

Cisco Expert-Level Training for CCIE Service Provider Exercise Workbook Configuration Lab 02 Answer Key

The Cisco Expert-Level Training for CCIE Service Provider Workbook contains challenging scenarios at the CCIE level that can be used for rigorous self-paced practice.

Each lab provides an extensive answer key that is designed to maximize learning by providing practical experience.

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Domain 1: Core Routing

1. MPLS Traffic Engineering

Configuration

MPLS Traffic-engineering and RSVP are already configured on the ISP-A MPLS network. All you need to do is to create the MPLS TE tunnel interface. Pay attention to the restrictions/requirements of the task.

```
! @A-PE8
interface tunnel-te100
  ipv4 unnumbered Loopback0
  signalled-bandwidth 50000
  autoroute announce 
  !
  destination 11.11.11.11
  path-option 1 dynamic 
```

Notes:

1 - Use 'announce' as alternative to send traffic to this MPLS TE tunnel interface. If you use a static route, you will not get the points for this task.

2 - Use 'dynamic'. If you use explicit path, you will not get the points for this task.

Checking

In the verification, you must match with all requirements of the task.

The MPLS TE tunnel with destination 11.11.11.11 is up.

```
RP/0/0/CPU0:A-PE8# show mpls traffic-eng tunnels brief

          TUNNEL NAME          DESTINATION      STATUS  STATE
          tunnel-te100         11.11.11.11     up      up
Displayed 1 (of 1) heads, 0 (of 0) midpoints, 0 (of 0) tails
Displayed 1 up, 0 down, 0 recovering, 0 recovered heads
```

This MPLS TE tunnel uses autoroute announce, it is requesting 50000kbps, and it uses a dynamic path.

```
RP/0/0/CPU0:A-PE8# show mpls traffic-eng tunnels

Name: tunnel-te100 Destination: 11.11.11.11 Ifhandle:0x480
  Signalled-Name: A-PE8 t100
  Status:
    Admin: up Oper: up Path: valid Signalling: connected

  path option 1, type dynamic (Basis for Setup, path weight 20)
  Last Signalled Error : Thu Jul 20 19:09:53 2017
    Info: [6] PathErr(24,0)-(routing, none) at 8.8.8.8
  G-PID: 0x0800 (derived from egress interface properties)
  Bandwidth Requested: 50000 kbps CT0
  Creation Time: Thu Jul 20 19:09:08 2017 (00:08:52 ago)
  Config Parameters:
    Bandwidth: 50000 kbps (CT0) Priority: 7 7 Affinity: 0x0/0xffff
    Metric Type: TE (default)
    Hop-limit: disabled
    Cost-limit: disabled
    AutoRoute: enabled LockDown: disabled Policy class: not set
    Forward class: 0 (default)
    Forwarding-Adjacency: disabled
    Loadshare: 0 equal loadshares
```

```
Auto-bw: disabled
Fast Reroute: Disabled, Protection Desired: None
Path Protection: Not Enabled
BFD Fast Detection: Disabled
Reoptimization after affinity failure: Enabled
Soft Preemption: Disabled
History:
  Tunnel has been up for: 00:07:19 (since Thu Jul 20 19:10:41 UTC 2017)
  Current LSP:
    Uptime: 00:07:19 (since Thu Jul 20 19:10:41 UTC 2017)

Path info (IS-IS 1 level-2):
Node hop count: 2
Hop0: 1.8.10.10
Hop1: 1.10.11.11
Hop2: 11.11.11.11
Displayed 1 (of 1) heads, 0 (of 0) midpoints, 0 (of 0) tails
Displayed 1 up, 0 down, 0 recovering, 0 recovered heads
```

Check the routing table and verify that the MPLS TE tunnel injects traffic by using an IGP and not by a static route.

```
RP/0/0/CPU0:A-PE8# show route ipv4 isis
```

```
i L2 1.9.10.0/24 [115/20] via 1.8.9.9, 00:11:19, GigabitEthernet0/0/0/2
  [115/20] via 1.8.10.10, 00:11:19, GigabitEthernet0/0/0/0
i L2 1.10.11.0/24 [115/20] via 1.8.10.10, 00:11:19, GigabitEthernet0/0/0/0
i L2 9.9.9.9/32 [115/10] via 1.8.9.9, 00:11:19, GigabitEthernet0/0/0/2
i L2 10.10.10.10/32 [115/10] via 1.8.10.10, 00:11:19, GigabitEthernet0/0/0/0
i L2 11.11.11.11/32 [115/20] via 11.11.11.11, 00:07:26, tunnel-te100
```

```
RP/0/0/CPU0:A-PE8# show route static
```

```
% No matching routes found
```

2.Multicast

Configuration

The characteristic defined in this task is the profile called ROSEN MLDP or Default MDT. You do not need to memorize the profiles name. You just need to understand the requirements, the signaling between PE-CE; the type and characteristics of the core tree, which protocol to use for this; and if BGP auto-discovery is required or not. For this task, we will:

- use PIM for PE-CE
- use MLDP for PE-P (MPLS core), for the MP2MP type of tree
- use PE9 loopback 0 as the root of the core tree
- not use BGP auto-discovery

```
! @A-PE8#
mpls ldp
  mpls
    logging notifications
  !
vrf Z
  vpn id 100:1
  !
multicast-routing
  address-family ipv4
    mdt source Loopback0
    interface all enable
  !
  vrf Z
    address-family ipv4
      interface all enable
      mdt default mldp ipv4 9.9.9.9
      mdt data mldp 30
      mdt source Loopback0
  !
route-policy MVPN
  set core-tree mldp-default
end-policy
!
router pim
  address-family ipv4
    interface Loopback 0
    enable
  !
  vrf Z
    address-family ipv4
      rpf topology route-policy MVPN
      rp-address 172.2.9.9
      interface GigabitEthernet 0/0/0/1
      enable
```

```
! @A-P10#
ip multicast mpls mldp
mpls mldp logging notifications
```

```

! @A-PE8#
ip multicast-routing distributed
ip multicast-routing vrf Z distributed
ip multicast mpls mldp
!
vrf definition Z
  vpn id 100:1
  address-family ipv4
    mdt preference mldp
    mdt default mpls mldp 9.9.9.9
!
interface gigabitethernet 3
  ip pim sparse-mode
!
ip pim mpls source Loopback 0
ip pim vrf Z rp-address 172.2.9.9

```

```

! @Z-CE1#
ip multicast-routing distributed
interface Loopback 0
  ip pim sparse-mode
!
interface GigabitEthernet 0/1
  ip pim sparse-mode
!
ip pim rp-address 172.2.9.9

```

```

! @Z-CE2#
ip multicast-routing distributed
interface Loopback 0
  ip pim sparse-mode
!
interface GigabitEthernet 0/1
  ip pim sparse-mode
!
ip pim rp-address 172.2.9.9

```

If you are not familiar with MVPN, the following links are the best study resources:

<http://www.cisco.com/c/en/us/support/docs/multiprotocol-label-switching-mpls/multiprotocol-label-switching-vpns-mpls-vpns/118983-configure-mpls-00.html#anc8>

http://www.cisco.com/c/en/us/td/docs/routers/crs/software/crs_r4-2/multicast/configuration/guide/b_mcast_cg42crs/b_mcast_cg42crs_chapter_00.html

<http://www.cisco.com/c/en/us/support/docs/ip/multicast/118985-configure-mcast-00.html>

Checking

There are many ways to verify the configuration, these are some examples:

```

RP/0/0/CPU0:A-PE8# show mpls mldp neighbors
mLDP neighbor database
MLDP peer ID      : 9.9.9.9:0, uptime 01:08:28 Up,
Capabilities      : Typed Wildcard FEC, P2MP, MP2MP
Target Adj       : No
Upstream count   : 1
Branch count     : 0
Label map timer  : never
Policy filter in : None
Path count       : 1
Path(s)          : 1.8.9.9           GigabitEthernet0/0/0/2 LDP
Adj list         : 1.8.9.9           GigabitEthernet0/0/0/2
Peer addr list   : 9.9.9.9
                  : 1.9.10.9
                  : 1.8.9.9

MLDP peer ID      : 10.10.10.10:0, uptime 01:08:28 Up,
Capabilities      : Typed Wildcard FEC, P2MP, MP2MP

```

```

Target Adj      : No
Upstream count : 0
Branch count   : 0
Label map timer : never
Policy filter in : None
Path count     : 1
Path(s)        : 1.8.10.10      GigabitEthernet0/0/0/0 LDP
Adj list       : 1.8.10.10      GigabitEthernet0/0/0/0
Peer addr list : 10.10.10.10
                : 1.8.10.10
                : 1.9.10.10
                : 1.10.11.10

```

A-PE9# show mpls mldp neighbors

```

MLDP peer ID   : 10.10.10.10:0, uptime 01:47:19 Up,
Target Adj     : No
Session hndl   : 1
Upstream count : 0
Branch count   : 0
Path count     : 1
Path(s)        : 1.9.10.10      LDP GigabitEthernet2
Nhop count     : 0

MLDP peer ID   : 8.8.8.8:0, uptime 01:46:17 Up,
Target Adj     : No
Session hndl   : 2
Upstream count : 0
Branch count   : 1
Path count     : 1
Path(s)        : 1.8.9.8        LDP GigabitEthernet5
Nhop count     : 0

