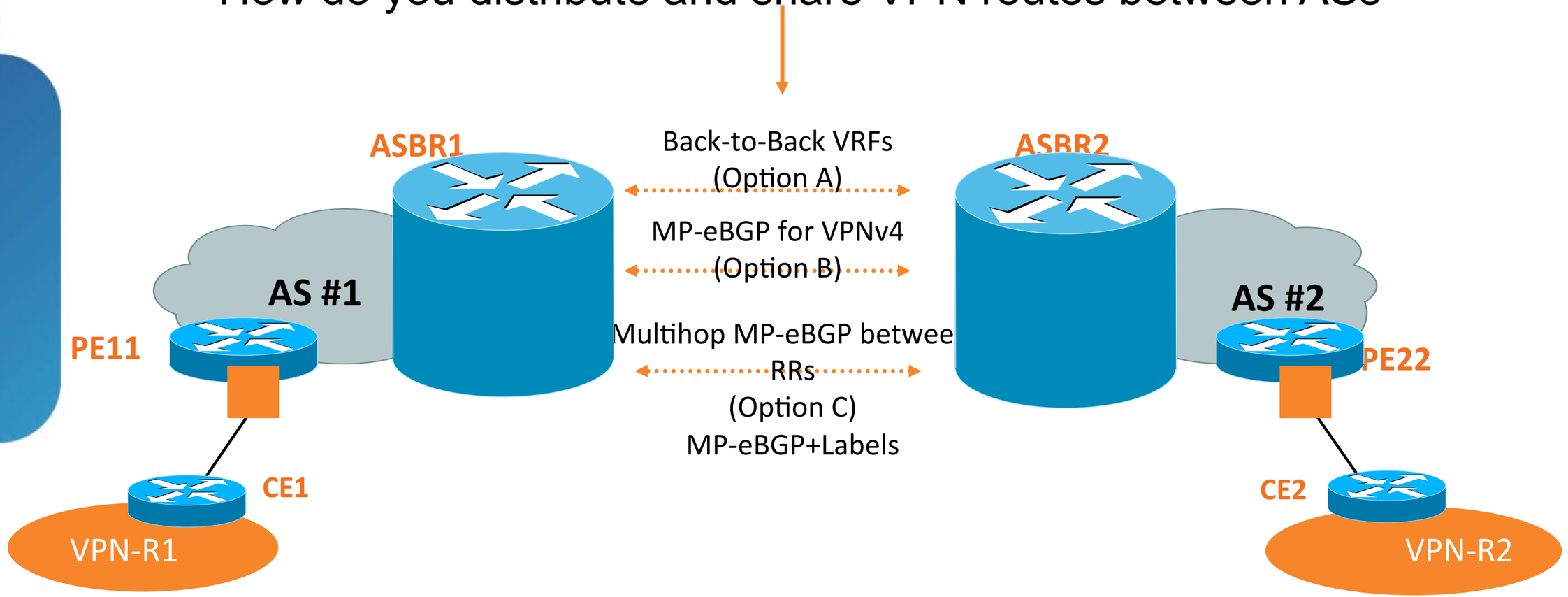
Introduction Inter-AS L3VPN

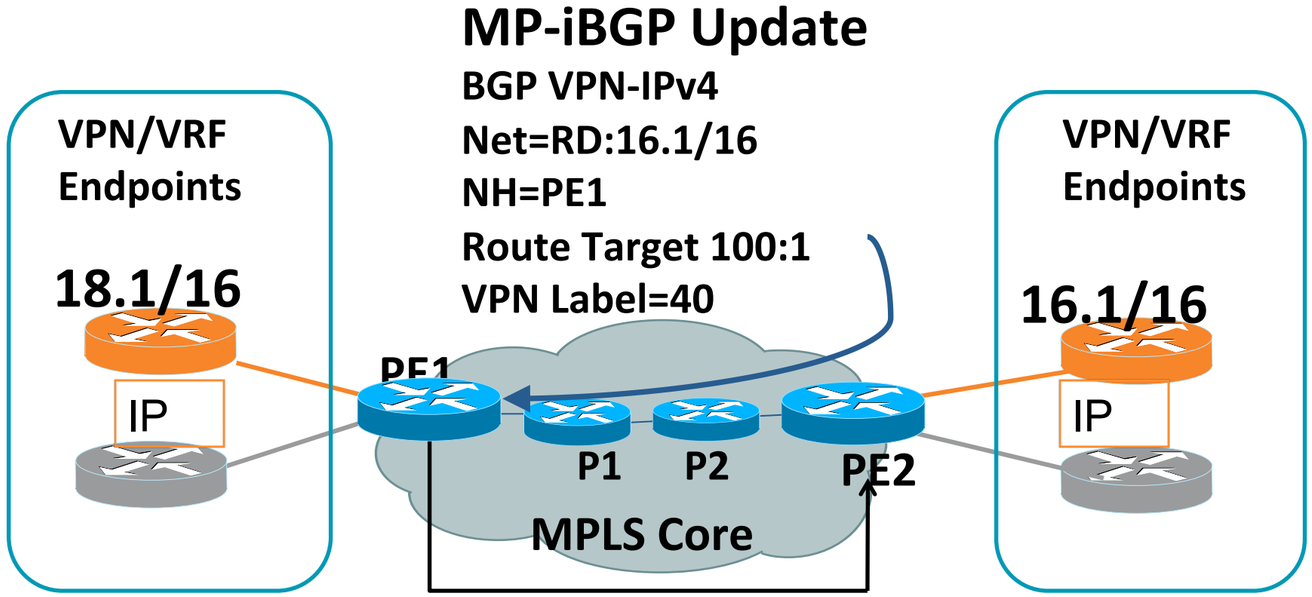
Extending VPN services over Inter-AS networks

