Agenda

- EVPN Basic Recap.

- Requeriments for Troubleshooting EVPN

- Case Study 1 - Broken Connectivity

- Case Study 2 - Multicast Duplication

EVPN Basic Recap.

EVPN Basic Recap.

- **EVPN Instance (EVI)**
  - Its our VPN

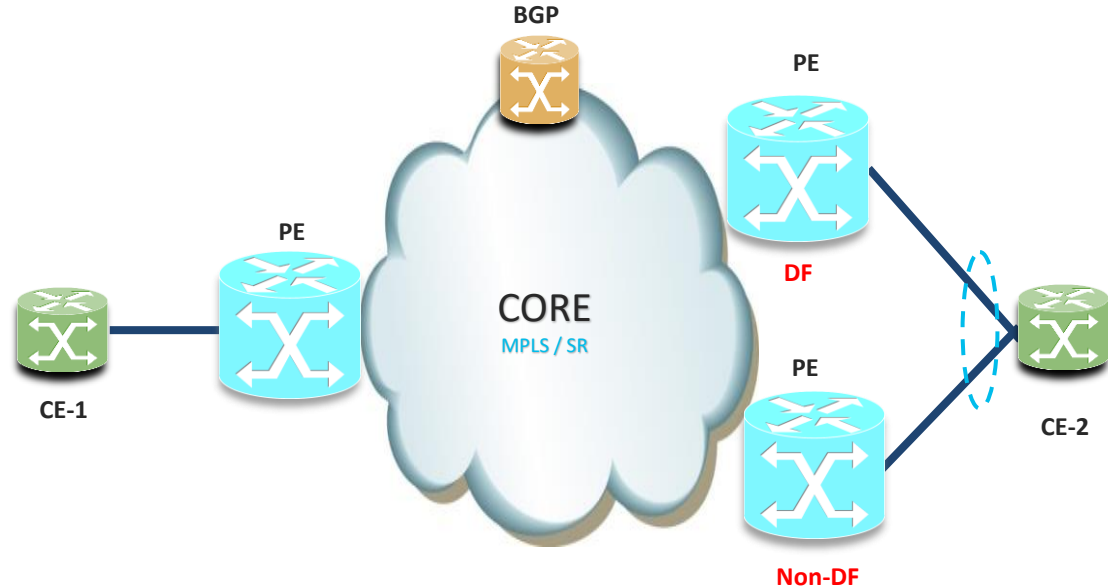- **Ethernet Segment**
  - Null
  - Auto or Set

- **Topology**
  - Single Home
  - Dual Home A/S
  - Dual Home A/A

- **BGP**
  - AFI = L2VPN (25) EVPN (70)
  - Route Type = 1 to 5
  - Route Attributes = RD + ESI + MAC + Label + RT

Minimum Requeriments for Troubleshooting

- **Topology**
  - Single Home
  - Dual Home Active / Standby
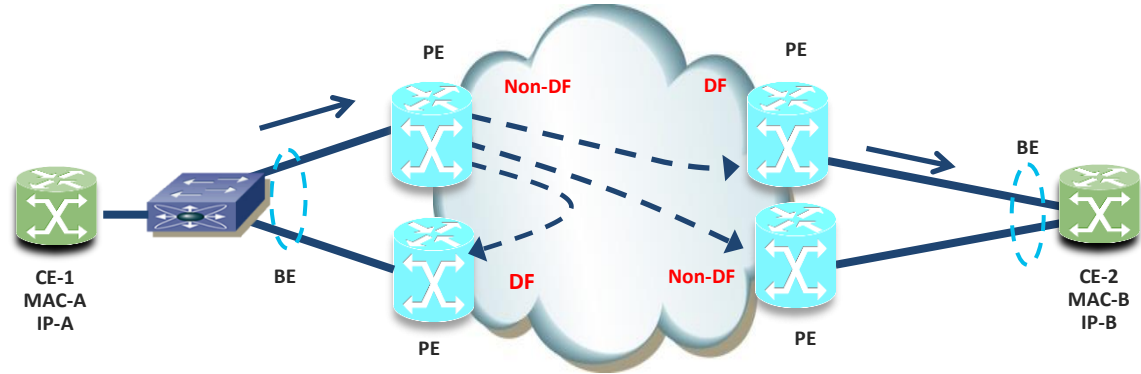 - Dual Home Active / Active

- **MACs + IPs**
  - Source & Destination

- **Flow Type**
  - Unicast
  - BUM (Multicast / Broadcast / Unknown Unicast)

- **EVI & ESI**

- **DF & Non-DF**

Case Study 1

Broken Connectivity between hosts in same DC

Broken Connectivity between hosts in same DC

Problem Description

- Service Provider A had an up and running EVPN network.

- SP had a MW where services were migrated to an exisiting L2VPN but with new VLAN and everything was left working.

