MPLS Lab 2

Internet Core Technologies

TELE34660

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2024/10/27

Chance Page

Bachelor of Computing and Network Communications (Honours) (Co-Op)

Contents

1. Introduction

This report details the configuration and setup of an MPLS network for a bank with two datacenters and six branch offices. The network utilizes IS-IS for the datacenters' IGP and OSPF for the MPLS cores to maintain simplicity and scalability. The setup ensures that the east branches are completely segregated, while the west branches can communicate with each other under certain conditions.

2. Network Topology

In my topology, I use IS-IS for the datacenters' IGP and OSPF for all of the MPLS cores. This approach avoids process ID conflicts and protocol mixing, making configuration easier. IS-IS is preferred in datacenters for its scalability.

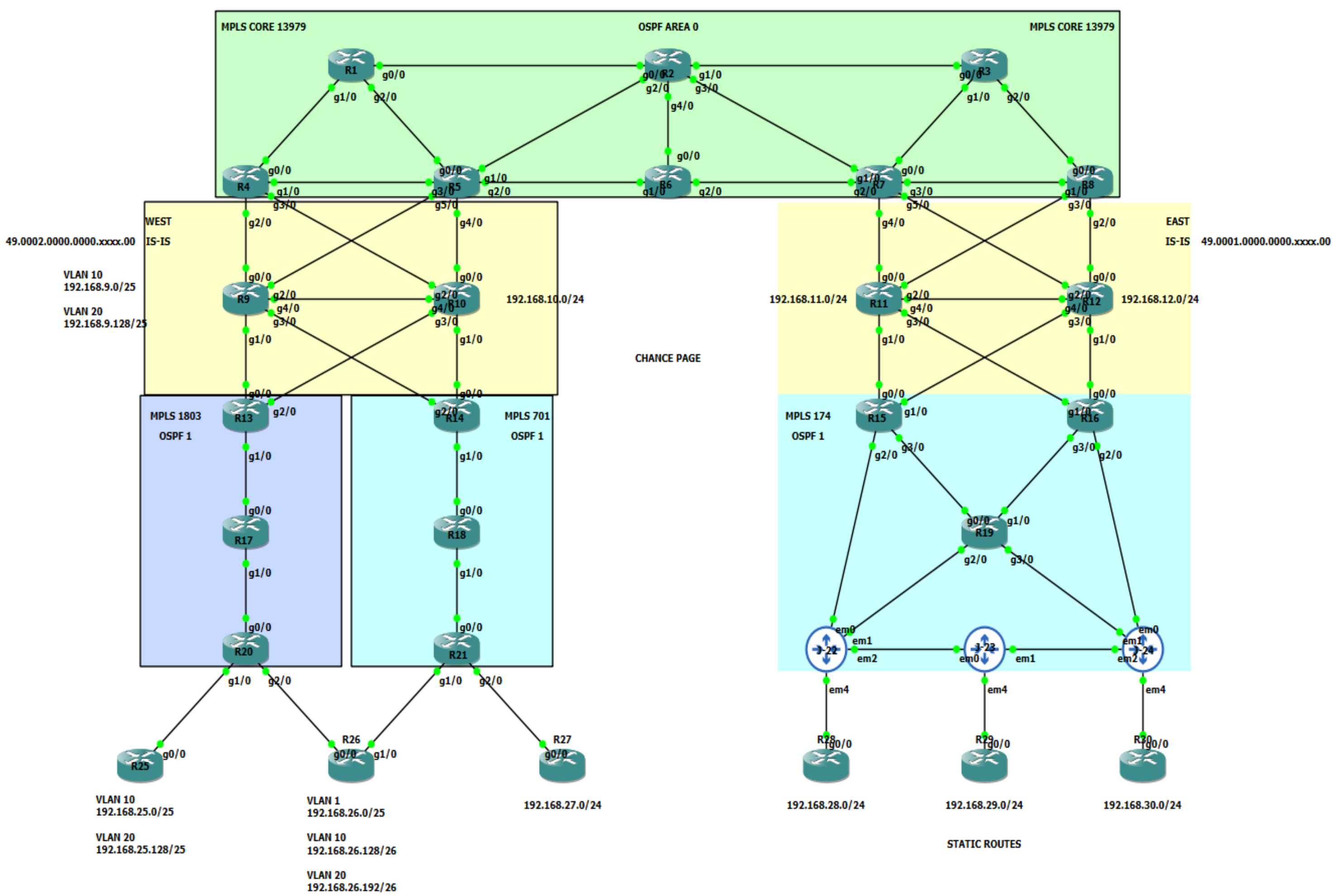

Figure 1: Chance Network Topology

3. Routing Protocols

In my lab, I use the following interior routing protocols:

IS-IS: Used in datacenters for its scalability and efficient handling of large routing tables.

