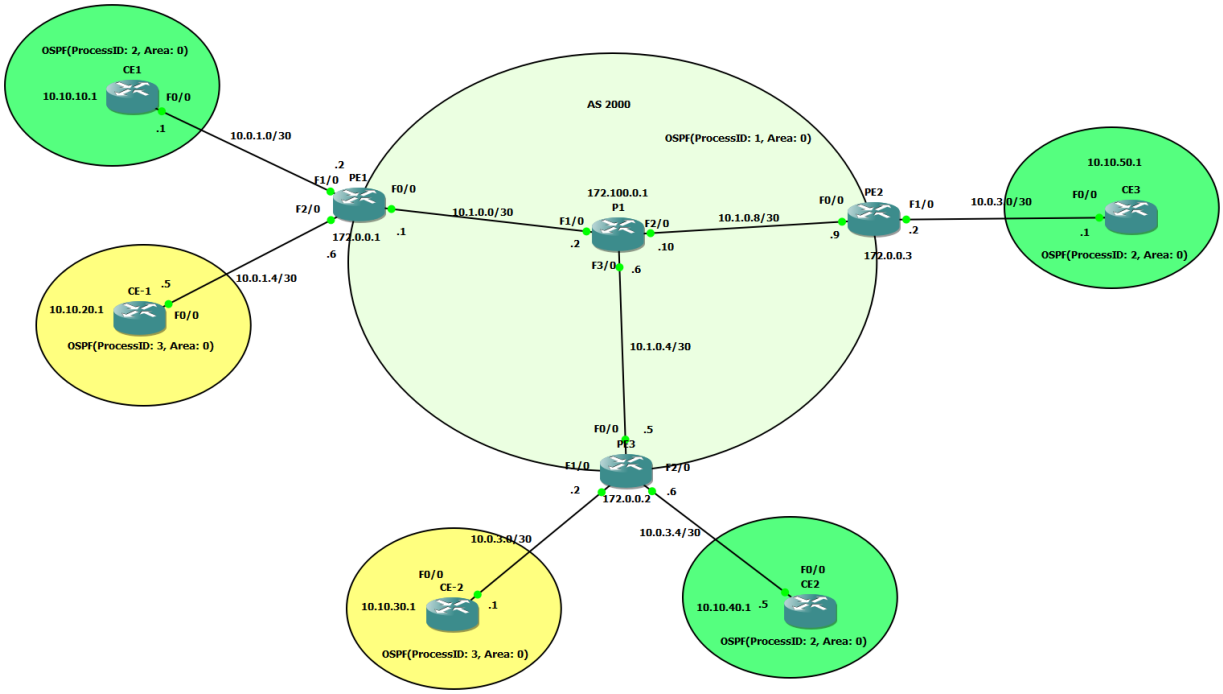
Redes II

Matheus Cândido Teixeira

Exercício 3

Topologia



1. Mostrar e explicar a configuração passo a passo;

I. Para configurar a rede é necessário, a princípio, configurar os endereços das interfaces de todos os roteadores na rede. Este passo é igual para os CEs, PEs e Ps.

Configuração para os CEs

```
[CE1]
configure terminal
    interface loopback 0
        ip address 10.10.10.1 255.255.255.255
        no shutdown
    interface F0/0
        ip address 10.0.1.1 255.255.255.252
        no shutdown
end
[CE-1]
configure terminal
    interface loopback 0
        ip address 10.10.20.1 255.255.255.255
        no shutdown
    interface F0/0
        ip address 10.0.1.5 255.255.255.252
        no shutdown
end
[CE2]
configure terminal
    interface loopback 0
        ip address 10.10.40.1 255.255.255.255
        no shutdown
    interface F0/0
        ip address 10.0.3.5 255.255.255.252
        no shutdown
end
[CE-2]
configure terminal
    interface loopback 0
        ip address 10.10.30.1 255.255.255.255
        no shutdown
    interface F0/0
        ip address 10.0.3.1 255.255.255.252
        no shutdown
end
[CE3]
configure terminal
    interface loopback 0
        ip address 10.10.50.1 255.255.255.255
        no shutdown
    interface F0/0
        ip address 10.0.3.1 255.255.255.252
        no shutdown
```

```
end
```

Configuração para os PEs

```
[PE1]
configure terminal
    interface loopback 0
        ip address 172.0.0.1 255.255.255.255
        no shutdown
    interface F0/0
        ip address 10.1.0.1 255.255.255.252
        no shutdown
    interface F1/0
        ip address 10.0.1.2 255.255.255.252
        no shutdown
    interface F2/0
        ip address 10.0.1.6 255.255.255.252
        no shutdown
end
[PE2]
configure terminal
    interface loopback 0
        ip address 172.0.0.3 255.255.255.255
        no shutdown
    interface F0/0
        ip address 10.1.0.9 255.255.255.252
        no shutdown
    interface F1/0
        no shutdown
end
[PE3]
configure terminal
    interface loopback 0
        ip address 172.0.0.2 255.255.255.255
        no shutdown
    interface F0/0
        ip address 10.1.0.5 255.255.255.252
        no shutdown
    interface F1/0
        ip address 10.0.3.2 255.255.255.252
        no shutdown
    interface F2/0
        ip address 10.0.3.6 255.255.255.252
        no shutdown
end
```

Para a configuração do Provider

```
[P1]
configure terminal
    interface loopback 0
        ip address 172.100.0.1 255.255.255.255
        no shutdown

    interface F1/0
        ip address 10.1.0.2 255.255.255.252
        no shutdown

    interface F2/0
        ip address 10.1.0.10 255.255.255.252
        no shutdown

    interface F3/0
        ip address 10.1.0.6 255.255.255.252
        no shutdown
end
```

A configuração das interfaces permite apenas a comunicação com roteadores que estão no mesmo enlace. Por exemplo, o roteador CE1 pode se comunicar com o roteador PE1 na interface que os conecta, mas não com o loopback dele. Na figura a seguir, é possível verificar este fato:

```
CE1#ping 10.0.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/28/36 ms
CE1#ping 172.0.0.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.0.0.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
CE1#
```

II. Após configurar os endereços das interfaces, é necessário configurar os protocolos de roteamento IGP, neste caso o OSPF. Os roteadores PE1, PE2, PE3 e P1 estão no *ProcessID* 1, os roteadores CE1, CE2 e CE3 estão no *ProcessID* 2 e os roteadores CE-1 e CE-2 estão no *ProcessID* 3.