- Next day SP saw that the service that was migrated is not working anymore.
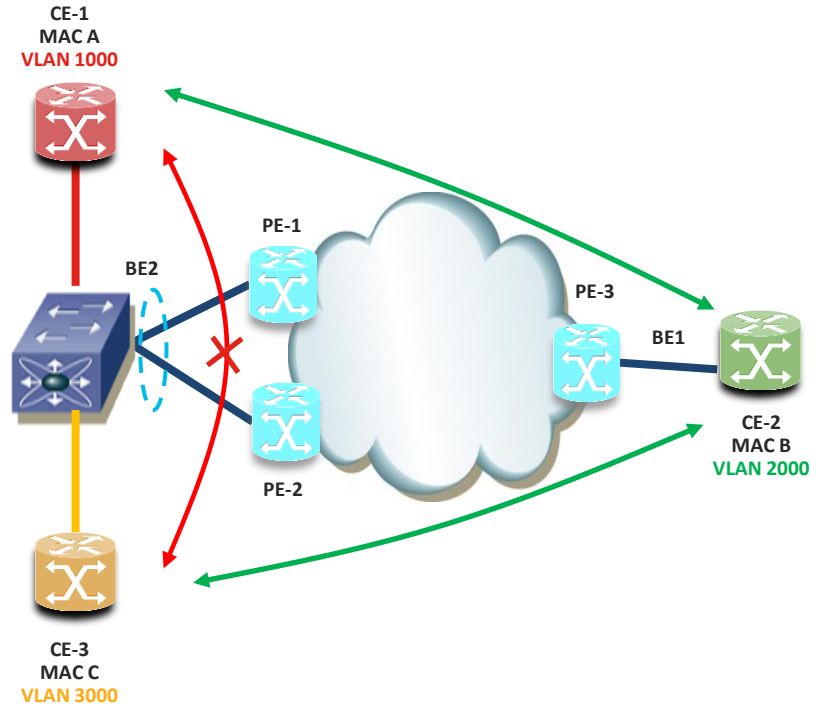
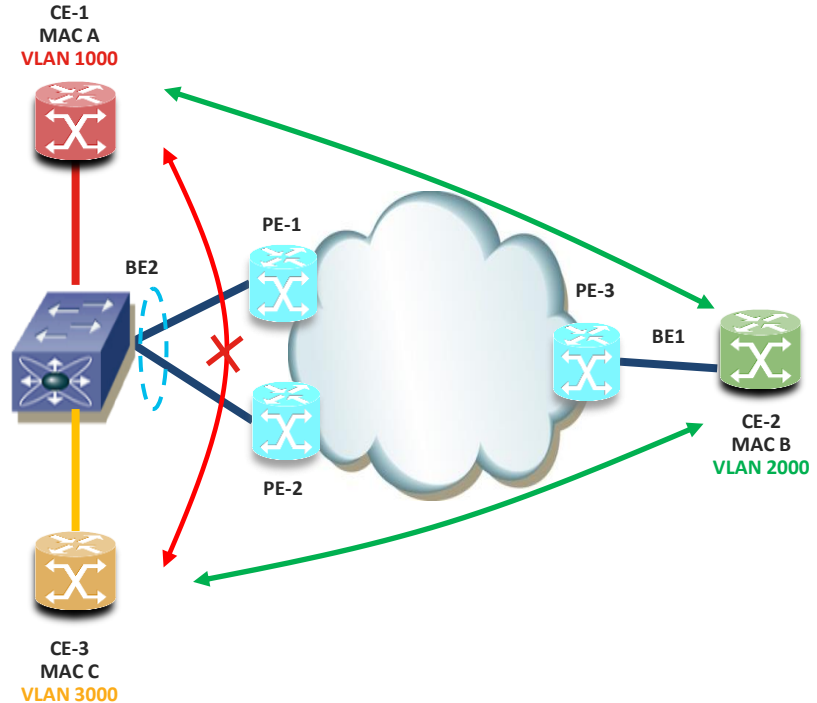# Broken Connectivity between hosts in same DC

Troubleshooting

- Are we learning the MACs in L2VPN BD?

- Are we learning the MACs in the right AC?

- Who is the Designated Forwarder (DF)?

- What PE is receiving the ARP request?

AC and L2VPN config for PE-1 and PE-2
```
!
interface Bundle-Ether2.1000 l2transport
 encapsulation dot1q 1000
 rewrite ingress tag pop 1 symmetric
!
interface Bundle-Ether2.3000 l2transport
 encapsulation dot1q 3000
 rewrite ingress tag pop 1 symmetric
!
l2vpn
 bridge group EVPN_BG_1234
  bridge-domain EVPN_BD_1234
   interface Bundle-Ether2.1000
   !
   interface Bundle-Ether2.3000
   !
   evi 1234
   !
```

AC and L2VPN config for PE-3
```
!
interface Bundle-Ether1.2000 l2transport
 encapsulation dot1q 2000
 rewrite ingress tag pop 1 symmetric
!
l2vpn
 bridge group EVPN_BG_1234
  bridge-domain EVPN_BD_1234
   interface Bundle-Ether1.2000
   !!
   evi 1234
   !
```


