

CCIE Service Provider v3.0

Sample Lab

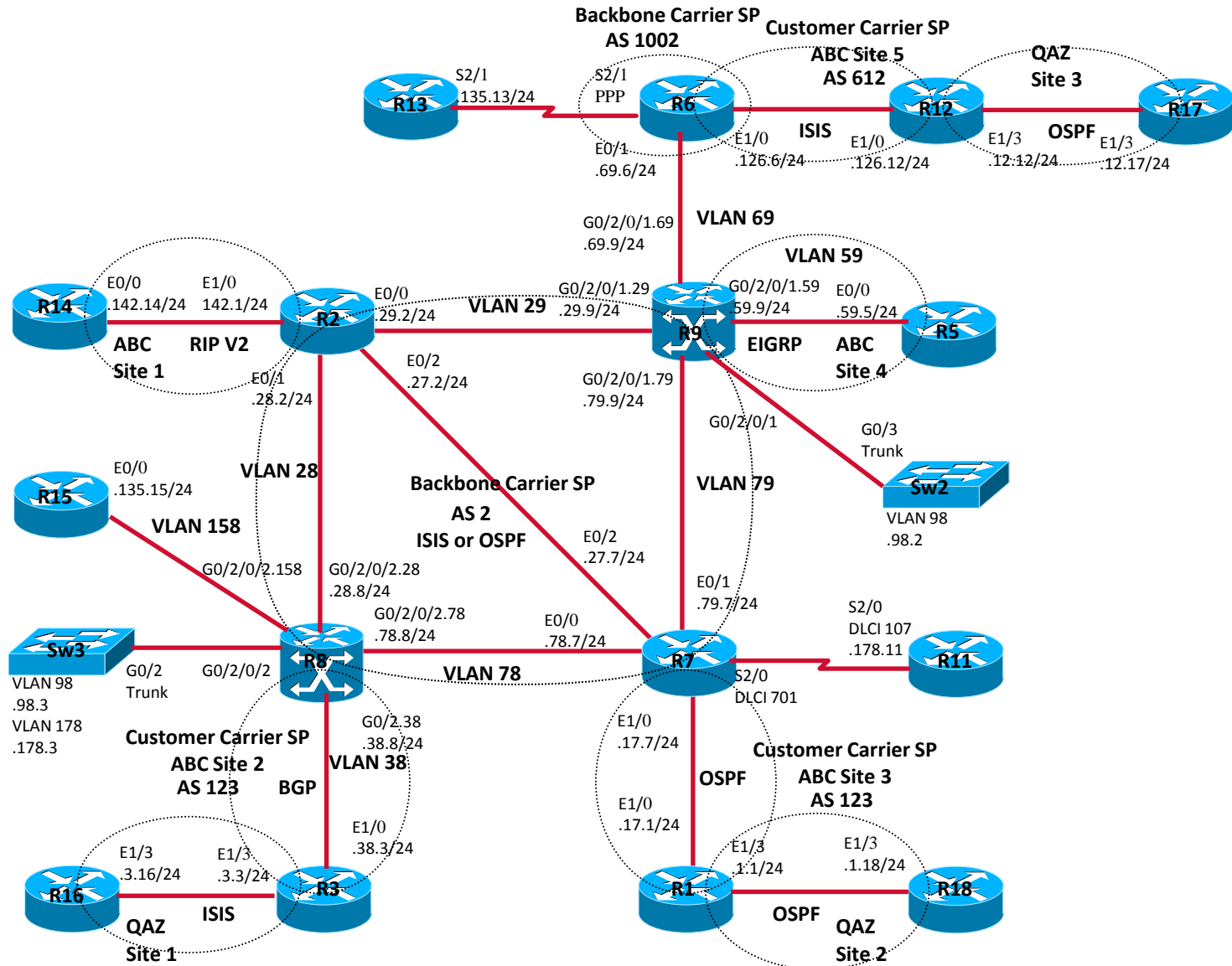
Part 4/7

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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

