

# **CCIE Service Provider v3.0**

## **Sample Lab**

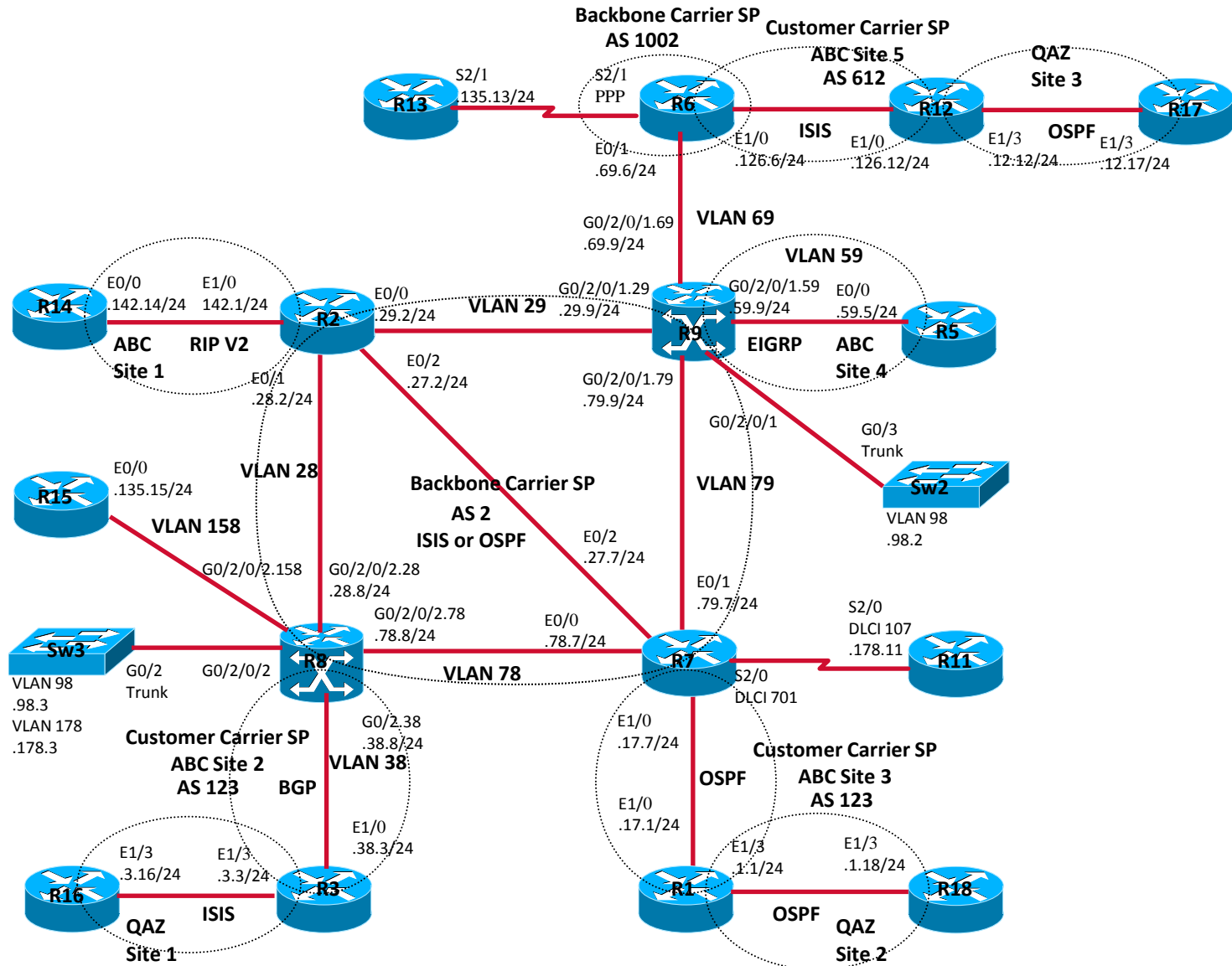
### **Part 3/7**

**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

# MPLS VPN Terminology

- LSR: Label switch router
- LSP: Label switched path
  - The chain of labels that are swapped at each hop to get from one LSR to another
- VRF: VPN routing and forwarding
  - Mechanism in Cisco IOS® used to build per-interface RIB and FIB
- MP-BGP: Multiprotocol BGP
- PE: Provider edge router interfaces with CE routers
- P: Provider (core) router, without knowledge of VPN
- VPNv4: Address family used in BGP to carry MPLS-VPN routes
- RD: Route distinguisher
  - Distinguish same network/mask prefix in different VRFs
- RT: Route target
  - Extended community attribute used to control import and export policies of VPN routes
- LFIB: Label forwarding information base
- FIB: Forwarding information base

