Task 1.1

SW1, SW2:
```
vtp mode transparent
```

SW1:
```
interface FastEthernet0/14
 switchport trunk allowed vlan 16,47,100,200
!
interface FastEthernet0/19
 switchport trunk allowed vlan 3003
```

SW2:
```
interface FastEthernet0/14
 switchport trunk allowed vlan 16,63
!
interface FastEthernet0/14
 switchport trunk allowed vlan 16,47,100,200
!
interface FastEthernet0/16
 switchport trunk allowed vlan 63
```

SW3:
```
interface FastEthernet0/16
 switchport trunk allowed vlan 63
```

SW4:
```
interface FastEthernet0/13
 switchport trunk allowed vlan 3003
```

Strategy Tip

Drawing a layer two diagram of the network for this task is recommend

Task 1.1 Verifications

```
Rack1SW1#show interfaces trunk | begin forwarding
Port        Vlans in spanning tree forwarding state and not pruned
Fa0/14      16,47,100,200

Rack1SW2#show interfaces trunk | begin forwarding
Port        Vlans in spanning tree forwarding state and not pruned
Fa0/6       16,63
Fa0/14      16,47,100,200
Fa0/16      63

Rack1SW3#show interfaces trunk | begin forwarding
Port        Vlans in spanning tree forwarding state and not pruned
Fa0/16      63

Rack1SW4#show interfaces trunk | begin forwarding
Port        Vlans in spanning tree forwarding state and not pruned
```

```
Rack1SW4#
```

Task 1.2

SW3:

```
interface FastEthernet0/13
 switchport access vlan 45
 switchport mode access
 no shutdown
!
interface FastEthernet0/14
 switchport access vlan 45
 switchport mode access
 no shutdown
```

SW4:

```
interface FastEthernet0/16
 switchport access vlan 45
 switchport mode access
 no shutdown
!
interface FastEthernet0/17
 switchport access vlan 45
 switchport mode access
 no shutdown
```

Task 1.2 Verification

```
Rack1R4#ping 154.1.45.5

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 154.1.45.5, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
Rack1R4#
```

Task 1.3

R1:

```
bridge irb
!
interface FastEthernet0/0
 no ip address
 bridge-group 1
!
interface Serial0/0
 encapsulation frame-relay
 frame-relay map bridge 102 broadcast
 bridge-group 1
 no shutdown
!
interface BVI1
```



```
 ip address 192.10.1.1 255.255.255.0
!
bridge 1 protocol ieee
bridge 1 route ip
```

R2:

```
bridge irb
!
interface FastEthernet0/0
 no ip address
 bridge-group 1
!
interface Serial0/0
 encapsulation frame-relay
 frame-relay map bridge 201 broadcast
 bridge-group 1
 no shutdown
!
interface BVI1
 ip address 192.10.1.2 255.255.255.0
!
bridge 1 protocol ieee
bridge 1 route ip
```


Task 1.3 Verification

Verify bridging configuration. Check that all bridges agree on common root. There should be no blocking ports, and unstable topology:

```
Rack1R1#show spanning-tree 1

 Bridge group 1 is executing the ieee compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, address 0004.27b5.2fa0
  Configured hello time 2, max age 20, forward delay 15
  Current root has priority 32768, address 0004.27b5.2f60
  Root port is 4 (Serial0/0), cost of root path is 647
  Topology change flag not set, detected flag not set
  Number of topology changes 3 last change occurred 00:03:15 ago
          from FastEthernet0/0
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet0/0) of Bridge group 1 is forwarding
    Port path cost 19, Port priority 128, Port Identifier 128.3.
    Designated root has priority 32768, address 0004.27b5.2f60
    Designated bridge has priority 32768, address 0004.27b5.2fa0
    Designated port id is 128.3, designated path cost 647
    Timers: message age 0, forward delay 0, hold 0
    Number of transitions to forwarding state: 1
    BPDU: sent 110, received 4

 Port 4 (Serial0/0) of Bridge group 1 is forwarding
    Port path cost 647, Port priority 128, Port Identifier 128.4.
    Designated root has priority 32768, address 0004.27b5.2f60
    Designated bridge has priority 32768, address 0004.27b5.2f60
    Designated port id is 128.4, designated path cost 0
    Timers: message age 2, forward delay 0, hold 0
    Number of transitions to forwarding state: 1
    BPDU: sent 4, received 106

Rack1R2#show spanning-tree 1

 Bridge group 1 is executing the ieee compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, address 0004.27b5.2f60
  Configured hello time 2, max age 20, forward delay 15
  We are the root of the spanning tree
  Topology change flag not set, detected flag not set
  Number of topology changes 1 last change occurred 00:05:10 ago
          from FastEthernet0/0
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 1, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet0/0) of Bridge group 1 is forwarding
    Port path cost 19, Port priority 128, Port Identifier 128.3.
    Designated root has priority 32768, address 0004.27b5.2f60
    Designated bridge has priority 32768, address 0004.27b5.2f60
    Designated port id is 128.3, designated path cost 0
    Timers: message age 0, forward delay 0, hold 0
```



```
   Number of transitions to forwarding state: 1
   BPDU: sent 151, received 4

 Port 4 (Serial0/0) of Bridge group 1 is forwarding
   Port path cost 647, Port priority 128, Port Identifier 128.4.
   Designated root has priority 32768, address 0004.27b5.2f60
   Designated bridge has priority 32768, address 0004.27b5.2f60
   Designated port id is 128.4, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   BPDU: sent 150, received 4

Rack1SW1#show spanning-tree vlan 16

VLAN0016
  Spanning tree enabled protocol ieee
  Root ID    Priority    32768
             Address     0004.27b5.2f60
             Cost        666
             Port        1 (FastEthernet0/1)
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32784  (priority 32768 sys-id-ext 16)
             Address     000f.8fe0.3500
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------
------
Fa0/1            Root FWD 19        128.1    P2p
Fa0/6            Desg FWD 19        128.6    P2p

Rack1SW1#show spanning-tree vlan 22

VLAN0022
  Spanning tree enabled protocol ieee
  Root ID    Priority    32768
             Address     0004.27b5.2f60
             Cost        19
             Port        2 (FastEthernet0/2)
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32790  (priority 32768 sys-id-ext 22)
             Address     000f.8fe0.3500
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------
------
Fa0/2            Root FWD 19        128.2    P2p
Fa0/6            Desg FWD 19        128.6    P2p
Fa0/13           Desg FWD 19        128.13   P2p
Fa0/14           Desg FWD 18        128.14   P2p
```



```
Rack1SW2#show spanning-tree vlan 22

VLAN0022
  Spanning tree enabled protocol ieee
  Root ID    Priority    32768
             Address     0004.27b5.2f60
             Cost        38
             Port        13 (FastEthernet0/13)
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32790  (priority 32768 sys-id-ext 22)
             Address     000f.8fb2.e800
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------
------
Fa0/13           Root FWD 19        128.13   P2p
Fa0/14           Altn BLK 19        128.14   P2p
Fa0/24           Desg FWD 100       128.24   Shr
```

Check briding talbes:

```
Rack1R1#show bridge 1 verbose

Total of 300 station blocks, 296 free
Codes: P - permanent, S - self

BG Hash   Address      Action  Interface      VC    Age   RX count   TX
count
 1 34/0 000f.8fe0.3501 forward  FastEthernet0/0 -    0         25
0
 1 4F/0 0004.27b5.2f60 forward  Serial0/0      102   0        236
66
 1 78/0 0015.62d0.4830 forward  FastEthernet0/0 -    0        324
102
 1 D6/0 0060.7015.ac7a forward  Serial0/0      102   0        557
65

Flood ports (BG 1)           RX count    TX count
FastEthernet0/0                    45         180
Serial0/0                         180          45
```