Configuração para os CEs

```
[CE1]
configure terminal
    router ospf 2
        network 0.0.0.0 255.255.255.255 area 0
end
[CE-1]
configure terminal
    router ospf 3
        network 0.0.0.0 255.255.255.255 area 0
end
[CE2]
configure terminal
    router ospf 2
        network 0.0.0.0 255.255.255.255 area 0
end
[CE-2]
configure terminal
    router ospf 3
        network 0.0.0.0 255.255.255.255 area 0
end
[CE3]
configure terminal
    router ospf 2
        network 0.0.0.0 255.255.255.255 area 0
end
```

Configuração para os PEs

```
[PE1]
configure terminal
    interface loopback 0
        ip ospf 1 area 0
    interface F0/0
        ip ospf 1 area 0
    interface F1/0
        ip ospf 2 area 0
    interface F2/0
        ip ospf 3 area 0
end
[PE2]
configure terminal
    interface loopback 0
        ip ospf 1 area 0
    interface F0/0
        ip ospf 1 area
    interface F1/0
        ip ospf 2 area 0
end
```

```
[PE3]
configure terminal
    interface loopback 0
        ip ospf 1 area 0
    interface F0/0
        ip ospf 1 area 0
    interface F1/0
        ip ospf 3 area 0
    interface F2/0
        ip ospf 2 area 0
end
```

Configuração para o Provider

```
configure terminal
    router ospf 1
        network 0.0.0.0 255.255.255.255 area 0
end
```

III. Até este momento todas as configurações necessárias nos roteadores dos clientes já estão concluídas. Agora é necessário configurar a rede MPLS. Para ativar o MPLS, é preciso ativá-lo nas interfaces dos roteadores que estão na rede MPLS.

Para a configuração dos PEs

```
[PE1]
configure terminal
      interface F0/0
       mpls ip
end
[PE2]
configure terminal
    interface F0/0
        mpls ip
end
[PE3]
configure terminal
    interface F0/0
        mpls ip
end
```

Para a configuração do Provider

```
configure terminal
    interface loopback 0
        mpls ip
    interface F1/0
        mpls ip
    interface F2/0
        mpls ip
    interface F3/0
        mpls ip
end
```

IV. Agora com o MPLS ativado é preciso configurar as VPNs nos PEs. Neste exercício há duas VPNs: (1) “Cliente_A” (Rodando o protocolo OSPF com Process ID igual a 2); (2) “Cliente_B” (Rodando o protocolo OSPF com Process ID igual a 3);

Configuração necessária apenas para os PEs

```
[PE1]
configure terminal
    ip vrf Cliente_A
        rd 2000:1
        route-target both 2000:1
    ip vrf Cliente_B
        rd 2000:2
        route-target both 2000:2
    interface F1/0
        ip vrf forwarding Cliente_A
    interface F2/0
        ip vrf forwarding Cliente_B
end
[PE2]
configure terminal
    ip vrf Cliente_A
        rd 2000:1
        route-target both 2000:1
    ip vrf Cliente_B
        rd 2000:2
        route-target both 2000:2
    interface F1/0
        ip vrf forwarding Cliente_A
end
[PE3]
configure terminal
    ip vrf Cliente_A
        rd 2000:1
        route-target both 2000:1
    ip vrf Cliente_B
        rd 2000:2
        route-target both 2000:2
    interface F1/0
        ip vrf forwarding Cliente_B
    interface F2/0
        ip vrf forwarding Cliente_A
end
```

V. Agora é necessário configurar o protocolo de roteamento BGP. Na configuração do protocolo é necessário declarar que todos os PEs são vizinhos do PE que está sendo configurado. É, também, preciso ativar o IPV4 na rede, isso é feito utilizando o comando **address-family vpnv4**.

```
[PE1]
configure terminal
    router bgp 2000
        neighbor 172.0.0.3 remote-as 2000
        neighbor 172.0.0.3 update-source loopback 0
```

```
        neighbor 172.0.0.2 remote-as 2000
        neighbor 172.0.0.2 update-source loopback 0

        address-family vpnv4
            neighbor 172.0.0.2 activate
            neighbor 172.0.0.3 activate
end
[PE2]
configure terminal
    router bgp 2000
        neighbor 172.0.0.1 remote-as 2000
        neighbor 172.0.0.1 update-source loopback 0

        neighbor 172.0.0.2 remote-as 2000
        neighbor 172.0.0.2 update-source loopback 0

        address-family vpnv4
            neighbor 172.0.0.1 activate
            neighbor 172.0.0.2 activate
end
[PE3]
configure terminal
    router bgp 2000
        neighbor 172.0.0.1 remote-as 2000
        neighbor 172.0.0.1 update-source loopback 0

        neighbor 172.0.0.3 remote-as 2000
        neighbor 172.0.0.3 update-source loopback 0

        address-family vpnv4
            neighbor 172.0.0.1 activate
            neighbor 172.0.0.3 activate
end
```

VI. Por fim, é necessário configurar a redistribuição de rotas OSPF através do protocolo BGP, o que é feito utilizando o comando **address-family ipv4 vrf** *nomaDaVrf*. Também é preciso distribuir o BGP através do OSPF para a distribuição de rotas aprendidas a partir de outros protocolos.

Configurações apenas para os PEs

```
[PE1]
configure terminal
    router bgp 2000
        address-family ipv4 vrf Cliente_A
            redistribute ospf 2
        address-family ipv4 vrf Cliente_B
            redistribute ospf 3
    router ospf 2
        redistribute bgp 2000 subnets
    router ospf 3
```

```
        redistribute bgp 2000 subnets
end
[PE2]
configure terminal
    router bgp 2000
        address-family ipv4 vrf Cliente_A
            redistribute ospf 2
        address-family ipv4 vrf Cliente_B
            redistribute ospf 3
    router ospf 2
        redistribute bgp 2000 subnets
    router ospf 3
        redistribute bgp 2000 subnets
end
[PE3]
configure terminal
    router bgp 2000
        address-family ipv4 vrf Cliente_A
            redistribute ospf 2
        address-family ipv4 vrf Cliente_B
            redistribute ospf 3
    router ospf 2
        redistribute bgp 2000 subnets
    router ospf 3
        redistribute bgp 2000 subnets
end
```

VII. Após estas configurações, os roteadores na mesma VRF devem ser capazes de encontrar rotas para os demais

```
CE1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.0.3.0/30 [110/2] via 10.0.1.2, 02:10:49, FastEthernet0/0
C       10.10.10.1/32 is directly connected, Loopback0
C       10.0.1.0/30 is directly connected, FastEthernet0/0
O IA    10.0.3.4/30 [110/2] via 10.0.1.2, 02:10:49, FastEthernet0/0
O IA    10.10.40.1/32 [110/3] via 10.0.1.2, 02:10:49, FastEthernet0/0
O IA    10.10.50.1/32 [110/3] via 10.0.1.2, 02:10:49, FastEthernet0/0
CE1#
```

```
CE-1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O IA    10.0.3.0/30 [110/2] via 10.0.1.6, 00:00:01, FastEthernet0/0
C       10.0.1.4/30 is directly connected, FastEthernet0/0
C       10.10.20.1/32 is directly connected, Loopback0
O IA    10.10.30.1/32 [110/3] via 10.0.1.6, 00:00:01, FastEthernet0/0
CE-1#
```

2. Em cada etapa da configuração, mostrar e explicar a tabela de roteamento de cada roteador e também a tabela LFIB dos roteadores da rede MPLS;

I. Apenas os endereços das interfaces configurados:

Apenas com as interfaces configuradas, apenas as redes conectadas as interfaces devem ser visíveis. Até este momento não há tabela de rotas e, portanto, a tabela LFIB ainda não pode ser construída.