# 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>

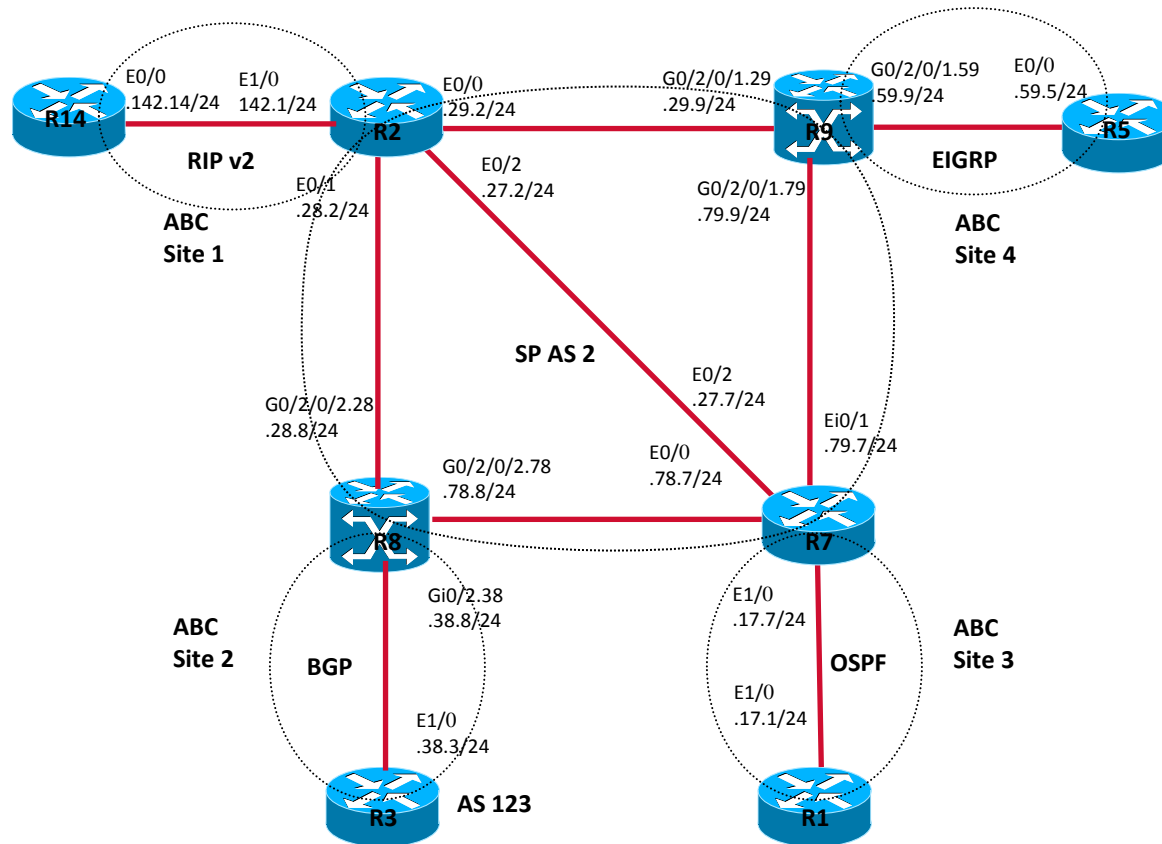
3.0 – Implement, Optimize and Troubleshoot L3VPN Technologies

3.1 – Implement, Optimize and Troubleshoot Intra-AS L3VPN

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

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

# MP-BGP Intra-AS VPNv4 – Sub Topology and Question



- Configure BGP VPNv4 on R2, R7, R8 and R9, configure R9 as VPNv4 Route-reflector for R2, R7 and R8
- Configure ABC sites router R14, R3, R1 and R5, ensure the Four sites can ping each other



# MP-BGP VPNv4 Configuration

## R2 (IOS) configuration

```
vrf definition ABC
rd 2:2
!
address-family ipv4
route-target export 2:2
route-target import 2:2
!
interface Ethernet0/0
ip address 2.2.29.2 255.255.255.0
mpls ip
!
interface Ethernet0/1
ip address 2.2.28.2 255.255.255.0
mpls ip
!
interface Ethernet0/2
ip address 2.2.27.2 255.255.255.0
mpls ip
!
interface Ethernet1/0
vrf forwarding ABC
ip address 172.2.142.2 255.255.255.0
```

```
router rip
version 2
!
address-family ipv4 vrf ABC
redistribute bgp 2 metric 1
network 172.2.0.0
version 2
exit-address-family
!
router bgp 2
neighbor 2.2.0.9 remote-as 2
neighbor 2.2.0.9 update-source Loopback0
!
address-family vpnv4
neighbor 2.2.0.9 activate
neighbor 2.2.0.9 send-community extended
neighbor 2.2.0.9 next-hop-self
!
address-family ipv4 vrf ABC
no synchronization
redistribute rip
exit-address-family
!
```

# MP-BGP VPNv4 Configuration (Cont.)

## R7 (IOS) configuration

```
vrf definition ABC
rd 2:2
!
address-family ipv4
route-target export 2:2
route-target import 2:2
!
interface Ethernet0/0
ip address 2.2.78.7 255.255.255.0
mpls ip
!
interface Ethernet0/1
ip address 2.2.79.7 255.255.255.0
mpls ip
!
interface Ethernet0/2
ip address 2.2.27.7 255.255.255.0
mpls ip
!
interface Ethernet1/0
vrf forwarding ABC
ip address 172.2.17.7 255.255.255.0
```

```
router ospf 100 vrf ABC
redistribute bgp 2 subnets
network 172.2.0.0 0.0.255.255 area 0
!
router bgp 2
neighbor 2.2.0.9 remote-as 2
neighbor 2.2.0.9 update-source Loopback0
!
address-family vpnv4
neighbor 2.2.0.9 activate
neighbor 2.2.0.9 send-community extended
exit-address-family
!
address-family ipv4 vrf ABC
no synchronization
redistribute ospf 100 vrf ABC
exit-address-family
!
```

# MP-BGP VPNv4 Configuration (Cont.)

## R8 (IOS-XR) configuration

```
interface GigabitEthernet0/2/0/2.28
  ipv4 address 2.2.28.8 255.255.255.0
  dot1q vlan 28
!
interface GigabitEthernet0/2/0/2.78
  ipv4 address 2.2.78.8 255.255.255.0
  dot1q vlan 78
!
interface GigabitEthernet0/2/0/2.38
  vrf ABC
  ipv4 address 172.2.38.8 255.255.255.0
  dot1q vlan 38
!
router bgp 2
  address-family vpnv4 unicast
!
  neighbor 2.2.0.9
  remote-as 2
  update-source Loopback0
!
  address-family vpnv4 unicast
!
```

```
vrf ABC
  rd 2:2
  address-family ipv4 unicast
  allocate-label all
!
  neighbor 172.2.38.3
  remote-as 123
  address-family ipv4 labeled-unicast
  route-policy default_policy_pass_all in
  route-policy default_policy_pass_all out
  as-override
  send-extended-community-ebgp
!
mpls ldp
  router-id 2.2.0.8
  interface GigabitEthernet0/2/0/2.28
!
  interface GigabitEthernet0/2/0/2.78
!
!
vrf ABC
  address-family ipv4 unicast
  import route-target
  2:2
!
  export route-target
  2:2
```