Finally, test IP connectivity:

```
Rack1R6#ping 192.10.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.10.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms

Rack1R6#ping 192.10.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.10.1.2, timeout is 2 seconds:
```



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

Rack1R6#ping 192.10.1.254

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.10.1.254, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 4/7/8 ms
```

Task 1.4

SW1:

```
interface FastEthernet0/16
 l2protocol-tunnel drop-threshold stp 100
!
interface FastEthernet0/17
 l2protocol-tunnel drop-threshold stp 100
```

SW2:

```
interface FastEthernet0/19
 l2protocol-tunnel drop-threshold stp 100
!
interface FastEthernet0/20
 l2protocol-tunnel drop-threshold stp 100
```

Task 1.4 Verification

```
Rack19SW1#show l2protocol-tunnel interface fastEthernet 0/17
COS for Encapsulated Packets: 5

Port       Protocol Shutdown  Drop      Encapsulation Decapsulation Drop
                    Threshold Threshold Counter       Counter       Counter
---------- -------- --------- --------- ------------- ------------- -----------
--
Fa0/17     ---            ----      ----          ----          ----          --
--
           stp            ----       100             0             0
0
           ---            ----      ----          ----          ----          --
--
           ---            ----      ----          ----          ----          --
--
           ---            ----      ----          ----          ----          --
--
           ---            ----      ----          ----          ----          --
--
```

Repeat the same procedure for other PE interfaces.

Task 1.5

R4:

```
interface lo0
 ip ospf network point-to-point
```



```
mpls ldp explicit-null
interface fastEthernet 0/1
 mpls ip
```

R5:

```
interface Loopback0
 ip ospf network point-to-point
!
mpls ldp explicit-null
!
int fastEthernet 0/1
 mpls ip
```

Task 1.4 Verification

```
Rack1R4#sh mpls ldp neighbor
    Peer LDP Ident: 150.1.5.5:0; Local LDP Ident 150.1.4.4:0
        TCP connection: 150.1.5.5.58833 - 150.1.4.4.646
        State: Oper; Msgs sent/rcvd: 44/44; Downstream
        Up time: 00:13:06
          FastEthernet0/1, Src IP addr: 154.1.45.5
        LDP discovery sources:
        Addresses bound to peer LDP Ident:
          154.1.5.5       154.1.45.5      154.1.0.5       150.1.5.5
```

```
Rack1R4#show mpls forwarding-table
Local  Outgoing      Prefix           Bytes Label   Outgoing   Next Hop
Label  Label or VC   or Tunnel Id     Switched      interface
16     16            150.1.1.1/32     0             Fa0/1      154.1.45.5
17     17            150.1.2.2/32     0             Fa0/1      154.1.45.5
18     18            150.1.3.3/32     0             Fa0/1      154.1.45.5
20     20            150.1.6.6/32     0             Fa0/1      154.1.45.5
21     No Label      150.1.7.7/32     0             Fa0/0      154.1.47.7
22     22            150.1.8.8/32     0             Fa0/1      154.1.45.5
23     23            154.1.3.0/24     0             Fa0/1      154.1.45.5
24     explicit-n    154.1.5.0/24     0             Fa0/1      154.1.45.5
25     24            154.1.13.0/24    0             Fa0/1      154.1.45.5
26     25            154.1.23.0/24    0             Fa0/1      154.1.45.5
27     26            154.1.38.0/24    0             Fa0/1      154.1.45.5
28     28            192.10.1.0/24    0             Fa0/1      154.1.45.5
29     explicit-n    150.1.5.0/24     0             Fa0/1      154.1.45.5
```

```
Rack1R5#show mpls ldp neighbor
    Peer LDP Ident: 150.1.4.4:0; Local LDP Ident 150.1.5.5:0
        TCP connection: 150.1.4.4.646 - 150.1.5.5.58833
        State: Oper; Msgs sent/rcvd: 45/45; Downstream
        Up time: 00:14:27
        LDP discovery sources:
          FastEthernet0/1, Src IP addr: 154.1.45.4
        Addresses bound to peer LDP Ident:
          154.1.47.4      154.1.45.4      154.1.0.4       150.1.4.4
```



```
Rack1R5#show mpls forwarding-table
Local  Outgoing      Prefix           Bytes Label   Outgoing   Next Hop
Label  Label or VC   or Tunnel Id     Switched      interface
16     No Label      150.1.1.1/32     0             Se0/0/0    154.1.0.3
17     No Label      150.1.2.2/32     0             Se0/0/0    154.1.0.3
18     No Label      150.1.3.3/32     0             Se0/0/0    154.1.0.3
20     No Label      150.1.6.6/32     0             Se0/0/0    154.1.0.3
21     21            150.1.7.7/32     0             Fa0/1      154.1.45.4
22     No Label      150.1.8.8/32     0             Se0/0/0    154.1.0.3
 23     No Label      154.1.3.0/24      0             Se0/0/0    54.1.0.3
24     No Label      154.1.13.0/24    0             Se0/0/0    154.1.0.3
25     No Label      154.1.23.0/24    0             Se0/0/0    154.1.0.3
26     No Label      154.1.38.0/24    0             Se0/0/0    154.1.0.3
27     explicit-n    154.1.47.0/24    0             Fa0/1      154.1.45.4
28     No Label      192.10.1.0/24    0             Se0/0/0    154.1.0.3
29     explicit-n    150.1.4.0/24     0             Fa0/1      154.1.45.4
```


2. IPv4

Task 2.1

R3:
```
interface Serial1/0
 ip ospf network point-to-multipoint non-broadcast
!
router ospf 1
 network 150.1.3.3 0.0.0.0 area 3457
 network 154.1.0.3 0.0.0.0 area 3457
 neighbor 154.1.0.5 cost 195
 neighbor 154.1.0.4 cost 97
```

R4:
```
interface Serial0/0/0
 ip ospf network point-to-multipoint non-broadcast
!
router ospf 1
 router-id 150.1.4.4
 network 150.1.4.4 0.0.0.0 area 3457
 network 154.1.0.4 0.0.0.0 area 3457
 network 154.1.45.4 0.0.0.0 area 3457
 network 154.1.47.4 0.0.0.0 area 3457
```

R5:
```
interface Serial0/0/0
 ip ospf network point-to-multipoint non-broadcast
!
router ospf 1
 router-id 150.1.5.5
 network 150.1.5.5 0.0.0.0 area 3457
 network 154.1.0.5 0.0.0.0 area 3457
 network 154.1.45.5 0.0.0.0 area 3457
```

SW1:
```
ip routing
!
router ospf 1
 router-id 150.1.7.7
 network 150.1.7.7 0.0.0.0 area 3457
 network 154.1.47.7 0.0.0.0 area 3457
```


Task 2.1 Verification

Verify OSPF neighbors at R3:

```
Rack1R3#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
150.1.2.2         0   FULL/  -        00:00:34    154.1.23.2      Serial1/3
150.1.1.1         0   FULL/  -        00:00:33    154.1.13.1      Serial1/2
150.1.4.4         0   FULL/  -        00:01:46    154.1.0.4       Serial1/0
150.1.5.5         0   FULL/  -        00:01:46    154.1.0.5       Serial1/0
```

```
Rack1R4#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
150.1.7.7         1   FULL/BDR        00:00:38    154.1.47.7
FastEthernet0/0
150.1.5.5         1   FULL/DR         00:00:32    154.1.45.5
FastEthernet0/1
150.1.3.3         0   FULL/  -        00:01:49    154.1.0.3       Serial0/0
```

Confirm that R3 takes in account different PVCs CIR. To do that, temporarily shutdown interface FastEthernet0/1 at R4.