CE1#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.10.10.1/32 is directly connected, Loopback0
C 10.0.1.0/30 is directly connected, FastEthernet0/0

CE-1#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.1.4/30 is directly connected, FastEthernet0/0
C 10.10.20.1/32 is directly connected, Loopback0

CE-2#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.3.0/30 is directly connected, FastEthernet0/0
C 10.10.30.1/32 is directly connected, Loopback0

CE2#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.3.4/30 is directly connected, FastEthernet0/0
C 10.10.40.1/32 is directly connected, Loopback0

CE3#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.3.0/30 is directly connected, FastEthernet0/0
C 10.10.50.1/32 is directly connected, Loopback0

PE1#show ip route
172.0.0.0/32 is subnetted, 1 subnets
C 172.0.0.1 is directly connected, Loopback0
10.0.0.0/30 is subnetted, 3 subnets
C 10.1.0.0 is directly connected, FastEthernet0/0
C 10.0.1.0 is directly connected, FastEthernet1/0
C 10.0.1.4 is directly connected, FastEthernet2/0

PE2#show ip route
172.0.0.0/32 is subnetted, 1 subnets
C 172.0.0.3 is directly connected, Loopback0
10.0.0.0/30 is subnetted, 1 subnets
C 10.1.0.8 is directly connected, FastEthernet0/0

PE3#show ip route
172.0.0.0/32 is subnetted, 1 subnets
C 172.0.0.2 is directly connected, Loopback0
10.0.0.0/30 is subnetted, 3 subnets
C 10.0.3.0 is directly connected, FastEthernet1/0
C 10.0.3.4 is directly connected, FastEthernet2/0
C 10.1.0.4 is directly connected, FastEthernet0/0

P1#show ip route

172.100.0.0/32 is subnetted, 1 subnets
C 172.100.0.1 is directly connected, Loopback0
10.0.0.0/30 is subnetted, 3 subnets
C 10.1.0.8 is directly connected, FastEthernet2/0
C 10.1.0.0 is directly connected, FastEthernet1/0
C 10.1.0.4 is directly connected, FastEthernet3/0

II. Como o protocolo de roteamento IGP configurado já há rotas nos roteadores que constituem a rede MPLS, porém os roteadores dos clientes ainda não possuem rotas pois eles não estão conectados diretamente a redes com mesmo *ProcessID* que eles e, portanto, o protocolo IGP não pode criar rotas.

CE1#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.10.10.1/32 is directly connected, Loopback0
C 10.0.1.0/30 is directly connected, FastEthernet0/0

CE-1#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.1.4/30 is directly connected, FastEthernet0/0
C 10.10.20.1/32 is directly connected, Loopback0

CE-2#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks

C 10.0.3.0/30 is directly connected, FastEthernet0/0
C 10.10.30.1/32 is directly connected, Loopback0

CE2#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.3.4/30 is directly connected, FastEthernet0/0
C 10.10.40.1/32 is directly connected, Loopback0

CE3#show ip route
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.0.3.0/30 is directly connected, FastEthernet0/0
C 10.10.50.1/32 is directly connected, Loopback0

PE1#show ip route
172.100.0.0/32 is subnetted, 1 subnets
O 172.100.0.1 [110/2] via 10.1.0.2, 00:01:10, FastEthernet0/0
172.0.0.0/32 is subnetted, 3 subnets
C 172.0.0.1 is directly connected, Loopback0
O 172.0.0.2 [110/3] via 10.1.0.2, 00:01:10, FastEthernet0/0
O 172.0.0.3 [110/3] via 10.1.0.2, 00:01:10, FastEthernet0/0
10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O 10.1.0.8/30 [110/2] via 10.1.0.2, 00:01:10, FastEthernet0/0
O 10.10.10.1/32 [110/2] via 10.0.1.1, 00:03:52, FastEthernet1/0
C 10.1.0.0/30 is directly connected, FastEthernet0/0
C 10.0.1.0/30 is directly connected, FastEthernet1/0
O 10.1.0.4/30 [110/2] via 10.1.0.2, 00:01:11, FastEthernet0/0
C 10.0.1.4/30 is directly connected, FastEthernet2/0
O 10.10.20.1/32 [110/2] via 10.0.1.5, 00:03:44, FastEthernet2/0

PE2#show ip route
172.100.0.0/32 is subnetted, 1 subnets
O 172.100.0.1 [110/2] via 10.1.0.10, 00:02:02, FastEthernet0/0

```
   172.0.0.0/32 is subnetted, 3 subnets
O     172.0.0.1 [110/3] via 10.1.0.10, 00:01:52, FastEthernet0/0
O     172.0.0.2 [110/3] via 10.1.0.10, 00:02:02, FastEthernet0/0
C     172.0.0.3 is directly connected, Loopback0
   10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C     10.1.0.8/30 is directly connected, FastEthernet0/0
C     10.0.3.0/30 is directly connected, FastEthernet1/0
O     10.1.0.0/30 [110/2] via 10.1.0.10, 00:01:52, FastEthernet0/0
O     10.1.0.4/30 [110/2] via 10.1.0.10, 00:02:02, FastEthernet0/0
O     10.10.50.1/32 [110/2] via 10.0.3.1, 00:02:31, FastEthernet1/0
```

PE3#show ip route

```
   172.100.0.0/32 is subnetted, 1 subnets
O     172.100.0.1 [110/2] via 10.1.0.6, 00:02:03, FastEthernet0/0
   172.0.0.0/32 is subnetted, 3 subnets
O     172.0.0.1 [110/3] via 10.1.0.6, 00:02:03, FastEthernet0/0
C     172.0.0.2 is directly connected, Loopback0
O     172.0.0.3 [110/3] via 10.1.0.6, 00:02:03, FastEthernet0/0
   10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O     10.1.0.8/30 [110/2] via 10.1.0.6, 00:02:03, FastEthernet0/0
C     10.0.3.0/30 is directly connected, FastEthernet1/0
O     10.1.0.0/30 [110/2] via 10.1.0.6, 00:02:03, FastEthernet0/0
C     10.0.3.4/30 is directly connected, FastEthernet2/0
C     10.1.0.4/30 is directly connected, FastEthernet0/0
O     10.10.30.1/32 [110/2] via 10.0.3.1, 00:03:46, FastEthernet1/0
O     10.10.40.1/32 [110/2] via 10.0.3.5, 00:03:48, FastEthernet2/0
```