# MP-BGP VPNv4 Configuration (Cont.)

## R9 (IOS-XR) configuration

```
vrf ABC
address-family ipv4 unicast
import route-target
 2:2
!
export route-target
 2:2
!
interface GigabitEthernet0/2/0/1.29
ipv4 address 2.2.29.9 255.255.255.0
dot1q vlan 29
!
interface GigabitEthernet0/2/0/1.59
vrf ABC
ipv4 address 172.2.59.9 255.255.255.0
dot1q vlan 59
!
interface GigabitEthernet0/2/0/1.79
ipv4 address 2.2.79.9 255.255.255.0
dot1q vlan 79
!
```

```
router bgp 2
address-family vpnv4 unicast
!
neighbor 2.2.0.2
remote-as 2
update-source Loopback0
address-family vpnv4 unicast
route-reflector-client
!
neighbor 2.2.0.7
remote-as 2
update-source Loopback0
address-family vpnv4 unicast
route-reflector-client
!
neighbor 2.2.0.8
remote-as 2
update-source Loopback0
address-family vpnv4 unicast
route-reflector-client
!
vrf ABC
rd 2:2
address-family ipv4 unicast
redistribute eigrp 100
!
```

```
mpls ldp
router-id 2.2.0.9
!
interface GigabitEthernet0/2/0/1.29
!
interface GigabitEthernet0/2/0/1.79
!
router eigrp 100
vrf ABC
address-family ipv4
default-metric 100000 10 250 1 1500
autonomous-system 100
redistribute bgp 2
interface GigabitEthernet0/2/0/1.59
!
!
```

# MP-BGP VPNv4 Configuration (Cont.)

## R14 configuration

```
interface Loopback0
ip address 172.2.0.14 255.255.255.255
!
interface Ethernet0/0
ip address 172.2.142.14 255.255.255.0
!
router rip
version 2
network 172.2.0.0
```

## R1 configuration

```
interface Loopback0
ip address 172.2.0.1 255.255.255.255
!
interface Ethernet1/0
ip address 172.2.17.1 255.255.255.0
!
router ospf 100
network 172.2.0.1 0.0.0.0 area 0
network 172.2.17.1 0.0.0.0 area 0
```

## R3 configuration

```
interface Loopback0
ip address 172.2.0.3 255.255.255.255
!
interface Ethernet1/0
ip address 172.2.38.3 255.255.255.0
!
router bgp 123
neighbor 172.2.38.8 remote-as 2
!
address-family ipv4
network 172.2.0.3 mask 255.255.255.255
neighbor 172.2.38.8 activate
```

## R5 configuration

```
interface Loopback0
ip address 172.2.0.5 255.255.255.255
!
interface Ethernet0/0
ip address 172.2.59.5 255.255.255.0
!
router eigrp 100
network 172.2.0.5 0.0.0.0
network 172.2.59.0 0.0.0.255
```

# MP-BGP VPNv4 Adjacency

RP/0/0/CPU0:R9#show bgp vpnv4 unicast summary

BGP router identifier 2.2.0.9, local AS number 2

Neighbor	Spk	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	St/PfxRcd
2.2.0.2	0	2	111048	108531	13904	0	0	4d02h	18
2.2.0.7	0	2	109794	104739	13904	0	0	4d01h	2
2.2.0.8	0	2	99301	108712	13904	0	0	4d02h	3

R2#show ip bgp vpnv4 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	185	183	29	0	0	02:28:55	10

R7#show ip bgp vpnv4 all summary

BGP router identifier 2.2.0.7, local AS number 2

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
2.2.0.9	4	2	181	177	31	0	0	02:33:17	12

RP/0/0/CPU0:R8#show bgp vpnv4 unicast summary

BGP router identifier 2.2.0.8, local AS number 2

Neighbor	Spk	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	St/PfxRcd
2.2.0.9	0	2	116418	107553	10590	0	0	03:44:31	11

# MP-BGP VPNv4 table

## R8 VPN table

RP/0/0/CPU0:R8#show bgp vpnv4 unicast vrf ABC

Route Distinguisher: 2:2 (default for vrf ABC)

```
*>i172.2.0.1/32 2.2.0.7 15 100 0 ?
*> 172.2.0.3/32 172.2.38.3 0 0 123 i
*>i172.2.0.5/32 2.2.0.9 130816 200 0 ?
*>i172.2.0.14/32 2.2.0.2 1 100 0 ?
*>i172.2.17.0/24 2.2.0.7 15 100 0 ?
*> 172.2.38.0/24 0.0.0.0 0 32768 ?
*>i172.2.59.0/24 2.2.0.9 0 200 0 ?
*>i172.2.142.0/24 2.2.0.2 0 100 0 ?
```

## R9 VPN table

RP/0/0/CPU0:R9#show bgp vpnv4 unicast vrf ABC

```
*>i172.2.0.1/32 2.2.0.7 15 100 0 ?
*>i172.2.0.3/32 2.2.0.8 0 100 0 123 i
*> 172.2.0.5/32 172.2.59.5 130816 32768 ?
*>i172.2.0.14/32 2.2.0.2 1 100 0 ?
*>i172.2.17.0/24 2.2.0.7 15 100 0 ?
*>i172.2.38.0/24 2.2.0.8 0 100 0 ?
*> 172.2.59.0/24 0.0.0.0 0 32768 ?
*>i172.2.142.0/24 2.2.0.2 0 100 0 ?
```

# MP-BGP VPNv4 table (Cont.)

## R2 VPN table

```
R2#show ip bgp vpnv4 vrf ABC
```

```
Route Distinguisher: 2:2 (default for vrf ABC)
```

```
*>i172.2.0.1/32 2.2.0.7 15 100 0 ?  
*>i172.2.0.3/32 2.2.0.8 0 100 0 123 i  
*>i172.2.0.5/32 2.2.0.9 130816 200 0 ?  
*> 172.2.0.14/32 172.2.142.14 1 32768 ?  
*>i172.2.17.0/24 2.2.0.7 15 100 0 ?  
*>i172.2.38.0/24 2.2.0.8 0 100 0 ?  
*>i172.2.59.0/24 2.2.0.9 0 200 0 ?  
*> 172.2.142.0/24 0.0.0.0 0 32768 ?
```

