Project Report Communication Architectures

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Contents

1	Intr	roduction	1
2	Ove	erall topology	2
3	Bas 3.1	ic assembly and core connectivity Lisbon show run	3 4
4		E1, SME2, and SME3 ociation MPLS Layer 3 VPN	7
	4.1	Configuration process	7
	4.1	9 1	8
	4.3		9
5	Cli	ent LB Layer 2 point-to-point Overlay network	
	Clie	ent LB bandwidth	
	rese	ervation and usage/routing	11
	5.1	Configuration process	11
	5.2	Show run Aveiro	12
	5.3	Aveiro show mpls traffic-eng tunnels	15
	5.4	Lisbon show run	16
		5.4.1 Client LB VLANs	19
6	Clie	ent LA Layer 2 VPN	20
	6.1	RA1	20
		6.1.1 RA1 show conf	20
		6.1.2 RA1 show bgp l2vpn evpn	23
	6.2	RL1	24
		6.2.1 RL1 show conf	24
		6.2.2 RL1 show bgp l2vpn evpn	26
	6.3	RN1	26
		6.3.1 RN1 show conf	26
		6.3.2 RN1 show bgp l2vpn evpn	30
7	Fin	al Network Topology	31

List of Figures

1.1	Conceptual Project Topology.	•		•	•		•	•		•			•	•	•	•	1
7.1	Enter Caption																31

Introduction

The goal of this project is to design the technical aspects in GNS3, configure and test a Content Delivery Network (CDN) with multiple corporate clients.

CDNRUS LLC is a CDN company that provides Infrastructure as a Service (IaaS), hosting, and connecting cluster servers virtually and bare-metal. They have different Points of Presence (PoP) in geographically distinct locations (Aveiro, Lisbon, Madrid, and New York) with various large and small clients requiring specific connectivity.

The project involves interconnecting the PoPs, configuring virtual private networks (VPN), and reserving bandwidth to meet the specific connectivity requirements of each client.

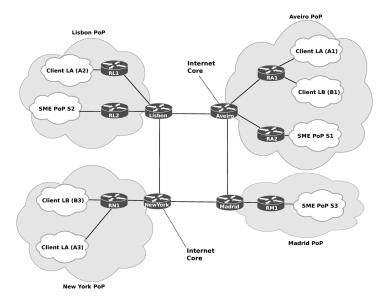


Figure 1.1: Conceptual Project Topology.

Overall topology

As we could see in the previous image the network has the 4 Pop's connected to each other. Besides that we have different clients with these following characteristics:

- Clients SME1, SME2, and SME3 belong to the same industrial association that will share the same CDN server clusters. They requested a MPLS Layer 3 VPN to interconnect its server cluster
- Client LB, has two server clusters B1 and B3, subdivided in three Ethernet VLANs (VLAN 10: 10.10.0.0/24, VLAN 20: 10.20.0.0/24, VLAN 30: 10.30.0.0/24). They requested a Layer 2 point-to-point overlay network between its server locations, with 10 Mbps.
- Client LA, has three server clusters A1, A2, and A3 (that share the same IPv4 network 10.2.0.0/16) connected to the respective PoPs. They requested a Layer 2 VPN between its server cluster locations.

Basic assembly and core connectivity

For the overall basic assembly we started by configuring each interface with the appropriate ip address for each necessary interface. Here is an example how we did a simple configuration:

```
Lisbon# configure terminal
Lisbon(config)# interface FastEthernet 0/0
Lisbon(config-if)# ip add 10.0.0.1 255.255.255.252
Lisbon(config-if)# no shutdown
Lisbon(config-if)# end
```

Then we configured OSPF(Open Shortest Path First) in all interfaces to distribute IP routing information throughout our AS. Here is a following example in how to do it:

```
Lisbon(config)# configure terminal
Lisbon(config)# interface f0/1
Lisbon(config-if)# ip ospf 1 area 0
Lisbon(config-if)# end
```

To actually get our OSPF working we created our company Internet Autonomous System with number 33900 and configured our iBGP Neighboring. Here is a following example:

```
Lisbon#configure terminal
Lisbon(config)#router bgp 33900
sisbon(config-router)# neighbor 10.0.0.2 remote-as 33900
Lisbon(config-router)# neighbor 10.0.0.18 remote-as 33900
Lisbon(config-router)# neighbor 10.0.0.22 remote-as 33900
Lisbon(config-router)# neighbor 10.0.0.22 remote-as 33900
```

Finally, we configured all loopback0 interfaces and activated ospf by doing the following configuration:

```
Lisbon#configure terminal
Lisbon(config)#int loopback 0
Lisbon(config-if)# ip ospf 1 area 0
Lisbon(config-if)#ip add 10.0.0.202 255.255.255
Lisbon(config-if)#no shutdown
Lisbon(config-if)#end
```

In the end we could ping successfully all interfaces.