P1#show ip route

```
   172.100.0.0/32 is subnetted, 1 subnets
C     172.100.0.1 is directly connected, Loopback0
   172.0.0.0/32 is subnetted, 3 subnets
O     172.0.0.1 [110/2] via 10.1.0.1, 00:02:09, FastEthernet1/0
O     172.0.0.2 [110/2] via 10.1.0.5, 00:02:09, FastEthernet3/0
O     172.0.0.3 [110/2] via 10.1.0.9, 00:02:09, FastEthernet2/0
   10.0.0.0/30 is subnetted, 3 subnets
C     10.1.0.8 is directly connected, FastEthernet2/0
C     10.1.0.0 is directly connected, FastEthernet1/0
C     10.1.0.4 is directly connected, FastEthernet3/0
```

III. Com o protocol IGP atuando, é possível ativar o MPLS nas redes e, assim, criar rotas. O MPLS utiliza o IGP para distribuir labels utilizando o protocolo LDP. Porém, mesmo com o MPLS configurado ainda não há VPN criadas, portanto, não houve alterações para os nós clientes.

```
PE1#show mpls forwarding-table
Local  Outgoing      Prefix           Bytes Label   Outgoing   Next Hop
Label  Label or VC   or Tunnel Id     Switched      interface
16     Pop Label     10.1.0.4/30      0             Fa0/0      10.1.0.2
17     Pop Label     10.1.0.8/30      0             Fa0/0      10.1.0.2
18     No Label      10.10.10.1/32    0             Fa1/0      10.0.1.1
19     No Label      10.10.20.1/32    0             Fa2/0      10.0.1.5
20     17            172.0.0.2/32     0             Fa0/0      10.1.0.2
21     18            172.0.0.3/32     0             Fa0/0      10.1.0.2
22     Pop Label     172.100.0.1/32   0             Fa0/0      10.1.0.2
```

```
PE2#show mpls forwarding-table
Local  Outgoing      Prefix           Bytes Label   Outgoing   Next Hop
Label  Label or VC   or Tunnel Id     Switched      interface
16     Pop Label     10.1.0.0/30      0             Fa0/0      10.1.0.10
17     Pop Label     10.1.0.4/30      0             Fa0/0      10.1.0.10
18     No Label      10.10.50.1/32    0             Fa1/0      10.0.3.1
19     16            172.0.0.1/32     0             Fa0/0      10.1.0.10
20     17            172.0.0.2/32     0             Fa0/0      10.1.0.10
21     Pop Label     172.100.0.1/32   0             Fa0/0      10.1.0.10
```

```
PE3#show mpls forwarding-table
Local  Outgoing      Prefix           Bytes Label   Outgoing   Next Hop
Label  Label or VC   or Tunnel Id     Switched      interface
16     Pop Label     10.1.0.0/30      0             Fa0/0      10.1.0.6
17     Pop Label     10.1.0.8/30      0             Fa0/0      10.1.0.6
18     No Label      10.10.30.1/32    0             Fa1/0      10.0.3.1
19     No Label      10.10.40.1/32    0             Fa2/0      10.0.3.5
20     16            172.0.0.1/32     0             Fa0/0      10.1.0.6
21     18            172.0.0.3/32     0             Fa0/0      10.1.0.6
22     Pop Label     172.100.0.1/32   0             Fa0/0      10.1.0.6
```

```
P1#show mpls forwarding-table
Local  Outgoing      Prefix           Bytes Label   Outgoing   Next Hop
Label  Label or VC   or Tunnel Id     Switched      interface
16     Pop Label     172.0.0.1/32     0             Fa1/0      10.1.0.1
17     Pop Label     172.0.0.2/32     0             Fa3/0      10.1.0.5
18     Pop Label     172.0.0.3/32     0             Fa2/0      10.1.0.9
```

IV. Com o forwarding ativado nos PEs, já é possível ver os clientes (CEs) que pertencem a cada VPN.

PE1#show ip route vrf Cliente_A

10.0.0.0/30 is subnetted, 1 subnets
C 10.0.1.0 is directly connected, FastEthernet1/0

PE1#show ip route vrf Cliente_B

10.0.0.0/30 is subnetted, 1 subnets
C 10.0.1.4 is directly connected, FastEthernet2/0

PE2#show ip route vrf Cliente_A

10.0.0.0/30 is subnetted, 1 subnets
C 10.0.3.0 is directly connected, FastEthernet1/0

PE3#show ip route vrf Cliente_A

10.0.0.0/30 is subnetted, 1 subnets
C 10.0.3.4 is directly connected, FastEthernet2/0

PE3#show ip route vrf Cliente_B

10.0.0.0/30 is subnetted, 1 subnets
C 10.0.3.0 is directly connected, FastEthernet1/0

V. Apenas ativando o VPNV4 não há alterações na rede. É necessário ativar a redistribuição do protocolo BGP e das rotas OSPF ainda. Após ativar a redistribuição de BGP e de OSPF:

i. Os CEs são capazes de ver as rotas dos demais CEs através da rede MPLS:

CE1#show ip route

```
    10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.0.3.0/30 [110/2] via 10.0.1.2, 00:00:24, FastEthernet0/0
C       10.10.10.1/32 is directly connected, Loopback0
C       10.0.1.0/30 is directly connected, FastEthernet0/0
O IA    10.0.3.4/30 [110/2] via 10.0.1.2, 00:00:24, FastEthernet0/0
O IA    10.10.40.1/32 [110/3] via 10.0.1.2, 00:00:24, FastEthernet0/0
O IA    10.10.50.1/32 [110/3] via 10.0.1.2, 00:00:24, FastEthernet0/0
```

CE-1#show ip route

```
    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O IA    10.0.3.0/30 [110/2] via 10.0.1.6, 00:02:58, FastEthernet0/0
C       10.0.1.4/30 is directly connected, FastEthernet0/0
C       10.10.20.1/32 is directly connected, Loopback0
O IA    10.10.30.1/32 [110/3] via 10.0.1.6, 00:02:44, FastEthernet0/0
```