## R7 VPN table

```
R7#show ip bgp vpnv4 vrf ABC
```

```
*> 172.2.0.1/32 172.2.17.1 15 32768 ?  
*>i172.2.0.3/32 2.2.0.8 0 100 0 123 i  
*>i172.2.0.5/32 2.2.0.9 130816 200 0 ?  
*>i172.2.0.14/32 2.2.0.2 1 100 0 ?  
*> 172.2.17.0/24 0.0.0.0 15 32768 ?  
*>i172.2.38.0/24 2.2.0.8 0 100 0 ?  
*>i172.2.59.0/24 2.2.0.9 0 200 0 ?  
*>i172.2.142.0/24 2.2.0.2 0 100 0 ?
```



# MPLS VPNv4 routes

## R14 and R3 route

R14#show ip route rip

```
R 172.2.0.1/32 [120/1] via 172.2.142.2, 00:00:12, Ethernet0/0
R 172.2.0.3/32 [120/1] via 172.2.142.2, 00:00:12, Ethernet0/0
R 172.2.0.5/32 [120/1] via 172.2.142.2, 00:00:12, Ethernet0/0
R 172.2.17.0/24 [120/1] via 172.2.142.2, 00:00:19, Ethernet0/0
R 172.2.38.0/24 [120/1] via 172.2.142.2, 00:00:19, Ethernet0/0
R 172.2.59.0/24 [120/1] via 172.2.142.2, 00:00:19, Ethernet0/0
```

R3#show ip route bgp

```
B 172.2.0.1/32 [20/0] via 172.2.38.8, 01:29:23
B 172.2.0.5/32 [20/0] via 172.2.38.8, 01:26:09
B 172.2.0.14/32 [20/0] via 172.2.38.8, 01:02:08
B 172.2.17.0/24 [20/0] via 172.2.38.8, 01:41:59
B 172.2.59.0/24 [20/0] via 172.2.38.8, 01:38:45
B 172.2.142.0/24 [20/0] via 172.2.38.8, 01:16:00
```

# MP-BGP VPNv4 routes (Cont.)

## R1 and R5 routes

R1#show ip route ospf

```
O E2 172.2.0.3/32 [110/1] via 172.2.17.7, 01:30:15, Ethernet1/0
O E2 172.2.0.5/32 [110/130816] via 172.2.17.7, 01:27:00, Ethernet1/0
O E2 172.2.0.14/32 [110/1] via 172.2.17.7, 01:02:54, Ethernet1/0
O E2 172.2.38.0/24 [110/1] via 172.2.17.7, 01:40:49, Ethernet1/0
O E2 172.2.59.0/24 [110/1] via 172.2.17.7, 01:40:49, Ethernet1/0
O E2 172.2.142.0/24 [110/1] via 172.2.17.7, 01:14:43, Ethernet1/0
```

R5#show ip route eigrp

```
D EX 172.2.0.1/32 [170/284160] via 172.2.59.9, 01:27:05, Ethernet0/0
D EX 172.2.0.3/32 [170/284160] via 172.2.59.9, 01:27:05, Ethernet0/0
D EX 172.2.0.14/32 [170/284160] via 172.2.59.9, 01:03:55, Ethernet0/0
D EX 172.2.17.0/24 [170/284160] via 172.2.59.9, 01:38:43, Ethernet0/0
D EX 172.2.38.0/24 [170/284160] via 172.2.59.9, 01:38:43, Ethernet0/0
D EX 172.2.142.0/24 [170/284160] via 172.2.59.9, 01:16:48, Ethernet0/0
```

# MP-BGP VPNv4 routes (Cont.)

## R2 and R7 VRF ABC routes

R2#show ip route vrf ABC

```
B 172.2.0.1/32 [200/15] via 2.2.0.7, 01:56:52
B 172.2.0.3/32 [200/0] via 2.2.0.8, 4d01h
B 172.2.0.5/32 [200/130816] via 2.2.0.9, 01:53:36
R 172.2.0.14/32 [120/1] via 172.2.142.14, 00:00:19, Ethernet1/0
B 172.2.17.0/24 [200/15] via 2.2.0.7, 01:57:00
B 172.2.38.0/24 [200/0] via 2.2.0.8, 4d01h
B 172.2.59.0/24 [200/0] via 2.2.0.9, 01:53:45
C 172.2.142.0/24 is directly connected, Ethernet1/0
L 172.2.142.2/32 is directly connected, Ethernet1/0
```

R7#show ip route vrf ABC

```
O 172.2.0.1/32 [110/11] via 172.2.17.1, 01:58:04, Ethernet1/0
B 172.2.0.3/32 [200/0] via 2.2.0.8, 01:58:04
B 172.2.0.5/32 [200/130816] via 2.2.0.9, 01:54:41
B 172.2.0.14/32 [200/1] via 2.2.0.2, 01:30:35
C 172.2.17.0/24 is directly connected, Ethernet1/0
L 172.2.17.7/32 is directly connected, Ethernet1/0
B 172.2.38.0/24 [200/0] via 2.2.0.8, 01:58:04
B 172.2.59.0/24 [200/0] via 2.2.0.9, 01:54:53
B 172.2.142.0/24 [200/0] via 2.2.0.2, 01:31:53
```

# MP-BGP VPNv4 routes (Cont.)

## R8 and R9 VRF ABC routes

RP/0/0/CPU0:R8#show route vrf ABC ipv4

```
B 172.2.0.1/32 [200/15] via 2.2.0.7 (nexthop in vrf default), 01:59:19
B 172.2.0.3/32 [20/0] via 172.2.38.3, 4d03h
B 172.2.0.5/32 [200/130816] via 2.2.0.9 (nexthop in vrf default), 01:56:05
B 172.2.0.14/32 [200/1] via 2.2.0.2 (nexthop in vrf default), 01:32:04
B 172.2.17.0/24 [200/15] via 2.2.0.7 (nexthop in vrf default), 01:59:19
C 172.2.38.0/24 is directly connected, 8w4d, GigabitEthernet0/2/0/2.38
L 172.2.38.8/32 is directly connected, 8w4d, GigabitEthernet0/2/0/2.38
B 172.2.59.0/24 [200/0] via 2.2.0.9 (nexthop in vrf default), 01:56:05
B 172.2.124.0/24 [200/0] via 2.2.0.9 (nexthop in vrf default), 2d06h
```