OSPF: Deployed in MPLS cores due to its widespread support and ease of integration.

This clear separation simplifies management and avoids duplicated protocols.

4. Datacenter VPNV4 Connection

The datacenters are connected via VPNV4 and share only the application subnets with each other. This allows each datacenter to access the application subnets from the other. Now, when applications are deployed on the subnets, they can reach each other, replicate, or perform whatever application tasks are needed. See *Figure 3*.

5. EAST Branches

The east branches are completely segregated from each other and cannot communicate. I achieved this by using route maps on the PE routers.

6. WEST Branches (Special Case)

The west branches can communicate with each other. I did not configure the VLAN portion correctly. I created subinterfaces with VLANs on the CE router. Consequently, “VLAN 10” and “VLAN 20” can ping each other, although I don't think they should. I couldn't figure out how to configure this properly. I have never worked with VLANs before. The only segregation we have is via route maps where VLAN 1 is properly segregated from VLANs 10 and 20, but this is not ideal.

7. Configuration Details

R9

```
interface Loopback0
 ip address 9.9.9.9 255.255.255.255
 ip router isis
!
interface GigabitEthernet0/0
 ip address 10.0.1.2 255.255.255.252
 ip router isis
 negotiation auto
!
interface GigabitEthernet1/0
 ip address 10.0.6.1 255.255.255.252
 ip router isis
 negotiation auto
!
interface GigabitEthernet2/0
 ip address 10.0.3.2 255.255.255.252
 ip router isis
 negotiation auto
!
interface GigabitEthernet3/0
 ip address 10.0.8.1 255.255.255.252
 ip router isis
 negotiation auto
!
interface GigabitEthernet4/0
 ip address 10.0.5.1 255.255.255.252
 ip router isis
 negotiation auto
!
interface GigabitEthernet6/0
 no ip address
 negotiation auto
!
interface GigabitEthernet6/0.10
 encapsulation dot1Q 10
 ip address 192.168.9.1 255.255.255.128
 ip router isis
!
interface GigabitEthernet6/0.20
 encapsulation dot1Q 20
 ip address 192.168.9.129 255.255.255.128
 ip router isis
!
router isis
 net 49.0002.0000.0000.0009.00
```

R13

```
ip vrf WEST-BRANCHES
 rd 1803:1
 route-target export 1803:1
 route-target import 1803:2
!
interface Loopback0
 ip address 13.13.13.13 255.255.255.255
 ip ospf 1 area 1
!
interface GigabitEthernet0/0
 ip vrf forwarding WEST-BRANCHES
 ip address 10.0.6.2 255.255.255.252
 ip router isis
 negotiation auto
!
interface GigabitEthernet1/0
 ip address 10.0.1.1 255.255.255.252
 ip ospf 1 area 1
 negotiation auto
 mpls ip
!
interface GigabitEthernet2/0
 ip vrf forwarding WEST-BRANCHES
 ip address 10.0.7.2 255.255.255.252
 ip router isis
 negotiation auto
!
router ospf 1
!
router isis
 vrf WEST-BRANCHES
 net 49.0002.0000.0000.0013.00
 redistribute bgp 1803 metric 2
!
router bgp 1803
 bgp log-neighbor-changes
 neighbor 20.20.20.20 remote-as 1803
 neighbor 20.20.20.20 update-source Loopback0
 !
 address-family ipv4
  neighbor 20.20.20.20 activate
  neighbor 20.20.20.20 send-community both
  neighbor 20.20.20.20 next-hop-self
 exit-address-family
 !
 address-family vpnv4
  neighbor 20.20.20.20 activate
  neighbor 20.20.20.20 send-community both
 exit-address-family
 !
```

```
 address-family ipv4 vrf WEST-BRANCHES
  redistribute isis level-1-2 metric 2 route-map DATACENTER-SUBNETS
 exit-address-family
!
ip prefix-list DATACENTER-SUBNETS seq 5 permit 192.168.9.0/25
ip prefix-list DATACENTER-SUBNETS seq 10 permit 192.168.9.128/25
!
route-map DATACENTER-SUBNETS permit 10
 match ip address prefix-list DATACENTER-SUBNETS
```