- VPN Sites attached to different MPLS VPN Service Providers
- How do you distribute and share VPN routes between ASs



Intra-AS MPLS VPNs Review

- Route Distinguisher (RD) convert IPv4 routes to VPNv4 Routes
- Route Target allows VPN routes to be imported/ exported to/from a VPN
- Peer PE loopbacks are known via IGP
- MP-BGP protocol carries VPNv4 routes and communities using BGP address-families



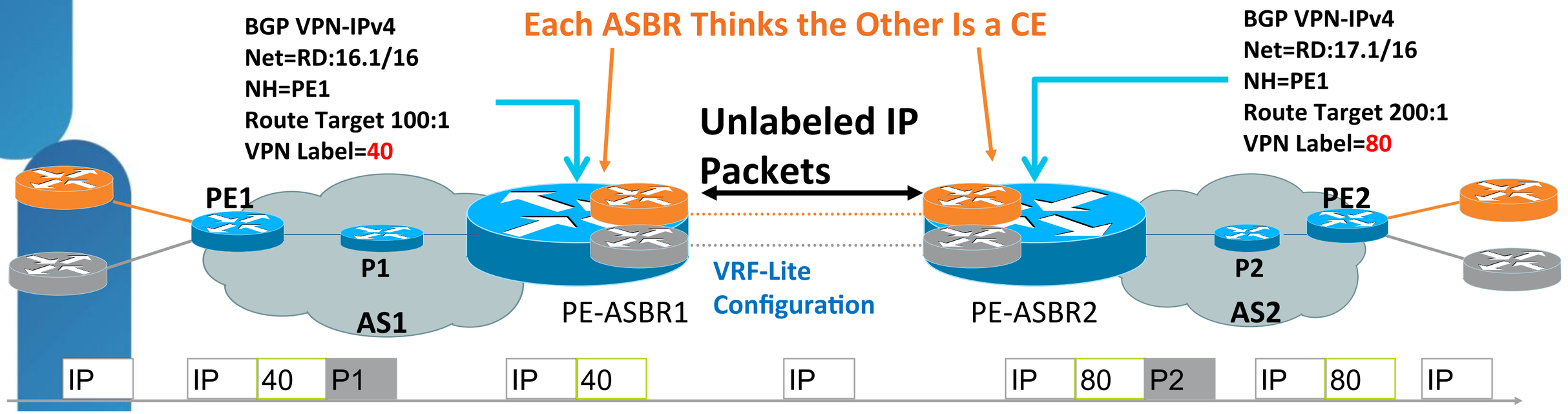
MP-iBGP Update:

BGP VPN-IPv4
Net=RD:18.1/16
NH=PE1
Route Target 100:1
VPN Label=41

@PE1 @PE2

Inter-AS VPN—Option A

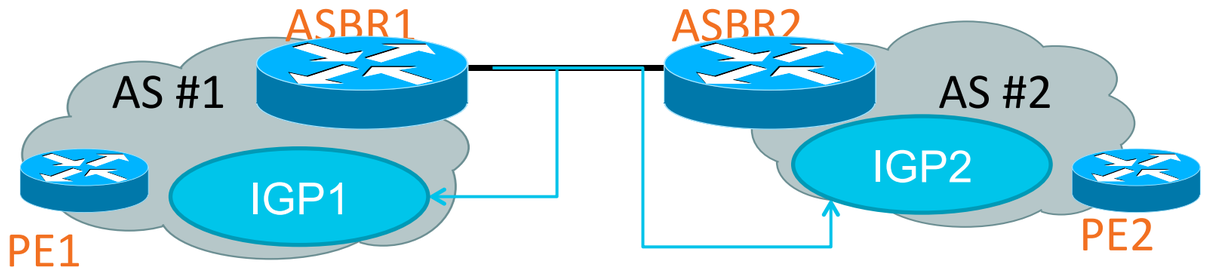
Connecting ASBRs using Back-to-Back VRFs