3.1 Lisbon show run

This was Lisbon Full configuration as an example:

```
1 Lisbon#show run
2 Building configuration...
4 Current configuration: 1723 bytes
6 ! Last configuration change at 01:41:25 UTC Sat Jan 6 2024
7 !
8 version 15.2
9 service timestamps debug datetime msec
10 service timestamps log datetime msec
11 !
12 hostname Lisbon
13 !
14 boot-start-marker
15 boot-end-marker
16 !
17 !
18 !
19 no aaa new-model
_{\rm 20} no ip icmp rate-limit unreachable
21 ip cef
22 !
23 !
24 !
25 !
26 !
27 !
28 no ip domain lookup
29 no ipv6 cef
30 !
32 multilink bundle-name authenticated
33 !
34 !
35 !
36 !
37 !
39 !
40 !
41 !
^{42} ip tcp synwait-time ^{5}
43 !
44 !
45 !
46 !
47 !
48 !
49 !
```

```
51 !
52 !
53 !
54 !
55 interface Loopback0
ip address 10.0.0.202 255.255.255.255 ip ospf 1 area 0
58 !
interface FastEthernet0/0
60 ip address 10.0.0.1 255.255.255.252
61 ip ospf 1 area 0
62 speed auto
63 duplex auto
64 !
65 interface FastEthernet0/1
ip address 10.0.0.13 255.255.255.252
ip ospf 1 area 0
68 speed auto
69 duplex auto
70 !
71 interface FastEthernet1/0
ip address 10.0.0.17 255.255.255.252
ip ospf 1 area 0
74 speed auto
75 duplex auto
76 !
77 interface FastEthernet1/1
78 ip address 10.0.0.21 255.255.255.252
ip ospf 1 area 0
80 speed auto
81 duplex auto
82 !
83 interface FastEthernet2/0
84 no ip address
85 shutdown
86 speed auto
87 duplex auto
89 interface FastEthernet2/1
90 no ip address
91 shutdown
92 speed auto
93 duplex auto
94 !
95 interface FastEthernet3/0
96 no ip address
97 shutdown
98 speed auto
99 duplex auto
100 !
101 interface FastEthernet3/1
no ip address
103 shutdown
104 speed auto
105 duplex auto
106 !
107 router ospf 1
```

```
108 !
109 router bgp 33900
bgp log-neighbor-changes
111 redistribute ospf 1
neighbor 10.0.0.2 remote-as 33900
neighbor 10.0.0.18 remote-as 33900 neighbor 10.0.0.22 remote-as 33900
115 !
116 ip forward-protocol nd
117 !
118 !
no ip http server
120 no ip http secure-server
121 !
122 !
123 !
124 !
125 control-plane
126 !
127 !
128 line con O
exec-timeout 0 0
privilege level 15
131 logging synchronous
stopbits 1
133 line aux 0
exec-timeout 0 0
privilege level 15
136 logging synchronous
137 stopbits 1
138 line vty 0 4
139 login
140 !
141 !
142 end
```

Here is an example of a successful ping:

SME1, SME2, and SME3 Association MPLS Layer 3 VPN

For this part of the project we started by, firstly, create the vrf in routers RL2, RA2 and RM1. We named our vrf "VPN-1" and in each physical interface (mpls ip) except the ones connected to the VPN-1.

4.1 Configuration process

```
RL2#configure terminal
RL2(config)#ip vrf VPN-1
RL2(config-vrf)#rd 33900:1
RL2(config-vrf)#route-target export 33900:1
RL2(config-vrf)#route-target import 33900:1
RL2(config-vrf)#exit
RL2(config)#interface f1/0
RL2(config-if)#ip vrf forwarding VPN-1
RL2(config-if)#ip add 10.0.2.1 255.255.255.0
RL2(config-if)#end
```

We, successfully, could ping the local vrf:

```
1 RL2#ping vrf VPN-1 10.0.2.1
2 Type escape sequence to abort.
3 Sending 5, 100-byte ICMP Echos to 10.0.0.22, timeout is 2 seconds:
4 !!!!!
5 Success rate is 100 percent (5/5), round-trip min/avg/max = 4/5/8
ms
```

After doing it in the two remaining routers it was time to do the global and VRF inter-routing. Here is an example of how we did it in RL2:

```
RL2#configure terminal
RL2(config)#router bgp 33900
RL2(config-router)# bgp router-id 10.0.0.102
RL2(config-router)# bgp log-neighbor-changes
RL2(config-router)# neighbor 10.0.0.21 remote-as 33900
RL2(config-router)# neighbor 10.0.0.112 remote-as 33900
RL2(config-router)# neighbor 10.0.0.112 update-source Loopback0
```

```
8 RL2(config-router)# neighbor 10.0.0.121 remote-as 33900
9 RL2(config-router)# neighbor 10.0.0.121 update-source Loopback0
10 RL2(config-router)# address-family vpnv4
11 RL2(config-router-af)# neighbor 10.0.0.112 activate
12 RL2(config-router-af)# neighbor 10.0.0.112 send-community both
13 RL2(config-router-af)# neighbor 10.0.0.121 activate
14 RL2(config-router-af)# neighbor 10.0.0.121 send-community both
15 RL2(config-router-af)# neighbor 10.0.0.121 send-community both
16 RL2(config-router-af)#exit
17 RL2(config-router)#address-family ipv4 vrf VPN-1
18 RL2(config-router-af)#redistribute connected
```

