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July 2020

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ABSTRACT

Mechanisms are provided to ensure the Protocol Independent Multicast (PIM) Assert mechanism works in the presence of Ethernet Virtual Private Networking (EVPN) multi-homing in a network. A mechanism synchronizes PIM Assert information across multi-home peers, processes the PIM assert received via EVPN routes, and generates a PIM Assert based on the PIM assert received over EVPN. In addition, a mechanism is provided for deterministic PIM Designated Router (DR) election between multi-homed and non-multi-homed peers in a local area network (LAN). PIM Hellos are synchronized to have the same list of neighbors across multi-home peers. A procedure is provided to have DR election in case one of the EVPN multi-home peer is eligible to be PIM DR.

DETAILED DESCRIPTION

Consider a traditional Protocol Independent Multicast (PIM) network shown in Figure 1 below.
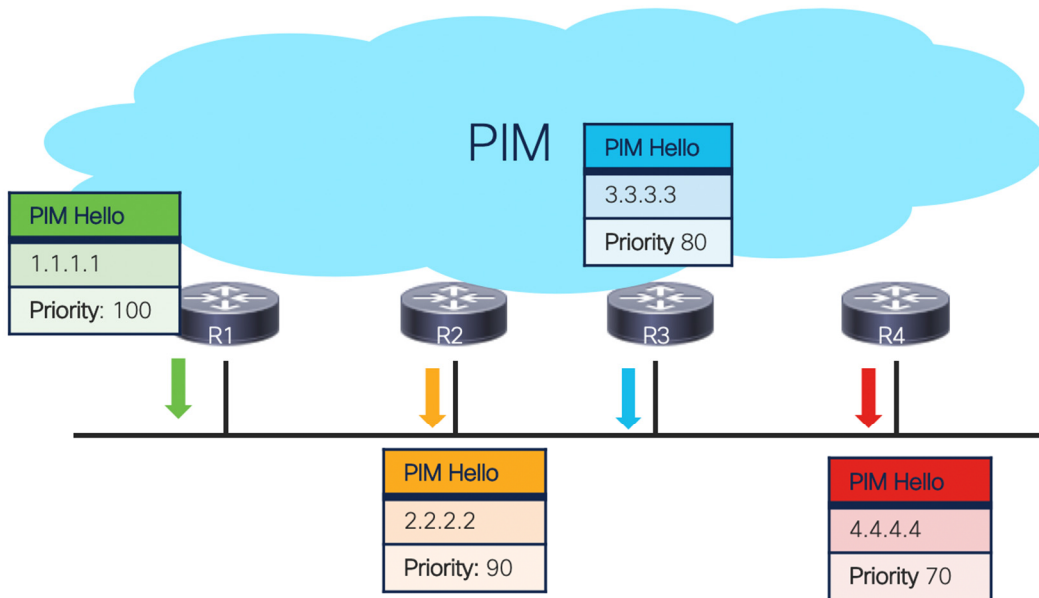
There are four routers (R1, R2, R3, R4) in the local area network (LAN) shown in Figure 1. PIM is enabled on shared LAN on each router. As per https://tools.ietf.org/html/rfc7761 each router would periodically send a PIM hello and each of them would build neighbor state. As per https://tools.ietf.org/html/rfc7761#section-4.3.2 these routers would run designated router (DR) election. For example, in the arrangement of Figure 1, each router would have the following neighbor details:

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Router	List of Neighbors with other detail in Hello	DR
R1	**R1 - IP 1.1.1.1 Priority 100** R2 - IP 2.2.2.2. Priority 90 R3 - IP 3.3.3.3 Priority 80 R4 - IP 4.4.4.4 Priority 70	R1 (Highest Priority)
R2	**R1 - IP 1.1.1.1 Priority 100** R2 - IP 2.2.2.2. Priority 90 R3 - IP 3.3.3.3 Priority 80 R4 - IP 4.4.4.4 Priority 70	R1 (Highest Priority)
R3	**R1 - IP 1.1.1.1 Priority 100** R2 - IP 2.2.2.2. Priority 90 R3 - IP 3.3.3.3 Priority 80 R4 - IP 4.4.4.4 Priority 70	R1 (Highest Priority)
R4	**R1 - IP 1.1.1.1 Priority 100** R2 - IP 2.2.2.2. Priority 90 R3 - IP 3.3.3.3 Priority 80 R4 - IP 4.4.4.4 Priority 7	