```

A-P10# show mpls mldp neighbors

```

MLDP peer ID   : 9.9.9.9:0, uptime 01:48:05 Up,
Target Adj     : No
Session hndl   : 1
Upstream count : 0
Branch count   : 0
Path count     : 1
Path(s)        : 1.9.10.9      LDP GigabitEthernet3
Nhop count     : 0

MLDP peer ID   : 11.11.11.11:0, uptime 01:47:59 Up,
Target Adj     : No
Session hndl   : 2
Upstream count : 0
Branch count   : 0
Path count     : 1
Path(s)        : 1.10.11.11    LDP GigabitEthernet4
Nhop count     : 0

MLDP peer ID   : 8.8.8.8:0, uptime 01:47:03 Up,
Target Adj     : No
Session hndl   : 3
Upstream count : 0
Branch count   : 0
Path count     : 1
Path(s)        : 1.8.10.8      LDP GigabitEthernet2
Nhop count     : 0

```

RP/0/0/CPU0:A-PE8# show mpls mldp root

```

mLDP root database
Root node      : 9.9.9.9
Metric        : 10
Distance      : 115
FEC count     : 1
Path count    : 1
Path(s)       : 1.8.9.9        LDP nbr: 9.9.9.9:0

```

A-PE9# show mpls mldp root

```
Root node      : 9.9.9.9 (We are the root)
Metric        : 0
Distance      : 0
Interface     : Loopback0 (via unicast RT)
FEC count     : 1
Path count    : 1
Path(s)       : 9.9.9.9                LDP nbr: none                Loopback0
```

RP/0/0/CPU0:A-PE8# show mpls mldp database

```
mLDP database
LSM-ID: 0x00001 (RNR LSM-ID: 0x00002)   Type: MP2MP   Uptime: 01:08:41
FEC Root      : 9.9.9.9
Opaque decoded : [mdt 100:1 0]
RNR active LSP : (this entry)
Candidate RNR ID(s):
Upstream neighbor(s) :
  9.9.9.9:0 [Active] Uptime: 01:08:41
  Next Hop       : 1.8.9.9
  Interface      : GigabitEthernet0/0/0/2
  Local Label (D) : 24011                Remote Label (U): 23
Downstream client(s):
  PIM MDT       Uptime: 01:08:41
  Egress intf   : LmdtZ
  Table ID      : IPv4: 0xe0000011 IPv6: 0xe0800011
  HLI           : 0x00002
  RPF ID        : 1
  Local Label   : 24010 (internal)
```

A-PE9# show mpls mldp database

* Indicates MLDP recursive forwarding is enabled

```
LSM ID : 1 (RNR LSM ID: 2)   Type: MP2MP   Uptime : 01:08:49
FEC Root      : 9.9.9.9 (we are the root)
Opaque decoded : [mdt 100:1 0]
Opaque length  : 11 bytes
Opaque value   : 02 000B 000100000000001000000000
RNR active LSP : (this entry)
Upstream client(s) :
  None
  Expires      : N/A                Path Set ID : 1
Replication client(s):
  8.8.8.8:0
  Uptime       : 01:08:49            Path Set ID : 2
  Out label (D) : 24011                Interface   : GigabitEthernet5*
  Local label (U): 23                Next Hop    : 1.8.9.8
MDT (VRF Z)
  Uptime       : 01:06:24            Path Set ID : 3
  Interface    : Lspvif0
```

RP/0/0/CPU0:A-PE8# show pim vrf Z neighbor

PIM neighbors in VRF Z
Flag: B - Bidir capable, P - Proxy capable, DR - Designated Router,
E - ECMP Redirect capable
* indicates the neighbor created for this router

Neighbor Address	Interface	Uptime	Expires	DR pri	Flags
172.1.8.1	GigabitEthernet0/0/0/1	01:10:56	00:01:16	1	P
172.1.8.8*	GigabitEthernet0/0/0/1	01:12:02	00:01:44	1 (DR)	B P E
8.8.8.8*	LmdtZ	01:11:57	00:01:28	1	P
9.9.9.9	LmdtZ	01:06:51	00:01:21	1 (DR)	P

```
A-PE9# show ip pim vrf Z neighbor
```

```
PIM Neighbor Table
```

```
Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,  
      P - Proxy Capable, S - State Refresh Capable, G - GenID Capable,  
      L - DR Load-balancing Capable
```

Neighbor Address	Interface	Uptime/Expires	Ver	DR Prio/Mode
8.8.8.8	Lspvif0	01:07:14/00:01:36	v2	1 / P G
172.2.9.2	GigabitEthernet3	01:06:35/00:01:43	v2	1 / S P G

```
RP/0/0/CPU0:A-PE8# show pim vrf Z rp mapping
```

```
PIM Group-to-RP Mappings
```

```
Group(s) 224.0.0.0/4
```

```
  RP 172.2.9.9 (?), v2
```

```
    Info source: 0.0.0.0 (?), elected via config
```

```
    Uptime: 01:12:55, expires: never
```

```
A-PE9# show ip pim vrf Z rp mapping
```

```
PIM Group-to-RP Mappings
```

```
Group(s): 224.0.0.0/4, Static
```

```
  RP: 172.2.9.9 (?)
```

3. Quality of Service

Configuration

This task might be tricky. Just remember that when customer traffic is going through a P router, it is a labelled packet. So, you must do a 'match mpls' and not a 'match ip/dscp'.

```
! @A-P10
class-map match-all EXP3
  match mpls experimental topmost 3
!
policy-map Z CE1
  class EXP3
    bandwidth 5000
!
interface GigabitEthernet 4
  service-policy output Z_CE1
```

Checking

Ensure QoS is applied on the correct interface .

```
A-P10# show policy-map interface gigabitEthernet 4

GigabitEthernet4

Service-policy output: Z CE1

Class-map: EXP3 (match-all)
  0 packets, 0 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: mpls experimental topmost 3
  Queueing
    queue limit 64 packets
    (queue depth/total drops/no-buffer drops) 0/0/0
    (pkts output/bytes output) 0/0
    bandwidth 5000 kbps

Class-map: class-default (match-any)
  60 packets, 24250 bytes
  5 minute offered rate 1000 bps, drop rate 0000 bps
  Match: any

  queue limit 64 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 0/0
```

Domain 2: Service Provider Architecture and Services

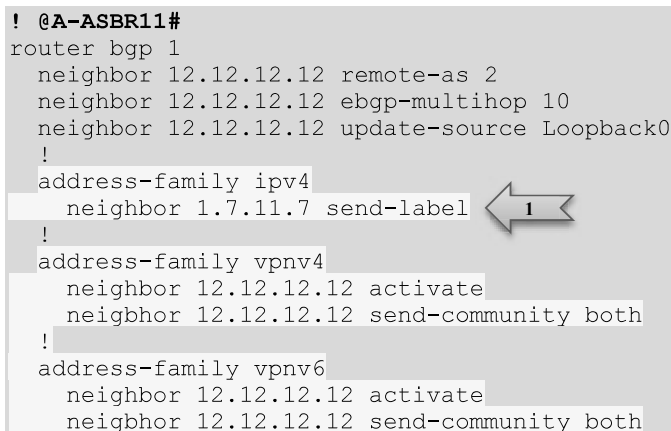
1.L3VPN

Configuration

This task is about CSC. For this we just need to enable “send-label” on the current BGP IPv4 session between AS 1 and AS 3 and also between AS 2 and AS3.

The tricky part of this question is that the VPNv4 session between AS 1 and AS2 will be down if the interface between AS 1 and AS 2 is down. The IPv4 addresses used in this session are from this interface. Consequently, you need to create a new VPNv4 session between AS 1 and AS 2 using another IPv4 address for the peering. Ensure that this IPv4 address is reachable and has an MPLS label associated to you along the path (AS 1 -- AS 3 -- AS 2).

```
! @A-ASBR11#
router bgp 1
  neighbor 12.12.12.12 remote-as 2
  neighbor 12.12.12.12 ebgp-multihop 10
  neighbor 12.12.12.12 update-source Loopback0
  !
  address-family ipv4
    neighbor 1.7.11.7 send-label
  !
  address-family vpnv4
    neighbor 12.12.12.12 activate
    neighbor 12.12.12.12 send-community both
  !
  address-family vpnv6
    neighbor 12.12.12.12 activate
    neighbor 12.12.12.12 send-community both
```

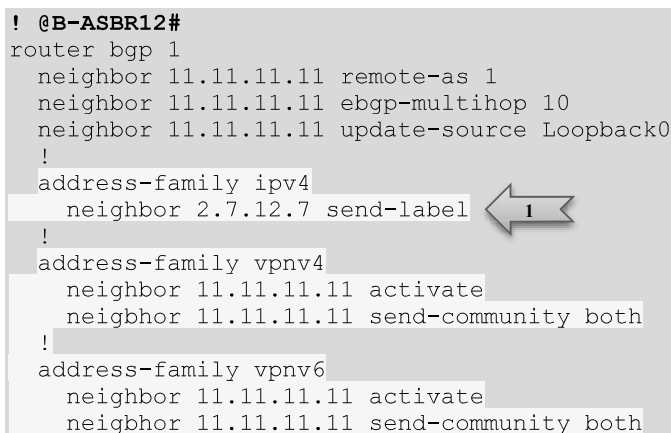


Notes:

1 - “send-label” for CSC session with AS 3

2 - Need to create a new BGP VPNv4 and VPNv6 peering between A-ASBR11 and B-ASBR12 because the original peering is down due to interface status being down.

```
! @B-ASBR12#
router bgp 1
  neighbor 11.11.11.11 remote-as 1
  neighbor 11.11.11.11 ebgp-multihop 10
  neighbor 11.11.11.11 update-source Loopback0
  !
  address-family ipv4
    neighbor 2.7.12.7 send-label
  !
  address-family vpnv4
    neighbor 11.11.11.11 activate
    neighbor 11.11.11.11 send-community both
  !
  address-family vpnv6
    neighbor 11.11.11.11 activate
    neighbor 11.11.11.11 send-community both
```



For the CSC device, it can be as simple as just sending the BGP label. This will attach a label for the BGP VPNv4 and VPNv6 next-hop.

