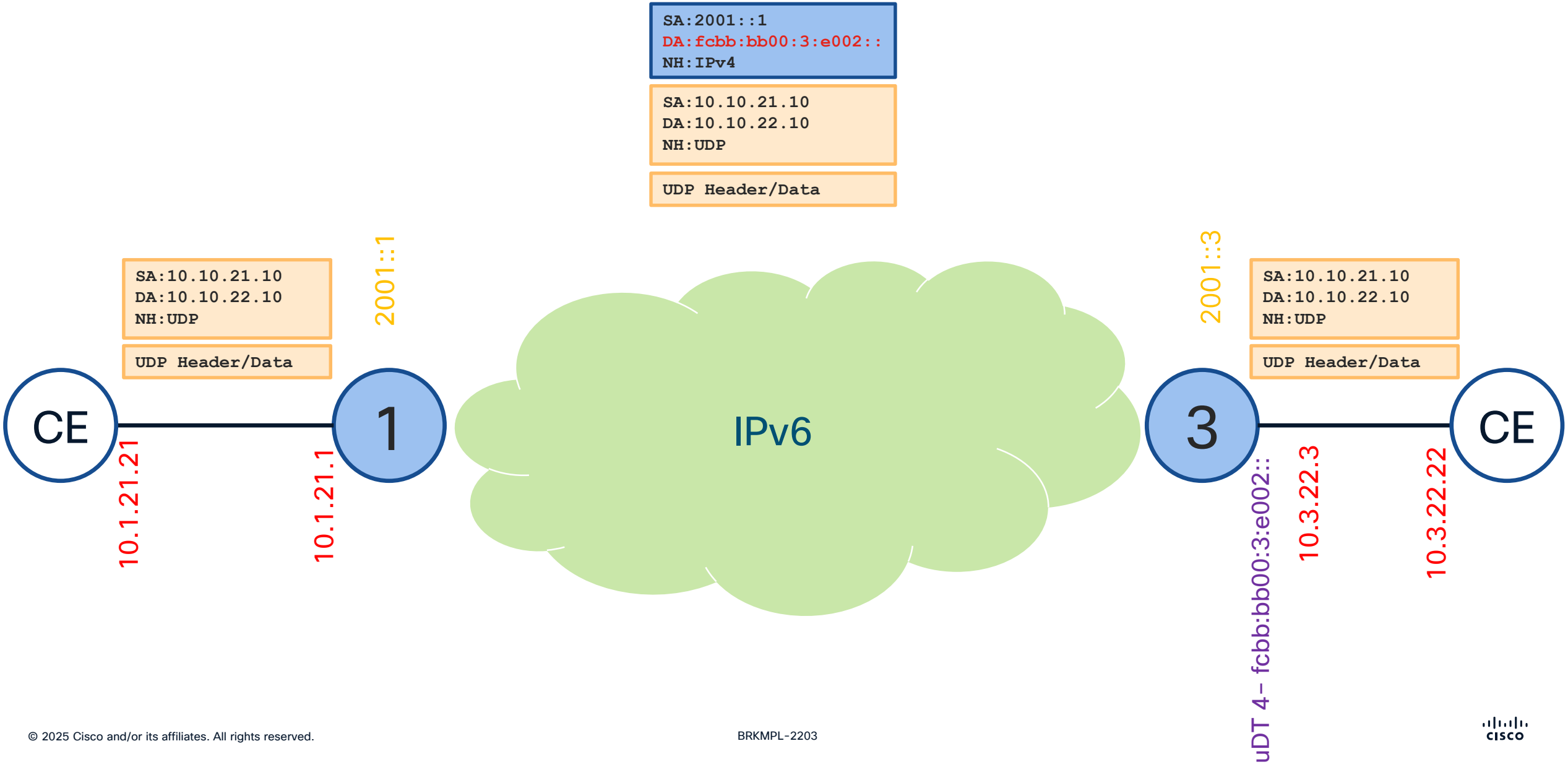
SID Structure

BGP

- No Changes Required!

