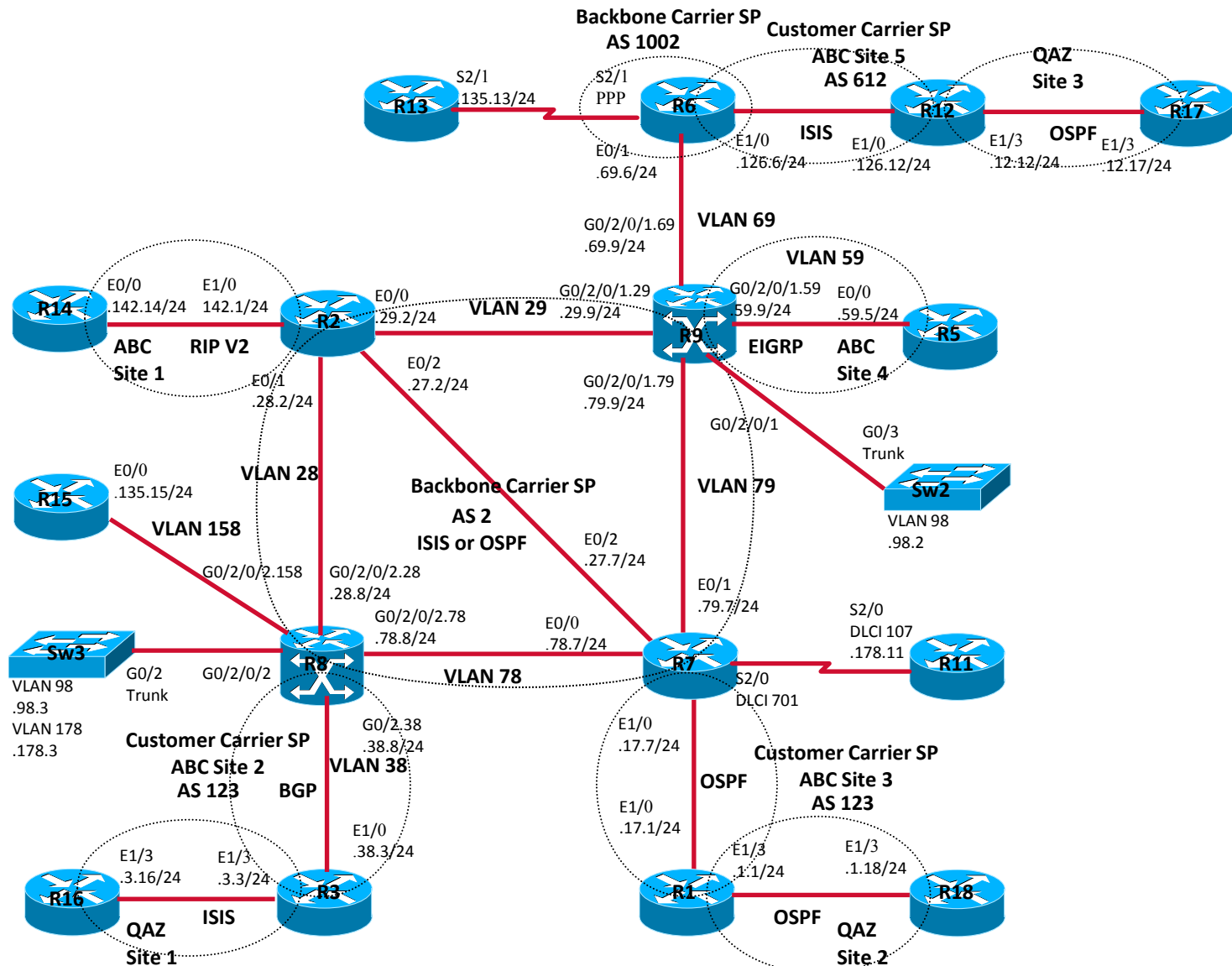# CCIE Service Provider v3.0 Sample Lab
Part 5/7

Vincent Jun Ling Zhou

CCIE Service Provider – Product Manager

Cisco Systems

SP Sample Lab – Main Topology

SP Sample Lab – Addressing Scheme

- Backbone Carrier SP network Prefix: 2.2.0.0/24, 2002:2:2::/64

- Backbone Carrier SP router Loopback0: 2.2.0.Z/32, 2002:2:2::Z/128

- Customer Carrier SP/VPN network Prefix: 172.2.0.0/24, 2002:172:2::/64

- Customer Carrier SP/VPN router Loopback0: 172.2.0.Z/32, 2002:172:2::Z/128

- End Customer VPN network Prefix: 192.2.0.0/24

- End Customer VPN router Loopback0: 192.2.0.Z/32

- L2 VPN Customer network Prefix: 172.2.0.0/24

- L2 VPN Customer router Loopback0: 172.2.0.Z/32

"Z" is router number, for example "Z" value for R12 is "12"