After doing the same configuration for the remaining routers we managed to ping between the vrf successfully:

```
1 RL2#ping vrf VPN-1 10.0.0.102
2 Type escape sequence to abort.
3 Sending 5, 100-byte ICMP Echos to 10.0.0.102, timeout is 2 seconds:
5 Success rate is 0 percent (0/5)
6 RL2#ping vrf VPN-1 10.0.2.1
7 Type escape sequence to abort.
8 Sending 5, 100-byte ICMP Echos to 10.0.2.1, timeout is 2 seconds:
9 !!!!!
10 Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4
      ms
11 RL2#ping vrf VPN-1 10.0.3.1
12 Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.3.1, timeout is 2 seconds:
Success rate is 100 percent (5/5), round-trip min/avg/max =
      100/113/132 ms
16 RL2#ping vrf VPN-1 10.0.1.1
17 Type escape sequence to abort.
18 Sending 5, 100-byte ICMP Echos to 10.0.1.1, timeout is 2 seconds:
19 !!!!!
20 Success rate is 100 percent (5/5), round-trip min/avg/max =
    64/79/100 ms
```

4.2 RL2 show ip route vrf VPN-1

This is the command show ip route vrf VPN-1 in RL2 as an example:

4.3 RL2 show ip cef vrf VPN-1 detail

This is the command show ip cef vrf VPN-1 detail in RL2 as an example:

```
RL2#show ip cef vrf VPN-1 detail
2 IPv4 CEF is enabled and running
3 VRF VPN-1
4 14 prefixes (14/0 fwd/non-fwd)
   Table id 0x1
                          0 (14 entries at this epoch)
  Database epoch:
8 0.0.0.0/0, epoch 0, flags default route handler, default route
9 no route
0.0.0.0/8, epoch 0
11
    Special source: drop
   drop
13 0.0.0.0/32, epoch 0, flags receive
Special source: receive
    receive
15
16 10.0.1.0/24, epoch 0, flags rib defined all labels
    recursive via 10.0.0.112 label 34
      nexthop 10.0.0.21 FastEthernet0/0 label 24
19 10.0.2.0/24, epoch 0, flags attached, connected, cover dependents,
      need deagg
    local label info: other/34
    Covered dependent prefixes: 2
21
      need deagg: 2
    attached to FastEthernet1/0
23
24 10.0.2.0/32, epoch 0, flags receive
    Interface source: FastEthernet1/0 flags: none
    Dependent covered prefix type cover need deagg, cover 10.0.2.0/24
    receive for FastEthernet1/0
_{\rm 28} 10.0.2.1/32, epoch 0, flags receive, local, source eligible
    Interface source: FastEthernet1/0 flags: local, source eligible
    receive for FastEthernet1/0
10.0.2.255/32, epoch 0, flags receive
    Interface source: FastEthernet1/0 flags: none
    Dependent covered prefix type cover need deagg, cover 10.0.2.0/24
33
    receive for FastEthernet1/0
35 10.0.3.0/24, epoch 0, flags rib defined all labels
36 recursive via 10.0.0.121 label 34
nexthop 10.0.0.21 FastEthernet0/0 label 22
```

```
127.0.0.0/8, epoch 0
Special source: drop
drop
224.0.0.0/4, epoch 0
Special source: drop
drop
224.0.0.0/24, epoch 0, flags receive
Special source: receive
receive
240.0.0.0/4, epoch 0
Special source: drop
drop
255.255.255.255/32, epoch 0, flags receive
Special source: receive
```

Client LB Layer 2 point-to-point Overlay network Client LB bandwidth reservation and usage/routing

To do the Client LB Layer 2 point-to-point Overlay network we needed to activate RSVP-TE and create a Tunnel between Aveiro and New York and Enabling traffic engineering features on OSPF in order to announce Multiprotocol Label Switching (MPLS) traffic engineering (TE).

5.1 Configuration process

We did the following steps:

- 1. In general configuration mode and in each physical interface: no mpls ip
- 2. We Enable MPLS (RSVP-TE) in each physical interface, like this:

```
Aveiro#configure terminal
Aveiro(config)#int f0/0
Aveiro(config-if)#mpls traffic-eng tunnels
Aveiro(config-if)#end
```

3. Enable traffic engineering features on OSPF configuration mode of all routers like this:

```
Aveiro#configure terminal
Aveiro(config)#router ospf 1
Aveiro(config-router)#mpls traffic-eng area 0
Aveiro(config-router)#mpls traffic-eng router-id Loopback 0
Aveiro(config-router)#end
```

4. Use the command **clear ip ospf process** to reinitialize the OSPF process in each router.

```
Aveiro#clear ip ospf process
Reset ALL OSPF processes? [no]: yes
```

5. We created 2 dynamic tunnels. First from Aveiro to New York:

We did these symmetric configurations from New york to Aveiro. Note that we also setup bandwidth values to 10 Mbps. Since the specification of the tunnel bandwidth is in Kbit/s, 10 Mbps = 10000 Kbit/s.