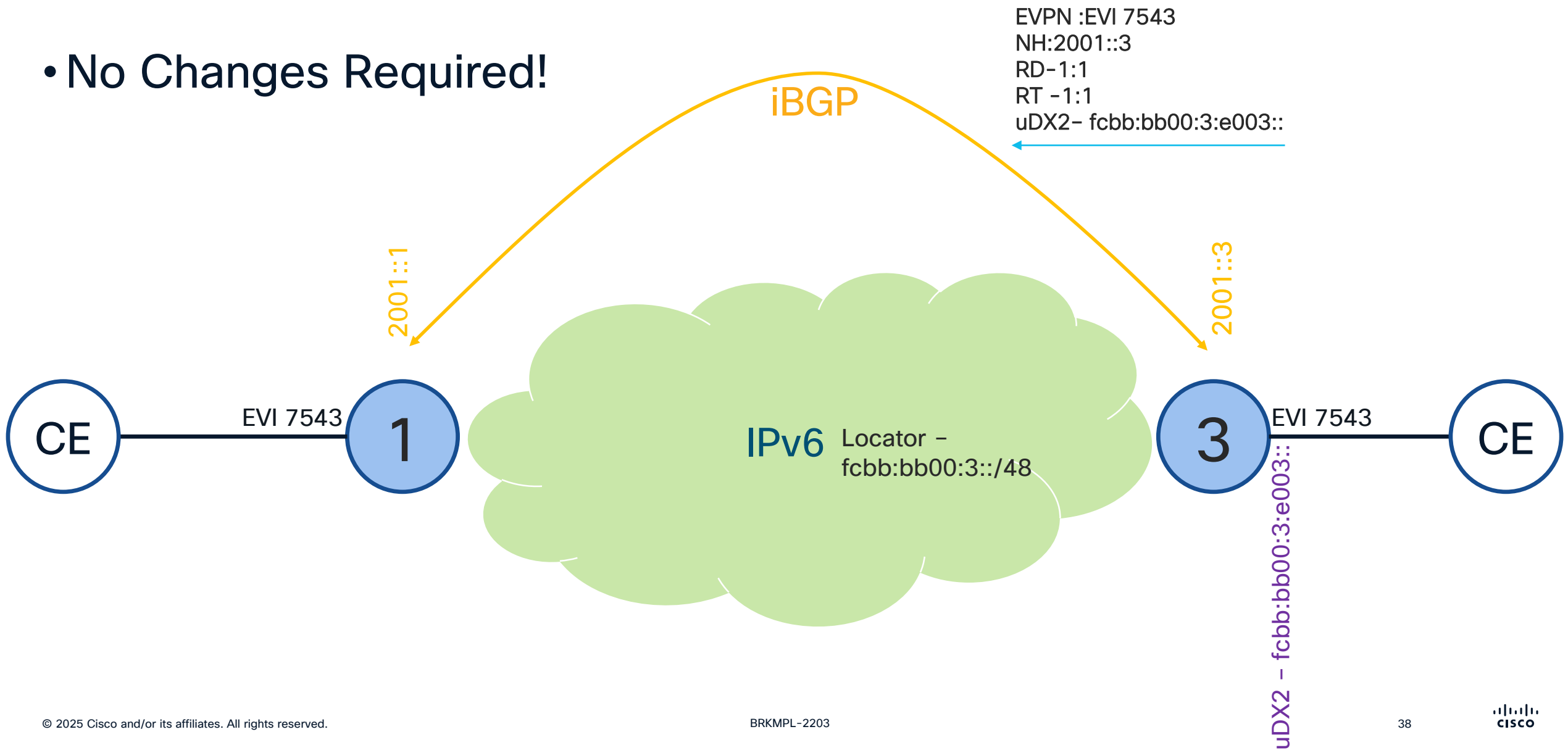


L3 VPN Dataplane

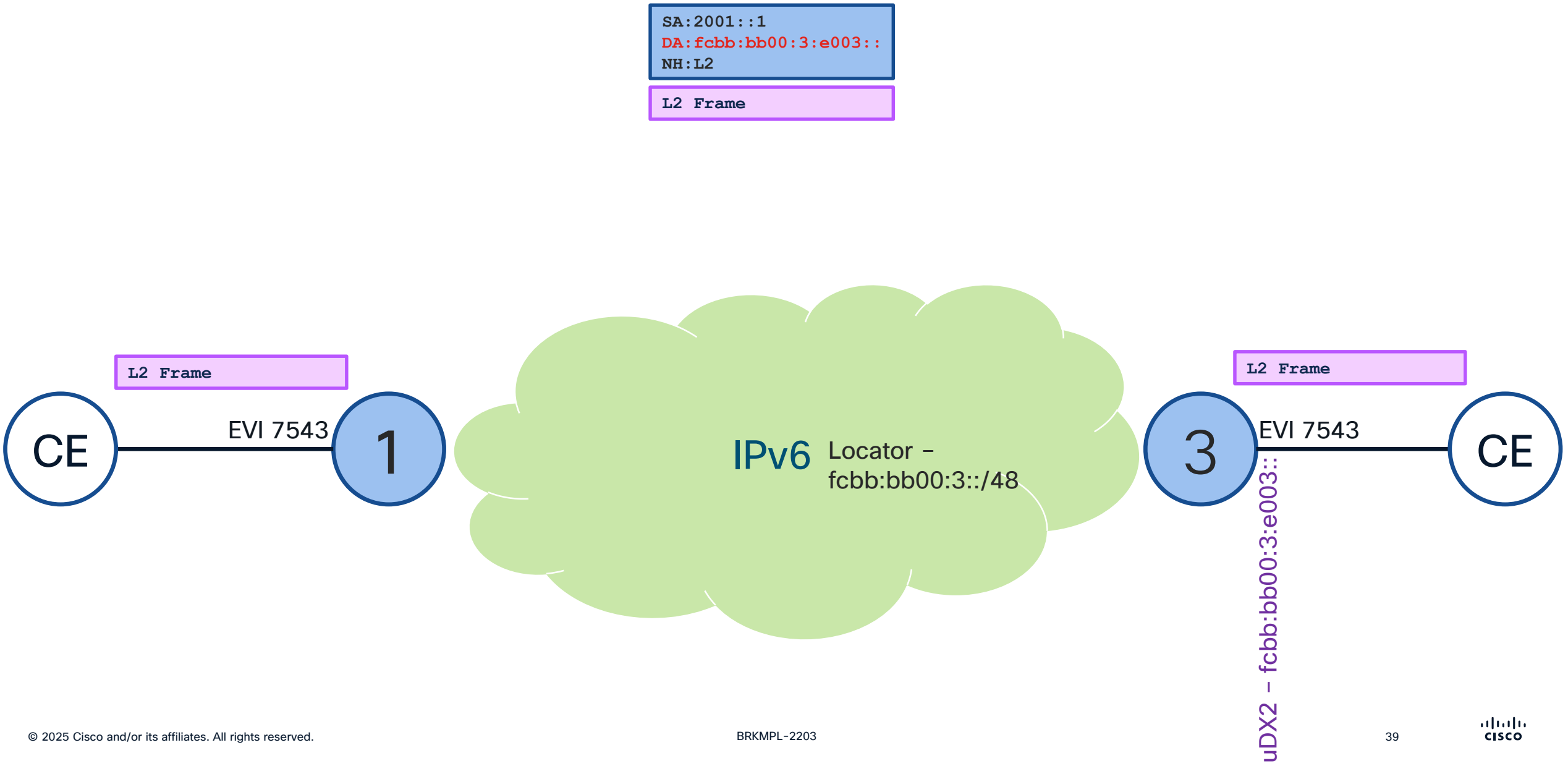


EVPN

- No Changes Required!