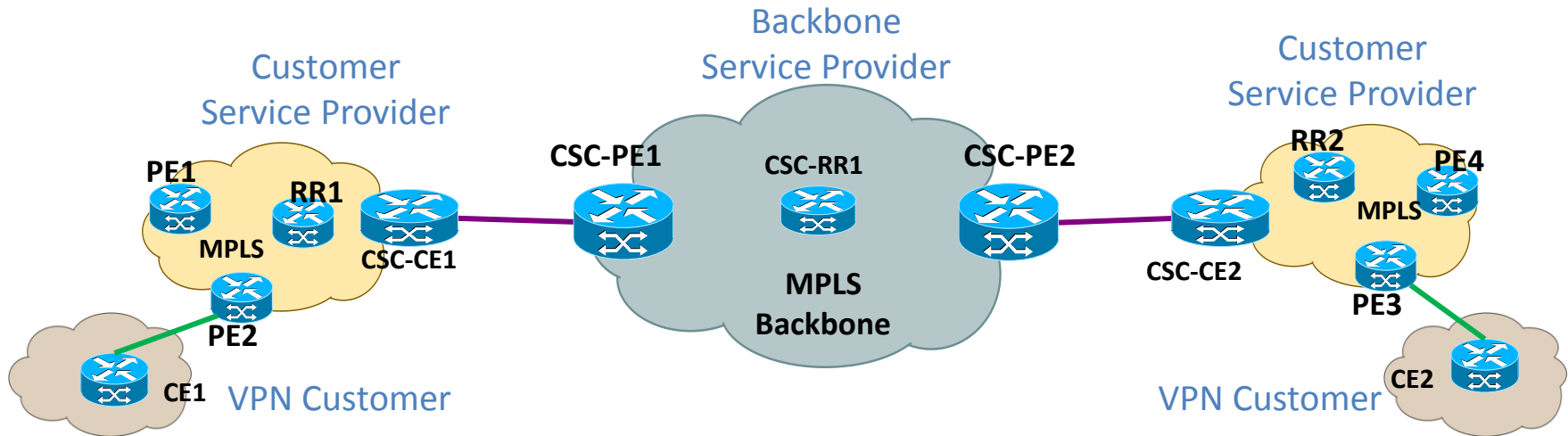
 - c7200-spservices-mz.122-33.SRE2.bin

 - 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

CSC Building Blocks



- MPLS MPLS-VPN enabled Carrier's backbone
- CSC-PE: MPLS VPN PEs located in backbone Carrier's Core
- CSC-CE: Located at the Customer Carrier network edge and connects to a CSC-PE
- PE: located in Customer carrier networks & carries customer VPN routers
- CSC-RR: Route Reflectors located in MPLS Backbone provider network
- RR: Route Reflectors located in Customer Carrier Network
- MPLS Label exchange between backbone Carrier's PE and customer Carrier's CE

CSC Building Blocks (Cont.)

- Control Plane configuration is similar to single domain MPLS VPN
- CSC-CE to CSC-PE is a VPN link to exchange Customer Carrier's internal routes. These routes are redistributed into the BSP's CSC-PE using:
 1. Static Routes OR
 2. Dynamic IGP OR
 3. eBGP
- Customer Carriers don't exchange their Subscribers' (external) VPN routes with the Backbone Service Provider
- CSC-PE-to-CSC-CE links extend Label Switching Path using:
 - IGP+LDP
 - eBGPv4 + Labels