6. Finally for each necessary interface in router Lisbon, Aveiro, New York and Madrid we setup 10 Mbps of guaranteed bandwidth between Client LB sites:

```
Aveiro#configure terminal
Aveiro(config)#interface f0/0
Aveiro(config-if)#ip rsvp bandwidth 10000
Aveiro(config-if)#end
```

5.2 Show run Aveiro

This was Aveiro's full configuration:

```
1 Aveiro#show run
2 Building configuration...
4 Current configuration: 2249 bytes
5 !
6 version 15.2
7 service timestamps debug datetime msec
8 service timestamps log datetime msec
9 !
10 hostname Aveiro
11 !
12 boot-start-marker
13 boot-end-marker
15 !
16 !
17 no aaa new-model
18 no ip icmp rate-limit unreachable
```

```
19 ip cef
20 !
21 !
22 !
23 !
24 !
25 !
26 no ip domain lookup
27 no ipv6 cef
28 !
29 !
30 mpls traffic-eng tunnels
31 multilink bundle-name authenticated
32 !
33 !
34 !
35 !
36 !
37 !
38 !
39 !
40 !
41 ip tcp synwait-time 5
42 !
43 !
44 !
45 !
46 !
47 !
48 !
49 !
50 !
51 !
52 !
53 !
54 interface Loopback0
ip address 10.0.0.110 255.255.255.255
ip ospf 1 area 0
57 !
58 interface Tunnel1
ip unnumbered Loopback0
60 tunnel mode mpls traffic-eng
tunnel destination 10.0.0.130
62 tunnel mpls traffic-eng autoroute announce
tunnel mpls traffic-eng priority 7 7
tunnel mpls traffic-eng bandwidth 10000
tunnel mpls traffic-eng path-option 1 dynamic
66 !
67 interface FastEthernet0/0
ip address 10.0.0.2 255.255.255.252
69 ip ospf 1 area 0
70 speed auto
71 duplex auto
72 mpls ip
73 mpls traffic-eng tunnels
^{74} ip rsvp bandwidth 10000
```

```
76 interface FastEthernet0/1
   ip address 10.0.0.5 255.255.255.252
78 ip ospf 1 area 0
   speed auto
79
80 duplex auto
81 mpls ip
82
   mpls traffic-eng tunnels
ip rsvp bandwidth 10000
85 interface FastEthernet1/0
   ip address 10.0.0.25 255.255.255.252
86
   ip ospf 1 area 0
87
88 speed auto
89 duplex auto
90 mpls ip
   mpls traffic-eng tunnels
91
_{92} ip rsvp bandwidth 10000
93 !
94 interface FastEthernet1/1
95 ip address 10.0.0.29 255.255.255.252
   ip ospf 1 area 0
97 speed auto
98 duplex auto
99 mpls ip
100 !
101 interface FastEthernet2/0
no ip address
103 shutdown
104 speed auto
105 duplex auto
106 !
107 interface FastEthernet2/1
108 no ip address
109 shutdown
110 speed auto
duplex auto
112 !
113 interface FastEthernet3/0
no ip address
115
   shutdown
116 speed auto
117 duplex auto
118 !
interface FastEthernet3/1
120 no ip address
121 shutdown
122 speed auto
123 duplex auto
124 !
125 router ospf 1
mpls traffic-eng router-id Loopback0
mpls traffic-eng area 0
128 !
129 router bgp 33900
bgp log-neighbor-changes
redistribute ospf 1
neighbor 10.0.0.1 remote-as 33900
```

```
neighbor 10.0.0.6 remote-as 33900
    neighbor 10.0.0.26 remote-as 33900
neighbor 10.0.0.30 remote-as 33900
137 ip forward-protocol nd
138 !
139 !
_{140} no ip http server
141 no ip http secure-server
142 !
143 !
144 !
145 !
146 control-plane
147 !
148 !
149 line con O
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
154 line aux 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
159 line vty 0 4
160 login
161 !
162 !
163 end
```