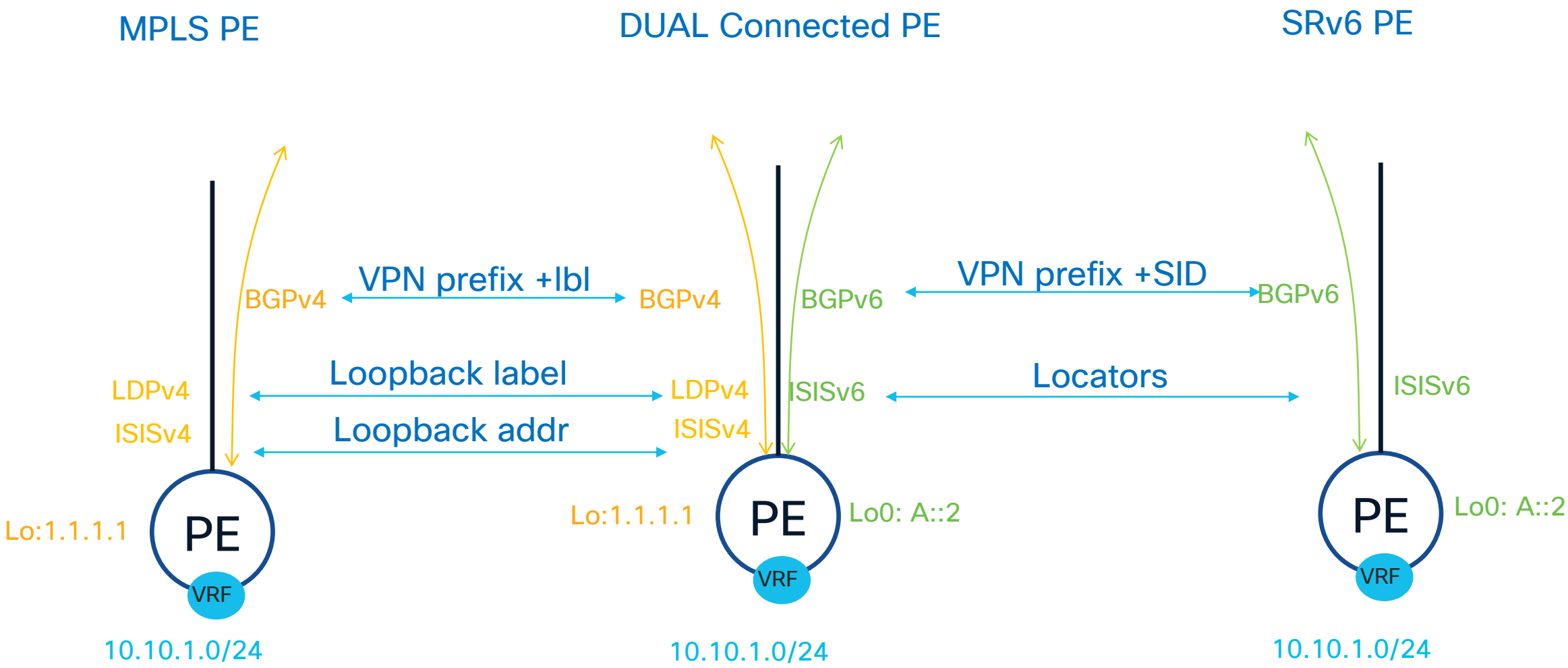


EVPN Dataplane

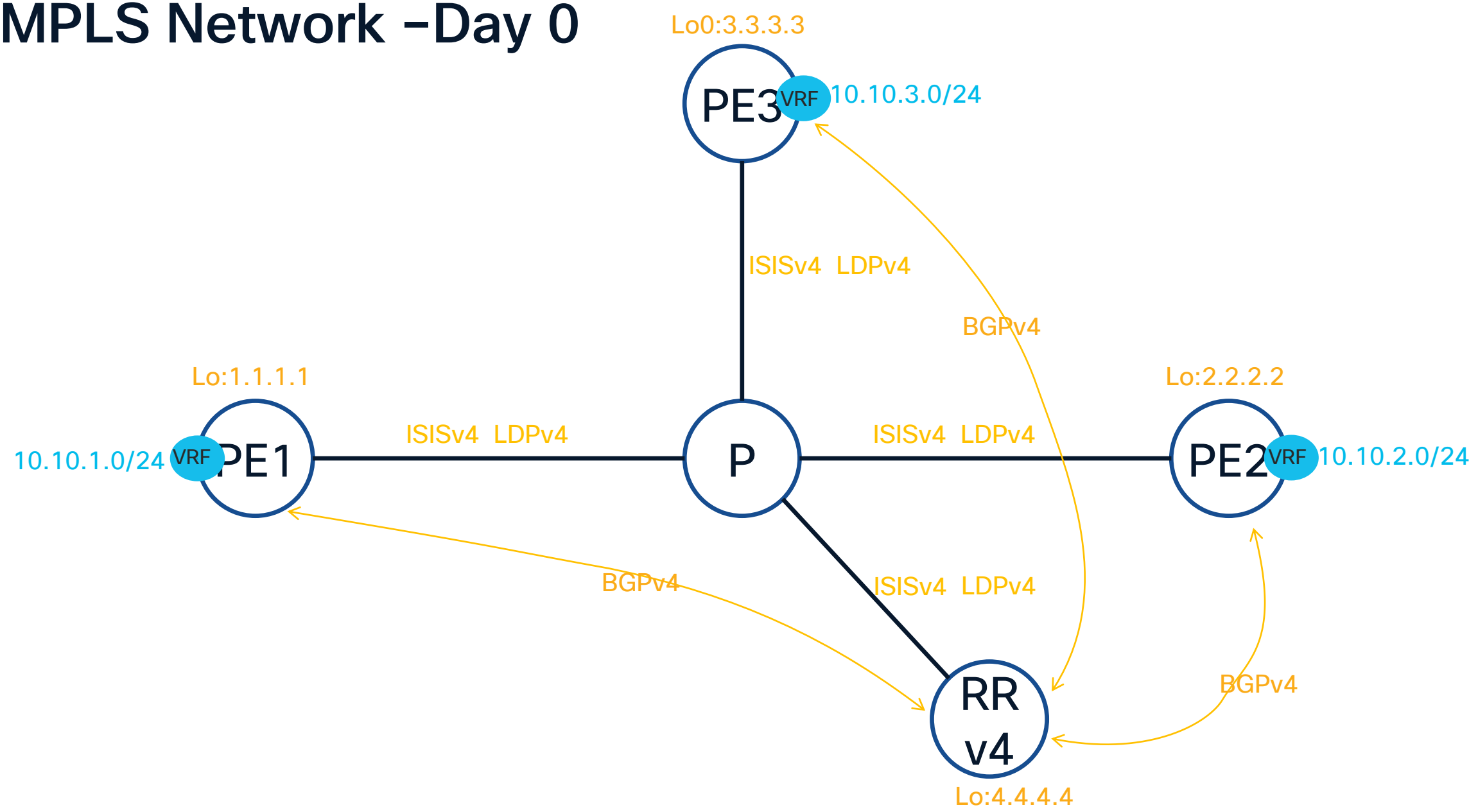


Migration to SRv6

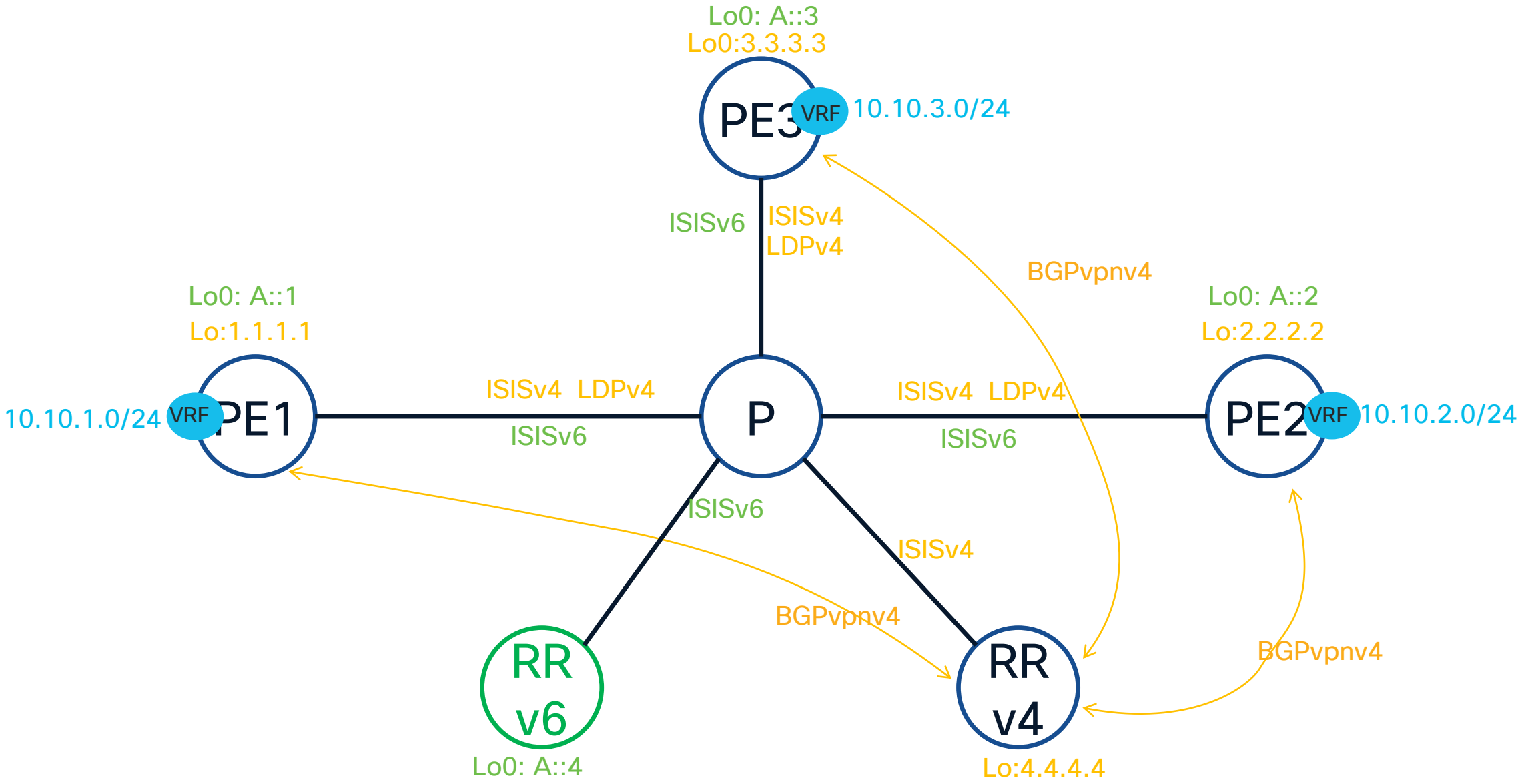