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>

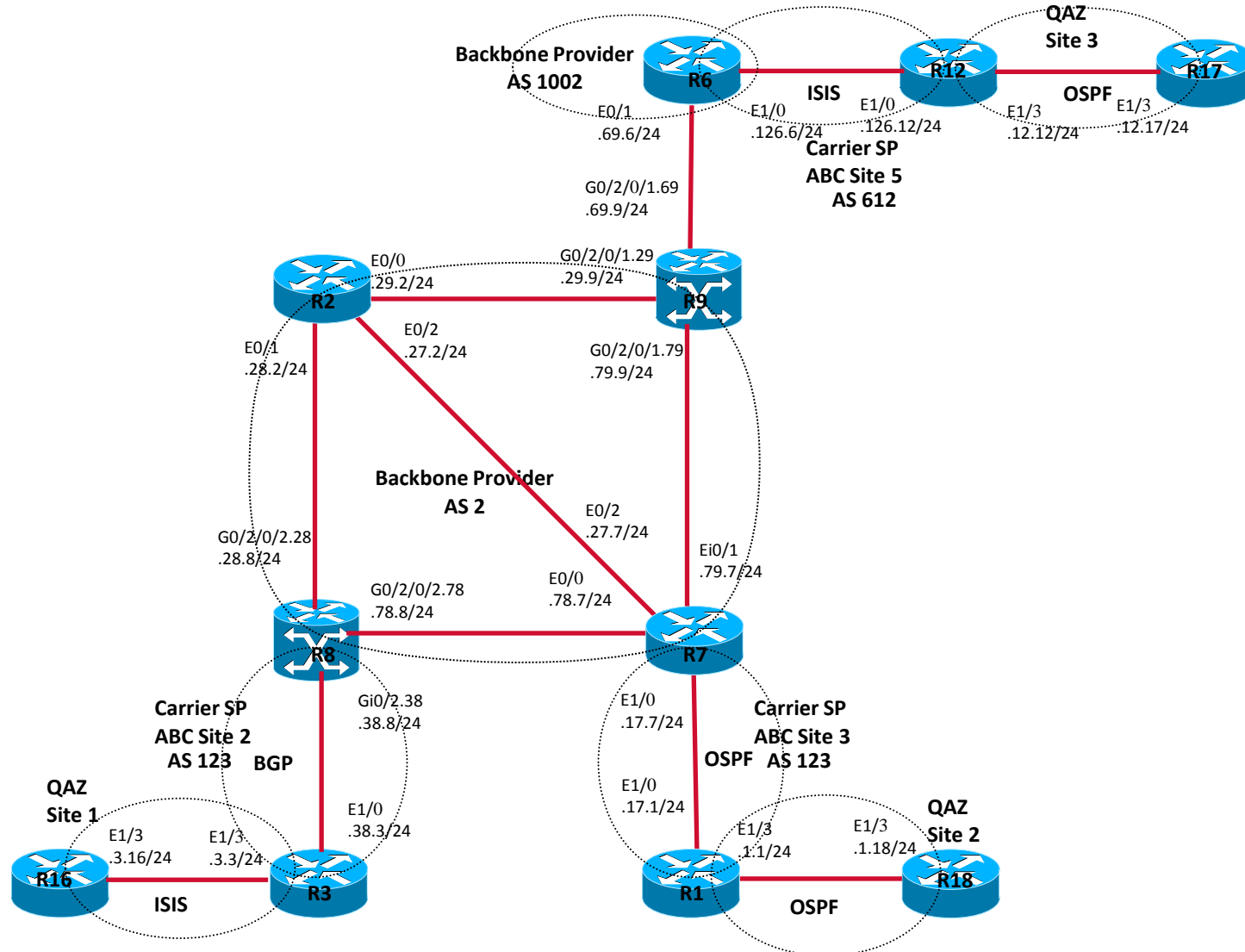
3.0 – Implement, Optimize and Troubleshoot L3VPN Technologies

3.3 – Implement, Optimize and Troubleshoot Carrier Supporting Carrier (CSC)

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

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

CSC – Sub Topology



CSC - Question

- R2, R7, R8 and R9 form Backbone Provider at AS 2. R6 is another Backbone Provider at AS 1002
- Configure EBGPv4+labels on R8 and R3 at ABC site 2
- Configure IGP+LDP on R7 and R1 at ABC site 3
- Configure R1 and R3 to establish IBGP VPNv4 to distribute VRF QAZ VPN information
- Ensure R16 and R18 can ping each other

- Configure IGP+LDP on R6 and R12 at ABC site 5
- Configure R3 and R12 to establish EBGP VPNv4 to distribute VRF QAZ VPN information, R1 and R12 are not be permitted to establish EBGP VPNv4 session
- Ensure R16, R17 and R18 can ping each other

CSC Configuration

R6 configuration

```
interface Ethernet1/0
vrf forwarding ABC
ip address 172.2.126.6 255.255.255.0
mpls ip
!
```

R7 configuration

```
interface Ethernet1/0
vrf forwarding ABC
ip address 172.2.17.7 255.255.255.0
mpls ip
!
```

R8 configuration

```
router bgp 2
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
!
!
```

CSC Configuration (Cont.)