In case there is more than one ISP, this CSC requires to transport traffic and needs to be isolated from each other. You need to create a VRF on the CSC side to separate the traffic.

```
! @C-ASBR7#
router bgp 3
  address-family ipv4
    neighbor 1.7.11.11 send-label
    neighbor 2.7.12.12 send-label
```

Checking

For verification purposes only, shut down the interface between A-ASBR11 and B-ASBR12.

```
! @C-ASBR7#
interface gigabitethernet 3
  shutdown
```

```
C-ASBR7# show bgp ipv4 unicast summary
```

Load for five secs: 1%/0%; one minute: 1%; five minutes: 1%

No time source, *12:54:43.342 UTC Fri Jul 21 2017

BGP router identifier 7.7.7.7, local AS number 3

BGP table version is 84, main routing table version 84

14 network entries using 3472 bytes of memory

20 path entries using 2400 bytes of memory

8/7 BGP path/bestpath attribute entries using 1984 bytes of memory

3 BGP AS-PATH entries using 88 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 7944 total bytes of memory

BGP activity 22/4 prefixes, 73/49 paths, scan interval 60 secs

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
1.7.11.11	4	1	28	14	84	0	0	00:03:10	6
2.7.12.12	4	2	18	16	84	0	0	00:03:10	13

```
C-ASBR7# show mpls forwarding-table
```

Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Label Switched	Outgoing interface	Next Hop
16	Pop Label	1.7.11.0/24	450	aggregate	
17	Pop Label	1.10.11.0/24	0	Gi2	1.7.11.11
18	Pop Label	1.11.12.0/24	0	Gi3	2.7.12.12
19	18	14.14.14.14/32	0	Gi3	2.7.12.12
20	Pop Label	1.7.11.7/32	0	aggregate	
21	22	8.8.8.8/32	0	Gi2	1.7.11.11
22	18	9.9.9.9/32	0	Gi2	1.7.11.11
23	Pop Label	11.11.11.11/32	63472	Gi2	1.7.11.11
24	17	15.15.15.15/32	0	Gi3	2.7.12.12
25	Pop Label	2.7.12.0/24	0	aggregate	
26	Pop Label	2.12.13.0/24	0	Gi3	2.7.12.12
27	Pop Label	2.7.12.7/32	0	aggregate	
28	Pop Label	12.12.12.12/32	66009	Gi3	2.7.12.12

C-ASBR7# show ip cef 12.12.12.12/32 internal

```
12.12.12.12/32, epoch 2, flags [rlbls], RIB[B], refcnt 6, per-destination
sharing
sources: RIB, LTE
feature space:
  IPRM: 0x00018000
  Broker: linked, distributed at 4th priority
  LFD: 12.12.12.12/32 1 local label
  local label info: global/28
    contains path extension list
    disposition chain 0x7FC0933FC840
    label switch chain 0x7FC0933FC3C0
ifnums:
  GigabitEthernet3(8): 2.7.12.12
  path list 7FC07026A8F0, 11 locks, per-destination, flags 0x269 [shble, rif,
rcrsv, hwcn, bgp]

  path 7FC0741BE6B8, share 1/1, type recursive, for IPv4
    MPLS short path extensions: MOI flags = 0x0 label implicit-null
    recursive via 2.7.12.12[IPv4:Default], fib 7FC070268908, 1 terminal fib,
v4:Default:2.7.12.12/32
    path list 7FC07026AFD0, 3 locks, per-destination, flags 0x49 [shble, rif,
hwcn]
      path 7FC0741BE808, share 1/1, type attached host, for IPv4
        MPLS short path extensions: MOI flags = 0x1 label implicit-null
        attached to GigabitEthernet3, IP adj out of GigabitEthernet3, addr
2.7.12.12 7FC070670128
output chain:
  IP adj out of GigabitEthernet3, addr 2.7.12.12 7FC070670128
```

C-ASBR7# show ip cef 12.12.12.12/32 detail

```
12.12.12.12/32, epoch 2, flags [rib defined all labels]
local label info: global/28
recursive via 2.7.12.12
attached to GigabitEthernet3
```

C-ASBR7# show bgp ipv4 unicast label

Network	Next Hop	In label/Out label
1.7.11.0/24	1.7.11.11	16/imp-null
1.7.11.7/32	1.7.11.11	20/27
1.10.11.0/24	1.7.11.11	17/imp-null
1.11.12.0/24	2.7.12.12	18/imp-null
2.7.12.0/24	2.7.12.12	25/imp-null
2.7.12.7/32	2.7.12.12	27/27
2.12.13.0/24	2.7.12.12	26/imp-null
7.7.7.7/32	0.0.0.0	imp-null/nolabel
8.8.8.8/32	1.7.11.11	21/22
9.9.9.9/32	1.7.11.11	22/18
11.11.11.11/32	1.7.11.11	23/imp-null
12.12.12.12/32	2.7.12.12	28/imp-null
14.14.14.14/32	2.7.12.12	19/18
15.15.15.15/32	2.7.12.12	24/17

A-ASBR11# show bgp ipv4 unicast summary

BGP router identifier 11.11.11.11, local AS number 1
 BGP table version is 159, main routing table version 159
 13 network entries using 3224 bytes of memory
 13 path entries using 1560 bytes of memory
 6/6 BGP path/bestpath attribute entries using 1488 bytes of memory
 3 BGP AS-PATH entries using 88 bytes of memory
 1 BGP extended community entries using 24 bytes of memory
 0 BGP route-map cache entries using 0 bytes of memory
 0 BGP filter-list cache entries using 0 bytes of memory
 BGP using 6384 total bytes of memory
 BGP activity 34/11 prefixes, 56/33 paths, scan interval 60 secs

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
1.7.11.7	4	3	14	28	159	0	0	00:03:06	7
1.11.12.12	4	2	0	0	1	0	0	00:01:46	Idle
8.8.8.8	4	1	1080	1245	159	0	0	17:47:48	1
9.9.9.9	4	1	1243	1244	159	0	0	17:48:38	1

A-ASBR11# show bgp vpnv4 unicast all summary

BGP router identifier 11.11.11.11, local AS number 1
 BGP table version is 18, main routing table version 18
 6 network entries using 1536 bytes of memory
 6 path entries using 720 bytes of memory
 5/5 BGP path/bestpath attribute entries using 1320 bytes of memory
 5 BGP AS-PATH entries using 152 bytes of memory
 1 BGP extended community entries using 24 bytes of memory
 0 BGP route-map cache entries using 0 bytes of memory
 0 BGP filter-list cache entries using 0 bytes of memory
 BGP using 3752 total bytes of memory
 BGP activity 44/12 prefixes, 66/34 paths, scan interval 60 secs

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
1.11.12.12	4	2	0	0	1	0	0	01:46:50	Idle
8.8.8.8	4	1	1185	1369	18	0	0	19:32:53	2
9.9.9.9	4	1	1366	1369	18	0	0	19:33:43	1
12.12.12.12	4	2	125	125	18	0	0	01:44:24	3

A-ASBR11# show bgp vpnv6 unicast all summary

BGP router identifier 11.11.11.11, local AS number 1
 BGP table version is 15, main routing table version 15
 3 network entries using 840 bytes of memory
 3 path entries using 444 bytes of memory
 3/3 BGP path/bestpath attribute entries using 792 bytes of memory
 3 BGP AS-PATH entries using 88 bytes of memory
 1 BGP extended community entries using 24 bytes of memory
 0 BGP route-map cache entries using 0 bytes of memory
 0 BGP filter-list cache entries using 0 bytes of memory
 BGP using 2188 total bytes of memory
 BGP activity 34/12 prefixes, 56/34 paths, scan interval 60 secs

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
1.11.12.12	4	2	0	0	1	0	0	00:03:58	Idle
8.8.8.8	4	1	1082	1248	15	0	0	17:50:00	2
9.9.9.9	4	1	1245	1247	15	0	0	17:50:51	1
12.12.12.12	4	2	6	12	15	0	0	00:01:32	0