CE-1
MAC A
VLAN 1000

PE-1

BE2

PE-3

BE1

PE-2

CE-2
MAC B
VLAN 2000

CE-3
MAC C
VLAN 3000

Case Study 1 : Broken Connectivity between hosts in same DC

Troubleshooting Outputs

```
CE-2

show arp vrf 2000
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  10.20.30.10          6      aaaa.aaaa.1000  ARPA   Port-channel1.2000.    <<<<< CE-1
Internet  10.20.30.30          6      cccc.cccc.3000  ARPA   Port-channel1.2000.    <<<<< CE-3

ping vrf 2000 10.20.30.10          <<< From CE-2 to CE-1
Sending 5, 100-byte ICMP Echos to 10.20.30.10, timeout is 2 seconds:
!!!!!

ping vrf 2000 10.20.30.30          <<< From CE-2 to CE-3
Sending 5, 100-byte ICMP Echos to 10.20.30.30, timeout is 2 seconds:
!!!!!

XR_PE-3

show l2vpn forwarding bridge-domain EVPN_BG_1234:EVPN_BD_1234 mac-address location 0/0/cpu0
Mac Address       Type       Learned from/Filtered on
--------------  -------  -----------------------
aaaa.aaaa.1000    EVPN       BD id: 1
cccc.cccc.3000    EVPN       BD id: 1
b0b0.b0b0.2000    dynamic    BE1.2000

show evpn evi vpn-id 1234 mac
VPN-ID   Encap      MAC address    IP address                    Nexthop                        Label
-------  ---------  -------------  ----------------------------  ----------------------------  -----
123      MPLS       aaaa.aaaa.1000 ::                            192.168.0.1                   24030
123      MPLS       aaaa.aaaa.1000 ::                            192.168.0.2                   24030
123      MPLS       b0b0.b0b0.2000 ::                            Bundle-Ether1.2000            24020
123      MPLS       cccc.cccc.3000 ::                            192.168.0.1                   24030
123      MPLS       cccc.cccc.3000 ::                            192.168.0.2                   24030
```
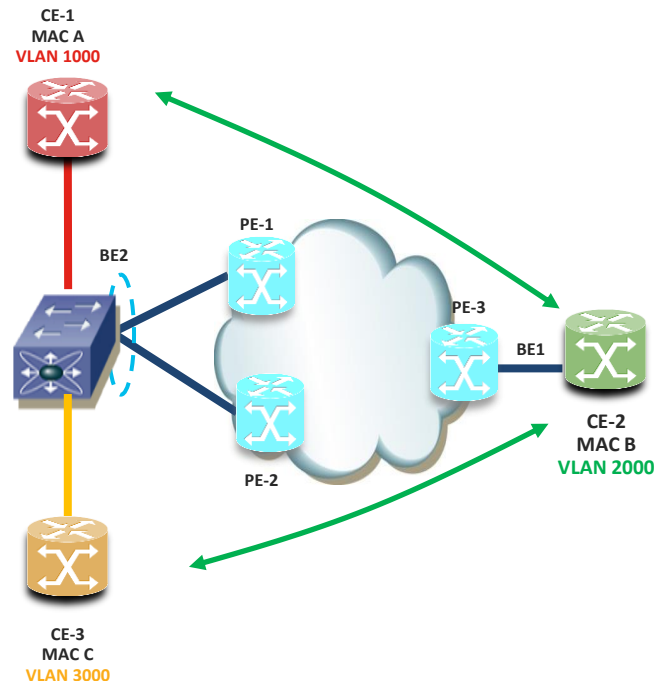
Case Study 1 : Broken Connectivity between hosts in same DC

Troubleshooting Outputs

```
CE-1
show arp vrf 1000
Protocol  Address         Age (min)  Hardware Addr   Type   Interface
Internet  10.20.30.10        -       aaaa.aaaa.1000  ARPA   Vlan1000
Internet  10.20.30.20        0       b0b0.b0b0.2000  ARPA   Vlan1000
Internet  10.20.30.30        0       Incomplete      ARPA             <<<<<<<<<<<< CE-3

ping vrf 1000 10.20.30.20          <<< From CE-1 to CE-2
Sending 5, 100-byte ICMP Echos to 10.20.30.20, timeout is 2 seconds:
!!!!!

ping vrf 1000 10.20.30.30          <<< Connectivity Failure Between CE-1 and CE-3
Sending 5, 100-byte ICMP Echos to 10.20.30.30, timeout is 2 seconds:
.....

XR_PE-1
show l2vpn forwarding bridge-domain EVPN_BG_1234:EVPN_BD_1234 mac-address location 0/0/cpu0

Mac Address       Type      Learned from/Filtered on
--------------  -------   -------------------------------
b0b0.b0b0.2000   EVPN       BD id: 2
aaaa.aaaa.1000   dynamic    BE2.1000
cccc.cccc.3000.  dynamic    BE2.3000       <<< MAC from CE-3 in PE-1

show evpn evi vpn-id 1234 mac

VPN-ID   Encap   MAC address     IP address     Nexthop          Label
-------  ------  -------------   ------------   -----------     ----------
123      MPLS    aaaa.aaaa.1000 ::              Bundle-Ether2.1000  24030
123      MPLS    b0b0.b0b0.2000 ::              192.168.0.5         24020
123      MPLS    cccc.cccc.3000 ::              Bundle-Ether2.3000  24030   <<< MAC from CE-3 in PE-1
```
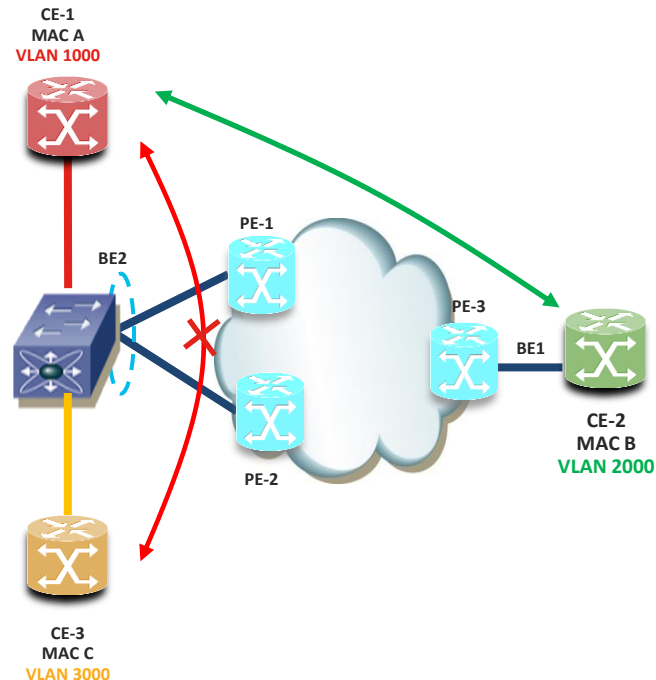