5.3 Aveiro show mpls traffic-eng tunnels

```
1 Aveiro#show mpls traffic-eng tunnels
3 P2P TUNNELS/LSPs:
                                            (Tunnel1) Destination:
5 Name: Aveiro_t1
     10.0.0.130
    Status:
     Admin: up
                        Oper: up
                                     Path: valid
                                                       Signalling:
      connected
      path option 1, type dynamic (Basis for Setup, path weight 2)
    Config Parameters:
10
     Bandwidth: 10000
                        kbps (Global) Priority: 7 7 Affinity: 0
1.1
      x0/0xFFFF
      Metric Type: TE (default)
      AutoRoute: enabled LockDown: disabled Loadshare: 10000
13
      [200000] bw-based
      auto-bw: disabled
14
    Active Path Option Parameters:
15
State: dynamic path option 1 is active
```

```
BandwidthOverride: disabled LockDown: disabled Verbatim:
17
      disabled
18
19
    InLabel :
20
    OutLabel : FastEthernet0/0, 17
21
22
    Next Hop: 10.0.0.1
    RSVP Signalling Info:
23
         Src 10.0.0.110, Dst 10.0.0.130, Tun_Id 1, Tun_Instance 10
24
      RSVP Path Info:
25
        My Address: 10.0.0.2
26
        Explicit Route: 10.0.0.1 10.0.0.13 10.0.0.14 10.0.0.130
27
        Record Route: NONE
28
29
        Tspec: ave rate=10000 kbits, burst=1000 bytes, peak rate
      =10000 kbits
      RSVP Resv Info:
30
        Record Route:
31
                           NONE
        Fspec: ave rate=10000 kbits, burst=1000 bytes, peak rate
32
      =10000 kbits
    History:
33
      Tunnel:
34
        Time since created: 5 minutes, 5 seconds
35
        Time since path change: 4 minutes, 22 seconds
36
37
        Number of LSP IDs (Tun_Instances) used: 10
      Current LSP: [ID: 10]
38
39
        Uptime: 4 minutes, 22 seconds
40
41 LSP Tunnel NewYork_t1 is signalled, connection is up
    InLabel : FastEthernet0/0, implicit-null
42
    Prev Hop : 10.0.0.1
43
    OutLabel :
44
    RSVP Signalling Info:
45
         Src 10.0.0.130, Dst 10.0.0.110, Tun_Id 1, Tun_Instance 11
46
      RSVP Path Info:
47
        My Address: 10.0.0.110
48
49
        Explicit Route: NONE
                          NONE
        Record Route:
50
51
        Tspec: ave rate=10000 kbits, burst=1000 bytes, peak rate
      =10000 kbits
      RSVP Resv Info:
52
        Record Route: NONE
53
        Fspec: ave rate=10000 kbits, burst=1000 bytes, peak rate
54
      =10000 kbits
55
56 P2MP TUNNELS:
57
58 P2MP SUB-LSPS:
```

5.4 Lisbon show run

```
Lisbon#show run
Building configuration...

Current configuration : 1888 bytes
!
```

```
6 version 15.2
7 service timestamps debug datetime msec
8 service timestamps log datetime msec
10 hostname Lisbon
11 !
12 boot-start-marker
13 boot-end-marker
15 !
16 !
17 no aaa new-model
18 no ip icmp rate-limit unreachable
19 ip cef
20 !
21 !
22 !
23 !
24 !
25 !
26 no ip domain lookup
27 no ipv6 cef
28 !
29 !
30 mpls traffic-eng tunnels
_{\rm 31} multilink bundle-name authenticated
32 !
33 !
34 !
35 !
36 !
37 !
38 !
39 !
40 !
41 ip tcp synwait-time 5
42 !
43 !
44 !
45 !
46 !
47 !
48 !
49 !
50 !
51 !
52 !
53 !
54 interface Loopback0
ip address 10.0.0.100 255.255.255.255
ip ospf 1 area 0
57 !
_{58} interface FastEthernet0/0
ip address 10.0.0.1 255.255.255.252
60 ip ospf 1 area 0
61 speed auto
62 duplex auto
```

```
63 mpls ip
   mpls traffic-eng tunnels
ip rsvp bandwidth 10000
_{67} interface FastEthernet0/1
ip address 10.0.0.13 255.255.255.252
69 ip ospf 1 area 0
70 speed auto
71 duplex auto
72 mpls ip
73 mpls traffic-eng tunnels
^{74} ip rsvp bandwidth 10000
75 !
76 interface FastEthernet1/0
77 ip address 10.0.0.17 255.255.255.252
78 ip ospf 1 area 0
79 speed auto
80 duplex auto
81 mpls ip
82 !
83 interface FastEthernet1/1
84 ip address 10.0.0.21 255.255.255.252
so ip ospf 1 area 0
86 speed auto
87 duplex auto
88 mpls ip
89 !
90 interface FastEthernet2/0
91 no ip address
92 shutdown
93
   speed auto
94 duplex auto
96 interface FastEthernet2/1
97 no ip address
98 shutdown
99 speed auto
100 duplex auto
101 !
102 interface FastEthernet3/0
103 no ip address
104 shutdown
105 speed auto
106 duplex auto
107 !
108 interface FastEthernet3/1
no ip address
110 shutdown
speed auto duplex auto
113 !
114 router ospf 1
mpls traffic-eng router-id Loopback0
_{\rm 116} mpls traffic-eng area 0
117
118 router bgp 33900
bgp log-neighbor-changes
```

```
_{120} redistribute ospf 1
neighbor 10.0.0.2 remote-as 33900 neighbor 10.0.0.18 remote-as 33900
neighbor 10.0.0.22 remote-as 33900
124
ip forward-protocol nd
126 !
127
128 no ip http server
129 no ip http secure-server
130 !
131
132 !
133 !
134 control-plane
135 !
136 !
137 line con O
exec-timeout 0 0
privilege level 15
140 logging synchronous
141 stopbits 1
142 line aux 0
143 exec-timeout 0 0
144 privilege level 15
145 logging synchronous
146 stopbits 1
147 line vty 0 4
148 login
149 !
150 !
151 end
```