Dual Connected PE



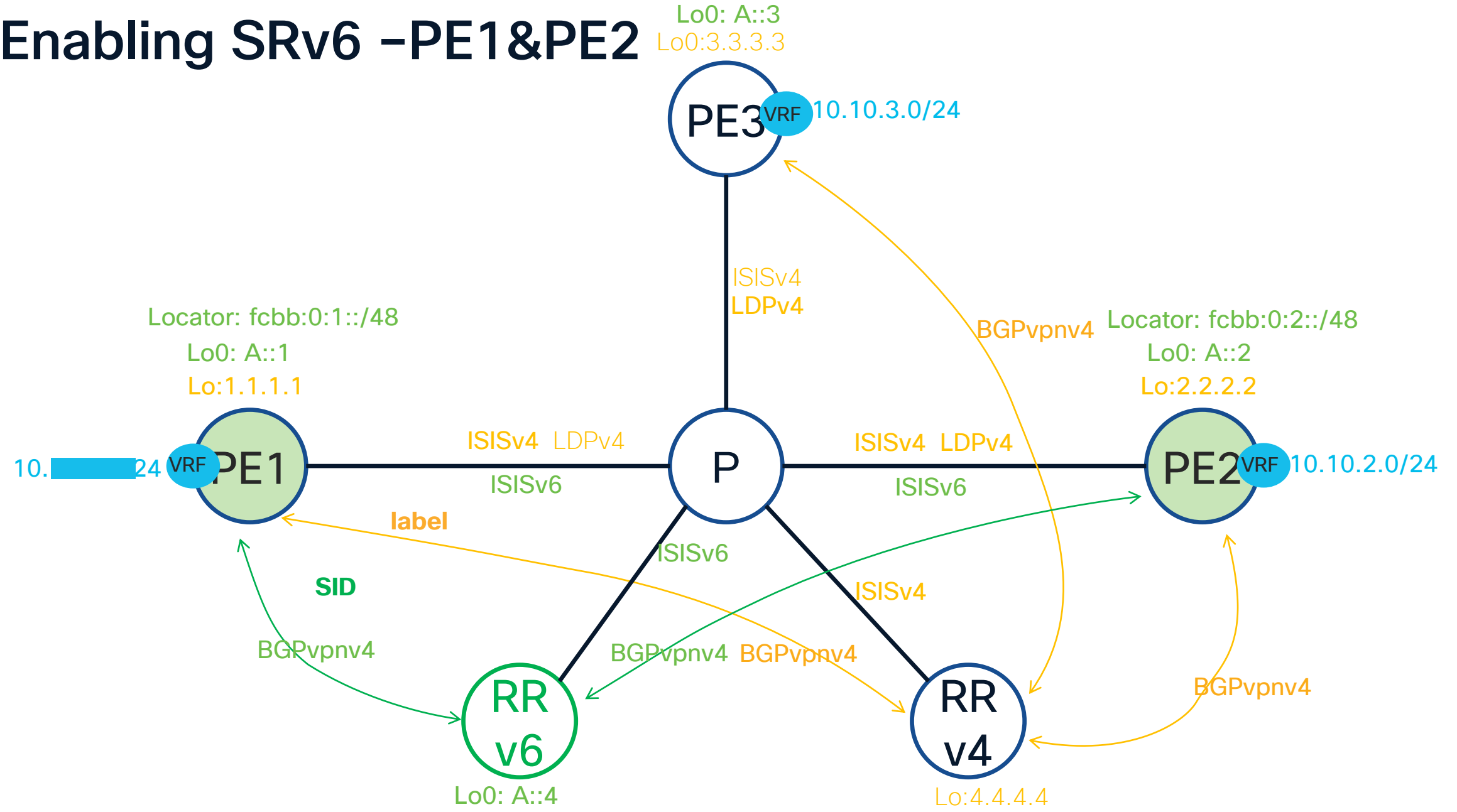
MPLS Network –Day 0



Enabling IPv6 Routing- Day 1

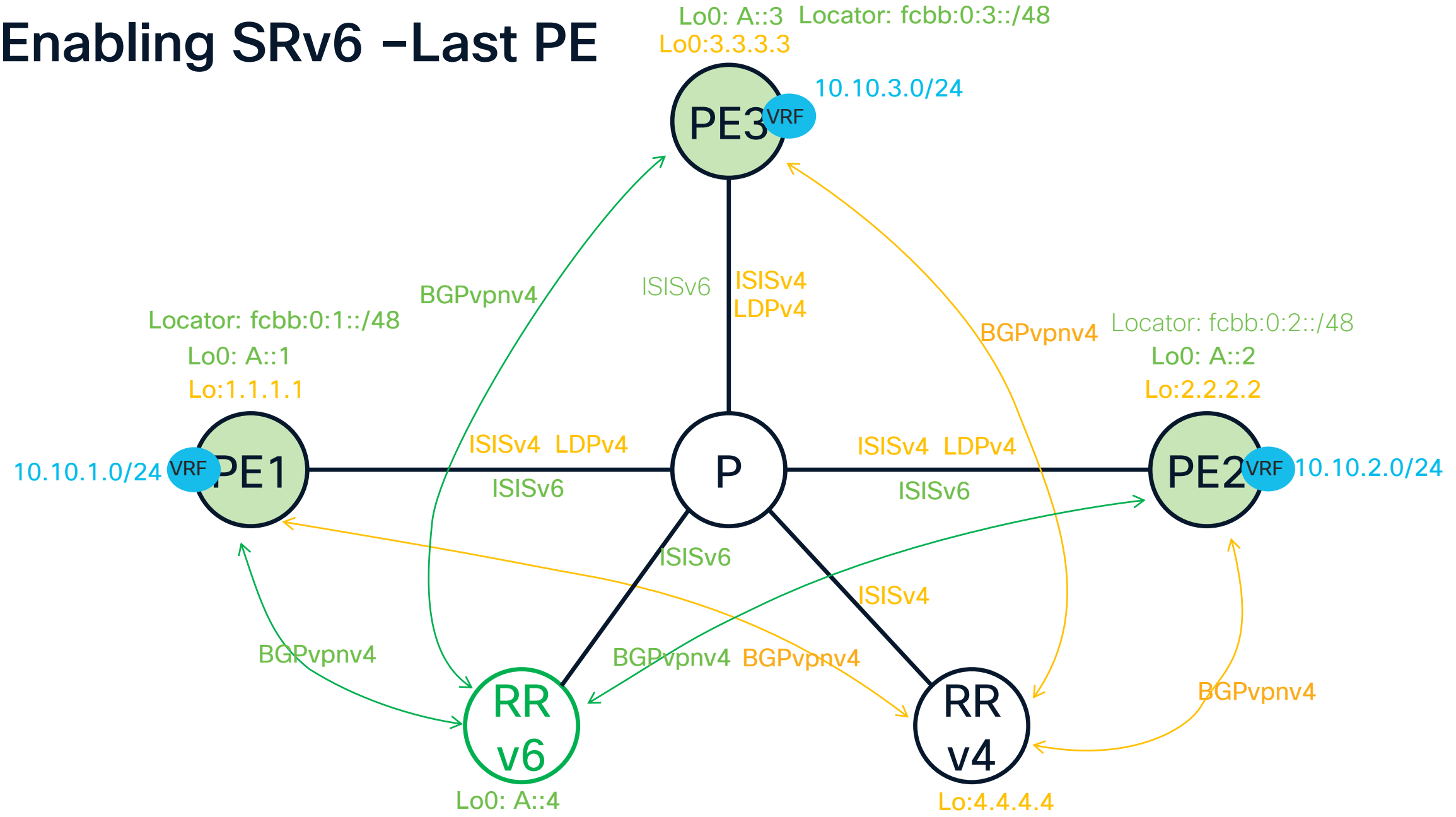