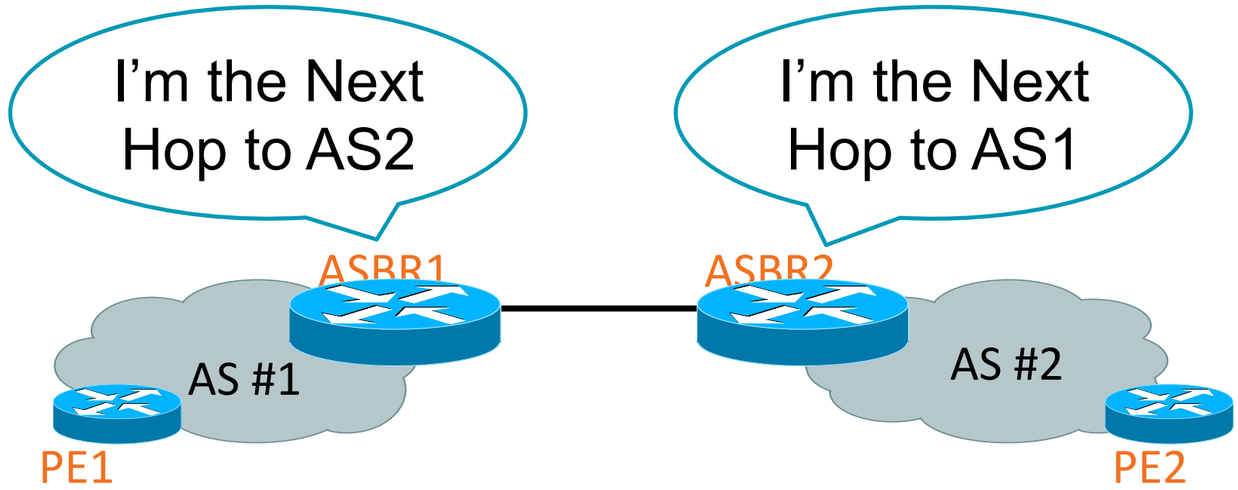
Inter-AS VPN—Option B

Connecting two ASBRs – Two Methods

1. Redistribute eBGP link into the IGP of both AS

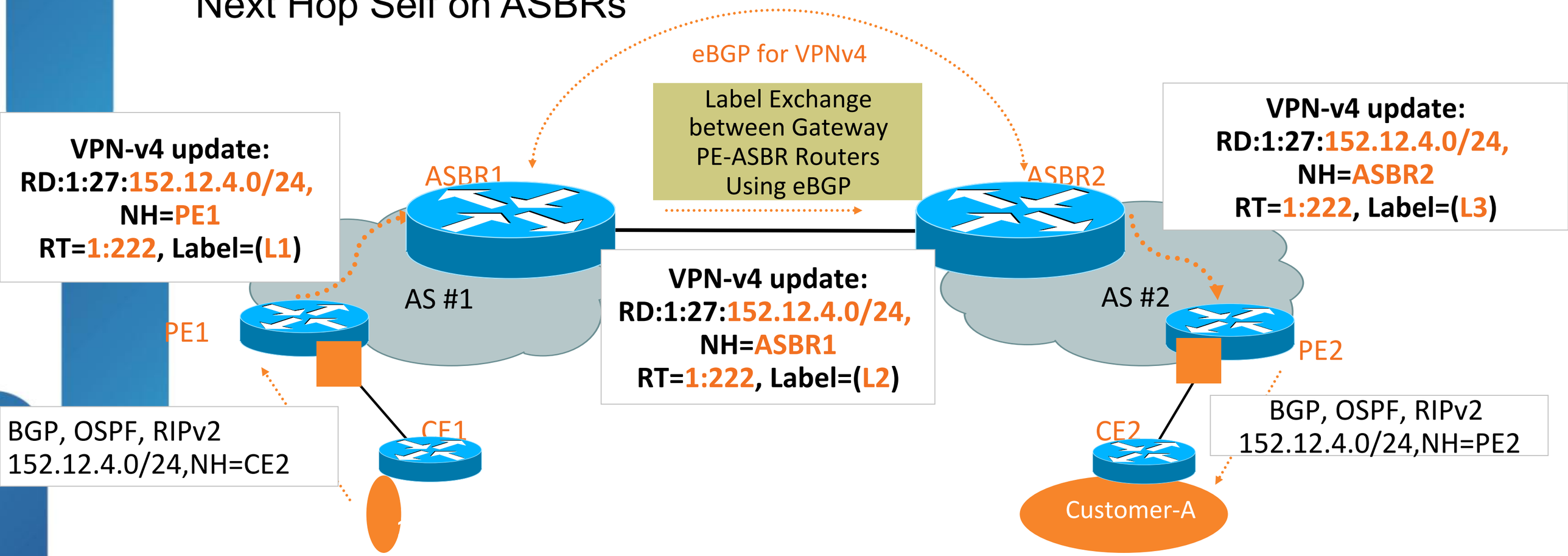


2. Receiving PE-ASBRs be the next hop



Inter-AS VPN—Option B

Establishing reachability between geographically dispersed VPNs using Next Hop Self on ASBRs