B-ASBR12# show bgp ipv4 unicast summary

```
BGP router identifier 12.12.12.12, local AS number 2
BGP table version is 186, main routing table version 186
14 network entries using 3472 bytes of memory
14 path entries using 1680 bytes of memory
6/6 BGP path/bestpath attribute entries using 1488 bytes of memory
5 BGP AS-PATH entries using 152 bytes of memory
1 BGP extended community entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 6816 total bytes of memory
BGP activity 44/12 prefixes, 86/54 paths, scan interval 60 secs
```

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
1.11.12.11	4	1	0	0	1	0	0	01:43:10	Active
2.7.12.7	4	3	132	150	186	0	0	01:46:40	7
14.14.14.14	4	2	16	20	186	0	0	00:01:22	1
15.15.15.15	4	2	16	26	186	0	0	00:01:22	1

B-ASBR12# show bgp vpnv4 unicast all summary

```
BGP router identifier 12.12.12.12, local AS number 2
BGP table version is 27, main routing table version 27
6 network entries using 1536 bytes of memory
6 path entries using 720 bytes of memory
5/5 BGP path/bestpath attribute entries using 1320 bytes of memory
5 BGP AS-PATH entries using 152 bytes of memory
1 BGP extended community entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3752 total bytes of memory
BGP activity 44/12 prefixes, 86/54 paths, scan interval 60 secs
```

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
1.11.12.11	4	1	0	0	1	0	0	01:43:16	Active
11.11.11.11	4	1	123	124	27	0	0	01:43:00	3
14.14.14.14	4	2	16	20	27	0	0	00:01:28	2
15.15.15.15	4	2	16	26	27	0	0	00:01:28	1

B-ASBR12# show bgp vpnv6 unicast all summary

```
BGP router identifier 12.12.12.12, local AS number 2
BGP table version is 27, main routing table version 27
6 network entries using 1680 bytes of memory
6 path entries using 888 bytes of memory
5/5 BGP path/bestpath attribute entries using 1320 bytes of memory
5 BGP AS-PATH entries using 152 bytes of memory
1 BGP extended community entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 4064 total bytes of memory
BGP activity 44/12 prefixes, 86/54 paths, scan interval 60 secs
```

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
1.11.12.11	4	1	0	0	1	0	0	01:43:22	Idle
11.11.11.11	4	1	123	124	27	0	0	01:43:05	3
14.14.14.14	4	2	16	20	27	0	0	00:01:34	2
15.15.15.15	4	2	16	26	27	0	0	00:01:34	1

Verifying if the MPLS data traffic is working between A-ASBR11 and B-ASBR12 via C-ASBR7,

A-ASBR11# show ip cef 12.12.12.12/32 detail

```
12.12.12.12/32, epoch 2, flags [rib defined all labels]
local label info: global/26
1 RR source [no flags]
recursive via 1.7.11.7 label 28
attached to GigabitEthernet4
```

```

A-ASBR11# ping mpls ipv4 12.12.12.12/32 source 11.11.11.11
Sending 5, 72-byte MPLS Echos to Target FEC Stack TLV descriptor,
  timeout is 2 seconds, send interval is 0 msec:

Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
'L' - labeled output interface, 'B' - unlabeled output interface,
'D' - DS Map mismatch, 'F' - no FEC mapping, 'f' - FEC mismatch,
'M' - malformed request, 'm' - unsupported tlvs, 'N' - no label entry,
'P' - no rx intf label prot, 'p' - premature termination of LSP,
'R' - transit router, 'I' - unknown upstream index,
'l' - Label switched with FEC change, 'd' - see DDMAP for return code,
'X' - unknown return code, 'x' - return code 0

Type escape sequence to abort.
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 6/17/60 ms
Total Time Elapsed 87 ms

```

```

A-ASBR11# trace mpls ipv4 12.12.12.12/32 source 11.11.11.11
more work needed here to demux the tfs subtlv and to display the right output

Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
'L' - labeled output interface, 'B' - unlabeled output interface,
'D' - DS Map mismatch, 'F' - no FEC mapping, 'f' - FEC mismatch,
'M' - malformed request, 'm' - unsupported tlvs, 'N' - no label entry,
'P' - no rx intf label prot, 'p' - premature termination of LSP,
'R' - transit router, 'I' - unknown upstream index,
'l' - Label switched with FEC change, 'd' - see DDMAP for return code,
'X' - unknown return code, 'x' - return code 0

Type escape sequence to abort.
 0 1.7.11.11 MRU 1500 [Labels: implicit-null/28 Exp: 0/0]
L 1 1.7.11.7 MRU 1500 [Labels: implicit-null Exp: 0] 72 ms
! 2 2.7.12.12 20 ms

```

Note that on PE8, the next-hop of the VPN Inter-AS prefixes is the ASBR.

```

RP/0/0/CPU0:A-PE8# show bgp vpnv4 unicast
BGP router identifier 8.8.8.8, local AS number 1
BGP generic scan interval 60 secs
BGP table state: Active
Table ID: 0x0 RD version: 0
BGP main routing table version 33
BGP scan interval 60 secs

Status codes: s suppressed, d damped, h history, * valid, > best
               i - internal, r RIB-failure, S stale, N Nexthop-discard
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network          Next Hop          Metric LocPrf Weight Path
Route Distinguisher: 8:8 (default for vrf Z)
*> 1.1.1.1/32       172.1.8.1           0             0 4 ?
*>i5.5.5.5/32       11.11.11.11         0            100           0 2 5 ?
*> 172.1.8.0/24     0.0.0.0             0             32768 ?
*                   172.1.8.1           0             0 4 ?
*>i172.2.9.0/24     9.9.9.9             0            100           0 ?
*>i172.5.14.0/24    11.11.11.11         0            100           0 2 5 ?
*>i172.15.15.15/32  11.11.11.11         0            100           0 2 ?
Route Distinguisher: 9:9
*>i172.2.9.0/24     9.9.9.9             0            100           0 ?
Route Distinguisher: 14:14
*>i5.5.5.5/32       11.11.11.11         0            100           0 2 5 ?
*>i172.5.14.0/24    11.11.11.11         0            100           0 2 5 ?
Route Distinguisher: 15:15
*>i172.15.15.15/32  11.11.11.11         0            100           0 2 ?

Processed 10 prefixes, 11 paths

```

A-PE9# show bgp vpnv6 unicast all

BGP table version is 68, local router ID is 9.9.9.9
 Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
 r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
 x best-external, a additional-path, c RIB-compressed,
 Origin codes: i - IGP, e - EGP, ? - incomplete
 RPKI validation codes: V valid, I invalid, N Not found

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 8:8					
*>i 1::1/128	::FFFF:8.8.8.8	0	100	0	4 ?
*>i 172:1:8::/64	::FFFF:8.8.8.8	0	100	0	? ?
Route Distinguisher: 9:9 (default for vrf Z)					
*>i 1::1/128	::FFFF:8.8.8.8	0	100	0	4 ?
*>i 5::5/128	::FFFF:11.11.11.11	0	100	0	2 5 ?
*>i 172:1:8::/64	::FFFF:8.8.8.8	0	100	0	? ?
*> 172:2:9::/64	::	0		32768	? ?
*>i 172:5:14::/64	::FFFF:11.11.11.11	0	100	0	2 5 ?
*>i 172:15:15::15/128	::FFFF:11.11.11.11	0	100	0	2 ?
Route Distinguisher: 14:14					
*>i 5::5/128	::FFFF:11.11.11.11	0	100	0	2 5 ?
*>i 172:5:14::/64	::FFFF:11.11.11.11	0	100	0	2 5 ?
Route Distinguisher: 15:15					
*>i 172:15:15::15/128	::FFFF:11.11.11.11	0	100	0	2 ?

B-PE14# show bgp vpnv4 unicast all

BGP table version is 31, local router ID is 14.14.14.14
 Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
 r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
 x best-external, a additional-path, c RIB-compressed,
 Origin codes: i - IGP, e - EGP, ? - incomplete
 RPKI validation codes: V valid, I invalid, N Not found

Network	Next Hop	Metric	LocPrf	Weight	Path
Route Distinguisher: 8:8					
*>i 1.1.1.1/32	12.12.12.12	0	100	0	1 4 ?
*>i 172.1.8.0/24	12.12.12.12	0	100	0	1 ?
Route Distinguisher: 9:9					
*>i 172.2.9.0/24	12.12.12.12	0	100	0	1 ?
Route Distinguisher: 14:14 (default for vrf Z)					
*>i 1.1.1.1/32	12.12.12.12	0	100	0	1 4 ?
*> 5.5.5.5/32	172.5.14.5	0		0	5 ?
*>i 172.1.8.0/24	12.12.12.12	0	100	0	1 ?
*>i 172.2.9.0/24	12.12.12.12	0	100	0	1 ?
r> 172.5.14.0/24	172.5.14.5	0		0	5 ?
Route Distinguisher: 15:15					
*>i 172.15.15.15/32	15.15.15.15	0	100	0	? ?
Route Distinguisher: 15:15					
*>i 172.15.15.15/32	15.15.15.15	0	100	0	? ?

```

B-PE15# show bgp vpnv6 unicast all
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is hardware calendar, *19:44:44.619 UTC Fri Jul 21 2017

BGP table version is 36, local router ID is 15.15.15.15
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

      Network          Next Hop          Metric LocPrf Weight Path
Route Distinguisher: 8:8
*>i 1::1/128           ::FFFF:12.12.12.12
                                0    100      0 1 4 ?
*>i 172:1:8::/64       ::FFFF:12.12.12.12
                                0    100      0 1 ?
Route Distinguisher: 9:9
*>i 172:2:9::/64       ::FFFF:12.12.12.12
                                0    100      0 1 ?
Route Distinguisher: 14:14
*>i 5::5/128           ::FFFF:14.14.14.14
                                0    100      0 5 ?
*>i 172:5:14::/64      ::FFFF:14.14.14.14
      Network          Next Hop          Metric LocPrf Weight Path
                                0    100      0 5 ?
Route Distinguisher: 15:15 (default for vrf Z)
*>i 1::1/128           ::FFFF:12.12.12.12
                                0    100      0 1 4 ?
*>i 5::5/128           ::FFFF:14.14.14.14
                                0    100      0 5 ?
*>i 172:1:8::/64       ::FFFF:12.12.12.12
                                0    100      0 1 ?
*>i 172:2:9::/64       ::FFFF:12.12.12.12
                                0    100      0 1 ?
*>i 172:5:14::/64      ::FFFF:14.14.14.14
                                0    100      0 5 ?
*> 172:15:15::15/128
      ::
                                0          32768 ?