CE-2#show ip route

```
    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet0/0
O IA    10.0.1.4/30 [110/2] via 10.0.3.2, 00:02:51, FastEthernet0/0
O IA    10.10.20.1/32 [110/3] via 10.0.3.2, 00:02:51, FastEthernet0/0
C       10.10.30.1/32 is directly connected, Loopback0
```

CE2#show ip route

```
    10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.0.3.0/30 [110/2] via 10.0.3.6, 00:04:10, FastEthernet0/0
O IA    10.10.10.1/32 [110/3] via 10.0.3.6, 00:03:10, FastEthernet0/0
O IA    10.0.1.0/30 [110/2] via 10.0.3.6, 00:04:23, FastEthernet0/0
C       10.0.3.4/30 is directly connected, FastEthernet0/0
C       10.10.40.1/32 is directly connected, Loopback0
O IA    10.10.50.1/32 [110/3] via 10.0.3.6, 00:04:23, FastEthernet0/0
```

CE3#show ip route

```
    10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet0/0
O IA    10.10.10.1/32 [110/3] via 10.0.3.2, 00:03:03, FastEthernet0/0
O IA    10.0.1.0/30 [110/2] via 10.0.3.2, 00:04:43, FastEthernet0/0
O IA    10.0.3.4/30 [110/2] via 10.0.3.2, 00:04:03, FastEthernet0/0
O IA    10.10.40.1/32 [110/3] via 10.0.3.2, 00:04:18, FastEthernet0/0
C       10.10.50.1/32 is directly connected, Loopback0
```

ii. Os PEs são capazes de verificar as rotas para todos os clientes que pertencem a uma determinada VPN.

PE1#show ip route vrf Cliente_A

```
Routing Table: Cliente_A
    10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
B       10.0.3.0/30 [200/0] via 172.0.0.3, 00:08:23
O       10.10.10.1/32 [110/2] via 10.0.1.1, 00:07:29, FastEthernet1/0
C       10.0.1.0/30 is directly connected, FastEthernet1/0
B       10.0.3.4/30 [200/0] via 172.0.0.2, 00:08:23
B       10.10.40.1/32 [200/2] via 172.0.0.2, 00:08:23
B       10.10.50.1/32 [200/2] via 172.0.0.3, 00:08:38
```

PE1#show ip route vrf Cliente_B

```
Routing Table: Cliente_B
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
B       10.0.3.0/30 [200/0] via 172.0.0.2, 00:08:39
C       10.0.1.4/30 is directly connected, FastEthernet2/0
O       10.10.20.1/32 [110/2] via 10.0.1.5, 00:07:42, FastEthernet2/0
B       10.10.30.1/32 [200/2] via 172.0.0.2, 00:07:24
```

PE2#show ip route vrf Cliente_A

```
Routing Table: Cliente_A
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet1/0
B       10.10.10.1/32 [200/2] via 172.0.0.1, 00:09:07
B       10.0.1.0/30 [200/0] via 172.0.0.1, 00:11:22
B       10.0.3.4/30 [200/0] via 172.0.0.2, 00:10:07
B       10.10.40.1/32 [200/2] via 172.0.0.2, 00:10:22
O       10.10.50.1/32 [110/2] via 10.0.3.1, 00:10:42, FastEthernet1/0
```

PE2#show ip route vrf Cliente_B

```
Routing Table: Cliente_B
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
B       10.0.3.0/30 [200/0] via 172.0.0.2, 00:10:07
B       10.0.1.4/30 [200/0] via 172.0.0.1, 00:11:22
B       10.10.20.1/32 [200/2] via 172.0.0.1, 00:09:07
B       10.10.30.1/32 [200/2] via 172.0.0.2, 00:08:52
```

PE3#show ip route vrf Cliente_A

```
Routing Table: Cliente_A
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
B       10.0.3.0/30 [200/0] via 172.0.0.3, 00:10:33
B       10.10.10.1/32 [200/2] via 172.0.0.1, 00:09:33
B       10.0.1.0/30 [200/0] via 172.0.0.1, 00:11:33
C       10.0.3.4/30 is directly connected, FastEthernet2/0
O       10.10.40.1/32 [110/2] via 10.0.3.5, 00:10:41, FastEthernet2/0
B       10.10.50.1/32 [200/2] via 172.0.0.3, 00:10:48
```

PE3#show ip route vrf Cliente_B

```
Routing Table: Cliente_B
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet1/0
B       10.0.1.4/30 [200/0] via 172.0.0.1, 00:11:33
B       10.10.20.1/32 [200/2] via 172.0.0.1, 00:09:18
O       10.10.30.1/32 [110/2] via 10.0.3.1, 00:09:17, FastEthernet1/0
```

VI. Com a rede configurada e o redistribute do BGP e do OSPF a tabela LFIB adiciona todos os Clientes na tabela e cria labels para eles.

PE1#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Label Switched	Outgoing interface	Next Hop
16	Pop Label	10.1.0.4/30	0	Fa0/0	10.1.0.2
17	Pop Label	10.1.0.8/30	0	Fa0/0	10.1.0.2
18	**No Label**	**10.0.1.0/30[V]**	**0**	**aggregate/Cliente_A**	
19	**No Label**	**10.0.1.4/30[V]**	**0**	**aggregate/Cliente_B**	
20	17	172.0.0.2/32	0	Fa0/0	10.1.0.2
21	18	172.0.0.3/32	0	Fa0/0	10.1.0.2
22	Pop Label	172.100.0.1/32	0	Fa0/0	10.1.0.2
23	**No Label**	**10.10.10.1/32[V]**	**0**	**Fa1/0**	**10.0.1.1**
24	**No Label**	**10.10.20.1/32[V]**	**0**	**Fa2/0**	**10.0.1.5**

PE2#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Label Switched	Outgoing interface	Next Hop
16	Pop Label	10.1.0.0/30	0	Fa0/0	10.1.0.10
17	Pop Label	10.1.0.4/30	0	Fa0/0	10.1.0.10
18	**No Label**	**10.10.50.1/32[V]**	**0**	**Fa1/0**	**10.0.3.1**
19	16	172.0.0.1/32	0	Fa0/0	10.1.0.10
20	17	172.0.0.2/32	0	Fa0/0	10.1.0.10
21	Pop Label	172.100.0.1/32	0	Fa0/0	10.1.0.10
22	**No Label**	**10.0.3.0/30[V]**	**0**	**aggregate/Cliente_A**	