CE-1
MAC A
VLAN 1000

PE-1

BE2

PE-3

BE1

PE-2

CE-2
MAC B
VLAN 2000

CE-3
MAC C
VLAN 3000

Case Study 1 : Broken Connectivity between hosts in same DC

Troubleshooting Outputs

```
CE-1
show arp vrf 1000
Internet  10.20.30.30        0  Incomplete     ARPA      <<<<< CE-3

ping vrf 1000 10.20.30.30
Sending 5, 100-byte ICMP Echos to 10.20.30.30, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)


16001 = Transport Label for PE1
24034 = Multicast Label for EVI 1234 in PE1
24039 = Split Horizon Label for ESI BE2 on PE1

XR_PE-2

show mpls forwarding prefix 192.168.0.1/32
------ ---------- ------------------- ----------

16001 16001      SR Pfx (idx 1)    Gi0/0/0/0

show evpn evi vpn-id 1234 inclusive-multicast  detail
---------- ------ ---------- --------------------

1234    MPLS  0       192.168.0.1
Nexthop: 192.168.0.1
   Label : 24034

show evpn ethernet-segment interface bundle-Ether 2 carving detai
---------- ------ ---------- --------------------

 Remote SHG labels : 1
        24039 : nexthop 192.168.0.1
```
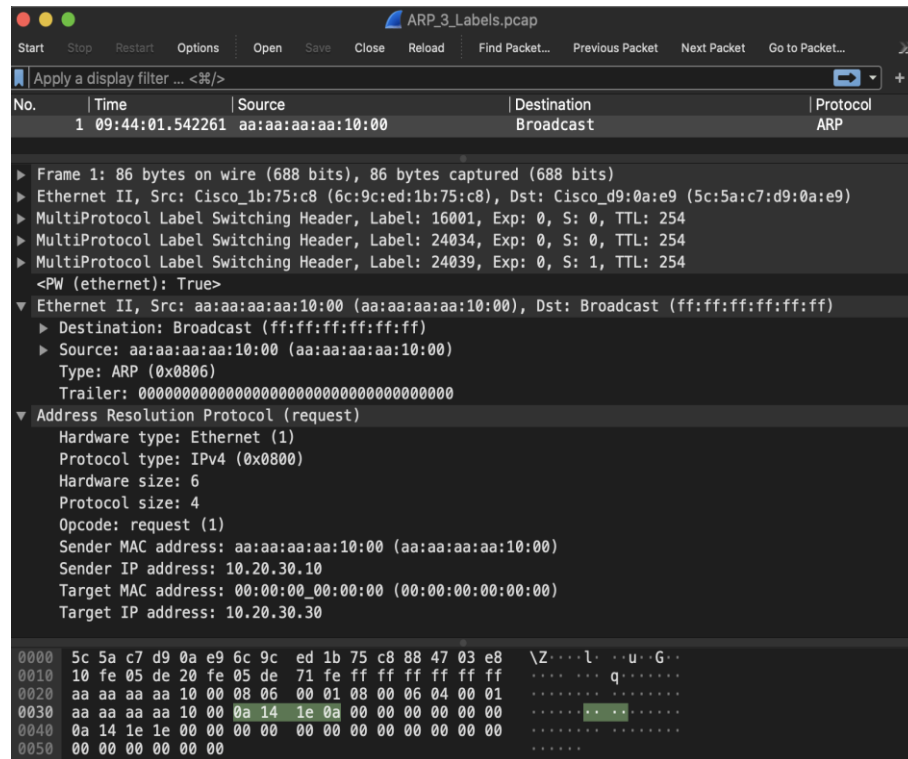
Case Study 1 : Broken Connectivity between hosts in same DC

Troubleshooting Outputs

```
XR_PE-1
show evpn ethernet-segment interface bundle-Ether 2 carving detail

Ethernet Segment Id       Interface                        Nexthops
----------------------- -------------------------------- --------------------
0011.2211.2211.2211.2211 BE2                              192.168.0.1

192.168.0.2
Main port        :
    Interface name : Bundle-Ether2
State            : Up
    Redundancy    : Active
 ESI type         : 0
    Value         : 11.2211.2211.2211.2211
Topology         :
    Operational   : MH, All-active
Service Carving  : Manual
    Primary       : 1
            Pri :    1234
    Secondary    : 1
            Sec :    4000

  Service Carving Results:
    Forwarders   : 2
    Elected      : 1
        EVI E    :      1234
    Not Elected  : 1
        EVI NE   :      4000

Local SHG label   : 24039
  Remote SHG labels : 1
            24028 : nexthop 192.168.0.2
  Access signal mode: Bundle OOS (Default)
```

```
XR_PE-2
show evpn ethernet-segment interface bundle-Ether 2 carving detail

Ethernet Segment Id       Interface                        Nexthops
----------------------- -------------------------------- --------------------
0011.2211.2211.2211.2211 BE2                              192.168.0.1

192.168.0.2
Main port        :
    Interface name : Bundle-Ether2
State            : Up
    Redundancy    : Active
 ESI type         : 0
    Value         : 11.2211.2211.2211.2211
Topology         :
    Operational   : MH, All-active
Service Carving  : Manual
    Primary       : 1
            Pri :    4000
    Secondary    : 1
            Sec :    1234

  Service Carving Results:
    Forwarders   : 2
    Elected      : 1
        EVI E    :      4000
    Not Elected  : 1
        EVI NE   :      1234
Local SHG label   : 24028
  Remote SHG labels : 1
            24039 : nexthop 192.168.0.1
  Access signal mode: Bundle OOS (Default)
```
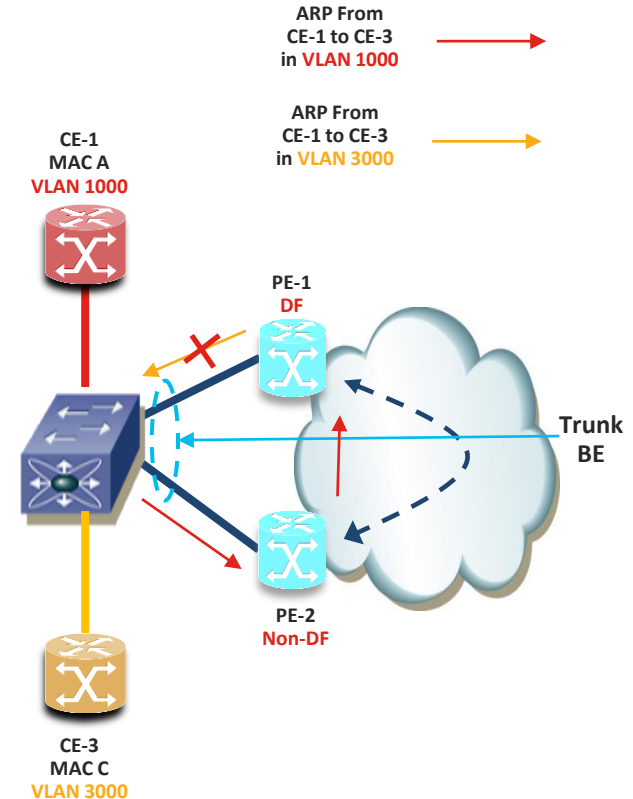
Broken Connectivity between hosts in same DC