```

Now verifying end-to-end connectivity.

```

RP/0/0/CPU0:A-PE8# show cef vrf Z ipv6 5::5/128
5::5/128, version 21, internal 0x5000001 0x0 (ptr 0xa13c2f74) [1], 0x0 (0x0),
0x208 (0xa14f0168)
Updated Jul 21 14:36:49.939
Prefix Len 128, traffic index 0, precedence n/a, priority 3
  via ::ffff:11.11.11.11, 3 dependencies, recursive [flags 0x6000]
  path-idx 0 NHID 0x0 [0xa174426c 0x0]
  recursion-via-/128
  next hop VRF - 'default', table - 0xe0000000
  next hop ::ffff:11.11.11.11 via ::ffff:11.11.11.11:0
  next hop 11.11.11.11/32 tt100          labels imposed {ImplNull 36}

```

Remember that we have an MPLS TE tunnel from PE8 toward ASBR11, as this is considered a directed connection, you see the next-hop label above is ImplNull.

```

RP/0/0/CPU0:A-PE8# show route 11.11.11.11
Routing entry for 11.11.11.11/32
  Known via "isis 1", distance 115, metric 20, type level-2
  Installed Jul 20 19:10:41.491 for 1d01h
  Routing Descriptor Blocks
    11.11.11.11, from 11.11.11.11, via tunnel-te100
    Route metric is 20
  No advertising protos.

```

```
RP/0/0/CPU0:A-PE8# show mpls traffic-eng tunnels 100 detail | i Label
```

```
Outgoing Interface: GigabitEthernet0/0/0/0, Outgoing Label: 20
```

```
B-PE14# show ip cef vrf Z 1.1.1.1/32 detail
```

```
1.1.1.1/32, epoch 0, flags [rib defined all labels]  
recursive via 12.12.12.12 label 34  
nexthop 2.13.14.13 GigabitEthernet0/1 label 19
```

In order to make it easier to understand where the labels come from in the following **traceroute** output, the label from the MPLS TE is highlighted with a green background, and the label from the BGP VPNv6 is highlighted with a blue background.

```
Z-CE1# trace 5::5
```

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

```
Tracing the route to 5::5
```

```
 1 172:1:8::8 8 msec 2 msec 3 msec  
 2 ::FFFF:1.8.10.10 [MPLS: Labels 20/36 Exp 3] 26 msec 21 msec 19 msec  
 3 ::FFFF:1.10.11.11 [MPLS: Label 36 Exp 3] 35 msec 16 msec 21 msec  
 4 ::FFFF:1.7.11.7 [MPLS: Labels 28/38 Exp 3] 26 msec 18 msec 23 msec  
 5 ::FFFF:2.12.13.13 [MPLS: Labels 16/20 Exp 3] 25 msec 22 msec 22 msec  
 6 172:5:14::14 [AS 5] [MPLS: Label 20 Exp 3] 27 msec 12 msec 18 msec  
 7 172:5:14::5 [AS 5] 19 msec 16 msec 36 msec
```

```
Z-CE5# trace 1.1.1.1 source 5.5.5.5
```

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

```
Tracing the route to 1.1.1.1
```

```
VRF info: (vrf in name/id, vrf out name/id)
```

```
 1 172.5.14.14 1 msec 2 msec 3 msec  
 2 2.13.14.13 [MPLS: Labels 19/34 Exp 0] 18 msec 15 msec 27 msec  
 3 2.12.13.12 [MPLS: Label 34 Exp 0] 22 msec 9 msec 30 msec  
 4 2.7.12.7 [MPLS: Labels 23/34 Exp 0] 30 msec 15 msec 26 msec  
 5 1.10.11.10 [MPLS: Labels 19/24006 Exp 0] 19 msec 13 msec 18 msec  
 6 1.8.10.8 [MPLS: Label 24006 Exp 0] 26 msec 16 msec 22 msec  
 7 172.1.8.1 [AS 1] 33 msec * 29 msec
```

2. Internet Service

Configuration

Leveraging the MPLS core network implies a 6PE solution. Any other IPv6 transition mechanism does not use MPLS. In this case only the 6PE solution is acceptable for this task.

Do not forget to enable “send-label” under the IPv6 address-family.

```
! @A-ASBR11
router bgp 1
  address-family ipv6 unicast
    neighbor 8.8.8.8 activate
    neighbor 8.8.8.8 send-label
    neighbor 8.8.8.8 next-hop-self
    neighbor 9.9.9.9 activate
    neighbor 9.9.9.9 send-label
    neighbor 9.9.9.9 next-hop-self
```

```
! @A-PE8
router bgp 1
  address-family ipv6 unicast
    allocate-label all
  !
  neighbor 11.11.11.11
    address-family ipv6 labeled-unicast
    next-hop-self
  !
  neighbor 9.9.9.9
    address-family ipv6 labeled-unicast
    next-hop-self
```

```
! @A-PE9
router bgp 1
  neighbor 172:3:9::3 remote-as 6
  address-family ipv6 unicast
    neighbor 8.8.8.8 activate
    neighbor 8.8.8.8 send-label
    neighbor 8.8.8.8 next-hop-self
    neighbor 11.11.11.11 activate
    neighbor 11.11.11.11 send-label
    neighbor 11.11.11.11 next-hop-self
  neighbor 172:3:9::3 activate
```

```
! @Y-CE3
router bgp 6
  no bgp default ipv4-unicast
  neighbor 172:3:9::9 remote-as 1
  !
  address-family ipv6
    redistribute connected
  neighbor 172:3:9::9 activate
```

Checking

Verify the BGP IPv6 label peering and the connectivity between Y-CE3 and C-ASBR7.

```
RP/0/0/CPU0:A-PE8# show bgp ipv6 labeled-unicast summary
BGP router identifier 8.8.8.8, local AS number 1
BGP generic scan interval 60 secs
BGP table state: Active
Table ID: 0xe0800000 RD version: 13
BGP main routing table version 13
BGP scan interval 60 secs
```

BGP is operating in STANDALONE mode.

Process Speaker	RcvTblVer	bRIB/RIB	LabelVer	ImportVer	SendTblVer	StandbyVer
	13	13	13	13	13	13

Neighbor	Spk	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	St/PfxRcd
9.9.9.9	0	1	1830	1585	0	0	0	00:00:03	2
11.11.11.11	0	1	1846	1593	13	0	0	00:04:31	6

A-PE9# show bgp ipv6 uni sum

BGP router identifier 9.9.9.9, local AS number 1
BGP table version is 49, main routing table version 49
8 network entries using 2176 bytes of memory
9 path entries using 1296 bytes of memory
5/5 BGP path/bestpath attribute entries using 1240 bytes of memory
6 BGP AS-PATH entries using 176 bytes of memory
1 BGP extended community entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 4912 total bytes of memory
BGP activity 69/25 prefixes, 129/84 paths, scan interval 60 secs

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
172:3:9::3	4	6	11	17	49	0	0	00:05:42	2
8.8.8.8	4	1	12	13	49	0	0	00:01:19	0
11.11.11.11	4	1	36	21	49	0	0	00:05:45	6

Y-CE3# show bgp ipv6 unicast

BGP table version is 9, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 1:7:11::/64	172:3:9::9			0	1 3 ?
*> 2:7:12::/64	172:3:9::9			0	1 3 ?
*> 3::3/128	::	0		32768	?
*> 7::7/128	172:3:9::9			0	1 3 i
*> 12::12/128	172:3:9::9			0	1 3 2 i
*> 14::14/128	172:3:9::9			0	1 3 2 i
*> 15::15/128	172:3:9::9			0	1 3 2 i
* 172:3:9::/64	172:3:9::9	0		0	1 ?
*>	::	0		32768	?