PE3#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Label Switched	Outgoing interface	Next Hop
16	Pop Label	10.1.0.0/30	0	Fa0/0	10.1.0.6
17	Pop Label	10.1.0.8/30	0	Fa0/0	10.1.0.6
18	**No Label**	**10.10.40.1/32[V]**	**0**	**Fa2/0**	**10.0.3.5**
19	**No Label**	**10.0.3.4/30[V]**	**0**	**aggregate/Cliente_A**	
20	16	172.0.0.1/32	0	Fa0/0	10.1.0.6
21	18	172.0.0.3/32	0	Fa0/0	10.1.0.6
22	Pop Label	172.100.0.1/32	0	Fa0/0	10.1.0.6
23	**No Label**	**10.0.3.0/30[V]**	**0**	**aggregate/Cliente_B**	
24	**No Label**	**10.10.30.1/32[V]**	**0**	**Fa1/0**	**10.0.3.1**

P1#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Label Switched	Outgoing interface	Next Hop
16	Pop Label	172.0.0.1/32	13656	Fa1/0	10.1.0.1
17	Pop Label	172.0.0.2/32	13745	Fa3/0	10.1.0.5
18	Pop Label	172.0.0.3/32	12975	Fa2/0	10.1.0.9

3. Explicar o resultado dos seguintes comandos em todos os LSR;

PE1

Este comando exibe todas as interfaces do roteador que estão com o MPLS ativo. Neste caso, apenas F0/0 está ativo.

```
PE1#show mpls interfaces
Interface              IP            Tunnel   BGP Static Operational
FastEthernet0/0        Yes (ldp)     No       No  No     Yes
```

Este comando lista a interfaces que estão associadas a alguma VRF.

```
PE1#show ip vrf interfaces
Interface              IP-Address      VRF                              Protocol
Fa1/0                  10.0.1.2        Cliente_A                        up
Fa2/0                  10.0.1.6        Cliente_B                        up
```

Este comando mostra as rotas para atingir todos os clientes que estão na VPN “Cliente_A”.

```
PE1#show ip route vrf Cliente_A
Routing Table: Cliente_A
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
B       10.0.3.0/30 [200/0] via 172.0.0.3, 01:20:17
O       10.10.10.1/32 [110/2] via 10.0.1.1, 01:19:23, FastEthernet1/0
C       10.0.1.0/30 is directly connected, FastEthernet1/0
B       10.0.3.4/30 [200/0] via 172.0.0.2, 01:20:17
B       10.10.40.1/32 [200/2] via 172.0.0.2, 01:20:17
B       10.10.50.1/32 [200/2] via 172.0.0.3, 01:20:32
```

Este comando mostra as rotas para atingir todos os clientes que estão na VPN “Cliente_B”.

```
PE1#show ip route vrf Cliente_B
Routing Table: Cliente_B
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
B       10.0.3.0/30 [200/0] via 172.0.0.2, 01:20:17
C       10.0.1.4/30 is directly connected, FastEthernet2/0
B       10.10.30.1/32 [200/2] via 172.0.0.2, 01:19:02
```

Este comando mostra todas as redes associadas a VRF “Cliente_A”.

```
PE1#show ip bgp vpnv4 vrf Cliente_A
   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 2000:1 (default for vrf Cliente_A)
*> 10.0.1.0/30      0.0.0.0                  0         32768 ?
*>i10.0.3.0/30      172.0.0.3                0    100      0 ?
*>i10.0.3.4/30      172.0.0.2                0    100      0 ?
*> 10.10.10.1/32    10.0.1.1                 2         32768 ?
*>i10.10.40.1/32    172.0.0.2                2    100      0 ?
*>i10.10.50.1/32    172.0.0.3                2    100      0 ?
```

Este comando mostra todas as redes associadas a VRF “Cliente_B”.

```
PE1#show ip bgp vpnv4 vrf Cliente_B
   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 2000:2 (default for vrf Cliente_B)
*> 10.0.1.4/30      0.0.0.0                  0         32768 ?
*>i10.0.3.0/30      172.0.0.2                0    100      0 ?
*>i10.10.30.1/32    172.0.0.2                2    100      0 ?
```

Envia um ICMP para o Cliente 10.10.10.1 que está na VRF “Cliente_A”

```
PE1#ping vrf Cliente_A 10.10.10.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.10.10.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/26/40 ms
```

PE2

Este comando exibe todas as interfaces do roteador que estão com o MPLS ativo. Neste caso, apenas F0/0 está ativo.

```
PE2#show mpls interfaces
Interface              IP            Tunnel   BGP Static Operational
FastEthernet0/0        Yes (ldp)     No       No  No     Yes
```

Este comando lista a interfaces que estão associadas a alguma VRF.

```
PE2#show ip vrf interfaces
Interface              IP-Address      VRF                              Protocol
Fa1/0                  10.0.3.2        Cliente_A                        up
```

Este comando mostra as rotas para atingir todos os clientes que estão na VPN “Cliente_A”.

```
PE2#show ip route vrf Cliente_A
Routing Table: Cliente_A
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet1/0
B       10.10.10.1/32 [200/2] via 172.0.0.1, 01:19:15
B       10.0.1.0/30 [200/0] via 172.0.0.1, 01:21:30
B       10.0.3.4/30 [200/0] via 172.0.0.2, 01:20:15
B       10.10.40.1/32 [200/2] via 172.0.0.2, 01:20:30
O       10.10.50.1/32 [110/2] via 10.0.3.1, 01:20:50, FastEthernet1/0
```

Este comando mostra as rotas para atingir todos os clientes que estão na VPN “Cliente_B”.

```
PE2#show ip route vrf Cliente_B
Routing Table: Cliente_B
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
B       10.0.3.0/30 [200/0] via 172.0.0.2, 01:20:15
B       10.0.1.4/30 [200/0] via 172.0.0.1, 01:21:30
B       10.10.30.1/32 [200/2] via 172.0.0.2, 01:19:00
```

Este comando mostra todas as redes associadas a VRF “Cliente_A”.

```
PE2#show ip bgp vpnv4 vrf Cliente_A
   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 2000:1 (default for vrf Cliente_A)
*>i10.0.1.0/30      172.0.0.1                0    100      0 ?
*> 10.0.3.0/30      0.0.0.0                  0         32768 ?
*>i10.0.3.4/30      172.0.0.2                0    100      0 ?
*>i10.10.10.1/32    172.0.0.1                2    100      0 ?
*>i10.10.40.1/32    172.0.0.2                2    100      0 ?
*> 10.10.50.1/32    10.0.3.1                 2         32768 ?
```

Este comando mostra todas as redes associadas a VRF “Cliente_B”.

```
PE2#show ip bgp vpnv4 vrf Cliente_B
   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 2000:2 (default for vrf Cliente_B)
*>i10.0.1.4/30      172.0.0.1                0    100      0 ?
*>i10.0.3.0/30      172.0.0.2                0    100      0 ?
*>i10.10.30.1/32    172.0.0.2                2    100      0 ?
```