```
Rack1R3#show ip route ospf
     154.1.0.0/16 is variably subnetted, 11 subnets, 2 masks
O       154.1.0.5/32 [110/195] via 154.1.0.5, 00:00:28, Serial1/0
O       154.1.0.4/32 [110/97] via 154.1.0.4, 00:00:28, Serial1/0
O       154.1.47.0/24 [110/107] via 154.1.0.4, 00:00:28, Serial1/0
O       154.1.45.0/24 [110/205] via 154.1.0.5, 00:00:28, Serial1/0
     150.1.0.0/16 is variably subnetted, 4 subnets, 2 masks
O       150.1.7.7/32 [110/108] via 154.1.0.4, 00:00:28, Serial1/0
O       150.1.5.5/32 [110/196] via 154.1.0.5, 00:00:28, Serial1/0
O       150.1.4.4/32 [110/98] via 154.1.0.4, 00:00:28, Serial1/0
```

Task 2.2

R1:

```
router ospf 1
 network 192.10.1.1 0.0.0.0 area 51
 network 150.1.1.1 0.0.0.0 area 51
 area 51 range 150.1.0.0 255.255.252.0
```

R2:

```
router ospf 1
 network 192.10.1.2 0.0.0.0 area 51
 network 150.1.2.2 0.0.0.0 area 51
 area 51 range 150.1.0.0 255.255.252.0
```

R6:

```
router ospf 1
 router-id 150.1.6.6
 network 192.10.1.6 0.0.0.0 area 51
 network 150.1.6.6 0.0.0.0 area 51
```

Task 2.2 Verification

Verify OSPF neighbors:

```
Rack1R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
150.1.3.3         0   FULL/  -        00:00:35    154.1.13.3
Serial0/1
150.1.2.2         1   FULL/DROTHER    00:00:33    192.10.1.2      BVI1
150.1.6.6         1   FULL/DROTHER    00:00:30    192.10.1.6      BVI1
192.10.1.254      1   FULL/DR         00:00:34    192.10.1.254    BVI1
```

Check OSPF routes:

```
Rack1R1#show ip route ospf
     51.0.0.0/32 is subnetted, 1 subnets
O E2    51.51.51.51 [110/20] via 192.10.1.254, 00:02:56, BVI1
     154.1.0.0/16 is variably subnetted, 9 subnets, 2 masks
O       154.1.23.0/24 [110/845] via 154.1.13.3, 00:03:36, Serial0/1
O       154.1.3.0/24 [110/74] via 154.1.13.3, 00:03:36, Serial0/1
O IA    154.1.0.3/32 [110/64] via 154.1.13.3, 00:02:56, Serial0/1
O IA    154.1.0.5/32 [110/171] via 154.1.13.3, 00:02:56, Serial0/1
O IA    154.1.0.4/32 [110/161] via 154.1.13.3, 00:02:56, Serial0/1
O IA    154.1.47.0/24 [110/171] via 154.1.13.3, 00:02:56, Serial0/1
O IA    154.1.45.0/24 [110/171] via 154.1.13.3, 00:02:56, Serial0/1
     150.1.0.0/16 is variably subnetted, 8 subnets, 3 masks
O IA    150.1.7.7/32 [110/172] via 154.1.13.3, 00:02:56, Serial0/1
O       150.1.6.6/32 [110/65] via 192.10.1.6, 00:02:56, BVI1
O IA    150.1.5.5/32 [110/172] via 154.1.13.3, 00:02:56, Serial0/1
O IA    150.1.4.4/32 [110/162] via 154.1.13.3, 00:02:56, Serial0/1
O IA    150.1.3.3/32 [110/65] via 154.1.13.3, 00:02:56, Serial0/1
O       150.1.2.2/32 [110/65] via 192.10.1.2, 00:02:57, BVI1
O       150.1.0.0/22 is a summary, 00:02:57, Null0
```

Verify summary OSPF prefix for Area 51:

```
Rack1R5#show ip route ospf
     51.0.0.0/32 is subnetted, 1 subnets
O E2    51.51.51.51 [110/20] via 154.1.0.3, 00:04:14, Serial0/0
     154.1.0.0/16 is variably subnetted, 9 subnets, 2 masks
O IA    154.1.23.0/24 [110/845] via 154.1.0.3, 00:05:39, Serial0/0
O IA    154.1.13.0/24 [110/845] via 154.1.0.3, 00:05:39, Serial0/0
O IA    154.1.3.0/24 [110/74] via 154.1.0.3, 00:05:39, Serial0/0
O       154.1.0.3/32 [110/64] via 154.1.0.3, 00:05:39, Serial0/0
O       154.1.0.4/32 [110/10] via 154.1.45.4, 00:05:39, FastEthernet0/1
O       154.1.47.0/24 [110/20] via 154.1.45.4, 00:05:39,
FastEthernet0/1
O IA 192.10.1.0/24 [110/909] via 154.1.0.3, 00:04:51, Serial0/0
     150.1.0.0/16 is variably subnetted, 6 subnets, 3 masks
O       150.1.7.7/32 [110/21] via 154.1.45.4, 00:05:39, FastEthernet0/1
O IA    150.1.6.6/32 [110/910] via 154.1.0.3, 00:04:19, Serial0/0
O       150.1.4.4/32 [110/11] via 154.1.45.4, 00:05:39, FastEthernet0/1
O       150.1.3.3/32 [110/65] via 154.1.0.3, 00:05:39, Serial0/0
```



```
O IA    150.1.0.0/22 [110/846] via 154.1.0.3, 00:05:08, Serial0/0
```

Task 2.3

R3:

```
router ospf 1
 network 154.1.38.3 0.0.0.0 area 38
 area 3457 filter-list prefix AREA_38 in
!
ip prefix-list AREA_38 seq 5 deny 150.1.8.8/32
ip prefix-list AREA_38 seq 10 deny 154.1.38.0/24
ip prefix-list AREA_38 seq 15 permit 0.0.0.0/0 le 32
```

SW2:

```
ip routing
!
router ospf 1
 router-id 150.1.8.8
 network 154.1.38.8 0.0.0.0 area 38
 network 150.1.8.8 0.0.0.0 area 38
```

Task 2.3 Verification

Verify OSPF neighbors:

```
Rack1SW2#show ip ospf neighbor

Neighbor ID     Pri   State      Dead Time   Address         Interface
150.1.3.3         1   FULL/BDR   00:00:34    154.1.38.3
FastEthernet0/15
```

Confirm prefix filtering:

```
Rack1R4#sho ip route 150.1.8.8
% Subnet not in table
Rack1R4#show ip route 154.1.38.0
% Subnet not in table
```


Task 2.4

R3:

```
router ospf 1
 timers throttle spf 4000 10000 90000
```

Quick Note
After 12.2(15)T

Task 2.4 Verification

Verify SPF throttle timers:

```
Rack1R3#show ip ospf
 Routing Process "ospf 1" with ID 150.1.3.3
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 It is an area border router
 Initial SPF schedule delay 4000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 90000 msecs
 Incremental-SPF disabled
<output omitted>
```

Task 2.5

R6:

```
router bgp 100
 neighbor 54.1.8.254 route-map BB1_IN in
 neighbor 204.12.1.254 route-map BB3_IN in
!
ip bgp-community new-format
!
ip as-path access-list 1 permit ^54$
ip as-path access-list 2 permit _60$
!
route-map BB1_IN permit 10
 match as-path 1
 set community 54:1
!
route-map BB1_IN permit 20
 match as-path 2
 set community 60:1
!
route-map BB3_IN permit 10
 match as-path 1
 set community 54:3
!
route-map BB3_IN permit 20
 match as-path 2
 set community 60:3
```

Quick Note
Only for clarity of display, does not affect community values or processing.

Task 2.5 Verification

Verify community tagging:

```
Rack1R6#show ip bgp 119.0.0.0
BGP routing table entry for 119.0.0.0/8, version 30
Paths: (2 available, best #1, table Default-IP-Routing-Table)
Flag: 0x8C0
  Advertised to update-groups:
     1
  54
    54.1.8.254 from 54.1.8.254 (212.18.3.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 54:1
  54
    204.12.1.254 from 204.12.1.254 (31.3.0.1)
      Origin IGP, localpref 100, valid, external
      Community: 54:3

Rack1R6#show ip bgp 112.0.0.0
BGP routing table entry for 112.0.0.0/8, version 31
Paths: (2 available, best #1, table Default-IP-Routing-Table)
Flag: 0x8C0
  Advertised to update-groups:
     1
  54 50 60
    54.1.8.254 from 54.1.8.254 (212.18.3.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 60:1
  54 50 60
    204.12.1.254 from 204.12.1.254 (31.3.0.1)
      Origin IGP, localpref 100, valid, external
      Community: 60:3
```

Task 2.6

R6:

```
route-map BB1_IN permit 10
 set weight 1
!
route-map BB3_IN permit 20
 set weight 1
```

Task 2.6 Verification

Verify best-paths:

```
Rack1R6#show ip bgp
BGP table version is 46, local router ID is 150.1.6.6
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
*> 28.119.16.0/24   54.1.8.254                             1 54 i
*                   204.12.1.254             0             0 54 i
*> 28.119.17.0/24   54.1.8.254                             1 54 i
*                   204.12.1.254             0             0 54 i
*> 54.1.8.0/24      0.0.0.0                  0         32768 i
*  112.0.0.0        54.1.8.254               0             0 54 50 60 i
*>                  204.12.1.254                           1 54 50 60 i
*  113.0.0.0        54.1.8.254               0             0 54 50 60 i
*>                  204.12.1.254                           1 54 50 60 i
*> 114.0.0.0        54.1.8.254               0             1 54 i
*                   204.12.1.254                           0 54 i
*> 115.0.0.0        54.1.8.254               0             1 54 i
*                   204.12.1.254                           0 54 i
*> 116.0.0.0        54.1.8.254               0             1 54 i
*                   204.12.1.254                           0 54 i
*> 117.0.0.0        54.1.8.254               0             1 54 i
*                   204.12.1.254                           0 54 i
*> 118.0.0.0        54.1.8.254               0             1 54 i
*                   204.12.1.254                           0 54 i
*> 119.0.0.0        54.1.8.254               0             1 54 i
*                   204.12.1.254                           0 54 i
*> 204.12.1.0       0.0.0.0                  0         32768 i
*> 205.90.31.0      192.10.1.254                           0 200 254 ?
*> 220.20.3.0       192.10.1.254                           0 200 254 ?
*> 222.22.2.0       192.10.1.254                           0 200 254 ?

Rack1R6#show ip bgp 28.119.16.0
BGP routing table entry for 28.119.16.0/24, version 43
Paths: (2 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
     1
  54
    54.1.8.254 from 54.1.8.254 (212.18.3.1)
      Origin IGP, localpref 100, weight 1, valid, external, best
      Community: 54:1
  54
    204.12.1.254 from 204.12.1.254 (31.3.0.1)
      Origin IGP, metric 0, localpref 100, valid, external
      Community: 54:3

Rack1R6#show ip bgp 112.0.0.0
BGP routing table entry for 112.0.0.0/8, version 41
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to update-groups:
     1
  54 50 60
    54.1.8.254 from 54.1.8.254 (212.18.3.1)
      Origin IGP, metric 0, localpref 100, valid, external
      Community: 60:1
  54 50 60
    204.12.1.254 from 204.12.1.254 (31.3.0.1)
      Origin IGP, localpref 100, weight 1, valid, external, best
      Community: 60:3
```


Task 2.7

R1:
```
router bgp 200
 neighbor 154.1.13.3 route-map R3_OUT out
!
ip bgp-community new-format
ip community-list 1 permit 60:3
!
route-map R3_OUT permit 10
 match community 1
 set as-path prepend 200
!
route-map R3_OUT permit 1000
```

R2:
```
router bgp 200
 neighbor 154.1.23.3 route-map R3_OUT out
!
ip bgp-community new-format
ip community-list 1 permit 54:1
!
route-map R3_OUT permit 10
 match community 1
 set as-path prepend 200
!
route-map R3_OUT permit 1000
```

R6:
```
router bgp 100
 redistribute ospf 1 route-map IGP_TO_BGP
 neighbor 192.10.1.1 route-map TO_R1 out
!
ip prefix-list INTERNAL_NETWORK seq 5 permit 154.1.0.0/16 le 32
!
route-map IGP_TO_BGP permit 10
 match ip address prefix-list INTERNAL_NETWORK
!
route-map TO_R1 deny 10
 match ip address prefix-list INTERNAL_NETWORK
!
route-map TO_R1 permit 1000
```

Task 2.7 Verification

Verify BGP best-paths at R3:

```
Rack1R3#show ip bgp community
BGP table version is 46, local router ID is 150.1.3.3
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
```



```
*  28.119.16.0/24   154.1.23.2                       0 200 200 100 54 i
*>                  154.1.13.1                       0 200 100 54 i
*  28.119.17.0/24   154.1.23.2                       0 200 200 100 54 i
*>                  154.1.13.1                       0 200 100 54 i
*> 112.0.0.0        154.1.23.2                       0 200 100 54 50 60
i
*                   154.1.13.1                       0 200 200 100 54 50
60 i
*> 113.0.0.0        154.1.23.2                       0 200 100 54 50 60
i
*                   154.1.13.1                       0 200 200 100 54 50
60 i
*  114.0.0.0        154.1.23.2                       0 200 200 100 54 i
*>                  154.1.13.1                       0 200 100 54 i
*  115.0.0.0        154.1.23.2                       0 200 200 100 54 i
*>                  154.1.13.1                       0 200 100 54 i
*  116.0.0.0        154.1.23.2                       0 200 200 100 54 i
*>                  154.1.13.1                       0 200 100 54 i
*  117.0.0.0        154.1.23.2                       0 200 200 100 54 i
*>                  154.1.13.1                       0 200 100 54 i
*  118.0.0.0        154.1.23.2                       0 200 200 100 54 i
*>                  154.1.13.1                       0 200 100 54 i
*  119.0.0.0        154.1.23.2                       0 200 200 100 54 i
*>                  154.1.13.1                       0 200 100 54 i

Rack1R3#show ip bgp 28.119.16.0
BGP routing table entry for 28.119.16.0/24, version 39
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to update-groups:
     1          2
  200 200 100 54
    154.1.23.2 from 154.1.23.2 (150.1.2.2)
      Origin IGP, localpref 100, valid, external
      Community: 54:1
  200 100 54
    154.1.13.1 from 154.1.13.1 (150.1.1.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 54:1