SP Sample Lab – Setup

- Hardware

  Two XR-12404 with two GigabitEthernet interfaces or equivalent

  Thirteen Cisco 7200 series routers with Ethernet interfaces or equivalent

  Three Cisco 3560G series or equivalent
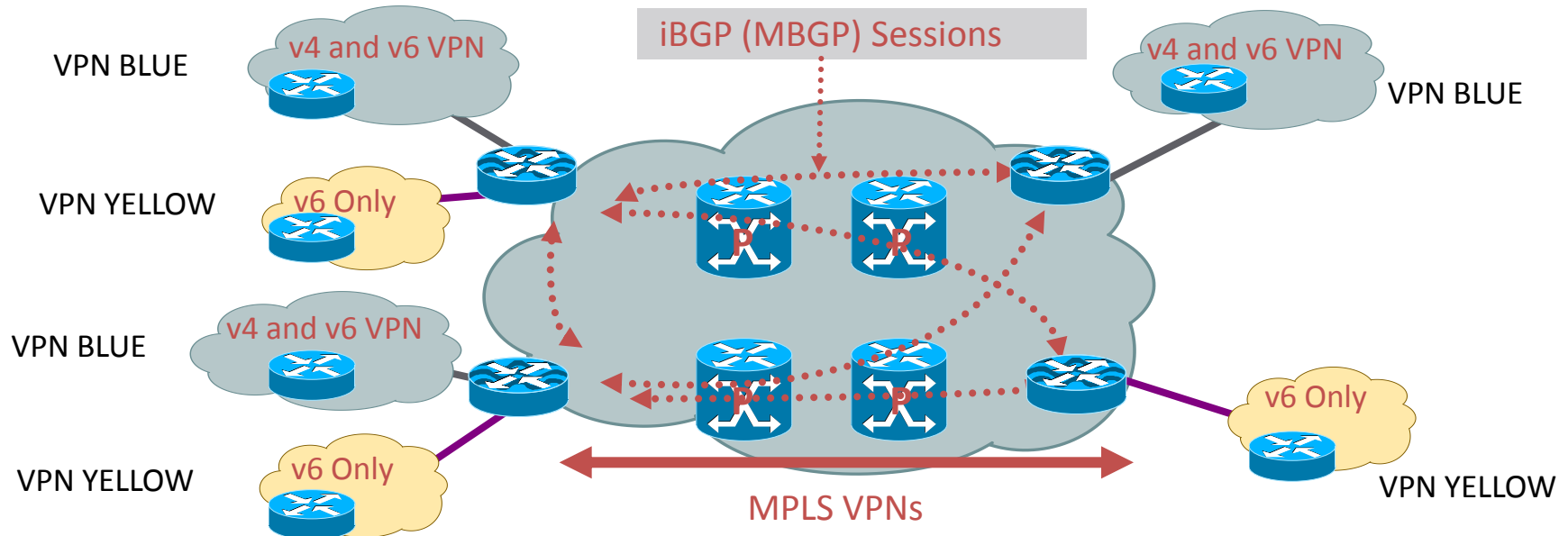
- Software Operating System

  XR12000-iosxr-k9-3.9.1.tar

  c7200-spservices-mz.122-33.SRE2.bin

  c3560-advipservicesk9-mz.122-46.SE.bin

SP Sample Lab Questions

	Question, Configuration and Verification
1	IS-IS IPv4/IPv6
2	OSPF IPv4/IPv6
3	BGP unicast IPv4/IPv6
4	MPLS LDP
5	MPLS TE
6	MPLS TE FRR
7	MP-BGP intra-AS VPNv4
8	MP-BGP inter-AS VPNv4
9	CSC
10	MP-BGP VPNv6 - 6VPE
11	Multicast VPN
12	AToM
13	VPLS
14	L2TPv3

MP-BGP VPNv6 - 6VPE Deployment

VPN BLUE

v4 and v6 VPN

iBGP (MBGP) Sessions

v4 and v6 VPN

VPN BLUE

VPN YELLOW

v6 Only

VPN BLUE

v4 and v6 VPN

v6 Only

VPN YELLOW

VPN YELLOW

v6 Only

VPN YELLOW

MPLS VPNs

- 6VPE ~ IPv6 + BGP-MPLS IPv4   VPN + 6PE

- Cisco 6VPE is an implementation of RFC4659

- VPNv6 address:
  – Address including the 64 bits route distinguisher and the 128 bits IPv6 address

- MP-BGP VPNv6 address-family:
  – AFI "IPv6" (2), SAFI "VPN" (128)

- VPN IPv6 MP_REACH_NLRI
  – With VPNv6 next-hop (192bits) and NLRI in the form of <length, IPv6-prefix, label>

- Encoding of the BGP next-hop

MP-BGP Inter-AS VPNv6 Options

ASBR1

ASBR2

MP-eBGP for IPV6

PE1

CE1

MP-iBGP for VPN-IPV6

OPTION - B

MP-iBGP for VPN-IPV6

PE2

CE2

VPN-R1
2001:0db8::

VPN-R2
2003:1::

MP-iBGP + Label

MP-iBGP + Label

RR1

RR2

MP-iBGP for VPN-IPV6

ASBR1

BGP + Label

ASBR2

MP-iBGP for VPN-IPV6

PE1

PE2

CE1

MP-eBGP for VPNv6 –
NH Unchanged

CE2

VPN-R1
2001:0db8::