RP/0/0/CPU0:R9#show route vrf ABC ipv4

```
B 172.2.0.1/32 [200/15] via 2.2.0.7 (nexthop in vrf default), 02:00:34
B 172.2.0.3/32 [200/0] via 2.2.0.8 (nexthop in vrf default), 4d01h
D 172.2.0.5/32 [90/130816] via 172.2.59.5, 01:59:03, GigabitEthernet0/2/0/1.59
B 172.2.0.14/32 [200/1] via 2.2.0.2 (nexthop in vrf default), 01:33:20
B 172.2.17.0/24 [200/15] via 2.2.0.7 (nexthop in vrf default), 02:00:34
B 172.2.38.0/24 [200/0] via 2.2.0.8 (nexthop in vrf default), 4d01h
C 172.2.59.0/24 is directly connected, 10w0d, GigabitEthernet0/2/0/1.59
L 172.2.59.9/32 is directly connected, 10w0d, GigabitEthernet0/2/0/1.59
B 172.2.142.0/24 [200/0] via 2.2.0.2 (nexthop in vrf default), 01:34:35
```

# MP-BGP VPNv4 connection verification

R1#ping 172.2.0.3 source loopback 0

Sending 5, 100-byte ICMP Echos to 172.2.0.3, timeout is 2 seconds:

Packet sent with a source address of 172.2.0.1

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 16/19/20 ms

R1#ping 172.2.0.5 source loopback 0

Sending 5, 100-byte ICMP Echos to 172.2.0.5, timeout is 2 seconds:

Packet sent with a source address of 172.2.0.1

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 16/20/24 ms

R1#ping 172.2.0.14 source loopback 0

Sending 5, 100-byte ICMP Echos to 172.2.0.14, timeout is 2 seconds:

Packet sent with a source address of 172.2.0.1

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms

R3#ping 172.2.0.5 source loopback 0

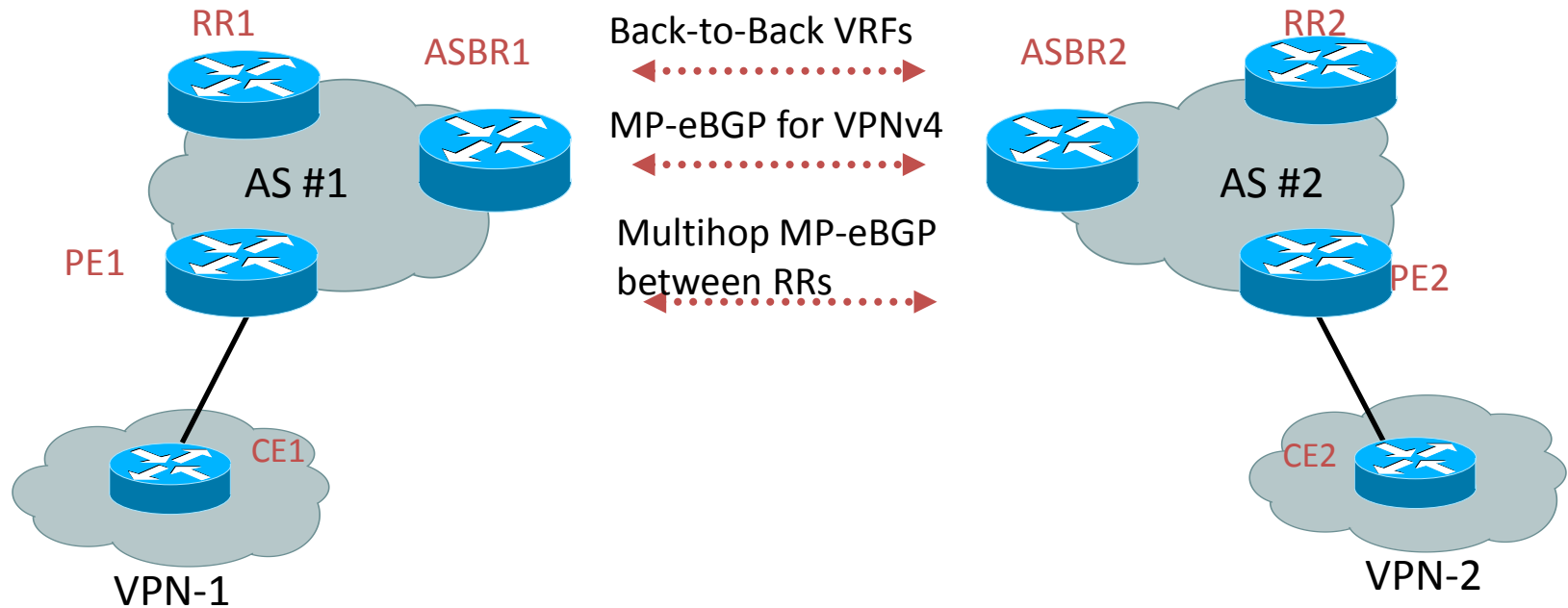
Sending 5, 100-byte ICMP Echos to 172.2.0.5, timeout is 2 seconds:

Packet sent with a source address of 172.2.0.3

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 40/40/44 ms

# MP-BGP Inter-AS VPNv4 Distribution Options



VPN Sites Attached to Different MPLS VPN Service Providers

# 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

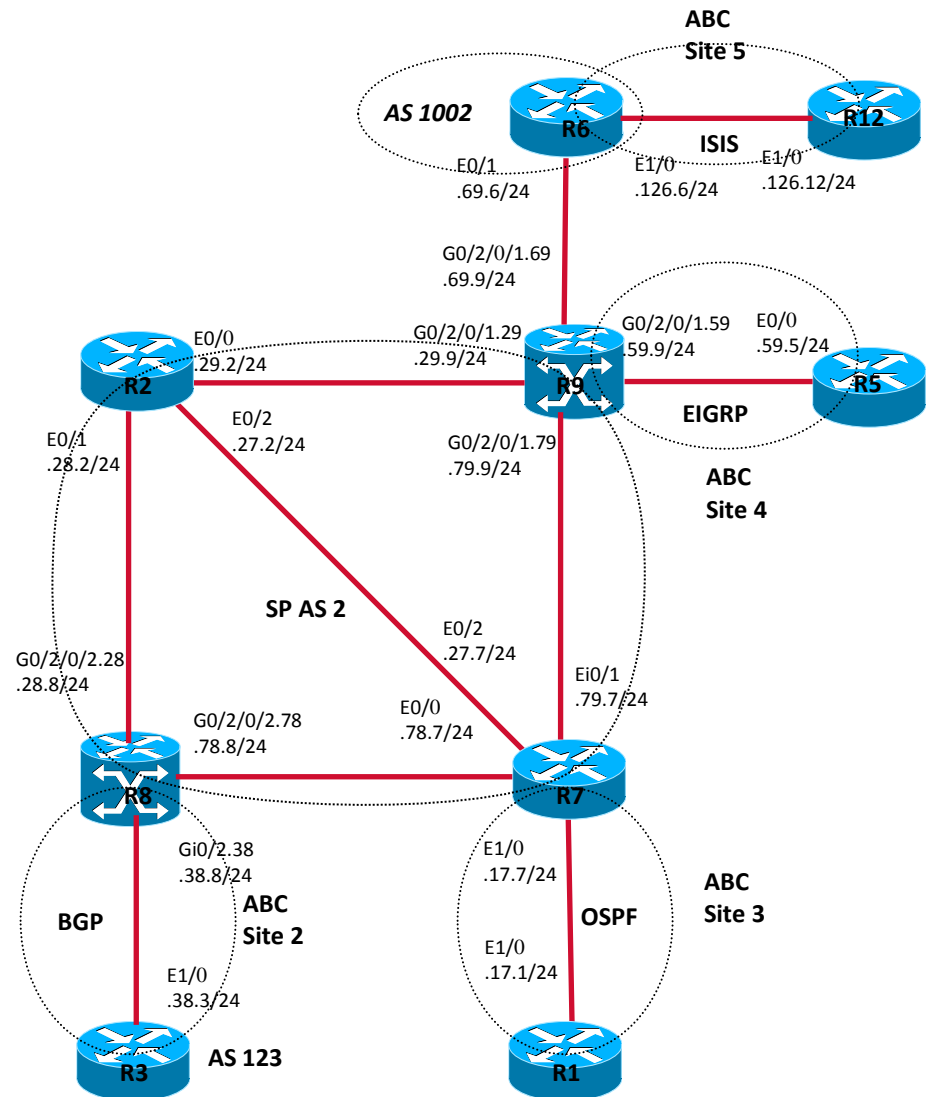
3.2 – Implement, Optimize and Troubleshoot Inter-AS L3VPN

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

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

# MP-BGP Inter-AS VPNv4 – Sub Topology and Question

- Configure Inter-AS BGP VPNv4 unicast on R6 and R9, ensure they can exchange VPNv4 unicast information
- Configure VPN site 2, 3, 4 and 5. Ensure these sites have full reach ability between each other
- You are permitted to define static host route on R9





# MP-BGP VPNv4 Configuration

## R6 (IOS) configuration

### vrf definition ABC

```
rd 1002:2
!  
address-family ipv4  
route-target export 1002:2  
route-target import 1002:2  
route-target import 2:2  
!  
interface Ethernet0/1  
ip address 2.2.69.6 255.255.255.0  
!  
interface Ethernet1/0  
vrf forwarding ABC  
ip address 172.2.126.6 255.255.255.0  
!  
router isis ABC  
vrf ABC  
net 47.0172.0000.0000.0006.00  
metric-style wide  
redistribute bgp 1002  
!
```

### router bgp 1002

```
no bgp default route-target filter  
neighbor 2.2.69.9 remote-as 2  
!  
address-family vpnv4  
neighbor 2.2.69.9 activate  
neighbor 2.2.69.9 send-community extended  
exit-address-family  
!  
address-family ipv4 vrf ABC  
no synchronization  
redistribute isis ABC level-1-2  
exit-address-family
```

# MP-BGP VPNv4 Configuration (Cont.)

## R9 (IOS-XR) configuration

```
vrf ABC
address-family ipv4 unicast
import route-target
  2:2
  1002:2
!
export route-target
  2:2
!
!
router bgp 2
address-family vpnv4 unicast
!
neighbor 2.2.69.6
remote-as 1002
address-family vpnv4 unicast
route-policy default_policy_pass_all in
route-policy default_policy_pass_all out
!
```

```
vrf ABC
rd 2:2
address-family ipv4 unicast
redistribute eigrp 100
!
router eigrp 100
vrf ABC
address-family ipv4
default-metric 100000 10 250 1 1500
autonomous-system 100
redistribute bgp 2
interface GigabitEthernet0/2/0/1.59
!
router static
address-family ipv4 unicast
2.2.69.6/32 GigabitEthernet0/2/0/1.69
!
```

Note: IOS-XR does not automatically learn directly connected host route, static host route request to ensure MPLS forwarding

# MP-BGP VPNv4 Configuration (Cont.)

## R12 configuration

```
interface Loopback0
ip address 172.2.0.12 255.255.255.255
ip router isis
!
interface Ethernet1/0
ip address 172.2.126.12 255.255.255.0
ip pim sparse-mode
ip router isis
!
router isis
net 47.0172.0000.0000.0012.00
metric-style wide
!
```

## R2 and R7 configuration

```
vrf definition ABC
rd 2:2
!
address-family ipv4
route-target export 2:2
route-target import 2:2
route-target import 1002:2
exit-address-family
!
```