R3 configuration

```
vrf definition QAZ
rd 123:123
!
address-family ipv4
route-target export 123:123
route-target import 123:123
exit-address-family
!
interface Ethernet1/0
ip address 172.2.38.3 255.255.255.0
mpls bgp forwarding
!
interface Ethernet1/3
vrf forwarding QAZ
ip address 192.2.3.3 255.255.255.0
ip router isis
!
router isis
vrf QAZ
net 47.0192.0000.0000.0003.00
metric-style wide
redistribute bgp 123
```

```
router bgp 123
neighbor 172.2.0.1 remote-as 123
neighbor 172.2.0.1 update-source Loopback0
neighbor 172.2.0.12 remote-as 612
neighbor 172.2.0.12 ebgp-multihop 255
neighbor 172.2.0.12 update-source Loopback0
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
neighbor 172.2.38.8 send-community both
neighbor 172.2.38.8 send-label
exit-address-family
!
address-family vpnv4
neighbor 172.2.0.1 activate
neighbor 172.2.0.1 send-community both
neighbor 172.2.0.12 activate
neighbor 172.2.0.12 send-community both
neighbor 172.2.0.12 next-hop-unchanged
exit-address-family
!
address-family ipv4 vrf QAZ
redistribute isis level-1-2 metric 10
exit-address-family
```

CSC Configuration (Cont.)

R1 configuration

```
vrf definition QAZ
rd 123:123
!
address-family ipv4
route-target export 123:123
route-target import 123:123
exit-address-family
!
interface Ethernet1/0
ip address 172.2.17.1 255.255.255.0
mpls ip
!
interface Ethernet1/3
vrf forwarding QAZ
ip address 192.2.1.1 255.255.255.0
!
router ospf 18 vrf QAZ
redistribute bgp 123 subnets
network 192.2.1.0 0.0.0.255 area 0
!
```

```
router bgp 123
neighbor 172.2.0.3 remote-as 123
neighbor 172.2.0.3 update-source Loopback0
!
address-family vpnv4
neighbor 172.2.0.3 activate
neighbor 172.2.0.3 send-community extended
exit-address-family
!
address-family ipv4 vrf QAZ
no synchronization
redistribute ospf 18 vrf QAZ
exit-address-family
!
```

CSC Configuration (Cont.)

R12 configuration

vrf definition QAZ

rd 12:12

!

address-family ipv4

route-target export 123:123

route-target import 123:123

!

interface Ethernet1/0

ip address 172.2.126.12 255.255.255.0

mpls ip

!

interface Ethernet1/3

vrf forwarding QAZ

ip address 192.2.12.12 255.255.255.0

!

router ospf 100 vrf QAZ

redistribute bgp 612 metric 10 subnets

network 192.2.12.0 0.0.0.255 area 0

!

router bgp 612

neighbor 172.2.0.3 remote-as 123

neighbor 172.2.0.3 ebgp-multihop 255

neighbor 172.2.0.3 update-source Loopback0

!

address-family vpv4

neighbor 172.2.0.3 activate

neighbor 172.2.0.3 send-community both

exit-address-family

!

address-family ipv4 vrf QAZ

no synchronization

redistribute ospf 100 vrf QAZ metric 20

exit-address-family

!

CSC Configuration (Cont.)

R16 configuration

```
interface Loopback0
ip address 192.2.0.16 255.255.255.255
ip router isis
!
interface Ethernet1/3
ip address 192.2.3.16 255.255.255.0
ip router isis
!
router isis
net 47.0192.0000.0000.0016.00
metric-style wide
```

R18 configuration

```
interface Loopback0
ip address 192.2.0.17 255.255.255.255
!
interface Ethernet1/3
ip address 192.2.12.17 255.255.255.0
!
router ospf 100
network 192.2.0.17 0.0.0.0 area 0
network 192.2.12.0 0.0.0.255 area 0
```

R17 configuration

```
interface Loopback0
ip address 192.2.0.18 255.255.255.255
!
interface Ethernet1/3
ip address 192.2.1.18 255.255.255.0
!
router ospf 18
network 192.2.0.18 0.0.0.0 area 0
network 192.2.1.0 0.0.0.255 area 0
```

CSC VPNv4 Session

R3 VPNv4 neighbor

R3#show ip bgp vpnv4 all summary

BGP router identifier 172.2.0.3, local AS number 123

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
172.2.0.1	4	123	2950	2959	85	0	0	1d20h	2
172.2.0.12	4	612	2769	2771	85	0	0	1d17h	2

R1 VPNv4 neighbor

R1#show ip bgp vpnv4 all summary

BGP router identifier 172.2.0.1, local AS number 123

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
172.2.0.3	4	123	2960	2951	105	0	0	1d20h	5

R12 VPNv4 neighbor

R12#show ip bgp vpnv4 all summary

BGP router identifier 172.2.0.12, local AS number 612

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
172.2.0.3	4	123	2773	2770	159	0	0	1d17h	5