- All VPNv4 Prefixes/Labels from PEs Distributed to ASBRs
- Next Hop and labels are rewritten on ASBRs when routes are advertised across domains. ASBRs store all VPNv4 routes in BGP table.

Inter-AS VPN—Option B

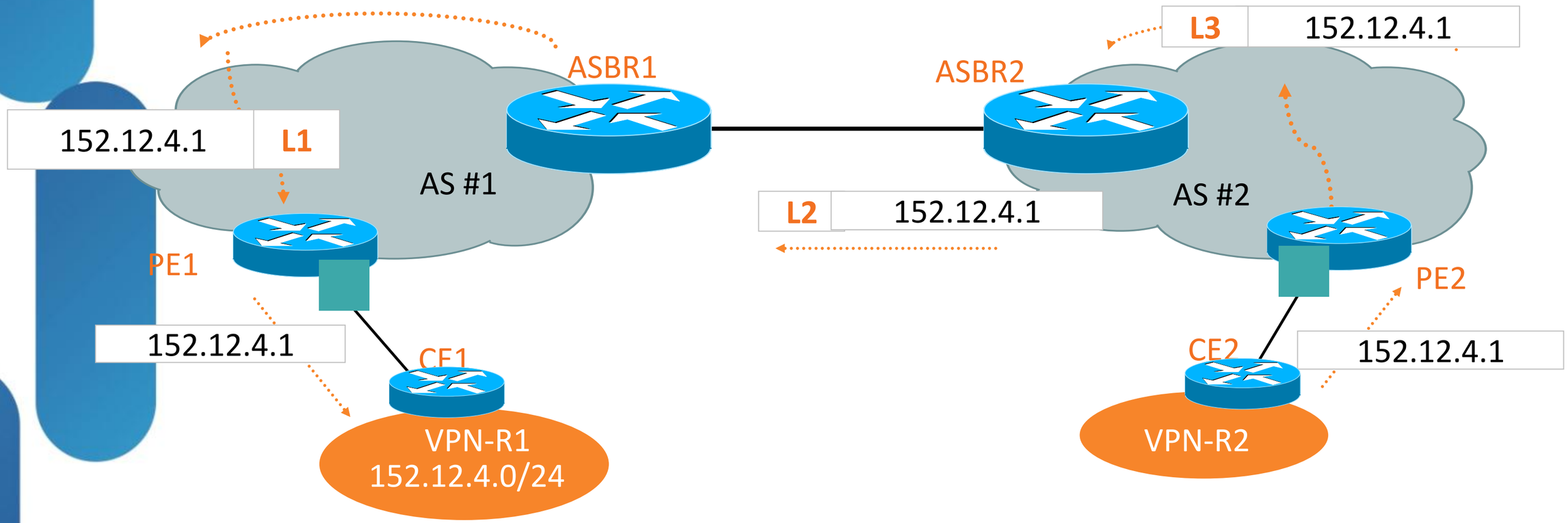
Establishing reachability between geographically dispersed VPNs using Next Hop Self on ASBRs

- No Virtual Routing Forwarding tables on ASBRs unless ASBR also supports PE functionality (has VRF interfaces)
- In IOS, Receiving PE-ASBR automatically creates a /32 host route to a peer ASBR

  Which must be advertised into receiving IGP if next-hop-self is not in operation to maintain the LSP
- In XR, **must** define a static route to the Next Hop of peer ASBR for Option B and C as well as **all address families (IPv4, IPv6, VPNv4, VPNv6). The CLI is only shown in Option B configuration example.**
- In XR, **must** define route-policy to pass or filter selected VPNv4 routes for **for Option B and Option C as well as all address families (IPv4, IPv6, VPNv4, VPNv6). The CLI is only shown in Option B configuration example.**
- **ASBR-ASBR link must be directly connected!!!!!! Could use GRE tunnel-considered directly connected.**