## R8 configuration

```
vrf ABC
address-family ipv4 unicast
import route-target
2:2
1002:2
!
export route-target
2:2
!
```

# MP-BGP VPNv4 Adjacency

## R9 VPNv4 neighbor

RP/0/0/CPU0:R9#show bgp vpnv4 unicast summary

BGP router identifier 2.2.0.9, local AS number 2

Neighbor	Spk	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	St/PfxRcd
2.2.0.2	0	2	111048	108531	13904	0	0	4d02h	18
2.2.0.7	0	2	109794	104739	13904	0	0	4d01h	2
2.2.0.8	0	2	99301	108712	13904	0	0	4d02h	3
2.2.69.6	0	1002	112963	104627	13918	0	0	2d22h	2

## R6 VPNv4 neighbor

R6#show ip bgp vpnv4 all summary

BGP router identifier 2.2.0.6, local AS number 1002

BGP table version is 158, main routing table version 158

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
2.2.69.9	4	2	4245	4658	158	0	0	2d22h	26

# MP-BGP VPNv4 table

## R6 VPNv4 table

R6#show ip bgp vpnv4 vrf ABC

BGP table version is 158, local router ID is 2.2.0.6

Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,  
r RIB-failure, S Stale

Origin codes: i - IGP, e - EGP, ? – incomplete

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 1002:2 (default for vrf ABC)					
*> 172.2.0.1/32	2.2.69.9			0 2	?
*> 172.2.0.3/32	2.2.69.9			0 2 123	i
*> 172.2.0.5/32	2.2.69.9	130816		0 2	?
*> 172.2.0.12/32	172.2.126.12	20		32768	?
*> 172.2.17.0/24	2.2.69.9			0 2	?
*> 172.2.38.0/24	2.2.69.9			0 2	?
*> 172.2.59.0/24	2.2.69.9	0		0 2	?
*> 172.2.126.0/24	0.0.0.0	0		32768	?

# MP-BGP VPNv4 table (Cont.)

## R9 VPNv4 table

RP/0/0/CPU0:R9#show bgp vpnv4 unicast vrf ABC

BGP router identifier 2.2.0.9, local AS number 2

BGP generic scan interval 60 secs

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)					
*>i172.2.0.1/32	2.2.0.7	15	100	0	?
*>i172.2.0.3/32	2.2.0.8	0	100	0	123 i
*> 172.2.0.5/32	172.2.59.5	130816		32768	?
*> 172.2.0.12/32	2.2.69.6	20		0	1002 ?
*>i172.2.17.0/24	2.2.0.7	15	100	0	?
*>i172.2.38.0/24	2.2.0.8	0	100	0	?
*> 172.2.59.0/24	0.0.0.0	0	32768		?
*> 172.2.126.0/24	2.2.69.6	0		0	1002 ?

# MP-BGP VPNv4 table (Cont.)

## R7 VPNv4 table

R7#show ip bgp vpnv4 vrf ABC

BGP table version is 342, local router ID is 2.2.0.7

Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,  
r RIB-failure, S Stale

Origin codes: i - IGP, e - EGP, ? - incomplete

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 2:2 (default for vrf ABC)					
*> 172.2.0.1/32	172.2.17.1	15		32768	?
*>i172.2.0.3/32	2.2.0.8	0	100	0	123 i
*>i172.2.0.5/32	2.2.0.9	130816	200	0	?
*>i172.2.0.12/32	2.2.0.9	20	200	0	1002 ?
*> 172.2.17.0/24	0.0.0.0	15		32768	?
*>i172.2.38.0/24	2.2.0.8	0	100	0	?
*>i172.2.59.0/24	2.2.0.9	0	200	0	?
*>i172.2.126.0/24	2.2.0.9	0	200	0	1002 ?

# VPNv4 routes

## R12 and R5 route

R12#show ip route isis

```
i L2 172.2.0.1/32 [115/10] via 172.2.126.6, Ethernet1/0
i L2 172.2.0.3/32 [115/10] via 172.2.126.6, Ethernet1/0
i L2 172.2.0.5/32 [115/10] via 172.2.126.6, Ethernet1/0
i L2 172.2.17.0/24 [115/10] via 172.2.126.6, Ethernet1/0
i L2 172.2.38.0/24 [115/10] via 172.2.126.6, Ethernet1/0
i L2 172.2.59.0/24 [115/10] via 172.2.126.6, Ethernet1/0
```

R5#show ip route eigrp

```
D EX 172.2.0.1/32 [170/284160] via 172.2.59.9, 17:31:10, Ethernet0/0
D EX 172.2.0.3/32 [170/284160] via 172.2.59.9, 17:31:10, Ethernet0/0
D EX 172.2.0.12/32 [170/284160] via 172.2.59.9, 00:40:57, Ethernet0/0
D EX 172.2.17.0/24 [170/284160] via 172.2.59.9, 17:31:10, Ethernet0/0
D EX 172.2.38.0/24 [170/284160] via 172.2.59.9, 17:31:10, Ethernet0/0
D EX 172.2.126.0/24 [170/284160] via 172.2.59.9, 00:41:27, Ethernet0/0
```



# VPNv4 routes (Cont.)

## R1 and R3 routes

R1#show ip route ospf

```
O E2 172.2.0.3/32 [110/1] via 172.2.17.7, 17:35:44, Ethernet1/0
O E2 172.2.0.5/32 [110/130816] via 172.2.17.7, 17:32:29, Ethernet1/0
O E2 172.2.0.12/32 [110/20] via 172.2.17.7, 00:41:31, Ethernet1/0
O E2 172.2.38.0/24 [110/1] via 172.2.17.7, 17:35:44, Ethernet1/0
O E2 172.2.59.0/24 [110/1] via 172.2.17.7, 17:35:44, Ethernet1/0
O E2 172.2.126.0/24 [110/1] via 172.2.17.7, 00:42:01, Ethernet1/0
```