R20

```
ip vrf WEST-BRANCHES
 rd 1803:2
 route-target export 1803:2
 route-target import 1803:1
!
interface Loopback0
 ip address 20.20.20.20 255.255.255.255
 ip ospf 1 area 1
!
interface GigabitEthernet0/0
 ip address 10.0.2.2 255.255.255.252
 ip ospf 1 area 1
 negotiation auto
 mpls ip
!
interface GigabitEthernet1/0
 ip vrf forwarding WEST-BRANCHES
 ip address 10.0.20.1 255.255.255.252
 negotiation auto
!
interface GigabitEthernet2/0
 ip vrf forwarding WEST-BRANCHES
 ip address 10.0.21.1 255.255.255.252
 negotiation auto
!
router ospf 1
!
router bgp 1803
 bgp log-neighbor-changes
 neighbor 13.13.13.13 remote-as 1803
 neighbor 13.13.13.13 update-source Loopback0
 !
 address-family ipv4
  neighbor 13.13.13.13 activate
  neighbor 13.13.13.13 send-community both
  neighbor 13.13.13.13 next-hop-self
 exit-address-family
 !
 address-family vpnv4
  neighbor 13.13.13.13 activate
  neighbor 13.13.13.13 send-community both
```

```
 exit-address-family
 !
 address-family ipv4 vrf WEST-BRANCHES
  redistribute static
 exit-address-family
!
ip route vrf WEST-BRANCHES 192.168.25.0 255.255.255.128 10.0.20.2
ip route vrf WEST-BRANCHES 192.168.25.128 255.255.255.128 10.0.20.2
ip route vrf WEST-BRANCHES 192.168.26.128 255.255.255.192 10.0.21.2
ip route vrf WEST-BRANCHES 192.168.26.192 255.255.255.192 10.0.21.2
```

R25

```
interface GigabitEthernet0/0
 ip address 10.0.20.2 255.255.255.252
 negotiation auto
!
interface GigabitEthernet6/0
 no ip address
 negotiation auto
!
interface GigabitEthernet6/0.10
 encapsulation dot1Q 10 native
 ip address 192.168.25.1 255.255.255.128
!
interface GigabitEthernet6/0.20
 encapsulation dot1Q 20
 ip address 192.168.25.129 255.255.255.128
!
ip route 0.0.0.0 0.0.0.0 10.0.20.1
```

R26

```
interface GigabitEthernet0/0
 ip address 10.0.21.2 255.255.255.252
 negotiation auto
!
interface GigabitEthernet1/0
 ip address 10.0.22.2 255.255.255.252
 negotiation auto
!
interface GigabitEthernet6/0
 no ip address
 negotiation auto
!
interface GigabitEthernet6/0.1
 encapsulation dot1Q 1 native
 ip address 192.168.26.1 255.255.255.128
!
interface GigabitEthernet6/0.10
 encapsulation dot1Q 10
 ip address 192.168.26.129 255.255.255.192
!
interface GigabitEthernet6/0.20
 encapsulation dot1Q 20
 ip address 192.168.26.193 255.255.255.192
!
ip route 0.0.0.0 0.0.0.0 10.0.21.1
ip route 0.0.0.0 0.0.0.0 10.0.22.1
```