OPTION - C

VPN-R2
2003:1::
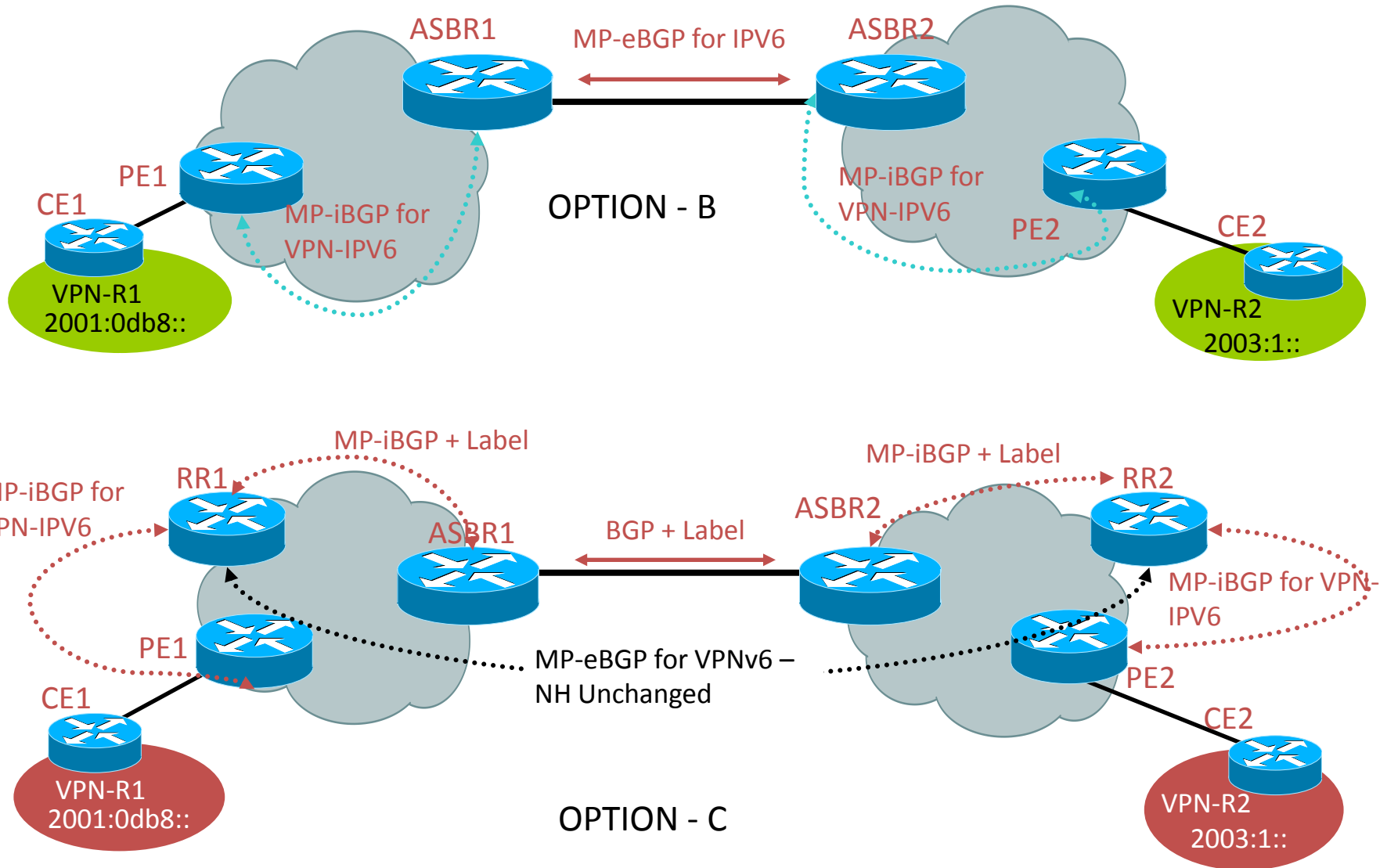
Mapping to Lab Exam Blueprint

- This question of the sample lab maps to following sections/sub-sections in the Lab Exam Blueprint document below;

  https://learningnetwork.cisco.com/docs/DOC-9991

  3.0 – Implement, Optimize and Troubleshoot L3VPN Technologies
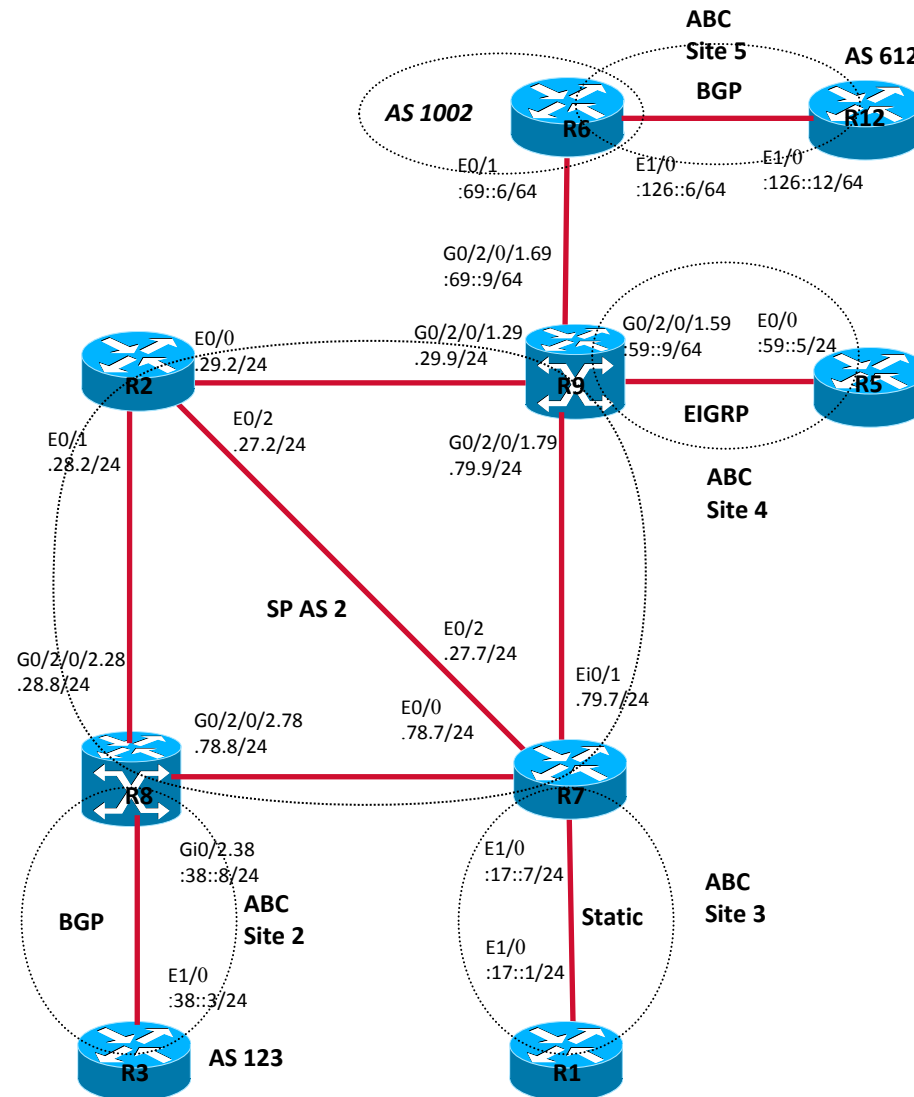
     3.1 – Implement, Optimize and Troubleshoot Intra-AS L3VPN