Root Cause

- ARP Request from VLAN 1000 reach PE-2.

- PE-2 is non-DF for EVI 1234 so traffic between ACs from same BE will not be bridged.

- PE-2 will forward the traffic to PE-1 with Multicast Label and Split Horizon Label.

- When PE-1 receives the packet it will be dropped because of the Split Horizon Label.

ARP From CE-1 to CE-3 in VLAN 1000

ARP From CE-1 to CE-3 in VLAN 3000

CE-1
MAC A
VLAN 1000

PE-1
DF

Trunk BE

PE-2
Non-DF

CE-3
MAC C
VLAN 3000

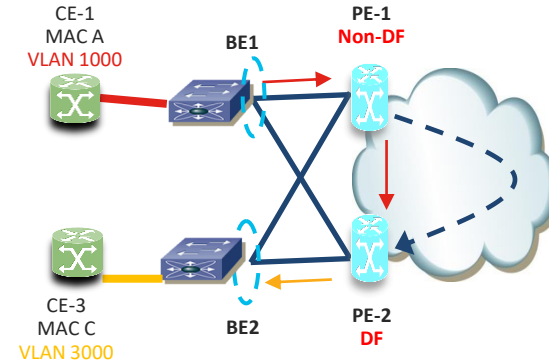# Broken Connectivity between hosts in same DC

Solution

1.- Having 2 Bundles between LAN and PEs.

AC-1 for Vlan 1000 in BE-X.

AC-2 for Vlan 2000 in BE-Y.

In this case if BUM traffic from AC-1 in BE-X reaches Non-DF the packet will be forwarded to PE-2 and it will forward to AC-2 since the SHL is for BE-X and not BE-Y.
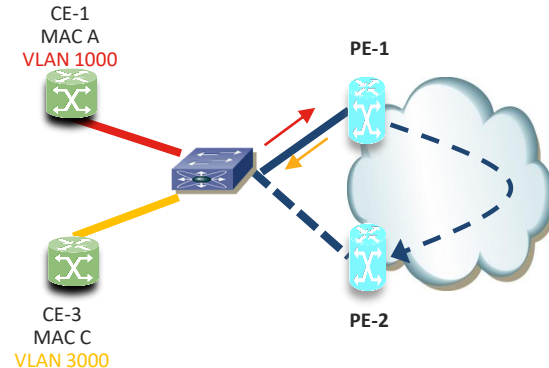
2.- Using an Active / Standby Solution.

AC for Vlan A and Vlan B in BE1.

ARP request reaches always DF (because of A/S setup).

ARP will be bridged from AC-A to AC-B.

Case Study 2

Duplicate Multicast Traffic being Received

Duplicate Multicast Traffic being Received

Problem Description

- CU X had requirement to run Multicast in existing L2VPN, and because of this, it enhances the network from Single Home to Dual Home.

- During initial test CU sees CC errors on receiver. Deeper analysis shows that CC errors is because of duplicate multicast traffic.
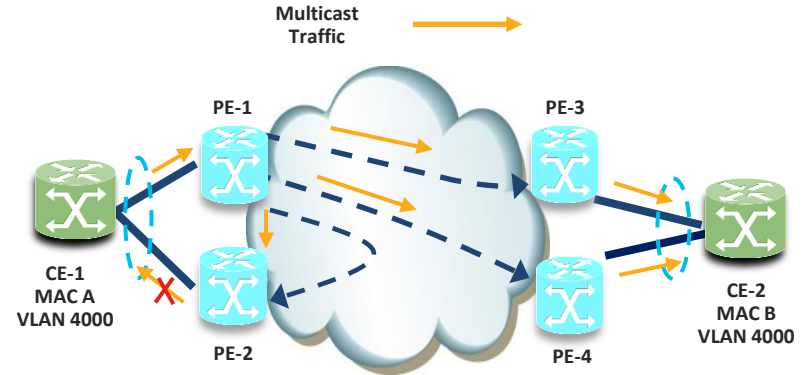
Duplicate Multicast Traffic being Received

Troubleshooting

- Who is the Source?

- What PEs are part of the EVI?

- What are the labels for Multicast and Split Horizon Label for those PEs in the EVI?