J23

```
interfaces {
  em0 {
    unit 0 {
      family inet {
        address 10.0.7.2/30;
      }
      family mpls;
    }
  }
  em1 {
    unit 0 {
      family inet {
        address 10.0.8.1/30;
      }
      family mpls;
    }
  }
  em4 {
    unit 0 {
      family inet {
        address 10.0.25.1/30;
      }
      family mpls;
    }
```

```
  }
  lo0 {
    unit 0 {
      family inet {
        address 23.23.23.23/32;
      }
    }
  }
}
routing-options {
  autonomous-system 174;
}
protocols {
  mpls {
    interface all;
  }
  bgp {
    group COGENT {
      type internal;
      local-address 23.23.23.23;
      family inet-vpn {
        unicast;
      }
      peer-as 174;
      neighbor 15.15.15.15;
      neighbor 16.16.16.16;
    }
  }
  ospf {
    area 0.0.0.1 {
      interface lo0.0;
      interface em0.0;
      interface em1.0;
    }
  }
  ldp {
    interface em0.0;
    interface em1.0;
    interface lo0.0;
  }
}
policy-options {
  policy-statement EAST-POLICY {
    term 1 {
      from community [ EAST-1 EAST-2 ];
      then accept;
    }
    term 2 {
      then reject;
    }
  }
  policy-statement LOCAL-POLICY {
    term 1 {
      from {
        instance LOCAL;
        protocol static;
      }
      then {
```

```
            community add LOCAL;
            accept;
        }
    }
    term 2 {
        then reject;
    }
  }
  community EAST-1 members target:174:1;
  community EAST-2 members target:174:2;
  community LOCAL members target:174:4;
}
routing-instances {
  LOCAL {
    instance-type vrf;
    interface em4.0;
    route-distinguisher 174:4;
    vrf-import EAST-POLICY;
    vrf-export LOCAL-POLICY;
    vrf-table-label source-class-usage;
    routing-options {
      static {
        route 192.168.29.0/24 next-hop 10.0.25.2;
      }
      router-id 23.23.23.23;
    }
  }
}
```

8. BGP VPNv4 VRF Labels

R4

```
R4#show ip bgp vpnv4 vrf WEST-DATACENTER
BGP table version is 12, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 13979:1 (default for vrf WEST-DATACENTER)
 *>   192.168.9.0/25   10.0.1.2                 2         32768 ?
 *>   192.168.9.128/25 10.0.1.2                 2         32768 ?
 *>   192.168.10.0     10.0.2.2                 2         32768 ?
 r i  192.168.11.0     8.8.8.8                  2    100      0 ?
 r>i                   7.7.7.7                  2    100      0 ?
 r i  192.168.12.0     8.8.8.8                  2    100      0 ?
 r>i                   7.7.7.7                  2    100      0 ?
R4#
```

Figure 2: R4 VPNv4 VRF Labels

R8

```
R8#show ip bgp vpnv4 vrf EAST-DATACENTER
BGP table version is 18, local router ID is 8.8.8.8
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 13979:4 (default for vrf EAST-DATACENTER)
 r>i 192.168.9.0/25   5.5.5.5                  2    100      0 ?
 r i                  4.4.4.4                  2    100      0 ?
 r>i 192.168.9.128/25 5.5.5.5                  2    100      0 ?
 r i                  4.4.4.4                  2    100      0 ?
 r>i 192.168.10.0     5.5.5.5                  2    100      0 ?
 r i                  4.4.4.4                  2    100      0 ?
 *>  192.168.11.0     10.0.12.2                2         32768 ?
 *>  192.168.12.0     10.0.13.2                2         32768 ?
R8#
```

Figure 3: R8 VPNv4 VRF Labels

R13

```
R13#show ip bgp vpnv4 vrf WEST-BRANCHES
BGP table version is 13, local router ID is 13.13.13.13
Status codes: s suppressed, d damped, h history, * valid, > best, i
              r RIB-failure, S Stale, m multipath, b backup-path, f
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 1803:1 (default for vrf WEST-BRANCHES)
 *>  192.168.9.0/25   10.0.6.1                 2         32768 ?
 *>  192.168.9.128/25 10.0.6.1                 2         32768 ?
 *>i 192.168.25.0/25  20.20.20.20              0    100      0 ?
 *>i 192.168.25.128/25
                       20.20.20.20              0    100      0 ?
 *>i 192.168.26.128/26
                       20.20.20.20              0    100      0 ?
 *>i 192.168.26.192/26
                       20.20.20.20              0    100      0 ?
R13#
```