Rack1R3#show ip bgp 112.0.0.0
BGP routing table entry for 112.0.0.0/8, version 37
Paths: (2 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
     1          2
  200 100 54 50 60
    154.1.23.2 from 154.1.23.2 (150.1.2.2)
      Origin IGP, localpref 100, valid, external, best
      Community: 60:3
  200 200 100 54 50 60
    154.1.13.1 from 154.1.13.1 (150.1.1.1)
      Origin IGP, localpref 100, valid, external
      Community: 60:3
```

Task 2.8

R1:

```
router bgp 200
 neighbor 192.10.1.2 next-hop-self
```

R3:

```
router bgp 300
 neighbor 154.1.23.2 route-map TO_R2 out
!
ip prefix-list VLAN5 seq 5 permit 154.1.5.0/24
!
route-map TO_R2 permit 10
 match ip address prefix-list VLAN5
 set metric 100
!
route-map TO_R2 permit 1000
```

R5:

```
router bgp 400
 network 154.1.5.0 mask 255.255.255.0
```

Task 2.8 Verification

Verify best-path for VLAN5:

```
Rack1R2#show ip bgp 154.1.5.0
BGP routing table entry for 154.1.5.0/24, version 41
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to non peer-group peers:
  154.1.23.3 192.10.1.254
  300 400
    154.1.23.3 from 154.1.23.3 (150.1.3.3)
      Origin IGP, metric 100, localpref 100, valid, external
  300 400
    192.10.1.1 from 192.10.1.1 (150.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, internal, best

Rack1R2#traceroute 154.1.5.5

Type escape sequence to abort.
Tracing the route to 154.1.5.5

  1 192.10.1.1 4 msec 8 msec 4 msec
  2 154.1.13.3 24 msec 16 msec 16 msec
  3 154.1.0.4 48 msec 48 msec 44 msec
  4 154.1.45.5 52 msec *  44 msec

Rack1R6#traceroute 154.1.5.5

Type escape sequence to abort.
Tracing the route to 154.1.5.5

  1 192.10.1.1 0 msec 4 msec 0 msec
  2 154.1.13.3 16 msec 16 msec 16 msec
  3 154.1.0.4 44 msec 44 msec 44 msec
  4 154.1.45.5 44 msec *  44 msec
```


Task 3.1

R6:
```
interface Tunnel56
 ipv6 address 2001:CC1E:1:56::6/64
 tunnel source Loopback0
 tunnel destination 150.1.5.5
 tunnel mode ipv6ip
```

R5:
```
interface Tunnel56
 ipv6 address 2001:CC1E:1:56::5/64
 tunnel source Loopback0
 tunnel destination 150.1.6.6
 tunnel mode ipv6ip
```

Task 3.1 Verification

Verify tunnel configuration:

```
Rack1R5#show interfaces tunnel 56
Tunnel56 is up, line protocol is up
  Hardware is Tunnel
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 150.1.5.5 (Loopback0), destination 150.1.6.6
  Tunnel protocol/transport IPv6/IP
<output omitted>

Rack1R5#ping 2001:CC1E:1:56::6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:CC1E:1:56::6, timeout is 2
seconds:
!!!!!
Success rate is 100 percent (5/5),round-trip min/avg/max = 92/99/104 ms
```

Task 3.2

R3:
```
interface Serial1/3
 ip policy route-map POLICY_ROUTE_IPv6IP
!
ip access-list extended IPv6IP
 permit 41 any any
!
route-map POLICY_ROUTE_IPv6IP permit 10
 match ip address IPv6IP
 set ip next-hop 154.1.0.5
```


Task 3.3

R5:

```
ipv6 router eigrp 56
 router-id 5.5.5.5
 no shutdown
!
interface lo0
 ipv6 eigrp 56
!
interface fastEthernet 0/0
 ipv6 eigrp 56
!
interface Tunnel 56
 ipv6 eigrp 56
```

R6:

```
ipv6 router eigrp 56
 router-id 6.6.6.6
 no shut
!
interface Looback0
 ipv6 eigrp 56
!
int fastEthernet 0/0
 ipv6 eigrp 56
!
interface tunnel56
 ipv6 eigrp 56
 ipv6 summary-address eigrp 56 2001:200::/26
!
interface loopback 100
 ipv6 eigrp 56
!
interface loopback 101
 ipv6 eigrp 56
!
interface loopback 103
 ipv6 eigrp 56
```

Task 3.3 Verification

```
Rack1R5#sh ipv6 ro eigrp
IPv6 Routing Table - Default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, M - MIPv6, R - RIP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF
ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
D   2001:192:1::/64 [90/26882560]
     via FE80::9601:606, Tunnel56
D   2001:200::/26 [90/27008000]
     via FE80::9601:606, Tunnel56
```



```
D   2001:CC1E:1::6/128 [90/27008000]
     via FE80::9601:606, Tunnel56
Rack1R5#

Rack1R6#sh ipv6 ro ei
IPv6 Routing Table - Default - 15 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, M - MIPv6, R - RIP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF
ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
D   2001:200::/26 [5/128256]
     via Null0, directly connected
D   2001:CC1E:1::5/128 [90/27008000]
     via FE80::9601:505, Tunnel56
D   2001:CC1E:1:5::/64 [90/26882560]
     via FE80::9601:505, Tunnel56
Rack1R6#

Rack1R5#ping 2001:220:20:3::1 so lo0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:220:20:3::1, timeout is 2
seconds:
Packet sent with a source address of 2001:CC1E:1::5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 176/176/180
ms
Rack1R5#ping 2001:222:22:2::1 so lo0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:222:22:2::1, timeout is 2
seconds:
Packet sent with a source address of 2001:CC1E:1::5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 176/176/176
ms
Rack1R5#ping 2001:205:90:31::1 so lo0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:205:90:31::1, timeout is 2
seconds:
Packet sent with a source address of 2001:CC1E:1::5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 176/177/180
ms
Rack1R5#
```


Task 5.1

R1:
```
ip pim autorp listener
```

R3:
```
ip pim autorp listener
!
interface Loopback0
 ip pim sparse-mode
!
ip pim send-rp-discovery Loopback0 scope 16
ip pim rp-announce-filter rp-list R4 group-list GROUP_224
ip pim rp-announce-filter rp-list R5 group-list GROUP_224
ip pim rp-announce-filter rp-list R6 group-list GROUP_232
ip mroute 154.1.0.4 255.255.255.255 Tunnel34
ip mroute 150.1.5.5 255.255.255.255 Tunnel35
!
ip access-list standard GROUP_224
 permit 224.0.0.0 7.255.255.255
!
ip access-list standard GROUP_232
 permit 232.0.0.0 3.255.255.255
 permit 236.0.0.0 1.255.255.255
 permit 238.0.0.0 0.255.255.255
!
ip access-list standard R4
 permit 154.1.0.4
!
ip access-list standard R5
 permit 150.1.5.5
!
ip access-list standard R6
 permit 150.1.6.6
```

R4:
```
ip pim autorp listener
!
ip pim send-rp-announce Serial0/0 scope 16 group-list GROUP_224
!
ip access-list standard GROUP_224
 permit 224.0.0.0 7.255.255.255
```

R5:
```
ip pim autorp listener
!
interface Loopback0
 ip pim sparse-mode
!
ip pim send-rp-announce Loopback0 scope 16 group-list GROUP_224
!
ip access-list standard GROUP_224
 permit 224.0.0.0 7.255.255.255
```