R3#show ip route bgp

```
B 172.2.0.1/32 [20/0] via 172.2.38.8, 17:48:55
B 172.2.0.5/32 [20/0] via 172.2.38.8, 17:45:41
B 172.2.0.12/32 [20/0] via 172.2.38.8, 00:54:38
B 172.2.17.0/24 [20/0] via 172.2.38.8, 17:48:55
B 172.2.59.0/24 [20/0] via 172.2.38.8, 17:45:41
B 172.2.126.0/24 [20/0] via 172.2.38.8, 00:55:08
```

# VPNv4 routes (Cont.)

## R6 and R9 VRF route

R6#show ip route vrf ABC

```
B 172.2.0.1/32 [20/0] via 2.2.69.9, 15:04:01
B 172.2.0.3/32 [20/0] via 2.2.69.9, 15:04:01
B 172.2.0.5/32 [20/130816] via 2.2.69.9, 15:04:01
i L1 172.2.0.12/32 [115/20] via 172.2.126.12, Ethernet1/0
B 172.2.17.0/24 [20/0] via 2.2.69.9, 15:04:01
B 172.2.38.0/24 [20/0] via 2.2.69.9, 15:04:01
B 172.2.59.0/24 [20/0] via 2.2.69.9, 15:04:01
C 172.2.126.0/24 is directly connected, Ethernet1/0
L 172.2.126.6/32 is directly connected, Ethernet1/0
```

RP/0/0/CPU0:R9#show route vrf ABC ipv4

```
B 172.2.0.1/32 [200/15] via 2.2.0.7 (nexthop in vrf default), 17:36:28
B 172.2.0.3/32 [200/0] via 2.2.0.8 (nexthop in vrf default), 4d17h
D 172.2.0.5/32 [90/130816] via 172.2.59.5, 17:34:57, GigabitEthernet0/2/0/1.59
B 172.2.0.12/32 [20/20] via 2.2.69.6 (nexthop in vrf default), 00:42:30
B 172.2.17.0/24 [200/15] via 2.2.0.7 (nexthop in vrf default), 17:36:28
B 172.2.38.0/24 [200/0] via 2.2.0.8 (nexthop in vrf default), 4d17h
C 172.2.59.0/24 is directly connected, 10w1d, GigabitEthernet0/2/0/1.59
L 172.2.59.9/32 is directly connected, 10w1d, GigabitEthernet0/2/0/1.59
B 172.2.126.0/24 [20/0] via 2.2.69.6 (nexthop in vrf default), 00:43:00
```

# MPLS forwarding table

## R6 MPLS label table

R6#show mpls forwarding-table vrf ABC

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Switched	Label	Outgoing interface	Next Hop
16003	16026	172.2.0.1/32[V]	194740		Et0/1	2.2.69.9
16021	No Label	172.2.0.12/32[V]	3360895		Et1/0	172.2.126.12
16022	No Label	172.2.126.0/24[V]	98070		aggregate/ABC	
16037	16011	172.2.0.5/32[V]	118		Et0/1	2.2.69.9
16038	16015	172.2.0.3/32[V]	10478523		Et0/1	2.2.69.9
16042	16027	172.2.17.0/24[V]	0		Et0/1	2.2.69.9
16043	16052	172.2.38.0/24[V]	0		Et0/1	2.2.69.9
16044	16029	172.2.59.0/24[V]	118		Et0/1	2.2.69.9

# MPLS forwarding table (Cont.)

## R9 MPLS label table

RP/0/0/CPU0:R9#show mpls forwarding

Local Label	Outgoing Label	Prefix or ID	Outgoing Interface	Next Hop	Bytes Switched
16011	Unlabelled	172.2.0.5/32[V]	Gi0/2/0/1.59	172.2.59.5	516064
16015	16009	172.2.0.3/32[V]		2.2.0.8	0
16026	62	172.2.0.1/32[V]		2.2.0.7	884
16027	27	172.2.17.0/24[V]		2.2.0.7	0
16028	16022	1002:2:172.2.126.0/24 \	Gi0/2/0/1.69	2.2.69.6	0
16048	16021	1002:2:172.2.0.12/32 \	Gi0/2/0/1.69	2.2.69.6	3156
16052	16019	172.2.38.0/24[V]		2.2.0.8	0

# MPLS forwarding table (Cont.)

## R8 MPLS label table

RP/0/0/CPU0:R8#show mpls forwarding vrf ABC

Local Label	Outgoing Label	Prefix or ID	Outgoing Interface	Next Hop	Bytes Switched
16001	Pop	172.2.38.3/32[V]	Gi0/2/0/2.38	172.2.38.3	56468989
16013	Pop	172.2.0.3/32[V]	Gi0/2/0/2.38	172.2.38.3	1650
16018	30	172.2.0.1/32[V]		2.2.0.7	0
16020	16015	172.2.0.5/32[V]		2.2.0.9	0
16022	29	172.2.17.0/24[V]		2.2.0.7	0
16023	16029	172.2.59.0/24[V]		2.2.0.9	0
16024	16028	172.2.0.12/32[V]		2.2.0.9	2547
16025	16030	172.2.126.0/24[V]		2.2.0.9	0

# Connection verification

```
R3#ping 172.2.0.12 source loopback 0
```

```
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 172.2.0.12, timeout is 2 seconds:
```

```
Packet sent with a source address of 172.2.0.3
```

```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/40/44 ms
```

```
R3#traceroute 172.2.0.12 source loopback 0
```

```
Type escape sequence to abort.
```

```
Tracing the route to 172.2.0.12
```

```
1 172.2.38.8 [AS 2] [MPLS: Label 16024 Exp 0] 40 msec 40 msec 40 msec
```

```
2 2.2.28.2 [MPLS: Labels 17/16028 Exp 0] 40 msec 40 msec 40 msec
```

```
3 2.2.29.9 [MPLS: Label 16028 Exp 0] 40 msec 40 msec 40 msec
```

```
4 172.2.126.6 [AS 1002] [MPLS: Label 16004 Exp 0] 40 msec 40 msec 40 msec
```

```
5 172.2.126.12 [AS 1002] 36 msec * 40 msec
```



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