Envia um ICMP para o Cliente 10.10.10.1 que está na VRF “Cliente_A”

```
PE2#ping vrf Cliente_A 10.10.10.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.10.10.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/61/68 ms
```

PE3

Este comando exibe todas as interfaces do roteador que estão com o MPLS ativo. Neste caso, apenas F0/0 está ativo.

```
PE3#show mpls interfaces
Interface              IP            Tunnel   BGP Static Operational
FastEthernet0/0        Yes (ldp)     No       No  No     Yes
```

Este comando lista a interfaces que estão associadas a alguma VRF.

```
PE3#show ip vrf interfaces
Interface              IP-Address      VRF                              Protocol
Fa2/0                  10.0.3.6        Cliente_A                        up
Fa1/0                  10.0.3.2        Cliente_B                        up
```

Este comando mostra as rotas para atingir todos os clientes que estão na VPN “Cliente_A”.

```
PE3#show ip route vrf Cliente_A
Routing Table: Cliente_A
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
B       10.0.3.0/30 [200/0] via 172.0.0.3, 01:20:30
B       10.10.10.1/32 [200/2] via 172.0.0.1, 01:19:30
B       10.0.1.0/30 [200/0] via 172.0.0.1, 01:21:30
C       10.0.3.4/30 is directly connected, FastEthernet2/0
O       10.10.40.1/32 [110/2] via 10.0.3.5, 01:20:38, FastEthernet2/0
B       10.10.50.1/32 [200/2] via 172.0.0.3, 01:20:45
```

Este comando mostra as rotas para atingir todos os clientes que estão na VPN “Cliente_B”.

```
PE3#show ip route vrf Cliente_B
Routing Table: Cliente_B
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet1/0
B       10.0.1.4/30 [200/0] via 172.0.0.1, 01:21:30
O       10.10.30.1/32 [110/2] via 10.0.3.1, 01:19:13, FastEthernet1/0
```

Este comando mostra todas as redes associadas a VRF “Cliente_A”.

```
PE3#show ip bgp vpnv4 vrf Cliente_A
   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 2000:1 (default for vrf Cliente_A)
*>i10.0.1.0/30      172.0.0.1                0    100      0 ?
```

```
*>i10.0.3.0/30      172.0.0.3               0    100      0 ?
*> 10.0.3.4/30      0.0.0.0                 0         32768 ?
*>i10.10.10.1/32    172.0.0.1               2    100      0 ?
*> 10.10.40.1/32    10.0.3.5                2         32768 ?
*>i10.10.50.1/32    172.0.0.3               2    100      0 ?
```

Este comando mostra todas as redes associadas a VRF “Cliente_B”.

```
PE3#show ip bgp vpnv4 vrf Cliente_B
   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 2000:2 (default for vrf Cliente_B)
*>i10.0.1.4/30      172.0.0.1               0    100      0 ?
*> 10.0.3.0/30      0.0.0.0                 0         32768 ?
*> 10.10.30.1/32    10.0.3.1                2         32768 ?
```

Envia um ICMP para o Cliente 10.10.10.1 que está na VRF “Cliente_A”

```
PE3#ping vrf Cliente_A 10.10.10.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.10.10.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/56/72 ms
```

P1

Este comando exibe todas as interfaces do roteador que estão com o MPLS ativo.

```
P1#show mpls interfaces
Interface              IP            Tunnel   BGP Static Operational
FastEthernet1/0        Yes (ldp)     No       No  No     Yes
FastEthernet2/0        Yes (ldp)     No       No  No     Yes
FastEthernet3/0        Yes (ldp)     No       No  No     Yes
```

4. Mostrar e explicar as tabelas de rotas dos roteadores dos clientes;

O roteador CE1 (OSPF 2) aprende as rotas dos roteadores CE2 e CE3 através do OSPF 2 que é distribuído através do BGP.

CE1#show ip route

```
    10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.0.3.0/30 [110/2] via 10.0.1.2, 00:21:58, FastEthernet0/0
C       10.10.10.1/32 is directly connected, Loopback0 (CE1)
C       10.0.1.0/30 is directly connected, FastEthernet0/0
O IA    10.0.3.4/30 [110/2] via 10.0.1.2, 00:21:58, FastEthernet0/0
O IA    10.10.40.1/32 [110/3] via 10.0.1.2, 00:21:58, FastEthernet0/0 (CE2)
O IA    10.10.50.1/32 [110/3] via 10.0.1.2, 00:21:58, FastEthernet0/0 (CE3)
```

O roteador CE-1 (OSPF 3) aprende as rotas do roteador CE-2 através do OSPF 3 que é distribuído através do BGP.

CE-1#show ip route

```
    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O IA    10.0.3.0/30 [110/2] via 10.0.1.6, 00:02:58, FastEthernet0/0
C       10.0.1.4/30 is directly connected, FastEthernet0/0
C       10.10.20.1/32 is directly connected, Loopback0 (CE-1)
O IA    10.10.30.1/32 [110/3] via 10.0.1.6, 00:02:44, FastEthernet0/0 (CE-2)
```

O roteador CE-2 (OSPF 3) aprende as rotas do roteador CE-1 através do OSPF 3 que é distribuído através do BGP.

CE-2#show ip route

```
    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet0/0
O IA    10.0.1.4/30 [110/2] via 10.0.3.2, 00:02:51, FastEthernet0/0
O IA    10.10.20.1/32 [110/3] via 10.0.3.2, 00:02:51, FastEthernet0/0 (CE-1)
C       10.10.30.1/32 is directly connected, Loopback0 (CE-2)
```

O roteador CE2 (OSPF 2) aprende as rotas dos roteadores CE1 e CE3 através do OSPF 2 que é distribuído através do BGP.

CE2#show ip route

```
    10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.0.3.0/30 [110/2] via 10.0.3.6, 00:04:10, FastEthernet0/0
O IA    10.10.10.1/32 [110/3] via 10.0.3.6, 00:03:10, FastEthernet0/0 (CE1)
O IA    10.0.1.0/30 [110/2] via 10.0.3.6, 00:04:23, FastEthernet0/0
C       10.0.3.4/30 is directly connected, FastEthernet0/0
C       10.10.40.1/32 is directly connected, Loopback0 (CE2)
O IA    10.10.50.1/32 [110/3] via 10.0.3.6, 00:04:23, FastEthernet0/0 (CE3)
```

O roteador CE3 (OSPF 2) aprende as rotas dos roteadores CE1 e CE2 através do OSPF 2 que é distribuído através do BGP.