     3.2 – Implement, Optimize and Troubleshoot Inter-AS L3VPN

- For more details, please review the Lab Exam Checklist document below;

  https://learningnetwork.cisco.com/docs/DOC-10145

MP-BGP VPNv6 - 6VPE – Sub Topology

MP-BGP VPNv6 - 6VPE - Question

- Configure R2, R7, R8 and R9 to support MP-BGP intra AS VPNv6 (6VPE) information exchange. R9 is VPNv6 route-reflector to R2, R7 and R8.

- Ensure R1, R3 and R5 can ping each other via IPv6

- Configure MP-BGP Inter-AS VPNv6 (6VPE) on R6 and R9

- Ensure R1, R3, R5 and R12 can ping each other via IPv6.

6VPE Configuration

R7 (IOS) configuration

```
vrf definition ABC
 rd 2:2
 !
 address-family ipv6
 route-target export 2:2
 route-target import 2:2
 route-target import 1002:2
 exit-address-family
!
interface Ethernet1/0
 vrf forwarding ABC
 ipv6 address 2002:172:2:17::7/64
!
router bgp 2
 neighbor 2.2.0.9 remote-as 2
 neighbor 2.2.0.9 update-source Loopback0
 !
 address-family vpnv6
  neighbor 2.2.0.9 activate
  neighbor 2.2.0.9 send-community both
 exit-address-family
 !
 address-family ipv6 vrf ABC
 redistribute static
  no synchronization
 exit-address-family
!
ipv6 route vrf ABC 2002:172:2::1/128 Ethernet1/0
FE80::C00:FF:FE00:A01
```

6VPE Configuration (Cont.)

R8 (IOS-XR) configuration

```
vrf ABC
 !
 address-family ipv6 unicast
  import route-target
   2:2
   1002:2
  !
  export route-target
   2:2
  !
 !
!
interface GigabitEthernet0/2/0/2.38
 vrf ABC
 ipv6 address 2002:172:2:38::8/64
 dot1q vlan 38
!
```

```
router bgp 2
 address-family vpnv6 unicast
 !
 neighbor 2.2.0.9
  remote-as 2
  update-source Loopback0
  address-family vpnv6 unicast
  !
 !
 vrf ABC
  rd 2:2
  !
  neighbor 2002:172:2:38::3
   remote-as 123
   address-family ipv6 unicast
    route-policy default_policy_pass_all in
    route-policy default_policy_pass_all out
!
```

6VPE Configuration (Cont.)

R9 (IOS-XR) configuration

vrf ABC
 address-family ipv6 unicast
  import route-target
   2:2
   1002:2
  !
  export route-target
   2:2
  !
 !
interface GigabitEthernet0/2/0/1.59
 vrf ABC
 ipv6 address 2002:172:2:59::9/64
 dot1q vlan 59
!
interface GigabitEthernet0/2/0/1.69
 ipv4 address 2.2.69.9 255.255.255.0
 ipv6 address 2002:2:2:69::9/64
 dot1q vlan 69
!

router bgp 2
 address-family vpnv6 unicast
 !
 neighbor 2.2.0.2
  remote-as 2
  update-source Loopback0
  address-family vpnv6 unicast
   route-reflector-client
   next-hop-self
  !
 neighbor 2.2.0.7
  remote-as 2
  update-source Loopback0
  address-family vpnv6 unicast
   route-reflector-client
   next-hop-self
  !
 neighbor 2.2.0.8
  remote-as 2
  update-source Loopback0
  address-family vpnv6 unicast
   route-reflector-client
   next-hop-self
  !

 neighbor 2.2.69.6
  remote-as 1002
  address-family vpnv6 unicast
   route-policy default_policy_pass_all in
   route-policy default_policy_pass_all out
  !
 vrf ABC
  rd 2:2
  address-family ipv6 unicast
   redistribute eigrp 100
  !
 !
router eigrp 100
 vrf ABC
  address-family ipv6
   default-metric 100000 10 250 1 1500
   autonomous-system 100
   redistribute bgp 2
   interface GigabitEthernet0/2/0/1.59
   !
  !

6VPE Configuration (Cont.)