A-ASBR11# show bgp ipv6 unicast label

Network	Next Hop	In label/Out label
1:7:11::/64	1:7:11::7	43/nolabel
2:7:12::/64	1:7:11::7	44/nolabel
3::3/128	::FFFF:9.9.9.9	nolabel/25
7::7/128	1:7:11::7	45/nolabel
12::12/128	1:7:11::7	40/nolabel
14::14/128	1:7:11::7	41/nolabel
15::15/128	1:7:11::7	42/nolabel
172:3:9::/64	::FFFF:9.9.9.9	nolabel/24

Y-CE3# trace 7::7

Type escape sequence to abort.
Tracing the route to 7::7

```
1 172:3:9::9 11 msec 10 msec 3 msec
2 ::FFFF:1.9.10.10 [MPLS: Labels 16/45 Exp 0] 9 msec 39 msec 34 msec
3 1:7:11::11 [AS 3] [MPLS: Label 45 Exp 0] 33 msec 33 msec 37 msec
4 1:7:11::7 [AS 3] 29 msec 36 msec 23 msec
```

Domain 3: Access and Aggregation

1. Transport and Encapsulation Technologies

Configuration

Ensure that before you apply the ip-address on the port-channel interface you remove the ip-address from the physical interface.

```
! @A-PE9#
default interface GigabitEthernet 2
interface port-channel 1
 ip address 1.9.10.9 255.255.255.0
 ip router isis 1
 mpls traffic-eng tunnels
 isis network point-to-point
 ip rsvp bandwidth
interface GigabitEthernet 2
 channel-group 1 mode active
 cdp enable
interface GigabitEthernet6
 channel-group 1 mode active
 cdp enable
```

```
! @A-P10#
default interface GigabitEthernet3
interface port-channel 1
 ip address 1.9.10.10 255.255.255.0
 ip router isis 1
 negotiation auto
 mpls traffic-eng tunnels
 isis network point-to-point
 ip rsvp bandwidth
interface GigabitEthernet 3
 channel-group 1 mode active
 cdp enable
interface GigabitEthernet5
 channel-group 1 mode active
 cdp enable
```

Checking

Check the state of the LACP and the neighborhood of the protocols used.

```
A-PE9# show lacp 1 neighbor
```

```
Flags:  S - Device is requesting Slow LACPDUs
        F - Device is requesting Fast LACPDUs
        A - Device is in Active mode           P - Device is in Passive mode
```

```
Channel group 1 neighbors
```

```
Partner's information:
```

Partner Port	Partner Flags	Partner LACP State	Partner Port	Partner Priority	Partner Admin Key	Partner Oper Key	Partner Oper Key	Partner Port	Partner Number	Partner Port	Partner State
Gi6	SA	bndl	32768	0x0	0x1	0x1	0x1	0x1	0x3D		
Gi2	SA	bndl	32768	0x0	0x1	0x1	0x1	0x1	0x3D		

```
A-PE9# show isis neighbors
```

```
Tag 1:
System Id      Type Interface  IP Address      State Holdtime Circuit Id
A-PE8          L2  Gi5          1.8.9.8         UP    23      00
A-P10          L2  Po1          1.9.10.10       UP    29      01
```

A-PE9# show mpls interfaces

Interface	IP	Tunnel	BGP	Static	Operational
GigabitEthernet5	Yes (ldp)	Yes	No	No	Yes
Lspvif1	No	No	No	No	Yes
Port-channell	Yes (ldp)	Yes	No	No	Yes

A-PE9# show ip rsvp interface

interface	rsvp	allocated	i/f max	flow max	sub max	VRF
Gi5	ena	0	750M	750M	0	
Po1	ena	0	1500M	1500M	0	

A-P10# show lacp 1 neighbor

Flags: S - Device is requesting Slow LACPDUs
 F - Device is requesting Fast LACPDUs
 A - Device is in Active mode P - Device is in Passive mode

Channel group 1 neighbors
 Partner's information:

Partner Port	Partner Flags	LACP State	Partner Port	Partner Priority	Partner Admin Key	Partner Oper Key	Partner Port	Partner Number	Partner Port	Partner State
Gi3	SA	bndl	32768		0x0	0x1	0x1		0x3D	
Gi5	SA	bndl	32768		0x0	0x1	0x1		0x3D	

A-P10# show isis neighbors

Tag 1:

System Id	Type	Interface	IP Address	State	Holdtime	Circuit Id
A-PE8	L2	Gi2	1.8.10.8	UP	21	00
A-PE9	L2	Po1	1.9.10.9	UP	25	00
A-ASBR11	L2	Gi4	1.10.11.11	UP	20	00

A-P10# show mpls interfaces

Interface	IP	Tunnel	BGP	Static	Operational
GigabitEthernet2	Yes (ldp)	Yes	No	No	Yes
GigabitEthernet4	Yes (ldp)	Yes	No	No	Yes
Port-channell	Yes (ldp)	Yes	No	No	Yes

A-P10# show ip rsvp interface

interface	rsvp	allocated	i/f max	flow max	sub max	VRF
Gi2	ena	0	750M	750M	0	
Gi4	ena	50M	750M	750M	0	
Po1	ena	0	1500M	1500M	0	

2.PE-CE Connectivity

Configuration

The implicit action in this question is to apply **as-override** to the exist BGP peering. If you forget to do this, you will not have connectivity between this CE and other CEs. Z-CE1 and Z-CE3 use the same AS number.

```
! @A-PE9#
router bgp 1
 address-family ipv4 vrf Z
  neighbor 172.2.9.2 remote-as 4
  neighbor 172.2.9.2 activate
  neighbor 172.2.9.2 as-override
 exit-address-family
 address-family ipv6 vrf Z
  neighbor 172:2:9::2 remote-as 4
  neighbor 172:2:9::2 activate
  neighbor 172:2:9::2 as-override
 exit-address-family
```

```
! @A-PE8#
router bgp 1
 vrf Z
  neighbor 172.1.8.1
  address-family ipv4 unicast
  as-override
  neighbor 172:1:8::1
  address-family ipv6 unicast
  as-override
```

```
! @Z-CE2#
router bgp 4
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 172:2:9::9 remote-as 1
 neighbor 172.2.9.9 remote-as 1
 !
 address-family ipv4
  redistribute connected
  neighbor 172.2.9.9 activate
 exit-address-family
 !
 address-family ipv6
  redistribute connected
  neighbor 172:2:9::9 activate
```

Checking

Verify PE-CE connectivity as well as connectivity to the remote CE.

```
Z-CE2# show bgp ipv4 unicast summary
--snip--
Neighbor      V  AS  MsgRcvd  MsgSent  TblVer  InQ  OutQ  Up/Down  State/PfxRcd
172.2.9.9     4  1    9         4        7    0    0 00:00:04      6
```

```
Z-CE2# show bgp ipv6 unicast summary
--snip--
Neighbor      V  AS  MsgRcvd  MsgSent  TblVer  InQ  OutQ  Up/Down  State/PfxRcd
172:2:9::9   4  1    9         4        7    0    0 00:00:03      6
```

```
Z-CE2# show ipv6 route bgp
--snip--
B  1::1/128 [20/0]
   via FE80::F816:3EFF:FEEE:7D2, GigabitEthernet0/1
B  5::5/128 [20/0]
   via FE80::F816:3EFF:FEEE:7D2, GigabitEthernet0/1
B  172:1:8::/64 [20/0]
   via FE80::F816:3EFF:FEEE:7D2, GigabitEthernet0/1
B  172:5:14::/64 [20/0]
   via FE80::F816:3EFF:FEEE:7D2, GigabitEthernet0/1
B  172:15:15::15/128 [20/0]
   via FE80::F816:3EFF:FEEE:7D2, GigabitEthernet0/1
```

```
Z-CE2 show ip route bgp
--snip--
Gateway of last resort is not set

    1.0.0.0/32 is subnetted, 1 subnets
B       1.1.1.1 [20/0] via 172.2.9.9, 00:00:41
    5.0.0.0/32 is subnetted, 1 subnets
B       5.5.5.5 [20/0] via 172.2.9.9, 00:00:41
    172.1.0.0/24 is subnetted, 1 subnets
B       172.1.8.0 [20/0] via 172.2.9.9, 00:00:41
    172.5.0.0/24 is subnetted, 1 subnets
B       172.5.14.0 [20/0] via 172.2.9.9, 00:00:41
    172.15.0.0/32 is subnetted, 1 subnets
B       172.15.15.15 [20/0] via 172.2.9.9, 00:00:41
```

```
Z-CE2# ping 1.1.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 3/4/7 ms
```

```
Z-CE2# ping 1::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/6/8 ms
```

Domain 4: High Availability and Fast Convergence

1. System Level High Availability

Configuration

The feature requested in this task is MPLS LDP IGP sync. Make sure you have enabled this feature on the correct IS-IS process id. To verify this, you can use the **show isis neighbor** command, and verify the tag id.

```
! @B-ASBR12, B-P13, B-PE14, and B-PE15#  
  
router isis 2  
  mpls ldp sync
```