CE3#show ip route

```
    10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet0/0
O IA    10.10.10.1/32 [110/3] via 10.0.3.2, 00:03:03, FastEthernet0/0 (CE1)
O IA    10.0.1.0/30 [110/2] via 10.0.3.2, 00:04:43, FastEthernet0/0
O IA    10.0.3.4/30 [110/2] via 10.0.3.2, 00:04:03, FastEthernet0/0
O IA    10.10.40.1/32 [110/3] via 10.0.3.2, 00:04:18, FastEthernet0/0 (CE2)
C       10.10.50.1/32 is directly connected, Loopback0 (CE3)
```

5. Depois de configurada e testada a rede, pare o algoritmo de roteamento no CE-1 e mostre o que muda na tabela de rotas no PE1, CE1 e CE3;

I. Antes de parar o algoritmo de roteamento, o estado das rotas dos roteadores é:

PE1#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Label Switched	Outgoing interface	Next Hop
16	Pop Label	10.1.0.4/30	0	Fa0/0	10.1.0.2
17	Pop Label	10.1.0.8/30	0	Fa0/0	10.1.0.2
18	No Label	10.0.1.0/30[V]	0	aggregate/Cliente_A	
19	**No Label**	**10.0.1.4/30[V]**	**0**	**aggregate/Cliente_B (CE-1)**	
20	17	172.0.0.2/32	0	Fa0/0	10.1.0.2
21	18	172.0.0.3/32	0	Fa0/0	10.1.0.2
22	Pop Label	172.100.0.1/32	0	Fa0/0	10.1.0.2
23	No Label	10.10.10.1/32[V]	0	Fa1/0	10.0.1.1
24	**No Label**	**10.10.20.1/32[V]**	**0**	**Fa2/0**	**10.0.1.5 (CE-1)**

PE1#show ip route vrf Cliente_B (CE-1 pertence a vrf Cliente_B)

Routing Table: Cliente_B

10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks

B 10.0.3.0/30 [200/0] via 172.0.0.2, 00:48:41

C 10.0.1.4/30 is directly connected, FastEthernet2/0

O 10.10.20.1/32 [110/2] via 10.0.1.5, 00:47:44, FastEthernet2/0 (CE-1)

B 10.10.30.1/32 [200/2] via 172.0.0.2, 00:47:26

CE1#show ip route (CE1 não "vê" CE-1 pois está em VRF diferente)

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks

O IA 10.0.3.0/30 [110/2] via 10.0.1.2, 00:43:27, FastEthernet0/0

C 10.10.10.1/32 is directly connected, Loopback0

C 10.0.1.0/30 is directly connected, FastEthernet0/0

O IA 10.0.3.4/30 [110/2] via 10.0.1.2, 00:43:27, FastEthernet0/0

O IA 10.10.40.1/32 [110/3] via 10.0.1.2, 00:43:27, FastEthernet0/0

O IA 10.10.50.1/32 [110/3] via 10.0.1.2, 00:43:27, FastEthernet0/0

CE3#show ip route (CE3 não "vê" CE-1 pois está em VRF diferente)

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks

C 10.0.3.0/30 is directly connected, FastEthernet0/0

O IA 10.10.10.1/32 [110/3] via 10.0.3.2, 00:43:32, FastEthernet0/0

O IA 10.0.1.0/30 [110/2] via 10.0.3.2, 00:45:12, FastEthernet0/0

O IA 10.0.3.4/30 [110/2] via 10.0.3.2, 00:44:32, FastEthernet0/0

O IA 10.10.40.1/32 [110/3] via 10.0.3.2, 00:44:47, FastEthernet0/0

C 10.10.50.1/32 is directly connected, Loopback0

CE-2#show ip route (CE-2 está na mesma VRF que CE-1)

10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks

C 10.0.3.0/30 is directly connected, FastEthernet0/0

O IA 10.0.1.4/30 [110/2] via 10.0.3.2, 00:43:47, FastEthernet0/0

O IA 10.10.20.1/32 [110/3] via 10.0.3.2, 00:43:47, FastEthernet0/0 (CE-1)

C 10.10.30.1/32 is directly connected, Loopback0

CE-1#show running-config

Building configuration...

```
router ospf 3
        log-adjacency-changes
        network 0.0.0.0 255.255.255.255 area 0
```

II. Após parar o algoritmo de roteamento (**no router ospf 3**)

PE1#show mpls forwarding-table

Local Label	Outgoing Label or VC	Prefix or Tunnel Id	Bytes Label Switched	Outgoing interface	Next Hop
16	Pop Label	10.1.0.4/30	0	Fa0/0	10.1.0.2
17	Pop Label	10.1.0.8/30	0	Fa0/0	10.1.0.2
18	No Label	10.0.1.0/30[V]	0	aggregate/Cliente_A	
19	No Label	10.0.1.4/30[V]	0	aggregate/Cliente_B	
20	17	172.0.0.2/32	0	Fa0/0	10.1.0.2
21	18	172.0.0.3/32	0	Fa0/0	10.1.0.2
22	Pop Label	172.100.0.1/32	0	Fa0/0	10.1.0.2
23	No Label	10.10.10.1/32[V]	0	Fa1/0	10.0.1.1

PE1#show ip route vrf Cliente_B

```
Routing Table: Cliente_B
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
B       10.0.3.0/30 [200/0] via 172.0.0.2, 00:56:31
C       10.0.1.4/30 is directly connected, FastEthernet2/0
B       10.10.30.1/32 [200/2] via 172.0.0.2, 00:55:16
```

CE1#show ip route

```
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.0.3.0/30 [110/2] via 10.0.1.2, 00:43:27, FastEthernet0/0
C       10.10.10.1/32 is directly connected, Loopback0
C       10.0.1.0/30 is directly connected, FastEthernet0/0
O IA    10.0.3.4/30 [110/2] via 10.0.1.2, 00:43:27, FastEthernet0/0
O IA    10.10.40.1/32 [110/3] via 10.0.1.2, 00:43:27, FastEthernet0/0
O IA    10.10.50.1/32 [110/3] via 10.0.1.2, 00:43:27, FastEthernet0/0
```

CE3#show ip route

```
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet0/0
O IA    10.10.10.1/32 [110/3] via 10.0.3.2, 01:01:29, FastEthernet0/0
O IA    10.0.1.0/30 [110/2] via 10.0.3.2, 01:03:09, FastEthernet0/0
O IA    10.0.3.4/30 [110/2] via 10.0.3.2, 01:02:29, FastEthernet0/0
O IA    10.10.40.1/32 [110/3] via 10.0.3.2, 01:02:44, FastEthernet0/0
C       10.10.50.1/32 is directly connected, Loopback0
```

CE-2#show ip route

```
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C       10.0.3.0/30 is directly connected, FastEthernet0/0
O IA    10.0.1.4/30 [110/2] via 10.0.3.2, 00:56:41, FastEthernet0/0
C       10.10.30.1/32 is directly connected, Loopback0
```