- Are we learning the MACs .....
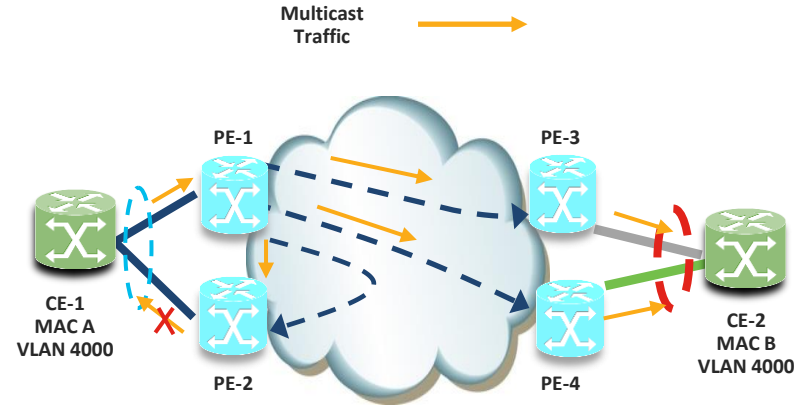
Case Study 2 : Duplicate Multicast Traffic being Received
Troubleshooting Outputs

```
PE-1 = 192.168.0.1
PE-2 = 192.168.0.2
!
interface Bundle-Ether2.4000 l2transport
 encapsulation dot1q 4000
 rewrite ingress tag pop 1 symmetric
!
l2vpn
 bridge group EVI_4000
  bridge-domain EVI_4000
   interface Bundle-Ether2.4000
   !
   evi 4000
 !
evpn
 evi 4000
  control-word-disable
  advertise-mac
  !
interface Bundle-Ether2
 ethernet-segment
  identifier type 0 11.22.11.22.11.22.11.22.11
!
```

```
CE-1
ping 232.11.22.33 source 192.168.40.2 repeat 3333 tim 0
Sending 3333, 100-byte ICMP Echos to 232.11.22.33
...........................................................
...........................................................

XR_PE-2
show interface bundle-ether 2.4000  <<< AC to CE-1
Bundle-Ether2.4000 is up, line protocol is up
    3334 packets input, 393370 bytes

show interface gig 0/0/0/0                      <<< CORE
GigabitEthernet0/0/0/1 is up, line protocol is up
    10020 packets output, 1375179 bytes,

show mpls forwarding
Local Outgoing    Prefix        Outgoing    Next Hop    Bytes
Label Label       or ID         Interface               Switched
------ ---------- -------------- ----------- ------------ -----------
16001 16001      SR Pfx (idx 1) Gi0/0/0/0   20.20.20.5   383670
16008 16008      SR Pfx (idx 8) Gi0/0/0/0   20.20.20.5   383670
16009 16009      SR Pfx (idx 9) Gi0/0/0/0   20.20.20.5   383670
```

```
XR_PE-2
show evpn evi vpn-id 4000 inclusive-multicast  detail

VPN-ID    Encap   EtherTag   Originating IP
--------- ------  ---------- ------------------------
4000      MPLS    0          192.168.0.1
   Nexthop: 192.168.0.1
   Label  : 24008
   Source : Remote

4000      MPLS    0          192.168.0.2
   Nexthop: ::
   Label  : 24018
   Source : Local

4000      MPLS    0          192.168.0.8
   Nexthop: 192.168.0.8
   Label  : 24122
   Source : Remote

4000      MPLS    0          192.168.0.9
   Nexthop: 192.168.0.9
   Label  : 24120
   Source : Remote
```

Case Study 2 : Duplicate Multicast Traffic being Received
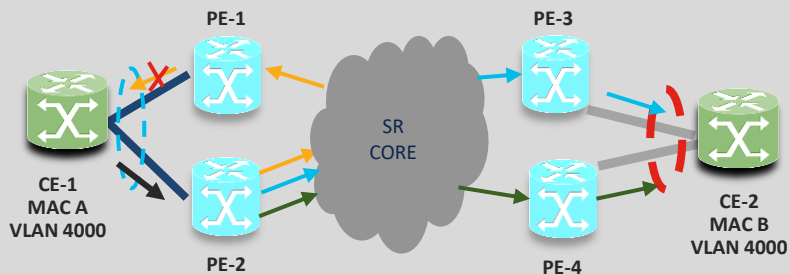## Troubleshooting Outputs

P Router

```
flow monitor-map FMM_EVPN_LABELS
  record mpls ipv4-fields
  cache entries 1000000
  cache timeout active 120
  cache timeout rate-limit 2500
!
sampler-map SM_EVPN_1of1
  random 1 out-of 1
!
interface GigabitEthernet0/0/0/1
  description CONNECT_TO_PE2
  cdp
flow mpls monitor FMM_EVPN_LABELS sampler SM_EVPN_1of1 ingress
```

show flow monitor FMM_EVPN_LABELS cache format table location 0/0/cpu0

Prefix/Length	Label1-EXP-S	Label2-EXP-S	Label3-EXP-S	InputInterface	OutputInterface	ForwardStatus	ByteCount	PacketCount	
192.168.0.8/32	16008-0-0	24122-0-1	-	Gi0/0/0/1	Gi0/0/0/3	Fwd	406706	3334	<<< From PE-2 to PE-3
192.168.0.9/32	16009-0-0	24120-0-1	-	Gi0/0/0/1	Gi0/0/0/4	Fwd	406706	3334	<<< From PE-2 to PE-4
192.168.0.1/32	16001-0-0	24008-0-0	24039-0-1	Gi0/0/0/1	Gi0/0/0/0	Fwd	406706	3334	<<< From PE-2 to PE-1

Case Study 2 : Duplicate Multicast Traffic being Received

Troubleshooting Outputs

XR_PE-1
GigabitEthernet0/0/0/1   <<< CORE Interface
3349 packets input, 454601 bytes, 1 total input drops