R6 (IOS) configuration

vrf definition ABC
 rd 1002:2
 !
 address-family ipv6
 route-target export 1002:2
 route-target import 1002:2
 route-target import 2:2
 exit-address-family
!
interface Ethernet1/0
 vrf forwarding ABC
 ipv6 address 2002:172:2:126::6/64
!

router bgp 1002
 no bgp default route-target filter
 neighbor 2.2.69.9 remote-as 2
!
 address-family vpnv6
 neighbor 2.2.69.9 activate
 neighbor 2.2.69.9 send-community both
 exit-address-family
 !
 address-family ipv6 vrf ABC
 no synchronization
 neighbor 2002:172:2:126::12 remote-as 612
 neighbor 2002:172:2:126::12 activate
 neighbor 2002:172:2:126::12 send-community both
 exit-address-family
 !

6VPE Configuration (Cont.)

R1 configuration

interface Loopback0
 ipv6 address 2002:172:2::1/128
!
interface Ethernet1/0
 ipv6 address 2002:172:2:17::1/64
!
ipv6 route 2002:172:2::/48 Ethernet1/0
FE80::C00:FF:FE00:4601

R3 configuration

interface Loopback0
 ipv6 address 2002:172:2::3/128
!
interface Ethernet1/0
 ipv6 address 2002:172:2:38::3/64
!
router bgp 123
 neighbor 2002:172:2:38::8 remote-as 2
 !
 address-family ipv6
  no synchronization
  network 2002:172:2::3/128
  neighbor 2002:172:2:38::8 activate
  neighbor 2002:172:2:38::8 send-community both
 exit-address-family
 !

6VPE Configuration (Cont.)

R5 configuration

interface Loopback0
 ipv6 address 2002:172:2::5/128
 ipv6 eigrp 100
!
interface Ethernet0/0
 ipv6 address 2002:172:2:59::5/64
 ipv6 eigrp 100
!
ipv6 router eigrp 100
 no shutdown

R12 configuration

interface Loopback0
 ipv6 address 2002:172:2::12/128
!
interface Ethernet1/0
 ipv6 address 2002:172:2:126::12/64
!
router bgp 612
 neighbor 2002:172:2:126::6 remote-as 1002
!
 address-family ipv6
 no synchronization
 network 2002:172:2::12/128
 neighbor 2002:172:2:126::6 activate
 neighbor 2002:172:2:126::6 send-community both

6VPE Adjacency

R9 6VPE neighbor

RP/0/0/CPU0:R9#show bgp vpnv6 unicast summary

Process	RcvTblVer	bRIB/RIB	LabelVer	ImportVer	SendTblVer	StandbyVer
Speaker	4025	4025	4025	4025	4025	4025

Neighbor	Spk	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	St/PfxRcd
2.2.0.2	0	2	112319	109696	4025	0	0	4d22h	1
2.2.0.7	0	2	111068	105904	4025	0	0	4d21h	2
2.2.0.8	0	2	100455	109877	4025	0	0	4d22h	3
2.2.69.6	0	1002	113188	104835	4025	0	0	3d01h	2

R6 6VPE neighbor

R6#show ip bgp vpnv6 unicast all summary
BGP router identifier 2.2.0.6, local AS number 1002

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
2002:172:2:126::12									
	4	612	264	268	32	0	0	03:47:37	1
2.2.69.9	4	2	4453	4883	32	0	0	3d01h	8

6VPE Adjacency (Cont.)

R7 6VPE neighbor

R7#show ip bgp vpnv6 unicast all summary
BGP router identifier 2.2.0.77, local AS number 2

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
2.2.0.9	4	2	1309	1421	25	0	0	21:21:52	8

R8 6VPE neighbor

RP/0/0/CPU0:R8#show bgp vpnv6 unicast summary
BGP router identifier 2.2.0.8, local AS number 2

Process	RcvTblVer	bRIB/RIB	LabelVer	ImportVer	SendTblVer	StandbyVer
Speaker	3687	3687	3687	3687	3687	3687

Neighbor	Spk	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	St/PfxRcd
2.2.0.9	0	2	117546	108682	3687	0	0	22:33:14	7

R2 6VPE neighbor

R2#show ip bgp vpnv6 unicast all summary
BGP router identifier 2.2.0.2, local AS number 2

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
2.2.0.9	4	2	1320	1431	24	0	0	21:24:08	9

VPNv6 table

R9 VPNv6 table

RP/0/0/CPU0:R9#show bgp vpnv6 unicast vrf ABC
BGP router identifier 2.2.0.9, local AS number 2
Status codes: s suppressed, d damped, h history, * valid, > best
        i - internal, S stale
Origin codes: i - IGP, e - EGP, ? - incomplete
  Network   Next Hop   Metric LocPrf Weight Path
Route Distinguisher: 2:2 (default for vrf ABC)
*>i2002:172:2::1/128 2.2.0.7   0   100   0 ?
*>i2002:172:2::3/128 2.2.0.8   0   100   0 123 i
*> 2002:172:2::5/128 fe80::c00:ff:fe00:3200
                130816   32768 ?
*> 2002:172:2::12/128 2.2.69.6   0 1002 612 i
*>i2002:172:2:17::/64 2.2.0.7   0   100   0 ?
*>i2002:172:2:38::/64 2.2.0.8   0   100   0 ?
*> 2002:172:2:59::/64 ::   0   32768 ?
*> 2002:172:2:126::/64
                2.2.69.6   0   0 1002 ?

VPNv6 table (Cont.)