```
R6:
ip pim autorp listener
!
interface Loopback0
 ip pim sparse-mode
!
ip pim send-rp-announce Loopback0 scope 16 group-list GROUP_232
!
ip access-list standard GROUP_232
 permit 232.0.0.0 3.255.255.255
 permit 236.0.0.0 1.255.255.255
 permit 238.0.0.0 0.255.255.255
```

Task 5.1 Verification

Verify RP-mapping at Mapping Agent:

```
Rack1R3#show ip pim rp mapping
PIM Group-to-RP Mappings
This system is an RP-mapping agent (Loopback0)

Group(s) 224.0.0.0/5
  RP 154.1.0.4 (?), v2v1
    Info source: 154.1.0.4 (?), elected via Auto-RP
         Uptime: 00:04:53, expires: 00:02:04
  RP 150.1.5.5 (?), v2v1
    Info source: 150.1.5.5 (?), via Auto-RP
         Uptime: 00:03:36, expires: 00:02:19
Group(s) 232.0.0.0/6
  RP 150.1.6.6 (?), v2v1
    Info source: 150.1.6.6 (?), elected via Auto-RP
         Uptime: 00:03:23, expires: 00:02:35
Group(s) 236.0.0.0/7
  RP 150.1.6.6 (?), v2v1
    Info source: 150.1.6.6 (?), elected via Auto-RP
         Uptime: 00:03:23, expires: 00:02:36
Group(s) 238.0.0.0/8
  RP 150.1.6.6 (?), v2v1
    Info source: 150.1.6.6 (?), elected via Auto-RP
         Uptime: 00:03:23, expires: 00:02:34
```

Confirm that RP-mapping information is disseminated:

```
Rack1R1#show ip pim rp mapping
PIM Group-to-RP Mappings

Group(s) 224.0.0.0/5
  RP 154.1.0.4 (?), v2v1
    Info source: 150.1.3.3 (?), elected via Auto-RP
         Uptime: 00:05:16, expires: 00:02:36
Group(s) 232.0.0.0/6
  RP 150.1.6.6 (?), v2v1
    Info source: 150.1.3.3 (?), elected via Auto-RP
         Uptime: 00:04:02, expires: 00:02:38
Group(s) 236.0.0.0/7
  RP 150.1.6.6 (?), v2v1
```



```
    Info source: 150.1.3.3 (?), elected via Auto-RP
         Uptime: 00:04:02, expires: 00:02:38
Group(s) 238.0.0.0/8
  RP 150.1.6.6 (?), v2v1
    Info source: 150.1.3.3 (?), elected via Auto-RP
         Uptime: 00:04:02, expires: 00:02:38
```

Temporarily disable RP-announces at R4:

R4:

```
no ip pim send-rp-announce Serial0/0 scope 16 group-list GROUP_224
```

Wait some time for announces to expire, and check Mapping Agent:

```
Rack1R3#show ip pim rp mapping
PIM Group-to-RP Mappings
This system is an RP-mapping agent (Loopback0)

Group(s) 224.0.0.0/5
  RP 150.1.5.5 (?), v2v1
    Info source: 150.1.5.5 (?), elected via Auto-RP
         Uptime: 00:15:46, expires: 00:02:12
Group(s) 232.0.0.0/6
  RP 150.1.6.6 (?), v2v1
    Info source: 150.1.6.6 (?), elected via Auto-RP
         Uptime: 00:15:32, expires: 00:02:27
Group(s) 236.0.0.0/7
  RP 150.1.6.6 (?), v2v1
    Info source: 150.1.6.6 (?), elected via Auto-RP
         Uptime: 00:15:32, expires: 00:02:26
Group(s) 238.0.0.0/8
  RP 150.1.6.6 (?), v2v1
    Info source: 150.1.6.6 (?), elected via Auto-RP
         Uptime: 00:15:32, expires: 00:02:26
```

Task 5.2

R6:

```
interface FastEthernet0/0.63
 ip multicast boundary AUTORP
!
ip access-list standard AUTORP
 deny   224.0.1.39
 deny   224.0.1.40
 permit 224.0.0.0 15.255.255.255
```


Task 5.2 Verification

Simulate multicast client at BB3:

BB3:

```
ip multicast-routing
!
interface FastEthernet0
 ip pim sparse-mode
 ip igmp join-group 224.0.1.39
 ip igmp join-group 224.0.1.40
```

Before applying multicast-boundary:

```
Rack1R6#show ip igmp groups
IGMP Connected Group Membership
Group Address  Interface              Uptime    Expires   Last Reporter
224.0.1.39     FastEthernet0/0.63  00:05:19  00:02:09  204.12.1.254
224.0.1.40     FastEthernet0/0.63  00:05:15  00:02:07  204.12.1.254
224.0.1.40     FastEthernet0/0.16  00:43:49  00:02:49  192.10.1.6

Rack1R6#show ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C -
Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry,
       X - Proxy Join Timer Running, A - Candidate for MSDP
<output omitted>

(*, 224.0.1.39), 00:28:54/stopped, RP 0.0.0.0, flags: DC
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    FastEthernet0/0.63, Forward/Sparse, 00:02:08/00:00:00
    FastEthernet0/0.16, Forward/Sparse, 00:28:54/00:00:00
<output omitted>
```

After that:

```
Rack1R6#show ip mroute
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C -
Connected,
       L - Local, P - Pruned, R - RP-bit set, F - Register flag,
       T - SPT-bit set, J - Join SPT, M - MSDP created entry,
       X - Proxy Join Timer Running, A - Candidate for MSDP
<output omitted>

(*, 224.0.1.39), 00:29:36/stopped, RP 0.0.0.0, flags: DC
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    FastEthernet0/0.16, Forward/Sparse, 00:29:36/00:00:00
```


Task 6.1

R2:

```
ip cef
interface BVI1
 ip verify unicast reverse-path
```

Task 6.1 Verification

Verify uRPF configuration:

```
Rack1R2#show ip interface bvi 1
BVI1 is up, line protocol is up
<snip>
  IP verify source reachable-via RX, allow default
  4 verification drops
  0 suppressed verification drops
```

Task 6.2

R6:

```
interface Virtual-Template1
 ip access-group RFC_1918 in
!
ip access-list standard RFC_1918
 deny   10.0.0.0 0.255.255.255
 deny   172.16.0.0 0.15.255.255
 deny   192.168.0.0 0.0.255.255
 permit any
```

Task 7.1

R4:

```
snmp-server user IELABUSER IELABGROUP v3 auth md5 CISCO access NMS
snmp-server group IELABGROUP v3 auth access NMS
snmp-server location San Jose, CA US
snmp-server contact CCIE Lab R4
snmp-server chassis-id 222-454322
snmp-server host 154.1.3.100 version 3 priv IELABUSER
!
ip access-list standard NMS
 permit 154.1.3.100
```

Task 7.1 Verification

Verify SNMP configuration:

```
Rack1R4#show snmp
Chassis: 222-454322
Contact: CCIE Lab R4
Location: San Jose, CA US
```



```
0 SNMP packets input
    0 Bad SNMP version errors
    0 Unknown community name
    0 Illegal operation for community name supplied
    0 Encoding errors
    0 Number of requested variables
    0 Number of altered variables
    0 Get-request PDUs
    0 Get-next PDUs
    0 Set-request PDUs
0 SNMP packets output
    0 Too big errors (Maximum packet size 1500)
    0 No such name errors
    0 Bad values errors
    0 General errors
    0 Response PDUs
    0 Trap PDUs

SNMP logging: enabled
    Logging to 154.1.3.100.162, 0/10, 0 sent, 0 dropped.