CSC VPNv4 table

R3 VPNv4 table

R3#show ip bgp vpnv4 vrf QAZ

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 123:123 (default for vrf QAZ)					
*> 192.2.0.16/32	192.2.3.16	10		32768	?
*> 192.2.0.17/32	172.2.0.12	20		0 612	?
*>i192.2.0.18/32	172.2.0.1	11	100	0	?
*>i192.2.1.0	172.2.0.1	0	100	0	?
*> 192.2.3.0	0.0.0.0	0		32768	?
*> 192.2.12.0	172.2.0.12	0		0 612	?

R1 VPNv4 table

R1#show ip bgp vpnv4 vrf QAZ

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 123:123 (default for vrf QAZ)					
*>i192.2.0.16/32	172.2.0.3	10	100	0	?
*>i192.2.0.17/32	172.2.0.12	20	100	0 612	?
*> 192.2.0.18/32	192.2.1.18	11		32768	?
*> 192.2.1.0	0.0.0.0	0		32768	?
*>i192.2.3.0	172.2.0.3	0	100	0	?
*>i192.2.12.0	172.2.0.12	0	100	0 612	?

CSC VPNv4 table (Cont.)

R12 VPNv4 table

R12#show ip bgp vpnv4 vrf QAZ

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 12:12 (default for vrf QAZ)					
*> 192.2.0.16/32	172.2.0.3	10		0	123 ?
*> 192.2.0.17/32	192.2.12.17	20		32768	?
*> 192.2.0.18/32	172.2.0.1			0	123 ?
*> 192.2.1.0	172.2.0.1			0	123 ?
*> 192.2.3.0	172.2.0.3	0		0	123 ?
*> 192.2.12.0	0.0.0.0	0		32768	?

CSC VPN customer routes

R16 , R18 and R17 route

R16#show ip route isis

```
i L2 192.2.0.17 [115/10] via 192.2.3.3, Ethernet1/3
i L2 192.2.0.18 [115/10] via 192.2.3.3, Ethernet1/3
i L2 192.2.1.0/24 [115/10] via 192.2.3.3, Ethernet1/3
i L2 192.2.12.0/24 [115/10] via 192.2.3.3, Ethernet1/3
```

R18#show ip route ospf

```
O E2 192.2.0.16 [110/10] via 192.2.1.1, 1d20h, Ethernet1/3
O E2 192.2.0.17 [110/20] via 192.2.1.1, 1d03h, Ethernet1/3
O E2 192.2.3.0/24 [110/1] via 192.2.1.1, 1d20h, Ethernet1/3
O E2 192.2.12.0/24 [110/1] via 192.2.1.1, 1d03h, Ethernet1/3
```

R17#show ip route ospf

```
O E2 192.2.0.16 [110/10] via 192.2.12.12, 1d03h, Ethernet1/3
O E2 192.2.0.18 [110/10] via 192.2.12.12, 1d03h, Ethernet1/3
O E2 192.2.1.0/24 [110/10] via 192.2.12.12, 1d03h, Ethernet1/3
O E2 192.2.3.0/24 [110/10] via 192.2.12.12, 1d03h, Ethernet1/3
```

CSC VPN customer routes (Cont.)

R3 and R1 VRF QAZ routes

R3#show ip route vrf QAZ

```
i L1 192.2.0.16 [115/20] via 192.2.3.16, Ethernet1/3
B    192.2.0.17 [20/20] via 172.2.0.12, 1d03h
B    192.2.0.18 [200/11] via 172.2.0.1, 1d20h
B    192.2.1.0/24 [200/0] via 172.2.0.1, 1d20h
     192.2.3.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.2.3.0/24 is directly connected, Ethernet1/3
L    192.2.3.3/32 is directly connected, Ethernet1/3
B    192.2.12.0/24 [20/0] via 172.2.0.12, 1d03h
```

R1#show ip route vrf QAZ

```
B    192.2.0.16 [200/10] via 172.2.0.3, 1d20h
B    192.2.0.17 [200/20] via 172.2.0.12, 1d03h
O    192.2.0.18 [110/11] via 192.2.1.18, 5d22h, Ethernet1/3
C    192.2.1.0/24 is directly connected, Ethernet1/3
L    192.2.1.1/32 is directly connected, Ethernet1/3
B    192.2.3.0/24 [200/0] via 172.2.0.3, 1d20h
B    192.2.12.0/24 [200/0] via 172.2.0.12, 1d03h
```

CSC VPN customer routes (Cont.)