R7 VPNv6 table

R7#show ip bgp vpnv6 unicast vrf ABC
BGP table version is 86, local router ID is 2.2.0.7
  Network   Next Hop   Metric LocPrf Weight Path
Route Distinguisher: 2:2 (default for vrf ABC)
*> 2002:172:2::1/128
            ::   0   32768 ?
*>i2002:172:2::3/128
          ::FFFF:2.2.0.8   0   100   0 123 i
*>i2002:172:2::5/128
          ::FFFF:2.2.0.9   130816   100   0 ?
*>i2002:172:2::12/128
          ::FFFF:2.2.0.9   100   0 1002 612 i
*> 2002:172:2:17::/64
            ::   0   32768 ?
*>i2002:172:2:38::/64
          ::FFFF:2.2.0.8   0   100   0 ?
*>i2002:172:2:59::/64
          ::FFFF:2.2.0.9   0   100   0 ?
*>i2002:172:2:126::/64
          ::FFFF:2.2.0.9   0   100   0 1002 ?

VPNv6 table (Cont.)

R6 VPNv6 table

R6#show ip bgp vpnv6 unicast vrf ABC
BGP table version is 32, local router ID is 2.2.0.6
  Network   Next Hop   Metric LocPrf Weight Path
Route Distinguisher: 1002:2 (default for vrf ABC)
*> 2002:172:2::1/128
       ::FFFF:2.2.69.9   0 2 ?
*> 2002:172:2::3/128
       ::FFFF:2.2.69.9   0 2 123 i
*> 2002:172:2::5/128
       ::FFFF:2.2.69.9   130816   0 2 ?
*> 2002:172:2::12/128
      2002:172:2:126::12
                0   0 612 i
*> 2002:172:2:17::/64
       ::FFFF:2.2.69.9   0 2 ?
*> 2002:172:2:38::/64
       ::FFFF:2.2.69.9   0 2 ?
*> 2002:172:2:59::/64
       ::FFFF:2.2.69.9   0   0 2 ?
*> 2002:172:2:126::/64
       ::   0   32768 ?

VPNv6 table (Cont.)

R8 VPNv6 table

RP/0/0/CPU0:R8#show bgp vpnv6 unicast vrf ABC
BGP router identifier 2.2.0.8, local AS number 2
  Network   Next Hop   Metric LocPrf Weight Path
Route Distinguisher: 2:2 (default for vrf ABC)
*>i2002:172:2::1/128 2.2.0.7   0   100   0 ?
*> 2002:172:2::3/128 2002:172:2:38::3
                0   0 123 i
*>i2002:172:2::5/128 2.2.0.9   130816   100   0 ?
*>i2002:172:2::12/128 2.2.0.9   100   0 1002 612 i
*>i2002:172:2:17::/64 2.2.0.7   0   100   0 ?
*> 2002:172:2:38::/64 ::   0   32768 ?
*>i2002:172:2:59::/64 2.2.0.9   0   100   0 ?
*>i2002:172:2:126::/64
         2.2.0.9   0   100   0 1002 ?

IPv6 routes

R1 ipv6 routes

R1#show ipv6 route

S   2002:172:2::/48 [1/0]
    via FE80::C00:FF:FE00:4601, Ethernet1/0
LC 2002:172:2::1/128 [0/0]
    via Loopback0, receive
C   2002:172:2:17::/64 [0/0]
    via Ethernet1/0, directly connected
L   2002:172:2:17::1/128 [0/0]
    via Ethernet1/0, receive
L   FF00::/8 [0/0]
    via Null0, receive

R3 ipv6 routes

R3#show ipv6 route bgp

B   2002:172:2::1/128 [20/0]
    via FE80::215:C7FF:FE5C:3552, Ethernet1/0
B   2002:172:2::5/128 [20/0]
    via FE80::215:C7FF:FE5C:3552, Ethernet1/0
B   2002:172:2::12/128 [20/0]
    via FE80::215:C7FF:FE5C:3552, Ethernet1/0
B   2002:172:2:17::/64 [20/0]
    via FE80::215:C7FF:FE5C:3552, Ethernet1/0
B   2002:172:2:59::/64 [20/0]
    via FE80::215:C7FF:FE5C:3552, Ethernet1/0
B   2002:172:2:126::/64 [20/0]
    via FE80::215:C7FF:FE5C:3552, Ethernet1/0

IPv6 routes (Cont.)

R5 ipv6 routes

R5#show ipv6 route eigrp

EX 2002:172:2::1/128 [170/309760]
    via FE80::213:7FFF:FEE1:C551, Ethernet0/0
EX 2002:172:2::3/128 [170/309760], tag 123
    via FE80::213:7FFF:FEE1:C551, Ethernet0/0
EX 2002:172:2::12/128 [170/309760], tag 1002
    via FE80::213:7FFF:FEE1:C551, Ethernet0/0
EX 2002:172:2:17::/64 [170/309760]
    via FE80::213:7FFF:FEE1:C551, Ethernet0/0
D   2002:172:2:38::/64 [90/281856]
    via FE80::213:7FFF:FEE1:C551, Ethernet0/0
EX 2002:172:2:126::/64 [170/309760], tag 1002
    via FE80::213:7FFF:FEE1:C551, Ethernet0/0

R12 ipv6 routes

R12#show ipv6 route bgp

B   2002:172:2::1/128 [20/0]
    via FE80::A8BB:CCFF:FE00:3C01, Ethernet1/0
B   2002:172:2::3/128 [20/0]
    via FE80::A8BB:CCFF:FE00:3C01, Ethernet1/0
B   2002:172:2::5/128 [20/0]
    via FE80::A8BB:CCFF:FE00:3C01, Ethernet1/0
B   2002:172:2:17::/64 [20/0]
    via FE80::A8BB:CCFF:FE00:3C01, Ethernet1/0
B   2002:172:2:38::/64 [20/0]
    via FE80::A8BB:CCFF:FE00:3C01, Ethernet1/0
B   2002:172:2:59::/64 [20/0]
    via FE80::A8BB:CCFF:FE00:3C01, Ethernet1/0

IPv6 routes (Cont.)