Inter-AS VPN—Option B

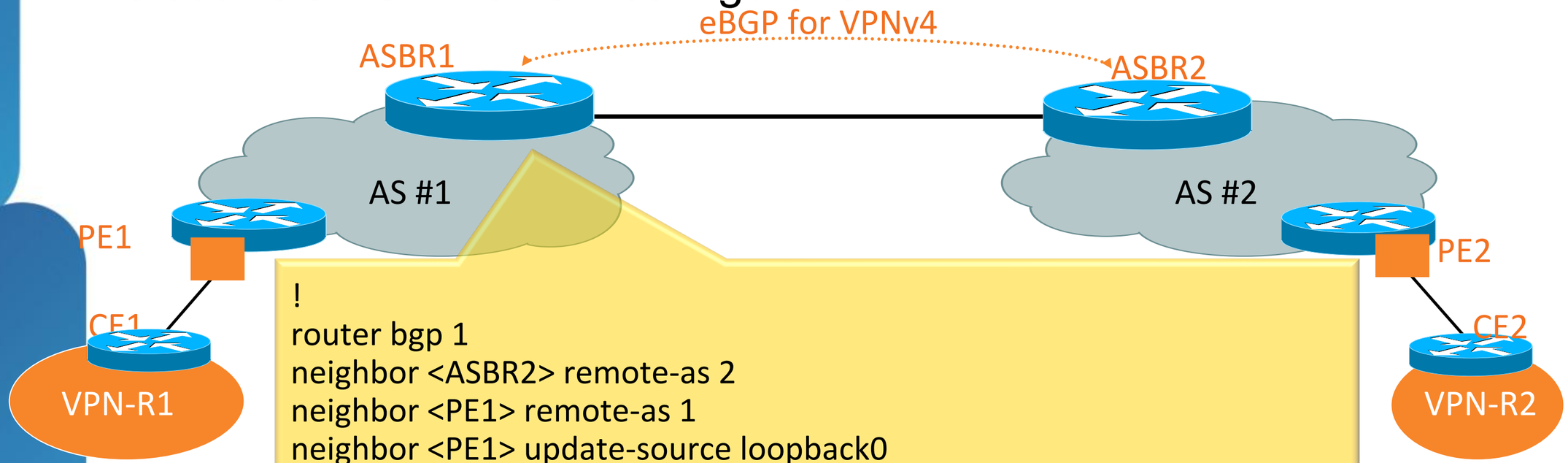
End-to-end VPN packet forwarding - Next Hop Self on ASBRs



- **L1, L2, L3 are BGP VPN label.**
- **The Outer Most Core (IGP Labels in an AS) Label Is not displayed in on this slide.**

Inter-AS VPN—Option B

Cisco IOS ASBR eBGP configuration

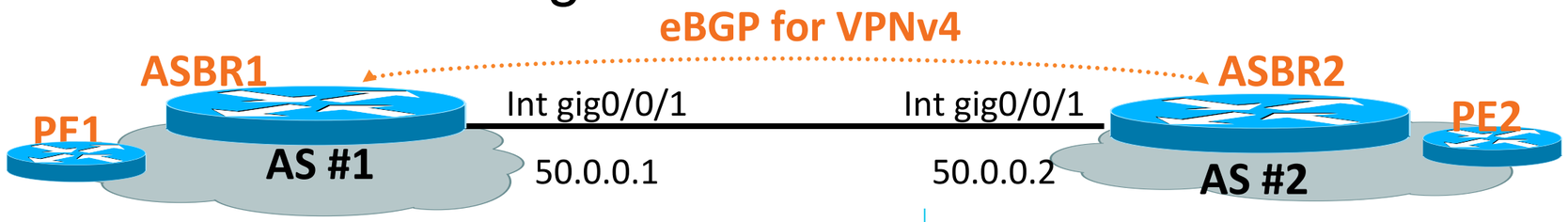



```
!
router bgp 1
neighbor <ASBR2> remote-as 2
neighbor <PE1> remote-as 1
neighbor <PE1> update-source loopback0
no bgp default route-target filter
!
address-family vpnv4
neighbor <PE1> remote-as 1 activate
neighbor <PE1> remote-as 1 next-hop-self
neighbor <ASBR2> remote-as 2 activate
neighbor <ASBR2> remote-as 2 send-community extended
```

ASBRs require no bgp default route-target filter command to store VPNv4 routes as it does not have any VRF interfaces.