Enabling SRv6 –PE1&PE2

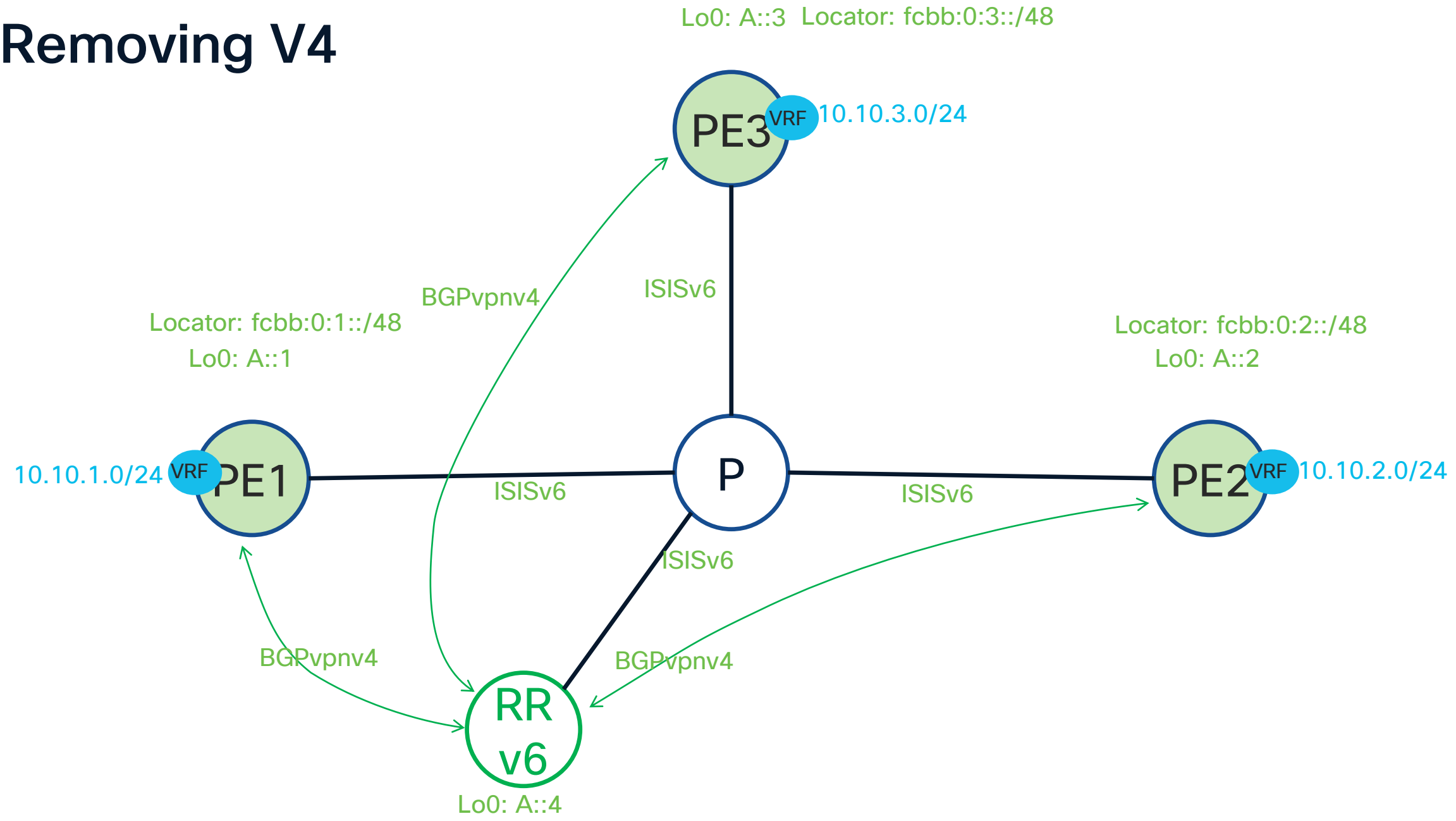


Everything is BGP best path selection driven!! (ie Local Preference)

Enabling SRv6 –Last PE



Removing V4



Conclusion

SRv6 is Fully Standardized

Architecture
- SR Architecture – **RFC 8402**
- SRTE Policy Architecture – **RFC 9256**
- Compressed SRv6 Segment List – **WG Draft**

Data Plane
- SRv6 Network Programming – **RFC 8986**
- IPv6 SR header – **RFC 8754**