Rack1R4#show snmp user

User name: IELABUSER
Engine ID: 8000000903000030947EE581
storage-type: nonvolatile        active access-list: NMS
Authentication Protocol: MD5
Privacy Protocol: None
Group-name: IELABGROUP

Rack1R4#show snmp group
groupname: ILMI                                 security model:v1
readview : *ilmi                                writeview: *ilmi
notifyview: <no notifyview specified>
row status: active

groupname: ILMI                                 security model:v2c
readview : *ilmi                                writeview: *ilmi
notifyview: <no notifyview specified>
row status: active

groupname: IELABGROUP                           security model:v3 auth
readview : v1default                            writeview: <no writeview
specified>
notifyview: <no notifyview specified>
row status: active      access-list: NMS

groupname: IELABGROUP                           security model:v3 priv
readview : <no readview specified>              writeview: <no writeview
specified>
notifyview: *tv.FFFFFFFF.FFFFFFFF.FFFFFFF0F
row status: active
```

Task 7.2

R2 & R6:

```
aaa new-model
aaa authentication login default line
aaa authorization exec default if-authenticated
aaa authentication login NO_AUTH none
aaa authentication attempts login 1
aaa authentication fail-message ^
Authentication Failed. Username or Password was Incorrect
^
line con 0
login authentication NO_AUTH
```

Task 7.2 Verification

Telnet to R2:

```
Rack1R6#telnet 150.1.2.2
Trying 150.1.2.2 ... Open


User Access Verification

Password: <cccc>

Authentication Failed. Username or Password was Incorrect

[Connection to 150.1.2.2 closed by foreign host]
```

Task 7.3

R2 & R6:

```
aaa authentication password-prompt "Passcode: "
aaa authentication username-prompt "Login Name: "
aaa authentication login default local
username cisco password 0 cisco
```

Task 7.3 Verification

Telnet to R6:

```
Rack1R6#telnet 150.1.6.6
Trying 150.1.6.6 ... Open


User Access Verification

Login Name: cisco
Passcode: <cisco>

Rack1R6>
```

Task 7.4

R6:

```
interface FastEthernet0/0.16
 ip nat inside
!
interface FastEthernet0/0.63
 ip nat outside
!
interface Virtual-Template1
 ip nat outside
!
ip nat inside source static tcp 192.10.1.112 22 54.1.8.6 22 extendable
ip nat inside source static tcp 192.10.1.112 23 54.1.8.6 23 extendable
ip nat inside source static tcp 192.10.1.112 22 204.12.1.6 22
extendable
ip nat inside source static tcp 192.10.1.112 23 204.12.1.6 23
extendable
```

Task 7.4 Verification

Verify NAT table before any sessions have been established:

```
Rack1R6#sho ip nat translations
Pro Inside global      Inside local       Outside local      Outside
global
tcp 54.1.8.6:22        192.10.1.112:22    ---                ---
tcp 54.1.8.6:23        192.10.1.112:23    ---                ---
tcp 204.12.1.6:22      192.10.1.112:22    ---                ---
tcp 204.12.1.6:23      192.10.1.112:23    ---                ---
```

Initiate session from BB1/BB3 and verify translations again:

```
BB3#telnet 204.12.1.6 22
Trying 204.12.1.6, 22 ...

BB1>telnet 54.1.8.6 23
Trying 54.1.8.6 ...

Rack1R6#show ip nat translations
Pro Inside global   Inside local       Outside local      Outside
global
tcp 204.12.1.6:22   192.10.1.112:22    204.12.1.254:11195
204.12.1.254:11195
tcp 54.1.8.6:22     192.10.1.112:22    ---                ---
tcp 54.1.8.6:23     192.10.1.112:23    54.1.8.254:21187
54.1.8.254:21187
tcp 54.1.8.6:23     192.10.1.112:23    ---                ---
tcp 204.12.1.6:22   192.10.1.112:22    ---                ---
tcp 204.12.1.6:23   192.10.1.112:23    ---                ---
```

Task 7.5

R4:

```
interface Loopback44
ip address 154.1.44.4 255.255.255.0
ip nat inside
!
```



```
interface FastEthernet0/0
ip nat outside
!
interface Serial0/0
ip nat outside
!
interface FastEthernet0/1
ip nat outside
!
ip nat inside source list NAT interface Loopback0 overload
ip ip telnet source-interface Loopback44
!
ip access-list extended NAT
permit tcp host 154.1.44.4 any eq telnet
```

Task 7.5 Verification

Telnet from R4 to R1:

```
Rack1R4#debug ip tcp transactions
TCP special event debugging is on
Rack1R4#telnet 150.1.1.1
Trying 150.1.1.1 ... Open


User Access Verification

Password:

TCP: Random local port generated 15392
TCB65C28EA8 created
TCB65C28EA8 setting property TCP_TOS (11) 65A34198
TCB65C28EA8 bound to 154.1.44.4.15392
TCP: sending SYN, seq 4184047953, ack 0
TCP0: Connection to 150.1.1.1:23, advertising MSS 536
TCP0: state was CLOSED -> SYNSENT [15392 -> 150.1.1.1(23)]
TCP0: state was SYNSENT -> ESTAB [15392 -> 150.1.1.1(23)]
TCP: tcb 65C28EA8 connection to 150.1.1.1:23, peer MSS 536, MSS is 536
TCB65C28EA8 connected to 150.1.1.1.23

Password: <cisco>
Rack1R1>en
Password: <cisco>
```

Verify the source address of the connection:

```
Rack1R1#show tcp brief
TCB       Local Address           Foreign Address         (state)
8340F280  150.1.1.1.23            150.1.4.4.38441         ESTAB
83758978  154.1.13.1.179          154.1.13.3.44104        ESTAB
8375D4AC  192.10.1.1.11000        192.10.1.2.179          ESTAB
8375A2D8  192.10.1.1.179          192.10.1.6.44781        ESTAB

Rack1R1#exit

[Connection to 150.1.1.1 closed by foreign host]
```


Check for the NAT translation on R4:

```
Rack1R4#show ip nat translations
Pro Inside global    Inside local      Outside local      Outside
global
tcp 150.1.4.4:38441  154.1.44.4:38441  150.1.1.1:23       150.1.1.1:23
```

Task 8.1

R3:

```
interface Serial1/0
 frame-relay traffic-shaping
 frame-relay interface-dlci 304
  class DLCI_304
 frame-relay interface-dlci 305
  class DLCI_305
!
map-class frame-relay DLCI_304
 frame-relay cir 1024000
 frame-relay bc 10240
!
map-class frame-relay DLCI_305
 frame-relay cir 512000
 frame-relay bc 5120
```

R4:

```
interface Serial0/0
 frame-relay traffic-shaping
 frame-relay interface-dlci 403
  class DLCI_403
!
map-class frame-relay DLCI_403
 frame-relay cir 1024000
 frame-relay bc 10240
 frame-relay be 5120
```

R5:

```
interface Serial0/0
 frame-relay traffic-shaping
 frame-relay interface-dlci 503
  class DLCI_503
!
map-class frame-relay DLCI_503
 frame-relay cir 512000
 frame-relay bc 5120
 frame-relay be 10240
```

Task 8.1 Verification

Verify FRTS configuration:

```
Rack1R3#show frame-relay pvc 304

PVC Statistics for interface Serial1/0 (Frame Relay DTE)
```



```
DLCI = 304, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial1/0

  input pkts 719           output pkts 1656         in bytes 59701
  out bytes 138706         dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 21        out bcast bytes 6972
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 04:03:28, last time pvc status changed 03:57:41
  cir 1024000   bc 10240     be 0         byte limit 1280   interval 10
  mincir 512000    byte increment 1280  Adaptive Shaping none
  pkts 14        bytes 1210      pkts delayed 0         bytes delayed 0
  shaping inactive
  traffic shaping drops 0
  Queueing strategy: fifo
  Output queue 0/40, 0 drop, 0 dequeued

Rack1R3#show frame-relay pvc 305

PVC Statistics for interface Serial1/0 (Frame Relay DTE)

DLCI = 305, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial1/0

  input pkts 708           output pkts 453          in bytes 63554
  out bytes 47292          dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 21        out bcast bytes 6972
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 04:03:32, last time pvc status changed 03:57:34
  cir 512000    bc 5120      be 0         byte limit 640    interval 10
  mincir 256000    byte increment 640   Adaptive Shaping none
  pkts 2         bytes 176       pkts delayed 0         bytes delayed 0
  shaping inactive
  traffic shaping drops 0
  Queueing strategy: fifo
  Output queue 0/40, 0 drop, 0 dequeued

Rack1R5#show frame-relay pvc 503

PVC Statistics for interface Serial0/0 (Frame Relay DTE)

DLCI = 503, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0

  input pkts 458           output pkts 940          in bytes 47928
  out bytes 82590          dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
```

```
  out bcast pkts 21        out bcast bytes 6972
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 04:05:12, last time pvc status changed 03:59:07
  cir 512000    bc 5120      be 10240     byte limit 1920   interval 10
  mincir 256000    byte increment 640   Adaptive Shaping none
  pkts 20        bytes 1921      pkts delayed 0         bytes delayed 0
  shaping inactive
  traffic shaping drops 0
  Queueing strategy: fifo
  Output queue 0/40, 0 drop, 0 dequeued

Rack1R4#show frame-relay pvc 403

PVC Statistics for interface Serial0/0 (Frame Relay DTE)

DLCI = 403, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0

  input pkts 1463          output pkts 972          in bytes 122170
  out bytes 80251          dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 21        out bcast bytes 6972
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 04:05:53, last time pvc status changed 04:00:03
  cir 1024000   bc 10240     be 5120      byte limit 1920   interval 10
  mincir 512000    byte increment 1280  Adaptive Shaping none
  pkts 24        bytes 1917      pkts delayed 0         bytes delayed 0
  shaping inactive
  traffic shaping drops 0
  Queueing strategy: fifo
  Output queue 0/40, 0 drop, 0 dequeued
```

Task 8.2

R5:

```
class-map match-all QUAKE_DURING_WORK_HOURS
match access-group name QUAKE_DURING_WORK_HOURS
!
policy-map DROP_QUAKE_DURING_WORK_HOURS
class QUAKE_DURING_WORK_HOURS
drop
!
interface FastEthernet0/0
service-policy input DROP_QUAKE_DURING_WORK_HOURS
!
ip access-list extended QUAKE_DURING_WORK_HOURS
permit udp host 154.1.5.100 154.1.47.0 0.0.0.255 eq 27960 time-range
WORK_HOURS
permit udp host 154.1.5.100 154.1.3.0 0.0.0.255 eq 27960 time-range
WORK_HOURS
!
time-range WORK_HOURS
```



```
periodic weekdays 9:00 to 11:59
periodic weekdays 13:00 to 16:59
```

Task 8.2 Verification

Verify policy-map configuration:

```
Rack1R5#show policy-map interface FastEthernet 0/0
 FastEthernet0/0

  Service-policy input: DROP_QUAKE_DURING_WORK_HOURS

    Class-map: QUAKE_DURING_WORK_HOURS (match-all)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: access-group name QUAKE_DURING_WORK_HOURS
      drop

    Class-map: class-default (match-any)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: any

Rack1R5#show ip access-list QUAKE_DURING_WORK_HOURS
Extended IP access list QUAKE_DURING_WORK_HOURS
    10 permit udp host 154.1.5.100 154.1.47.0 0.0.0.255 eq 27960 time-
range WORK_HOURS (inactive)
    20 permit udp host 154.1.5.100 154.1.3.0 0.0.0.255 eq 27960 time-
range WORK_HOURS (inactive)

Rack1R5#show time-range
time-range entry: WORK_HOURS (inactive)
   periodic weekdays 9:00 to 11:59
   periodic weekdays 13:00 to 16:59
   used in: IP ACL entry
   used in: IP ACL entry
```

Task 8.3

R5:

```
class-map match-all QUAKE_TO_VLAN3003
 match access-group name QUAKE_TO_VLAN3003
!
policy-map PRIORITY_FOR_QUAKE
 class QUAKE_TO_VLAN3003
  priority percent 100
!
ip access-list extended QUAKE_TO_VLAN3003
 permit udp host 154.1.5.100 154.1.3.0 0.0.0.255 eq 27960
!
map-class frame-relay DLCI_503
 frame-relay mincir 1536000
 service-policy output PRIORITY_FOR_QUAKE
```

Quick Note
Maximum possible output rate is (Bc + Be) * 1000/Tc.

Task 8.3 Verification

Verify policy-map configuration:

```
Rack1R5#show policy-map interface s0/0
 Serial0/0: DLCI 503 -

  Service-policy output: PRIORITY_FOR_QUAKE

    Class-map: QUAKE_TO_VLAN3003 (match-all)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: access-group name QUAKE_TO_VLAN3003
      Queueing
        Strict Priority
        Output Queue: Conversation 72
        Bandwidth 100 (%)
        Bandwidth 1536 (kbps) Burst 38400 (Bytes)
        (pkts matched/bytes matched) 0/0
        (total drops/bytes drops) 0/0

    Class-map: class-default (match-any)
      4 packets, 384 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: any
```

Task 8.4

R1:

```
interface Serial 0/1
 compress stac
```

R2:

```
interface Serial 0/1
 compress stac
```

R3:

```
interface Serial 1/2
 compress stac
!
interface Serial 1/3
 compress stac
```

Task 8.4 Verification

```
Rack19R1#ping 129.19.13.3 repeat 100 size 500

Type escape sequence to abort.
Sending 100, 500-byte ICMP Echos to 129.19.13.3, timeout is 2 seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 100 percent (100/100), round-trip min/avg/max =
16/18/21 ms
```



```
Rack19R1#show compress
 Serial0/1
         Software compression enabled
         uncompressed bytes xmt/rcv 50958/50691
         compressed bytes   xmt/rcv 4218/4225
         Compressed bytes sent:      4218 bytes   0 Kbits/sec  ratio:
12.081
         Compressed bytes recv:      4225 bytes   0 Kbits/sec  ratio:
11.997
         1  min avg ratio xmt/rcv 5.516/6.298
         5  min avg ratio xmt/rcv 5.516/6.298
         10 min avg ratio xmt/rcv 5.516/6.298
         no bufs xmt 0 no bufs rcv 0
         resyncs 0
         Additional Stac Stats:
         Transmit bytes:  Uncompressed =        0 Compressed =
4218
         Received bytes:  Compressed =       4329 Uncompressed =
88
```