Inter-AS VPN—Option B

Cisco IOS XR ASBR1 Configuration




```
router bgp 1
  mpls activate
(!Enables MPLS forwarding onASBR!)
  interface <type & #>
(!Specify ASBR-ASBR link!)
  address-family vpnv4 unicast
!
neighbor <ASBR2>
   remote-as 2
   address-family vpnv4 unicast
(!Initialize VPNv4 address family for ASBR)
   route-policy pass-all in
   route-policy pass-all out
(!Allow forwarding of VPNv4 routes to other AS!)
!
route-policy pass-all
pass
end-policy
!
```

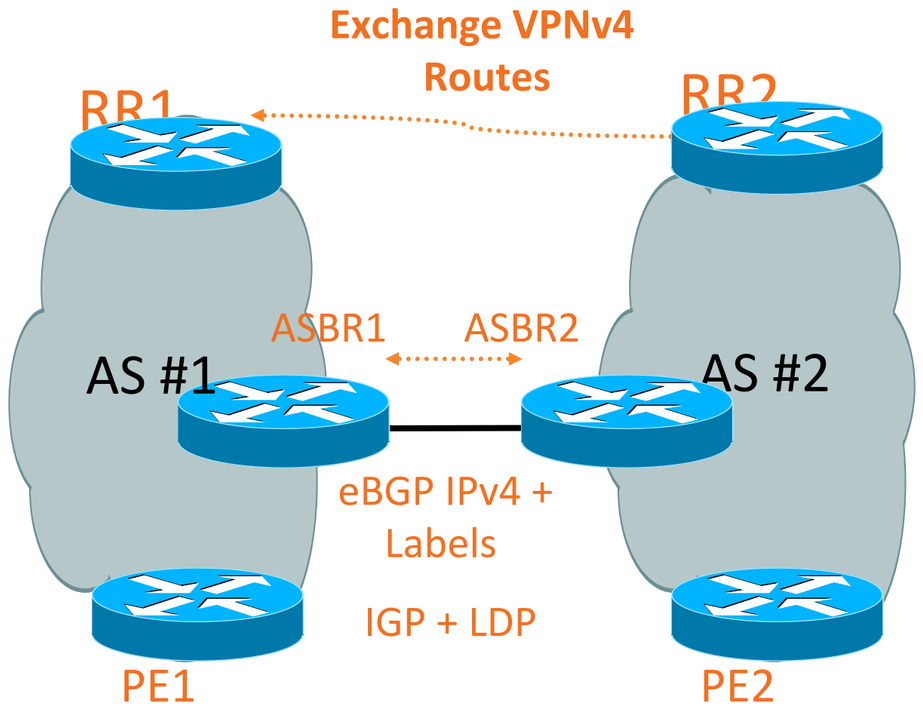
```
!
neighbor <PE1>
   remote-as 1
   update-source loopback0
   address-family vpnv4 unicast
   next-hop-self
(!Set ASBR1 as next-hop-self!)
!
router static
   50.0.0.2/32 interface gig0/0/1
!
(!Static Route for ASBR-ASBR link must be configured. It is not installed automatically like in IOS!)
```

- **Note: Static route and route-policy required for all address-families & Option B and C**

Inter-AS VPN—Option C

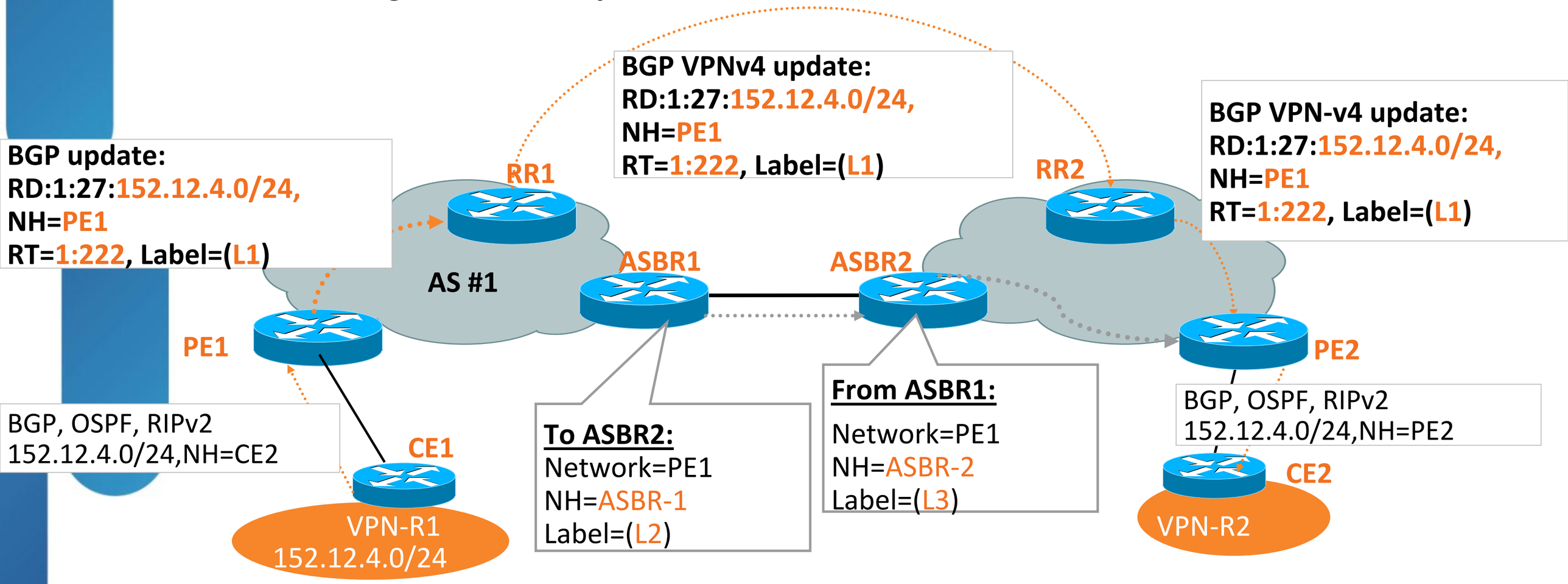
Multihop eBGP VPNv4 Between RRs for better scale