Control Plane
- SRv6 BGP Services – **RFC 9252**
- SRv6 ISIS – **RFC 9352**
- SR Flex-Algo – **RFC 9350**

Operation & Management
- SRv6 OAM – **RFC 9259**
- Performance Management – **RFC 5357**

Strong Cisco Commitment and Leadership

Editor of 96% IETF RFCs
Co-author of 100% IETF RFCs

Rich SRv6 uSID Ecosystem

Network Equipment Manufacturers

Cisco, Huawei, Nokia, Ciena, Juniper Networks, ZTE, Arrcus, Arista, H3C

Merchant Silicon

Broadcom, Marvell, Barefoot Networks (Intel)

SR v6 Segment Routing

Open-Source Networking Stacks

Linux, FD.io, P4, OPEN Compute Project, Kubernetes, SONiC, FRRouting

Smart NIC

Intel, Mellanox Technologies

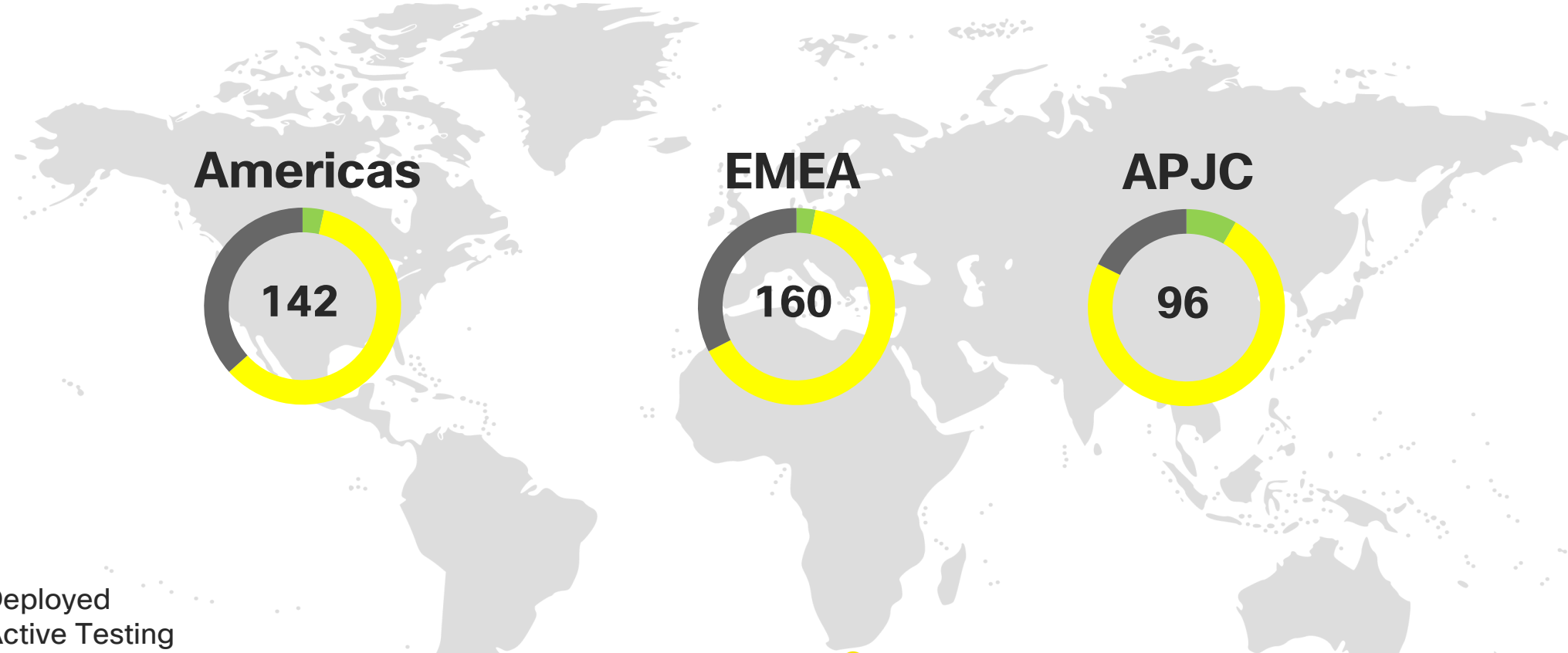
Open-Source Applications

Pyroute2, IPTABLES SERA, GoBGP, exa BGP, eBPF, cilium, TCPDUMP, Wireshark, Snort, GoBMP

Partners

kaloom, Trend Micro, ENEA Qosmos Division, NoviFlow, ixia A Keysight Business, Spirent Promise. Assured.

SRv6 ... at Record-Speed



- Deployed
- Active Testing
- Deployment Planned

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Simplicity Always Prevails

~~LDP~~

~~RSVP-TE~~

~~BGP 3107~~

~~MPLS~~

~~UDP/VxLAN~~

~~NSH~~

Furthermore, with more scale

and functionality

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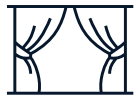

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