RSV_EGR_L2_EVPN_ESI_DROP   **3336**

Bundle-Ether2.4000   <<< AC to CE-1
0 packets output, 0 bytes

XR_PE-3
GigabitEthernet0/0/0/0   <<< CORE Interface
3394 packets input, 444923 bytes

Bundle-Ether1.4000   <<< AC to CE-2
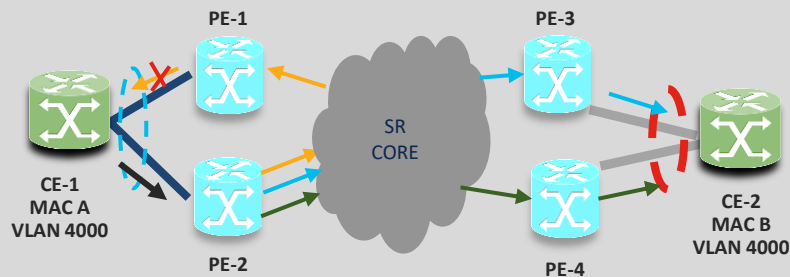3337 packets output, 393586 bytes

XR_PE-4
GigabitEthernet0/0/0/0   <<< CORE Interface
3394 packets input, 444923 bytes

Bundle-Ether1.4000   <<< AC to CE-2
3337 packets output, 393586 bytes

CE-2
6797 packets input, 795577 bytes **<<< Duplicate Multicast Packets**

Case Study 2 : Duplicate Multicast Traffic being Received
Troubleshooting Outputs

PE-3 = 192.168.0.8
```
!
l2vpn
 bridge group EVI_4000
  bridge-domain EVI_4000
   interface Bundle-Ether1.4000
   !
   evi 4000
  !
evpn
!
interface Bundle-Ether1
 ethernet-segment
  identifier type 0 88.99.88.99.88.99.88.99.88
!
```

PE-4 = 192.168.0.9
```
!!
l2vpn
 bridge group EVI_4000
  bridge-domain EVI_4000
   interface Bundle-Ether1.4000
   !
   evi 4000
  !
evpn
!
interface Bundle-Ether1
 ethernet-segment
  identifier type 0 89.89.89.89.89.89.89.89.89
!
```

PE-3

show evpn ethernet-segment interface bundle-Ether 1 carving detail

```
Ethernet Segment Id     Interface           Nexthops
---------------------- --------------------------------
0088.9988.9988.9988.9988 BE1              192.168.0.8
  Main port        :
    Interface name : Bundle-Ether1
    Interface MAC  : bc5a.561d.8cdf
  ESI type         : 0
    Value          : 88.9988.9988.9988.9988
  ES Import RT      : 8899.8899.8899 (from ESI)
  Topology         :
    Operational    : SH
    Configured     : All-active (AApF) (default)
  Service Carving  : Auto-selection
  Peering Details  :
    192.168.0.8 [MOD:P:00]
  Service Carving Results:
    Forwarders    : 2
    Elected       : 2
      EVI E  :  1000,  4000
  Local SHG label  : 24022
```

PE-4

show evpn ethernet-segment interface bundle-Ether 1 carving detail

```
Ethernet Segment Id     Interface           Nexthops
---------------------- --------------------------------
0089.8989.8989.8989.8989 BE1              192.168.0.9
  Main port        :
    Interface name : Bundle-Ether1
    Interface MAC  : bc5a.561d.68de
    IfHandle       : 0x08004024
  ESI type         : 0
    Value          : 89.8989.8989.8989.8989
  ES Import RT      : 8989.8989.8989 (from ESI)
  Topology         :
    Operational    : SH
    Configured     : All-active (AApF) (default)
  Service Carving  : Auto-selection
  Peering Details  :
    192.168.0.9 [MOD:P:00]
  Service Carving Results:
    Forwarders    : 2
    Elected       : 2
      EVI E  :  1000,  4000
  Local SHG label  : 24017
```

Duplicate Multicast Traffic being Received

Root Cause and Solution

- "Remote" PEs will recibe the multicast, and only Designated Forwarder (DF) will flood the Multicast.

- **If two PEs working in Dual Home Active / Active do not have same ESI, both will be DF for the ESI and both will forward multicast frames to the LAN, duplicated traffic will happen.**
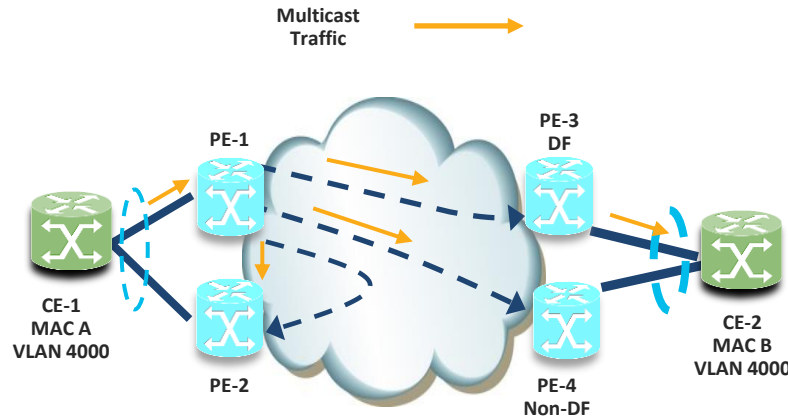
Appendix

Swiss Army Knife

EVPN Basic Configuration for Single Home

BGP
```
router bgp 65500
!
 address-family l2vpn evpn
!
 neighbor-group Route_Reflector
  address-family l2vpn evpn
!
```

AC
```
interface Bundle-Ether1.1000 l2transport
 encapsulation dot1q 1000
 rewrite ingress tag pop 1 symmetric
!
```

EVPN
```
evpn
 evi 1000
  control-word-disable
  advertise-mac
  !
```

L2VPN
```
l2vpn
 bridge group EVPN_BG
  bridge-domain EVPN_BD
   interface Bundle-Ether1.1000
   !
   evi 1000
   !
```

EVPN Basic Configuration for Dual Home A/A (1 of 2)

	PE-1	PE-2

BGP	router bgp 65500
	!
	 address-family l2vpn evpn
	!
	 neighbor-group Route_Reflector
	  address-family l2vpn evpn
	!
		router bgp 65500
		!
		 address-family l2vpn evpn
		!
		 neighbor-group Route_Reflector
		  address-family l2vpn evpn
		!