- Route Reflectors exchange VPNv4 routes
- ASBRs Exchange PE loopbacks (IPv4) with labels as these are BGP NH addresses
- Eliminates LFIB duplication at ASBRs. ASBRs don't hold VPNv4 prefix/label info.
- Two Options for Label Distribution for BGP NH Addresses for PEs in each domain:
  1. BGP IPv4 + Labels (RFC3107) – most preferred & recommended
  2. IGP + LDP
- BGP exchange Label Advertisement Capability - Enables end-end LSP Paths
- Subsequent Address Family Identifier (SAFI value 4) field is used to indicate that the NLRI contains a label
- Disable Next-hop-self on eBGP RRs (peers)



Inter-AS VPN—Option C

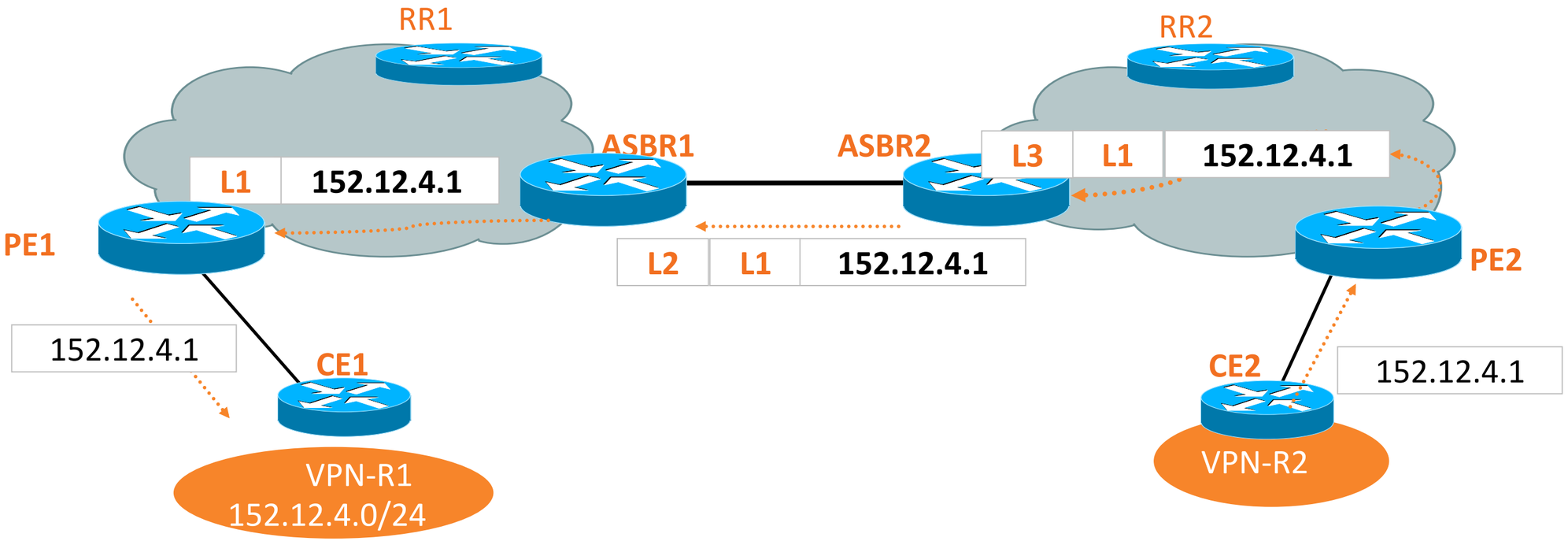
Establishing reachability between VPNs



- **ASBRs store PE loopbacks & exchange labels for PE Loopback addresses**
- **RRs store and exchage VPNv4 routes & labels**