5.4.1 Client LB VLANs

Client LA Layer 2 VPN

6.1 RA1

6.1.1 RA1 show conf

```
vyos@RA1:~$ show conf
2 interfaces {
      bridge br101 {
         address 10.2.1.1/16
          description "client LA1"
          member {
6
               interface eth1 {
               interface vxlan101 {
9
          }
11
12
      bridge br110 {
13
14
         member {
              interface eth2.10 {
16
17
               interface vxlan110 {
18
19
20
      bridge br120 {
21
22
          member {
              interface eth2.20 {
23
24
25
               interface vxlan120 {
26
          }
27
28
      bridge br130 {
          member {
30
31
               interface eth2.30 {
32
               interface vxlan130 {
33
```

```
34
35
          }
36
37
      dummy dum0 {
          address 10.0.0.111/32
38
39
       ethernet eth0 {
40
          address 10.0.0.26/30
41
42
          hw-id 08:00:27:58:13:bb
      }
43
      ethernet eth1 {
44
          hw-id 08:00:27:1d:74:c5
45
46
       ethernet eth2 {
47
          hw-id 08:00:27:75:74:d2
48
          vif 10 {
49
50
          }
          vif 20 {
51
52
          }
          vif 30 {
53
54
55
56
       ethernet eth3 {
          hw-id 08:00:27:95:c4:17
57
58
       ethernet eth4 {
59
          hw-id 08:00:27:72:88:53
60
61
       ethernet eth5 {
62
          hw-id 08:00:27:75:b1:69
63
64
      loopback lo {
65
66
      vxlan vxlan101 {
67
          mtu 1500
68
69
          source-address 10.0.0.111
          vni 101
70
71
      }
      vxlan vxlan110 {
72
73
          mtu 1500
          remote 10.0.0.38
74
75
          vni 110
      }
76
      vxlan vxlan120 {
77
78
          mtu 1500
          remote 10.0.0.38
79
          vni 120
80
      }
81
      vxlan vxlan130 {
82
83
          mtu 1500
          remote 10.0.0.38
84
          vni 130
85
86
87 }
88 protocols {
   bgp {
89
     address-family {
```

```
12vpn-evpn {
91
92
                     advertise-all-vni
93
94
            }
            neighbor 10.0.0.101 {
95
                peer-group evpn
96
97
            neighbor 10.0.0.131 {
98
99
                peer-group evpn
            }
100
            parameters {
101
                router-id 10.0.0.111
102
103
104
            peer-group evpn {
                address-family {
106
                     12vpn-evpn {
                         nexthop-self {
108
109
                         route-reflector-client
                     }
110
111
                remote-as 33900
112
                update-source dum0
            }
114
            system-as 33900
115
       }
116
       ospf {
117
            area 0 {
118
                network 10.0.0.24/30
119
                network 10.0.0.111/32
120
121
            }
122
123 }
124 system {
125
        config-management {
126
           commit-revisions 100
127
128
        conntrack {
           modules {
129
130
                ftp
                h323
131
                nfs
132
133
                pptp
                sip
134
135
                 sqlnet
136
                tftp
            }
137
       }
138
        console {
139
            device ttyS0 {
140
                speed 115200
141
142
       }
143
       host-name RA1
144
145
        login {
           user vyos {
146
147
               authentication {
```

```
encrypted-password **********
148
149
                     plaintext-password ***********
150
            }
151
       }
152
153
       ntp {
154
            server time1.vyos.net {
155
156
            server time2.vyos.net {
            }
158
            server time3.vyos.net {
159
            }
160
161
        syslog {
            global {
162
                 facility all {
163
164
                     level info
165
166
                 facility protocols {
                     level debug
167
168
            }
169
       }
170
171 }
```

6.1.2 RA1 show bgp l2vpn evpn

```
vyos@RA1:~$ show bgp l2vpn evpn
_{\rm 2} BGP table version is 1, <code>local</code> router ID is 10.0.0.111
3 Status codes: s suppressed, d damped, h history, * valid, > best, i
       - internal
4 Origin codes: i - IGP, e - EGP, ? - incomplete
5 EVPN type-1 prefix: [1]:[EthTag]:[ESI]:[IPlen]:[VTEP-IP]:[Frag-id]
6 EVPN type-2 prefix: [2]:[EthTag]:[MAClen]:[MAC]:[IPlen]:[IP]
7 EVPN type-3 prefix: [3]:[EthTag]:[IPlen]:[OrigIP]
8 EVPN type-4 prefix: [4]:[ESI]:[IPlen]:[OrigIP]
9 EVPN type-5 prefix: [5]:[EthTag]:[IPlen]:[IP]
10
                       Next Hop
                                           Metric LocPrf Weight Path
11
     Network
Route Distinguisher: 10.0.0.101:2
*>i[3]:[0]:[32]:[10.0.0.101]
                       10.0.0.101
                                                      100
                                                               0 i
                       RT:33900:101 ET:8
15
Route Distinguisher: 10.0.0.111:5
*> [3]:[0]:[32]:[10.0.0.111]
                                                           32768 i
                       10.0.0.111
18
                       ET:8 RT:33900:101
Route Distinguisher: 10.0.0.131:5
*>i[3]:[0]:[32]:[10.0.0.131]
                       10.0.0.131
                                                      100
                                                               0 i
                       RT:33900:101 ET:8
23
25 Displayed 3 out of 3 total prefixes
```