R8 VRF ABC ipv6 route

RP/0/0/CPU0:R8#show route vrf ABC ipv6

B   2002:172:2::1/128
     [200/0] via ::ffff:2.2.0.7 (nexthop in vrf default), 02:11:12
B   2002:172:2::3/128
     [20/0] via fe80::c00:ff:fe00:1e01, 4d22h, GigabitEthernet0/2/0/2.38
B   2002:172:2::5/128
     [200/130816] via ::ffff:2.2.0.9 (nexthop in vrf default), 4d21h
B   2002:172:2::12/128
     [200/0] via ::ffff:2.2.0.9 (nexthop in vrf default), 04:06:06
B   2002:172:2:17::/64
     [200/0] via ::ffff:2.2.0.7 (nexthop in vrf default), 4d21h
C   2002:172:2:38::/64 is directly connected,
     8w5d, GigabitEthernet0/2/0/2.38
L   2002:172:2:38::8/128 is directly connected,
     8w5d, GigabitEthernet0/2/0/2.38
B   2002:172:2:59::/64
     [200/0] via ::ffff:2.2.0.9 (nexthop in vrf default), 4d21h
B   2002:172:2:126::/64
     [200/0] via ::ffff:2.2.0.9 (nexthop in vrf default), 04:10:07

IPv6 routes (Cont.)

R9 VRF ABC ipv6 route

RP/0/0/CPU0:R9#show route vrf ABC ipv6

B   2002:172:2::1/128
    [200/0] via ::ffff:2.2.0.7 (nexthop in vrf default), 02:12:12
B   2002:172:2::3/128
    [200/0] via ::ffff:2.2.0.8 (nexthop in vrf default), 4d20h
D   2002:172:2::5/128
    [90/130816] via fe80::c00:ff:fe00:3200, 4d21h, GigabitEthernet0/2/0/1.59
B   2002:172:2::12/128
    [20/0] via ::ffff:2.2.69.6 (nexthop in vrf default), 04:07:02
B   2002:172:2:17::/64
    [200/0] via ::ffff:2.2.0.7 (nexthop in vrf default), 4d20h
B   2002:172:2:38::/64
    [200/0] via ::ffff:2.2.0.8 (nexthop in vrf default), 4d20h
C   2002:172:2:59::/64 is directly connected,
    10w1d, GigabitEthernet0/2/0/1.59
L   2002:172:2:59::9/128 is directly connected,
    10w1d, GigabitEthernet0/2/0/1.59
B   2002:172:2:126::/64
    [20/0] via ::ffff:2.2.69.6 (nexthop in vrf default), 04:11:02

IPv6 routes (Cont.)

R7 VRF ABC ipv6 route

R7#show ipv6 route vrf ABC

S 2002:172:2::1/128 [1/0]
     via FE80::C00:FF:FE00:A01, Ethernet1/0
B 2002:172:2::5/128 [200/130816]
     via 2.2.0.9%default, indirectly connected
B 2002:172:2::8/128 [200/0]
     via 2.2.0.8%default, indirectly connected
B 2002:172:2::12/128 [200/0]
     via 2.2.0.9%default, indirectly connected
C 2002:172:2:17::/64 [0/0]
     via Ethernet1/0, directly connected
L 2002:172:2:17::7/128 [0/0]
     via Ethernet1/0, receive
B 2002:172:2:38::/64 [200/0]
     via 2.2.0.8%default, indirectly connected
B 2002:172:2:59::/64 [200/0]
     via 2.2.0.9%default, indirectly connected
B 2002:172:2:126::/64 [200/0]
     via 2.2.0.9%default, indirectly connected
L FF00::/8 [0/0]
     via Null0, receive

IPv6 routes (Cont.)

R6 VRF ABC ipv6 route

R6#show ipv6 route vrf ABC

B   2002:172:2::1/128 [20/0]
       via 2.2.69.9%default, indirectly connected
B   2002:172:2::3/128 [20/0]
       via 2.2.69.9%default, indirectly connected
B   2002:172:2::5/128 [20/130816]
       via 2.2.69.9%default, indirectly connected
B   2002:172:2::12/128 [20/0]
       via FE80::A8BB:CCFF:FE00:7801, Ethernet1/0
B   2002:172:2:17::/64 [20/0]
       via 2.2.69.9%default, indirectly connected
B   2002:172:2:38::/64 [20/0]
       via 2.2.69.9%default, indirectly connected
B   2002:172:2:59::/64 [20/0]
       via 2.2.69.9%default, indirectly connected
C   2002:172:2:126::/64 [0/0]
       via Ethernet1/0, directly connected
L   2002:172:2:126::6/128 [0/0]
       via Ethernet1/0, receive
L   FF00::/8 [0/0]
       via Null0, receive

MPLS forwarding table

R9 mpls forwarding table

```
RP/0/0/CPU0:R9#show mpls forwarding
Local  Outgoing   Prefix           Outgoing     Next Hop       Bytes
Label  Label      or ID            Interface                   Switched
------ ---------- ---------------- ----------- -------------- ------------
16002  Unlabelled 2002:172:2::5/128[V]  \
                       Gi0/2/0/1.59 fe80::c00:ff:fe00:3200  \
16016  16010      2002:172:2::3/128[V]  \
                           point2point    0
16019  16000      2002:172:2:38::/64[V]  \
                           point2point    0
16028  16022      1002:2:172.2.126.0/24  \
                       Gi0/2/0/1.69 2.2.69.6     0
16046  16019      1002:2:2002:172:2::12/128  \
                       Gi0/2/0/1.69 2.2.69.6     825
16048  16021      1002:2:172.2.0.12/32  \
                       Gi0/2/0/1.69 2.2.69.6     0
16049  46         2002:172:2::1/128[V]  \
                           point2point    0
16051  29         2002:172:2:17::/64[V]  \
                           point2point    0
16053  16020      1002:2:2002:172:2:126::/64  \
                       Gi0/2/0/1.69 2.2.69.6     0
```

MPLS forwarding table (Cont.)