R12 VRF QAZ routes

R12#show ip route vrf QAZ

```
B    192.2.0.16 [20/10] via 172.2.0.3, 1d03h
O    192.2.0.17 [110/11] via 192.2.12.17, 5d22h, Ethernet1/3
B    192.2.0.18 [20/0] via 172.2.0.1, 1d03h
B    192.2.1.0/24 [20/0] via 172.2.0.1, 1d03h
B    192.2.3.0/24 [20/0] via 172.2.0.3, 1d03h
C    192.2.12.0/24 is directly connected, Ethernet1/3
L    192.2.12.12/32 is directly connected, Ethernet1/3
```

CSC MPLS table

R3 and R1 mpls table

R3#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Switched	Label	Outgoing interface	Next Hop
17	Pop Label	172.2.38.8/32	0		Et1/0	172.2.38.8
20	No Label	192.2.0.16/32[V]	1266		Et1/3	192.2.3.16
21	No Label	192.2.3.0/24[V]	0		aggregate/QAZ	

R1#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Switched	Label	Outgoing interface	Next Hop
16	No Label	192.2.0.18/32[V]	570		Et1/3	192.2.1.18
17	No Label	192.2.1.0/24[V]	570		aggregate/QAZ	
18	45	172.2.0.12/32	0		Et1/0	172.2.17.7
39	31	172.2.0.3/32	0		Et1/0	172.2.17.7
43	37	172.2.38.0/24	0		Et1/0	172.2.17.7
45	44	172.2.126.0/24	0		Et1/0	172.2.17.7

CSC MPLS table (Cont.)

R12 MPLS table

R12#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Switched	Label	Outgoing interface	Next Hop
17	No Label	192.2.0.17/32[V]	4751		Et1/3	192.2.12.17
18	No Label	192.2.12.0/24[V]	0		aggregate/QAZ	
23	16038	172.2.0.3/32	0		Et1/0	172.2.126.6
24	16042	172.2.17.0/24	0		Et1/0	172.2.126.6
25	16043	172.2.38.0/24	0		Et1/0	172.2.126.6
51	16003	172.2.0.1/32	0		Et1/0	172.2.126.6

Connection and Path Verification

```
R16#ping 192.2.0.18 source loopback 0
```

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

```
Sending 5, 100-byte ICMP Echos to 192.2.0.18, timeout is 2 seconds:
```

```
Packet sent with a source address of 192.2.0.16
```

```
!!!!
```

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

```
R16#traceroute 192.2.0.18 source loopback 0
```

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

```
Tracing the route to 192.2.0.18
```

```
1 192.2.3.3 4 msec 0 msec 0 msec
```

```
2 172.2.38.8 [MPLS: Labels 16021/16 Exp 0] 24 msec 20 msec 16 msec
```

```
3 2.2.78.7 [MPLS: Labels 62/16 Exp 0] 20 msec 20 msec 20 msec
```

```
4 192.2.1.1 [MPLS: Label 16 Exp 0] 16 msec 24 msec 20 msec
```

```
5 192.2.1.18 20 msec * 20 msec
```


Connection and Path Verification (Cont.)

```
R16#ping 192.2.0.17 source loopback 0
```

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

```
Sending 5, 100-byte ICMP Echos to 192.2.0.17, timeout is 2 seconds:
```

```
Packet sent with a source address of 192.2.0.16
```

```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/42/52 ms
```

```
R16#trace 192.2.0.17 source loopback 0
```

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

```
Tracing the route to 192.2.0.17
```

```
 1 192.2.3.3 4 msec 0 msec 0 msec
```

```
 2 172.2.38.8 [MPLS: Labels 16028/17 Exp 0] 36 msec 36 msec 40 msec
```

```
 3 2.2.78.7 [MPLS: Labels 18/16048/17 Exp 0] 40 msec 40 msec 40 msec
```

```
 4 2.2.79.9 [MPLS: Labels 16048/17 Exp 0] 40 msec 40 msec 40 msec
```

```
 5 2.2.69.6 [MPLS: Labels 16021/17 Exp 0] 40 msec 40 msec 40 msec
```

```
 6 192.2.12.12 [MPLS: Label 17 Exp 0] 40 msec 40 msec 40 msec
```

```
 7 192.2.12.17 40 msec * 40 msec
```