6.2 RL1

6.2.1 RL1 show conf

```
vyos@RL1:~$ show conf
2 interfaces {
      bridge br101 {
           address 10.2.2.2/16
           description "client LA2"
           member {
6
               interface eth1 {
               interface vxlan101 {
               }
10
           }
11
      }
12
      dummy dum0 {
13
           address 10.0.0.101/32
14
15
      ethernet eth0 {
16
          address 10.0.0.18/30
17
           hw-id 08:00:27:c0:e3:50
18
19
      }
       ethernet eth1 {
20
21
           hw-id 08:00:27:8e:e7:79
22
       ethernet eth2 {
23
          hw-id 08:00:27:88:19:50
24
25
26
       ethernet eth3 {
          hw-id 08:00:27:aa:3f:c5
27
28
       ethernet eth4 \{
29
          hw-id 08:00:27:2f:34:05
30
31
       ethernet eth5 {
32
33
          hw-id 08:00:27:36:3c:98
34
      loopback lo {
35
36
      }
      vxlan vxlan101 {
37
          mtu 1500
           source-address 10.0.0.101
39
40
           vni 101
41
42 }
43 protocols {
      bgp {
44
45
           address-family {
               12vpn-evpn {
46
                   advertise-all-vni
47
48
           }
49
           neighbor 10.0.0.111 {
50
               peer-group evpn
51
```

```
parameters {
53
54
                router-id 10.0.0.101
55
56
           peer-group evpn {
                address-family {
57
58
                    12vpn-evpn {
59
                        nexthop-self {
60
                    }
61
                }
62
                remote-as 33900
63
64
                update-source dum0
65
            system-as 33900
66
       }
67
68
       ospf {
           area 0 {
69
                network 10.0.0.16/30
70
71
                network 10.0.0.101/32
           }
72
73
74 }
75 system {
       config-management {
76
77
           commit-revisions 100
78
       conntrack {
79
           modules {
80
                ftp
81
                h323
82
83
                nfs
84
                pptp
85
                sip
86
                sqlnet
87
                tftp
           }
88
       }
89
90
       console {
           device ttySO {
91
92
                speed 115200
93
94
       \verb|host-name| RL1|
95
       login {
96
97
           user vyos {
                authentication {
98
                    encrypted-password **********
99
                    plaintext-password ***********
100
           }
102
       }
       ntp {
104
105
            server time1.vyos.net {
           }
106
            server time2.vyos.net {
107
108
109
           server time3.vyos.net {
```

```
110
111
        syslog {
112
             global {
113
                  facility all {
114
                       level info
115
116
                  facility protocols {
117
118
                       level debug
119
             }
120
        }
121
122 }
```

6.2.2 RL1 show bgp l2vpn evpn

```
vyos@RL1:~$ show bgp 12vpn evpn
_{\rm 2} BGP table version is 1, <code>local</code> router ID is 10.0.0.101
3 Status codes: s suppressed, d damped, h history, * valid, > best, i
        - internal
4 Origin codes: i - IGP, e - EGP, ? - incomplete
5 EVPN type-1 prefix: [1]:[EthTag]:[ESI]:[IPlen]:[VTEP-IP]:[Frag-id]
6 EVPN type-2 prefix: [2]:[EthTag]:[MAClen]:[MAC]:[IPlen]:[IP]
7 EVPN type-3 prefix: [3]:[EthTag]:[IPlen]:[OrigIP]
8 EVPN type-4 prefix: [4]:[ESI]:[IPlen]:[OrigIP]
9 EVPN type-5 prefix: [5]:[EthTag]:[IPlen]:[IP]
10
11
     Network
                       Next Hop
                                            Metric LocPrf Weight Path
Route Distinguisher: 10.0.0.101:2
*> [3]:[0]:[32]:[10.0.0.101]
                                                           32768 i
                       10.0.0.101
                       ET:8 RT:33900:101
15
16 Route Distinguisher: 10.0.0.111:5
*>i[3]:[0]:[32]:[10.0.0.111]
                                                      100
                       10.0.0.111
                                                               0 i
                       RT:33900:101 ET:8
Route Distinguisher: 10.0.0.131:5
21 *>i[3]:[0]:[32]:[10
```