Figure 4: R13 VPNv4 VRF Labels

R14

```
R14#show ip bgp vpnv4 vrf WEST-BRANCHES
BGP table version is 6, local router ID is 14.14.14.14
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 701:1 (default for vrf WEST-BRANCHES)
 *>  192.168.10.0     10.0.9.1                 2         32768 ?
 *>i 192.168.26.0/25  21.21.21.21              0    100      0 ?
 *>i 192.168.27.0     21.21.21.21              0    100      0 ?
R14#
```

Figure 5: R14 VPNv4 VRF Labels

R15

```
R15#show ip bgp vpnv4 vrf EAST-BRANCHES
BGP table version is 144, local router ID is 15.15.15.15
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 174:1 (default for vrf EAST-BRANCHES)
 *>  192.168.11.0     10.0.15.1                2         32768 ?
 *>  192.168.12.0     10.0.17.1                2         32768 ?
 r>i 192.168.28.0     22.22.22.22                   100      0 i
 r>i 192.168.29.0     23.23.23.23                   100      0 i
 r>i 192.168.30.0     24.24.24.24                   100      0 i
R15#
```

Figure 6: R15 VPNv4 VRF Labels

R16

```
R16#show ip bgp vpnv4 vrf EAST-BRANCHES
BGP table version is 146, local router ID is 16.16.16.16
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 174:2 (default for vrf EAST-BRANCHES)
 *>   192.168.11.0     10.0.16.1                2         32768 ?
 *>   192.168.12.0     10.0.18.1                2         32768 ?
 *>i  192.168.28.0     22.22.22.22                   100      0 i
 *>i  192.168.29.0     23.23.23.23                   100      0 i
 *>i  192.168.30.0     24.24.24.24                   100      0 i
R16#
```

Figure 7: R16 VPNv4 VRF Labels

9. Traceroutes

R25 VLAN 10 to R9's VLAN 10 and R26's VLAN 10

```
R25#traceroute 192.168.26.129 source 192.168.25.1
Type escape sequence to abort.
Tracing the route to 192.168.26.129
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.20.1 32 msec 84 msec 32 msec
  2 10.0.21.2 60 msec 44 msec 28 msec
R25#traceroute 192.168.9.1 source 192.168.25.1
Type escape sequence to abort.
Tracing the route to 192.168.9.1
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.20.1 28 msec 32 msec 12 msec
  2 10.0.2.1 [MPLS: Labels 16/19 Exp 0] 84 msec 36 msec 40 msec
  3 10.0.6.2 [MPLS: Label 19 Exp 0] 40 msec 32 msec 36 msec
  4 10.0.6.1 72 msec 40 msec 80 msec
R25#
```

Figure 8:R25 Traceroute to VLAN 10

R25 VLAN 20 to R26's VLAN 20 and R9's VLAN 20

```
R25#traceroute 192.168.26.193 source 192.168.25.129
Type escape sequence to abort.
Tracing the route to 192.168.26.193
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.20.1 16 msec 48 msec 12 msec
  2 10.0.21.2 44 msec 64 msec 64 msec
R25#traceroute 192.168.9.129 source 192.168.25.129
Type escape sequence to abort.
Tracing the route to 192.168.9.129
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.20.1 44 msec 8 msec 16 msec
  2 10.0.2.1 [MPLS: Labels 16/21 Exp 0] 68 msec 72 msec 80 msec
  3 10.0.6.2 [MPLS: Label 21 Exp 0] 44 msec 72 msec 40 msec
  4 10.0.6.1 40 msec 52 msec 72 msec
R25#
```

Figure 9: R25 Traceroute to VLAN 20

10. Conclusion

In this MPLS Lab, I established a network for a bank encompassing two datacenters and six branch offices. By implementing IS-IS for the datacenters and OSPF for the MPLS cores, the network is both scalable and straightforward to manage. Route maps ensure the east branches are effectively isolated, while the west branches communicate despite VLAN configuration obstacles. This lab highlighted the importance of selecting appropriate protocols, offering valuable insights into network configuration and troubleshooting. I always enjoy doing the labs because successfully seeing pings makes me happy. This experience has expanded my understanding of complex network setups and enhanced my expertise in MPLS technologies.