Inter-AS VPN—Option C

VPN packet forwarding

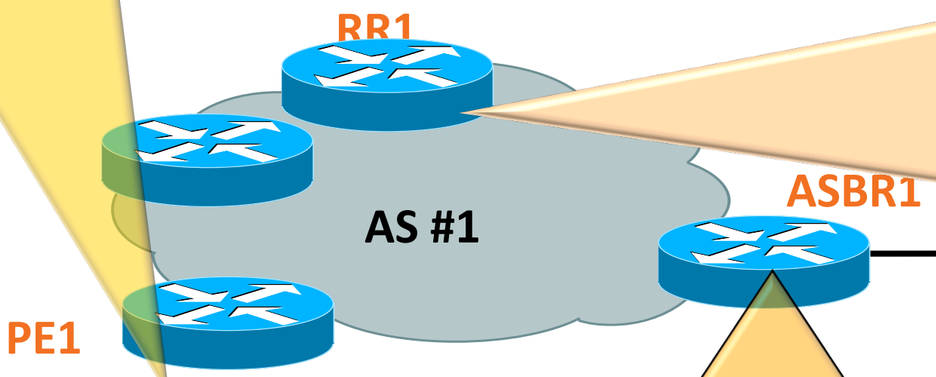


- L1 is a VPN label. L2 and L3 are IPv4 labels.
- The Outer Most Core (IGP Labels in an AS) Label Is not displayed in on this slide.

Inter-AS VPN—Option C

IPv4+Label, Cisco IOS Configuration

```
!
address-family ipv4
neighbor <RR1> activate
neighbor <RR1> send-label
!
```




```
!
router bgp 1
neighbor <RR2> ebgp-multihop 255
!
address-family ipv4
neighbor <RR2> activate

neighbor <PE1> activate
neighbor <PE1> send-label

neighbor <ASBR1> activate
neighbor <ASBR1> send-label
!
address-family vpnv4
neighbor <RR2> next-hop-unchanged
exit-address-family
!
```

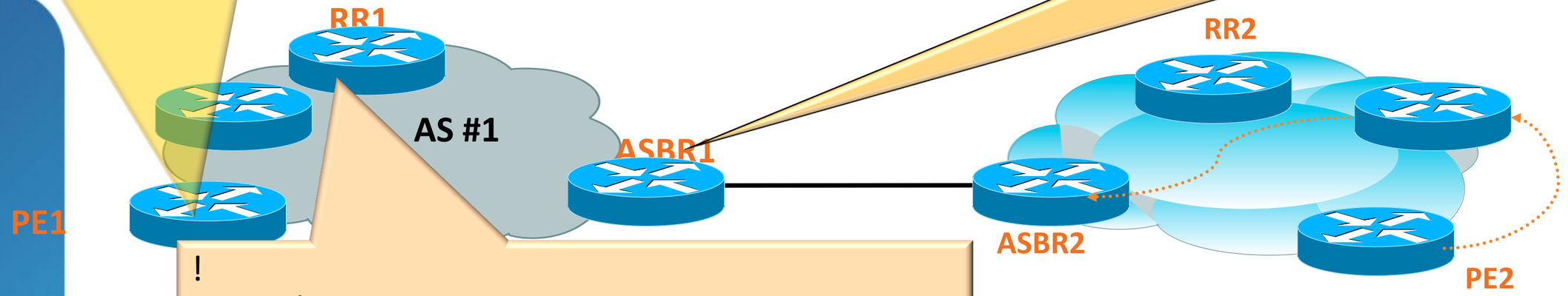
```
!
address-family ipv4
neighbor <ASBR2> activate
neighbor <ASBR2> send-label

neighbor <RR1> activate
neighbor <RR1> next-hop-self
neighbor <RR1> send-label
!
```

Inter-AS VPN—Option C

IPv4+Label, Cisco IOS XR Configuration

```
! Command towards all peers!
address-family ipv4 labeled-unicast
!
```

```
!  Command towards all peers!
address-family ipv4 labeled-unicast
!
```




```
!
router bgp 1
address-family vpnv4 unicast
!
neighbor  <RR2>
   remote-as 2
   address-family vpnv4 unicast
   ebgp-multihop 255
   next-hop-unchanged
!
```

Inter-AS L3VPN Summary

- Three models: Option A, B, and C
- Option A is the most secured, least invasive. Support granular QoS.
- Option B, more scalable than Option-A for high numbers of VRFs. more adoptable by different provider corporations
  - Less invasive than Option C, More invasive than Option A
  - More scalable than Option-A if have high numbers of VRFs
  - Use eBGP for ASBR peering
  - ASBRs store VPNv4 routes and allocate labels for VPN prefixes
- Option C, most scalable, most invasive, mostly deployed in a single service provider's multi-AS network
  - Use ASBRs to handle IPv4 PE loopbacks
  - Route Reflectors exchange VPNv4 routes

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