R6 mpls forwarding table

R6#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Label Switched	Outgoing interface	Next Hop
16011	16019	[2:2]2002:172:2:38::/64 \			
		0		Et0/1	2.2.69.9
16012	16021	[2:2]2002:172:2:59::/64 \			
		0		Et0/1	2.2.69.9
16013	16051	[2:2]2002:172:2:17::/64 \			
		0		Et0/1	2.2.69.9
16015	16049	[2:2]2002:172:2::1/128 \			
		0		Et0/1	2.2.69.9
16017	16016	[2:2]2002:172:2::3/128 \			
		0		Et0/1	2.2.69.9
16018	16002	[2:2]2002:172:2::5/128 \			
		0		Et0/1	2.2.69.9
16019	No Label	2002:172:2::12/128[V] \			
		4830		Et1/0	FE80::A8BB:CCFF:FE00:7801
16020	Pop Label	2002:172:2:126::/64[V] \			
		570		aggregate/ABC	

MPLS forwarding table(Cont.)

R8 mpls forwarding table

```
RP/0/0/CPU0:R8#show mpls forwarding
Local  Outgoing   Prefix            Outgoing     Next Hop      Bytes
Label  Label      or ID             Interface                  Switched
------ ---------- ----------------- ----------- -------------- ------------
16010  Unlabelled 2002:172:2::3/128[V]  \
                  Gi0/2/0/2.38 fe80::c00:ff:fe00:1e01   \
                                  5280
```

R7 mpls forwarding table

```
R7#show mpls forwarding-table
Local  Outgoing    Prefix        Bytes Label  Outgoing   Next Hop
Label  Label or VC   or Tunnel Id    Switched      interface
46     No Label    2002:172:2::1/128[V]   \
                   1710      Et1/0    FE80::C00:FF:FE00:A01
```

Connectivity verification

R3#ping 2002:172:2::1 source loopback 0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:172:2::1, timeout is 2 seconds:
Packet sent with a source address of 2002:172:2::3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/19/20 ms

R3#traceroute 2002:172:2::1

Type escape sequence to abort.
Tracing the route to 2002:172:2::1

 1 2002:172:2:38::8 [AS 2] 12 msec 8 msec 12 msec
 2 2002:172:2:17::7 [AS 2] [MPLS: Label 46 Exp 0] 20 msec 20 msec 20 msec
 3 2002:172:2:17::1 [AS 2] 20 msec 20 msec 20 msec

Connectivity verification (Cont.)

R3#ping 2002:172:2::12 source loopback 0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:172:2::12, timeout is 2 seconds:
Packet sent with a source address of 2002:172:2::3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/41/56 ms

R3#traceroute 2002:172:2::12

Type escape sequence to abort.
Tracing the route to 2002:172:2::12

 1 2002:172:2:38::8 [AS 2] 12 msec 8 msec 8 msec
 2 2002:2:2:29::2 [MPLS: Labels 52/16046 Exp 0] 44 msec 40 msec 36 msec
 3 2002:2:2:29::9 [MPLS: Label 16046 Exp 0] 40 msec 40 msec 40 msec
 4 2002:172:2:126::6 [AS 1002] [MPLS: Label 16019 Exp 0] 40 msec 40 msec 40 msec
 5 2002:172:2:126::12 [AS 1002] 40 msec 40 msec 44 msec

Connectivity verification (Cont.)

R1#ping 2002:172:2::12 source loopback 0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:172:2::12, timeout is 2 seconds:
Packet sent with a source address of 2002:172:2::1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/19/20 ms

R1#traceroute 2002:172:2::12

Type escape sequence to abort.
Tracing the route to 2002:172:2::12

 1 2002:172:2:17::7 4 msec 0 msec 0 msec
 2 2002:2:2:79::9 [MPLS: Label 16046 Exp 0] 24 msec 20 msec 20 msec
 3 2002:172:2:126::6 [MPLS: Label 16019 Exp 0] 20 msec 20 msec 20 msec
 4 2002:172:2:126::12 20 msec 20 msec 20 msec

Connectivity verification (Cont.)

R5#ping 2002:172:2::1 source loopback 0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:172:2::1, timeout is 2 seconds:
Packet sent with a source address of 2002:172:2::5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/2/4 ms

R5#ping 2002:172:2::3 source loopback 0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:172:2::3, timeout is 2 seconds:
Packet sent with a source address of 2002:172:2::5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/4/8 ms

R5#ping 2002:172:2::12 source loopback 0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:172:2::12, timeout is 2 seconds:
Packet sent with a source address of 2002:172:2::5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/2/4 ms

Connectivity verification (Cont.)

R12#ping 2002:172:2::1 source loopback 0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:172:2::1, timeout is 2 seconds:
Packet sent with a source address of 2002:172:2::12
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/2/4 ms

R12#ping 2002:172:2::3 source loopback 0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:172:2::3, timeout is 2 seconds:
Packet sent with a source address of 2002:172:2::12
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms

R12#ping 2002:172:2::5 source loopback 0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:172:2::5, timeout is 2 seconds:
Packet sent with a source address of 2002:172:2::12
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/2/4 ms