Checking

Do not forget to check if the 'sync' was achieved on all IS-IS interfaces.

```
B-P13# show isis neighbors  
Tag 2:  
System Id      Type Interface  IP Address      State Holdtime Circuit Id  
B-ASBR12      L2   Gi0/2       2.12.13.12     UP    27      B-P13.02  
B-PE14        L2   Gi0/1       2.13.14.14     UP    7       B-PE14.01  
B-PE15        L2   Gi0/3       2.13.15.15     UP    9       B-PE15.01
```

```
B-ASBR12# show mpls ldp igp sync  
GigabitEthernet2:  
  LDP configured; LDP-IGP Synchronization enabled.  
  Sync status: sync achieved; peer reachable.  
  Sync delay time: 0 seconds (0 seconds left)  
  IGP holddown time: infinite.  
  Peer LDP Ident: 13.13.13.13:0  
  IGP enabled: ISIS 2
```

```
B-P13# show mpls ldp igp sync  
GigabitEthernet0/1:  
  LDP configured; LDP-IGP Synchronization enabled.  
  Sync status: sync achieved; peer reachable.  
  Sync delay time: 0 seconds (0 seconds left)  
  IGP holddown time: infinite.  
  Peer LDP Ident: 14.14.14.14:0  
  IGP enabled: ISIS 2  
GigabitEthernet0/2:  
  LDP configured; LDP-IGP Synchronization enabled.  
  Sync status: sync achieved; peer reachable.  
  Sync delay time: 0 seconds (0 seconds left)  
  IGP holddown time: infinite.  
  Peer LDP Ident: 12.12.12.12:0  
  IGP enabled: ISIS 2  
GigabitEthernet0/3:  
  LDP configured; LDP-IGP Synchronization enabled.  
  Sync status: sync achieved; peer reachable.  
  Sync delay time: 0 seconds (0 seconds left)  
  IGP holddown time: infinite.  
  Peer LDP Ident: 15.15.15.15:0  
  IGP enabled: ISIS 2
```

```
B-PE15# show mpls ldp igp sync
GigabitEthernet0/1:
  LDP configured; LDP-IGP Synchronization enabled.
  Sync status: sync achieved; peer reachable.
  Sync delay time: 0 seconds (0 seconds left)
  IGP holddown time: infinite.
  Peer LDP Ident: 13.13.13.13:0
  IGP enabled: ISIS 2
GigabitEthernet0/3:
  LDP configured; LDP-IGP Synchronization enabled.
  Sync status: sync achieved; peer reachable.
  Sync delay time: 0 seconds (0 seconds left)
  IGP holddown time: infinite.
  Peer LDP Ident: 14.14.14.14:0
  IGP enabled: ISIS 2
```

```
B-PE14# show mpls ldp igp sync
GigabitEthernet0/1:
  LDP configured; LDP-IGP Synchronization enabled.
  Sync status: sync achieved; peer reachable.
  Sync delay time: 0 seconds (0 seconds left)
  IGP holddown time: infinite.
  Peer LDP Ident: 13.13.13.13:0
  IGP enabled: ISIS 2
GigabitEthernet0/4:
  LDP configured; LDP-IGP Synchronization enabled.
  Sync status: sync achieved; peer reachable.
  Sync delay time: 0 seconds (0 seconds left)
  IGP holddown time: infinite.
  Peer LDP Ident: 15.15.15.15:0
  IGP enabled: ISIS 2
```

2. Routing/Fast Convergence

Configuration

This task is asking to enable FRR for the MPLS TE tunnel that was created. In order to protect the link we need to verify which physical link this MPLS TE tunnel is using.

```
RP/0/0/CPU0:A-PE8# show mpls traffic-eng tunnels | begin Path info
  Path info (IS-IS 1 level-2):
  Node hop count: 2
  Hop0: 1.8.10.10
  Hop1: 1.10.11.11
  Hop2: 11.11.11.11
Displayed 1 (of 1) heads, 0 (of 0) midpoints, 0 (of 0) tails
Displayed 1 up, 0 down, 0 recovering, 0 recovered heads
```

```
RP/0/0/CPU0:A-PE8# show ipv4 interface brief

Interface                IP-Address      Status         Protocol
Loopback0                8.8.8.8         Up             Up
tunnel-te100             8.8.8.8         Up             Up
MgmtEth0/0/CPU0/0       unassigned      Shutdown       Down
GigabitEthernet0/0/0/0  1.8.10.8        Up             Up
GigabitEthernet0/0/0/2  1.8.9.8         Up             Up
```

According to this output the physical interface to be protected is GigabitEthernet0/0/0/0.

Explicit path can either be achieved by specifying the alternative path by adding an ip-address or by excluding the ip-address used on the primary MPLS TE tunnel (not allowing to be used as the backup path).

Do not forget enabling **fast-reroute** under the MPLS TE tunnel already created.

```
! @A-PE8#
explicit-path name VIA-A-PE9
  index 1 next-address loose ipv4 unicast 1.8.9.9
!
interface tunnel-te100
  fast-reroute
!
interface tunnel-te200
  bandwidth 50000
  ipv4 unnumbered Loopback0
  signalled-bandwidth 50000
  destination 11.11.11.11
  path-option 1 explicit name VIA-A-PE9
!
mpls traffic-eng
  interface GigabitEthernet0/0/0/0
    backup-path tunnel-te 200
```

Checking

Check if the MPLS TE backup tunnel is ready.

```
RP/0/0/CPU0:A-PE8# show mpls traffic-eng tunnels brief

          TUNNEL NAME      DESTINATION      STATUS  STATE
          -----
tunnel-te100             11.11.11.11      up      up
tunnel-te200             11.11.11.11      up      up
Displayed 2 (of 2) heads, 0 (of 0) midpoints, 0 (of 0) tails
Displayed 2 up, 0 down, 0 recovering, 0 recovered heads
```

RP/0/0/CPU0:A-PE8# show mpls traffic-eng tunnels

```
Name: tunnel-te100 Destination: 11.11.11.11 Ifhandle:0x480
Signalled-Name: A-PE8 t100
Status:
  Admin:    up Oper:    up Path:  valid Signalling: connected

  path option 1, type dynamic (Basis for Setup, path weight 20)
  Last Signalled Error : Thu Jul 20 19:09:53 2017
  Info: [6] PathErr(24,0)-(routing, none) at 8.8.8.8
  G-PID: 0x0800 (derived from egress interface properties)
  Bandwidth Requested: 50000 kbps CT0
  Creation Time: Thu Jul 20 19:09:08 2017 (3d22h ago)
Config Parameters:
  Bandwidth:    50000 kbps (CT0) Priority:  7 7 Affinity: 0x0/0xffff
  Metric Type: TE (default)
  Hop-limit: disabled
  Cost-limit: disabled
  AutoRoute: enabled LockDown: disabled Policy class: not set
  Forward class: 0 (default)
  Forwarding-Adjacency: disabled
  Loadshare:    0 equal loadshares
  Auto-bw: disabled
  Fast Reroute: Enabled, Protection Desired: Any
  Path Protection: Not Enabled
  BFD Fast Detection: Disabled
  Reoptimization after affinity failure: Enabled
  Soft Preemption: Disabled
History:
  Tunnel has been up for: 3d22h (since Thu Jul 20 19:10:41 UTC 2017)
  Current LSP:
    Uptime: 3d22h (since Thu Jul 20 19:10:41 UTC 2017)
  Reopt. LSP:
    Last Failure:
      LSP not signalled, identical to the [CURRENT] LSP
      Date/Time: Mon Jul 24 15:06:38 UTC 2017 [02:53:53 ago]

  Path info (IS-IS 1 level-2):
  Node hop count: 2
  Hop0: 1.8.10.10
  Hop1: 1.10.11.11
  Hop2: 11.11.11.11

Name: tunnel-te200 Destination: 11.11.11.11 Ifhandle:0x780
Signalled-Name: A-PE8 t200
Status:
  Admin:    up Oper:    up Path:  valid Signalling: connected

  path option 1, type explicit VIA-A-PE9 (Basis for Setup, path weight 10)
  G-PID: 0x0800 (derived from egress interface properties)
  Bandwidth Requested: 50000 kbps CT0
  Creation Time: Mon Jul 24 18:00:21 2017 (00:00:10 ago)
Config Parameters:
  Bandwidth:    50000 kbps (CT0) Priority:  7 7 Affinity: 0x0/0xffff
  Metric Type: TE (default)
  Hop-limit: disabled
  Cost-limit: disabled
  AutoRoute: disabled LockDown: disabled Policy class: not set
  Forward class: 0 (default)
  Forwarding-Adjacency: disabled
  Loadshare:    0 equal loadshares
  Auto-bw: disabled
  Fast Reroute: Disabled, Protection Desired: None
  Path Protection: Not Enabled
  BFD Fast Detection: Disabled
  Reoptimization after affinity failure: Enabled
  Soft Preemption: Disabled
History:
  Tunnel has been up for: 00:00:10 (since Mon Jul 24 18:00:21 UTC 2017)
```

```
Current LSP:
  Uptime: 00:00:10 (since Mon Jul 24 18:00:21 UTC 2017)

Path info (IS-IS 1 level-2):
Node hop count: 1
Hop0: 1.8.9.9
Hop1: 9.9.9.9
Displayed 2 (of 2) heads, 0 (of 0) midpoints, 0 (of 0) tails
Displayed 2 up, 0 down, 0 recovering, 0 recovered heads

RP/0/0/CPU0:A-PE8# show RSVP fast-reroute destination 11.11.11.11
Type      Destination TunID      Source      PSBs      RSBs
-----
LSP4      11.11.11.11  100        8.8.8.8    Ready     Ready
```

If you would like to verify if the MPLS TE backup tunnel will protect the link, you can **shut down** the GigabitEthernet0/0/0/0 interface. However, before doing this, have a ping command sending 1000 packet to 11.11.11.11 destination, and then **shut down** the interface. It shouldn't miss many packets because of the backup MPLS TE.