AC	interface Bundle-Ether1.1000 l2transport encapsulation dot1q 1000 rewrite ingress tag pop 1 symmetric !	interface Bundle-Ether1.1000 l2transport encapsulation dot1q 1000 rewrite ingress tag pop 1 symmetric !

EVPN	evpn
	 evi 1000
	  control-word-disable
	  advertise-mac
	  !
		evpn
		 evi 1000
		  control-word-disable
		  advertise-mac
		  !

L2VPN	l2vpn
	 bridge group EVPN_BG
	  bridge-domain EVPN_BD
	   interface Bundle-Ether1.1000
	   !
	   evi 1000
	   !
		l2vpn
		 bridge group EVPN_BG
		  bridge-domain EVPN_BD
		   interface Bundle-Ether1.1000
		   !
		   evi 1000
		   !

EVPN Basic Configuration for Dual Home A/A (2 of 2)

	PE-1	PE-2	
	redundancy	redundancy	
	iccp	iccp	
	group 12	group 12	<<< Same Values for P-1 and P-2
	mlacp node 1	mlacp node 2	<<< Dif Values in P-1 and P-2
	mlacp system mac 0111.0111.0111	mlacp system mac 0111.0111.0111	<<< Same Values for P-1 and P-2
	mlacp system priority 1	mlacp system priority 1	
	mode singleton	mode singleton	
MLACP	backbone	backbone	
	interface xxxx	interface xxxx	<<< CORE Link(s)
	!	!	
	interface Bundle-Ether1	interface Bundle-Ether1	
	lacp switchover suppress-flaps 300	lacp switchover suppress-flaps 300	
	mlacp iccp-group 12	mlacp iccp-group 12	
	mlacp port-priority 1	mlacp port-priority 1	
	!	!	
	evpn	evpn	
	interface Bundle-Ether1	interface Bundle-Ether1	
EVPN	ethernet-segment	ethernet-segment	
	identifier type 0 12.12.12.12.12.12.12.12.12	identifier type 0 12.12.12.12.12.12.12.12.12	<<< Same Values for P-1 and P-2
	!	!	

EVPN Optional Configs.

Configuration	Action	Default
evpn		
evi 1000		
advertise-mac	Advertise local mac addr in BGP	Default is NOT to advertise.
unknown-unicast-suppression	Avoid flooding of unknown unicast frames through EVPN.	Default is to flood.
control-word-disable	Add CW on packets.	Default is CW enable.
load-balancing flow-label static	Add Extra label to allow load balancing on core links.	Default is no Flow Label.
!		
interface bundle-ether1		
ethernet-segment		
load-balancing-mode single-active	Only one PE handles the traffic, per EVI.	Default is Active / Active.
service-carving manual		Controls DF and Non-DF.
primary 1-10 secondary 11-20	Manual load balancing per EVI	Default is Even on PE-X and Odd on PE-Y
!		
group 1234		
core interface xxxxxx		
Interface yyyyy <<< Int. to LAN		
Core isolation group 1234		

EVPN

Swiss Army Knife

EVPN:

show evpn ethernet-segment
show evpn ethernet-segment esi xxxxx carving detail
show evpn ethernet-segment virtual vfi xxxxx detail
show evpn ehternet-segment virtual neighbor xxxxx pw-id xxxxx detail
show evpn ethernet-segment detail
show evpn ethernet-segment interface ... detail
show evpn evi inclusive-multicast detail
show evpn evi detail
show evpn evi vpn <evi id> mac <mac> detail
show evpn evi mac private
show evpn evi ead
show evpn internal-label
show evpn summary

L2VPN:

show l2vpn xconnect
show l2vpn xconnect detail
show l2vpn bridge-domain summary
show l2vpn mac-learning mac all location <loc>
show l2vpn forwarding bridge-domain xxxxx evpn inclusive-multicast detail location <loc>
show l2vpn forwarding bridge-domain <BD>:<BG> mac-address location <loc>
show l2vpn bridge-domain bd-name <bd name> detail
show l2vpn forwarding protection main-interface location <loc>
show l2vpn forwarding bridge-domain mac location <loc>
show l2vpn forwarding bridge-domain xxxxx detail location <loc>
show l2vpn forwarding xc <xc id> detail location <loc>

BGP:

show bgp l2vpn evpn summary
show bgp l2vpn evpn bridge-domain <bd name>
show bgp l2vpn evpn bridge-domain <bd name> rnh
show bgp l2vpn evpn bridge-domain <bd name> <prefix>
show bgp l2vpn evpn route-type <1|2|3|4|5>
show bgp rt l2vpn evpn
show bgp vrf-db table all
show bgp vrf-db table <table id>
show bgp l2vpn evpn ethernet-ad
show bgp l2vpn evpn route-type mac-advertisement
show bgp l2vpn evpn rd ...

L2RIB:

show l2route evpn mac all
show l2route evpn mac evi <topo id>
show l2route summar

DEBUG:

debug l2vpn forwarding platform ...
debug l2vpn forwarding bcdl location <> debug l2vpn forwarding mac locat

Thank you

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