Connection and Path Verification (Cont.)

```
R18#ping 192.2.0.16 source loopback 0
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.2.0.16, timeout is 2 seconds:

Packet sent with a source address of 192.2.0.18

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/4 ms

```
R18#traceroute 192.2.0.16 source loopback 0
```

Type escape sequence to abort.

Tracing the route to 192.2.0.16

1 192.2.1.1 0 msec 4 msec 0 msec

2 172.2.17.7 [MPLS: Labels 28/20 Exp 0] 4 msec 4 msec 0 msec

3 2.2.78.8 [MPLS: Labels 16020/20 Exp 0] 8 msec 4 msec 4 msec

4 192.2.3.3 [MPLS: Label 20 Exp 0] 0 msec 4 msec 0 msec

5 192.2.3.16 4 msec * 4 msec

Connection and Path Verification (Cont.)

```
R18#ping 192.2.0.17 source loopback 0
```

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

```
Sending 5, 100-byte ICMP Echos to 192.2.0.17, timeout is 2 seconds:
```

```
Packet sent with a source address of 192.2.0.18
```

```
!!!!
```

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

```
R18#traceroute 192.2.0.17 source loopback 0
```

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

```
Tracing the route to 192.2.0.17
```

```
1 192.2.1.1 4 msec 0 msec 0 msec
```

```
2 172.2.17.7 [MPLS: Labels 45/17 Exp 0] 24 msec 20 msec 20 msec
```

```
3 2.2.79.9 [MPLS: Labels 16048/17 Exp 0] 20 msec 20 msec 20 msec
```

```
4 2.2.69.6 [MPLS: Labels 16021/17 Exp 0] 20 msec 20 msec 20 msec
```

```
5 192.2.12.12 [MPLS: Label 17 Exp 0] 20 msec 20 msec 20 msec
```

```
6 192.2.12.17 20 msec * 20 msec
```

Connection and Path Verification (Cont.)

```
R17#ping 192.2.0.16 source loopback 0
```

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

```
Sending 5, 100-byte ICMP Echos to 192.2.0.16, timeout is 2 seconds:
```

```
Packet sent with a source address of 192.2.0.17
```

```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/8 ms
```

```
R17#traceroute 192.2.0.16 source loopback 0
```

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

```
Tracing the route to 192.2.0.16
```

```
1 192.2.12.12 [MPLS: Label 34 Exp 0] 8 msec 4 msec 4 msec
```

```
2 172.2.126.6 [MPLS: Labels 121/20 Exp 0] 4 msec 4 msec 4 msec
```

```
3 2.2.69.9 [MPLS: Labels 16019/20 Exp 0] 4 msec 8 msec 8 msec
```

```
4 2.2.79.7 [MPLS: Labels 20/16020/20 Exp 0] 4 msec 4 msec 4 msec
```

```
5 2.2.78.8 [MPLS: Labels 16020/20 Exp 0] 4 msec 8 msec 8 msec
```

```
6 192.2.3.3 [MPLS: Label 20 Exp 0] 4 msec 4 msec 0 msec
```

```
7 192.2.3.16 4 msec * 4 msec
```

Connection and Path Verification (Cont.)

```
R17#ping 192.2.0.18 source loopback 0
```

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

```
Sending 5, 100-byte ICMP Echos to 192.2.0.18, timeout is 2 seconds:
```

```
Packet sent with a source address of 192.2.0.17
```

```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/8 ms
```

```
R17#traceroute 192.2.0.18 source loopback 0
```

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

```
Tracing the route to 192.2.0.18
```

```
 1 192.2.12.12 [MPLS: Label 18 Exp 0] 8 msec 4 msec 4 msec
```

```
 2 172.2.126.6 [MPLS: Labels 120/23 Exp 0] 4 msec 4 msec 4 msec
```

```
 3 2.2.69.9 [MPLS: Labels 16018/23 Exp 0] 4 msec 8 msec 8 msec
```

```
 4 2.2.79.7 [MPLS: Labels 35/23 Exp 0] 4 msec 4 msec 4 msec
```

```
 5 192.2.1.1 [MPLS: Label 23 Exp 0] 0 msec 0 msec 4 msec
```

```
 6 192.2.1.18 4 msec * 4 msec
```



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