6.3 RN1

6.3.1 RN1 show conf

```
vyos@RN1:~$ show conf
interfaces {
    bridge br101 {
        address 10.2.3.3/16
        description "client LA3"
        member {
            interface eth2 {
            }
            interface vxlan101 {
```

```
10
11
           }
12
13
       bridge br110 {
           member {
14
15
               interface eth1.10 {
16
               interface vxlan110 {
17
18
           }
19
20
       bridge br120 {
21
           member {
22
               interface eth1.20 {
23
24
25
               interface vxlan120 {
26
           }
27
28
      }
       bridge br130 {
29
30
           member {
               interface eth1.30 {
31
32
33
               interface vxlan130 {
34
           }
35
36
       dummy dum0 {
37
           address 10.0.0.131/32
38
39
40
       ethernet eth0 {
          address 10.0.0.38/30
41
42
          hw-id 08:00:27:38:c7:4d
43
       ethernet eth1 {
44
          hw-id 08:00:27:9d:9e:aa
45
           vif 10 {
46
47
          }
           vif 20 {
48
49
           }
           vif 30 {
50
51
52
       ethernet eth2 {
53
54
          hw-id 08:00:27:3e:fc:6d
55
       ethernet eth3 {
56
          hw-id 08:00:27:51:b5:f5
57
       }
58
59
       ethernet eth4 {
          hw-id 08:00:27:69:3e:53
60
61
62
       ethernet eth5 {
          hw-id 08:00:27:9e:f9:53
63
64
      loopback lo {
65
```

```
vxlan vxlan101 {
67
68
           mtu 1500
           source-address 10.0.0.131
69
70
           vni 101
71
72
       vxlan vxlan110 {
           mtu 1500
73
           remote 10.0.0.26
74
75
           vni 110
       }
76
77
       vxlan vxlan120 {
           mtu 1500
78
79
           remote 10.0.0.26
           vni 120
80
       }
81
       vxlan vxlan130 {
82
83
           mtu 1500
           remote 10.0.0.26
84
85
           vni 130
86
87 }
88 protocols {
89
       bgp {
           address-family {
90
                12vpn-evpn {
91
                    advertise-all-vni
92
93
           }
94
           neighbor 10.0.0.111 {
95
                peer-group evpn
96
97
            parameters {
98
99
                router-id 10.0.0.131
100
101
           peer-group evpn {
102
                address-family {
                   12vpn-evpn {
103
104
                        nexthop-self {
105
106
                    }
                }
107
108
                remote-as 33900
109
                update-source dum0
           }
110
111
            system-as 33900
       }
112
       ospf {
113
           area 0 {
114
                network 10.0.0.131/32
115
                network 10.0.0.36/30
116
           }
117
118
119 }
120 system {
       config-management {
121
          commit-revisions 100
122
123
```

```
conntrack {
124
125
            modules {
                 ftp
126
127
                 h323
                 nfs
128
129
                 pptp
130
                 sip
                 sqlnet
131
132
                 tftp
            }
133
134
        console {
135
136
            device ttyS0 {
                 speed 115200
137
138
139
       \verb|host-name|| \verb|RN1||
140
141
        login {
142
           user vyos {
                 authentication {
143
144
                     encrypted-password **********
                     plaintext-password ***********
145
146
            }
147
       }
148
        ntp {
149
            server time1.vyos.net {
150
            server time2.vyos.net {
152
153
154
            server time3.vyos.net {
155
156
        syslog {
157
158
            global {
159
                facility all {
                    level info
160
161
                 facility protocols {
162
163
                     level debug
                 }
164
165
            }
       }
166
167 }
```

6.3.2 RN1 show bgp l2vpn evpn

```
vyos@RN1:~$ show bgp 12vpn evpn
2 BGP table version is 1, local router ID is 10.0.0.131
3 Status codes: s suppressed, d damped, h history, * valid, > best, i
        - internal
4 Origin codes: i - IGP, e - EGP, ? - incomplete
5 EVPN type-1 prefix: [1]:[EthTag]:[ESI]:[IPlen]:[VTEP-IP]:[Frag-id]
6 EVPN type-2 prefix: [2]:[EthTag]:[MAClen]:[MAC]:[IPlen]:[IP]
7 EVPN type-3 prefix: [3]:[EthTag]:[IPlen]:[OrigIP]
8 EVPN type-4 prefix: [4]:[ESI]:[IPlen]:[OrigIP]
9 EVPN type-5 prefix: [5]:[EthTag]:[IPlen]:[IP]
10
                                             Metric LocPrf Weight Path
11
      Network
                        Next Hop
Route Distinguisher: 10.0.0.101:2
*>i[3]:[0]:[32]:[10.0.0.101]
                                                        100
                                                   0
                                                                 0 i
                        10.0.0.101
                        RT:33900:101 ET:8
15
Route Distinguisher: 10.0.0.111:5
*>i[3]:[0]:[32]:[10.0.0.111]
                        10.0.0.111
                                                        100
                                                                 0 i
                        RT:33900:101 ET:8
19
20 Route Distinguisher: 10.0.0.131:5
*> [3]:[0]:[32]:[10.0.0.131]
                        10.0.0.131
                                                             32768 i
22
                        ET:8 RT:33900:101
25 Displayed 3 out of 3 total prefixes
```

Final Network Topology

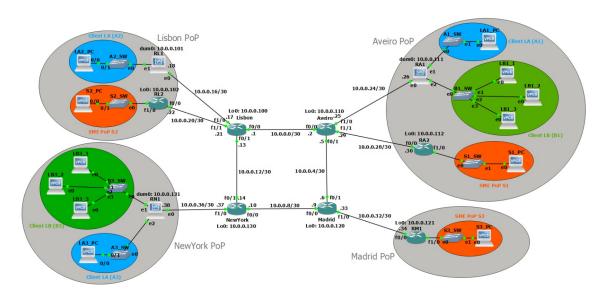


Figure 7.1: Enter Caption