Domain 5: Service Provider Security, Operation, and Management

1. Control Plane Security

Configuration

Add the MD5 password in all LDP peering sessions.

```
! @ B-P13#  
mpls ldp neighbor 15.15.15.15 password CISCO  
mpls ldp neighbor 14.14.14.14 password CISCO  
mpls ldp neighbor 12.12.12.12 password CISCO
```

```
! @ B-ASBR12#  
mpls ldp neighbor 13.13.13.13 password CISCO
```

```
! @ B-PE15#  
mpls ldp neighbor 13.13.13.13 password CISCO  
mpls ldp neighbor 14.14.14.14 password CISCO
```

```
! @ B-PE14#  
mpls ldp neighbor 13.13.13.13 password CISCO  
mpls ldp neighbor 15.15.15.15 password CISCO
```

Checking

To verify if the password is being used, check the TCP session information.

```
B-PE14# show mpls ldp neighbor password  
Peer LDP Ident: 13.13.13.13:0; Local LDP Ident 14.14.14.14:0  
TCP connection: 13.13.13.13.646 - 14.14.14.14.15250  
Password: not required, neighbor, in use  
State: Oper; Msgs sent/rcvd: 4888/5005  
Peer LDP Ident: 15.15.15.15:0; Local LDP Ident 14.14.14.14:0  
TCP connection: 15.15.15.15.30487 - 14.14.14.14.646  
Password: not required, neighbor, in use  
State: Oper; Msgs sent/rcvd: 4888/4982
```

```
B-PE15# show mpls ldp neighbor password  
Peer LDP Ident: 13.13.13.13:0; Local LDP Ident 15.15.15.15:0  
TCP connection: 13.13.13.13.646 - 15.15.15.15.56831  
Password: not required, neighbor, in use  
State: Oper; Msgs sent/rcvd: 4994/5007  
Peer LDP Ident: 14.14.14.14:0; Local LDP Ident 15.15.15.15:0  
TCP connection: 14.14.14.14.646 - 15.15.15.15.30487  
Password: not required, neighbor, in use  
State: Oper; Msgs sent/rcvd: 4982/4888
```

```
B-ASBR12# show mpls ldp neighbor password  
Peer LDP Ident: 13.13.13.13:0; Local LDP Ident 12.12.12.12:0  
TCP connection: 13.13.13.13.36552 - 12.12.12.12.646  
Password: not required, neighbor, in use  
State: Oper; Msgs sent/rcvd: 5064/4990
```

```
B-ASBR12# show mpls ldp neighbor password  
Peer LDP Ident: 13.13.13.13:0; Local LDP Ident 12.12.12.12:0  
TCP connection: 13.13.13.13.36552 - 12.12.12.12.646  
Password: not required, neighbor, in use  
State: Oper; Msgs sent/rcvd: 5064/4990
```

B-PE14# show tcp tcb

```
--snip--
Stand-alone TCP connection to host 13.13.13.13
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 255
Local host: 14.14.14.14, Local port: 15250
Foreign host: 13.13.13.13, Foreign port: 646
Connection tableid (VRF): 0
Maximum output segment queue size: 50

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

--snip--

SRTT: 1000 ms, RTTO: 1003 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 1 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 256442939 ms, Sent idletime: 37637 ms, Receive idletime: 37433 ms
Status Flags: active open
Option Flags: non-blocking reads, non-blocking writes, Retrans timeout
  MD5 lossless password switchover, Retrans timeout
IP Precedence value : 6
```

```
--snip--
```

```
Stand-alone TCP connection from host 15.15.15.15
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 255
Local host: 14.14.14.14, Local port: 646
Foreign host: 15.15.15.15, Foreign port: 30487
Connection tableid (VRF): 0
Maximum output segment queue size: 50

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

--snip--

SRTT: 1000 ms, RTTO: 1003 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 4 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 256437824 ms, Sent idletime: 16196 ms, Receive idletime: 16396 ms
Status Flags: passive open, gen tcbs
Option Flags: non-blocking reads, non-blocking writes, Retrans timeout
  MD5 lossless password switchover, Retrans timeout
IP Precedence value : 6
```

```
--snip--
```

B-PE15# show tcp tcb

```
Stand-alone TCP connection to host 14.14.14.14
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 255
Local host: 15.15.15.15, Local port: 30487
Foreign host: 14.14.14.14, Foreign port: 646
Connection tableid (VRF): 0
Maximum output segment queue size: 50

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

--snip--

SRTT: 1000 ms, RTTO: 1003 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 4 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 261478012 ms, Sent idletime: 5348 ms, Receive idletime: 5142 ms
Status Flags: active open
Option Flags: non-blocking reads, non-blocking writes, Retrans timeout
  MD5 lossless password switchover, Retrans timeout
IP Precedence value : 6
```

```
--snip--
```

```
Stand-alone TCP connection to host 13.13.13.13
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 255
Local host: 15.15.15.15, Local port: 56831
Foreign host: 13.13.13.13, Foreign port: 646
Connection tableid (VRF): 0
Maximum output segment queue size: 50
```

```
Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0 (0 bytes)
```

```
--snip--
```

```
SRTT: 1000 ms, RTTO: 1003 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 1 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 261481239 ms, Sent idletime: 646 ms, Receive idletime: 846 ms
Status Flags: active open
Option Flags: non-blocking reads, non-blocking writes, Retrans timeout
  MD5 lossless password switchover, Retrans timeout
IP Precedence value : 6
```

```
--snip--
```

```
B-ASBR12# show tcp tcb
```

```
--snip--
```

```
Stand-alone TCP connection from host 13.13.13.13
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 255
Local host: 12.12.12.12, Local port: 646
Foreign host: 13.13.13.13, Foreign port: 36552
Connection tableid (VRF): 0
Maximum output segment queue size: 50
```

```
Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0 (0 bytes)
```

```
--snip--
```

```
SRTT: 1000 ms, RTTO: 1003 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 3 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 264969062 ms, Sent idletime: 6976 ms, Receive idletime: 6617 ms
Status Flags: passive open, gen tcbs
Option Flags: non-blocking reads, non-blocking writes, Retrans timeout
  MD5 lossless password switchover, Retrans timeout
IP Precedence value : 6
```

```
--snip--
```

```
B-P13# show tcp tcb
```

```
Stand-alone TCP connection to host 12.12.12.12
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 255
Local host: 13.13.13.13, Local port: 21628
Foreign host: 12.12.12.12, Foreign port: 646
Connection tableid (VRF): 0
Maximum output segment queue size: 50
```

```
Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0 (0 bytes)
```

```
--snip--
```

```
SRTT: 954 ms, RTTO: 1319 ms, RTV: 365 ms, KRTT: 0 ms
minRTT: 7 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 1048525 ms, Sent idletime: 5819 ms, Receive idletime: 6019 ms
Status Flags: active open
Option Flags: non-blocking reads, non-blocking writes,
  MD5 lossless password switchover, Retrans timeout
IP Precedence value : 6
```

```
--snip--
```

```
Stand-alone TCP connection from host 14.14.14.14
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 255
Local host: 13.13.13.13, Local port: 646
Foreign host: 14.14.14.14, Foreign port: 62770
Connection tableid (VRF): 0
Maximum output segment queue size: 50
```

```
Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)
```

```
--snip--
```

```
SRTT: 947 ms, RTTO: 1362 ms, RTV: 415 ms, KRTT: 0 ms
minRTT: 8 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 1047876 ms, Sent idletime: 128 ms, Receive idletime: 328 ms
Status Flags: passive open, gen tcbs
Option Flags: non-blocking reads, non-blocking writes,
  MD5 lossless password switchover, Retrans timeout
IP Precedence value : 6
```

```
--snip--
```

```
Stand-alone TCP connection from host 15.15.15.15
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 255
Local host: 13.13.13.13, Local port: 646
Foreign host: 15.15.15.15, Foreign port: 12009
Connection tableid (VRF): 0
Maximum output segment queue size: 50
```

```
Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)
```

```
--snip--
```

```
SRTT: 954 ms, RTTO: 1319 ms, RTV: 365 ms, KRTT: 0 ms
minRTT: 4 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 1048840 ms, Sent idletime: 4376 ms, Receive idletime: 4576 ms
Status Flags: passive open, gen tcbs
Option Flags: non-blocking reads, non-blocking writes,
  MD5 lossless password switchover, Retrans timeout
IP Precedence value : 6
```

```
--snip--
```

2.Management Plane Security

Configuration

This is a feature for Cisco IOS XR specifically.

```
! @ A-PE8#  
  
control-plane  
management-plane  
  inband  
  interface GigabitEthernet0/0/0/0  
    allow SSH  
    allow Telnet
```

Checking

Check if the new policy control is applied.

```
RP/0/0/CPU0:A-PE8# show mgmt-plane  
  
Management Plane Protection  
  
inband interfaces  
-----  
  
interface - GigabitEthernet0/0/0/0  
  ssh configured -  
    All peers allowed  
  telnet configured -  
    All peers allowed
```