In this setup, R1 becomes the PIM DR, and it is responsible to build the upstream multicast tree. In any transient case, if there are two PIM routers forwarding on the LAN, the PIM Assert procedure will kick in, and one of the two PIM routers would be assert loser and stops forwarding the traffic.

One important factor to consider is that at any given point of time, all of the routers on the LAN will have the exact same visibility of network.

Next, with reference to Figure 2, the problem is considered when some of the provider edges (PEs) are multi-homed.
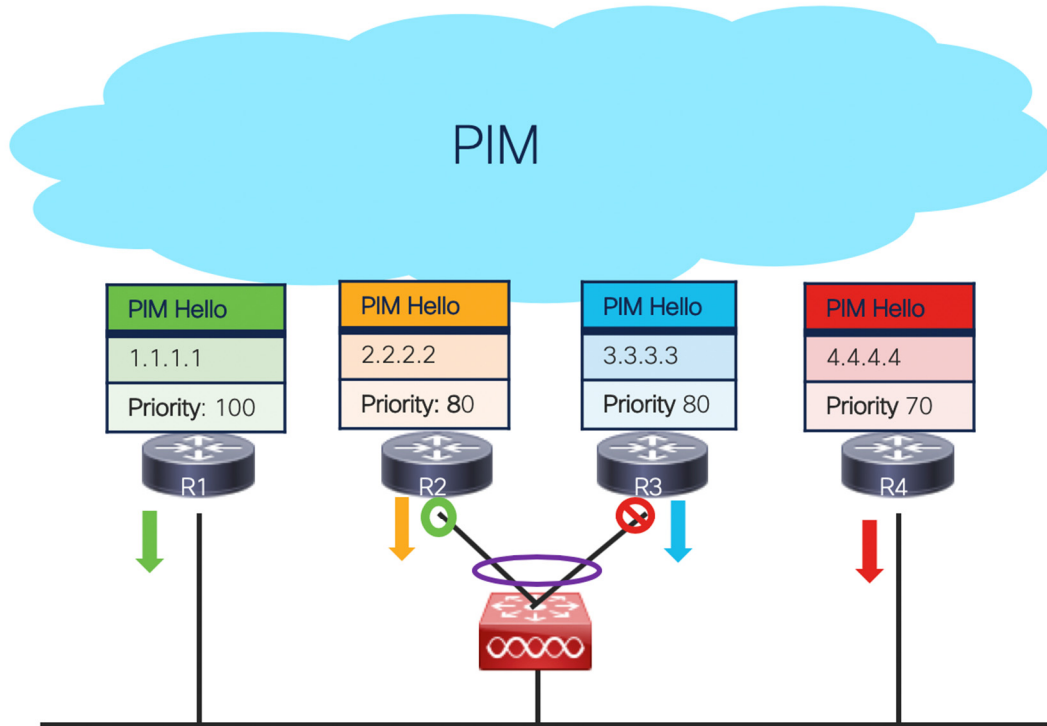
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Figure 2

In the case that some of the last hop routers are now multi-homed, the neighbor table appears as below in Table 1.

PIM Router	List of Neighbor	Note
R1	R1,R2,R4	Hello from R3 was dropped due to nDF state
R2	R2	All Hellos are hashed to R3
R3	R3,R1,R4	R2 hello are not coming back
R4	R4,R1,R2	

Table 1

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As compared to the simple LAN case such as shown in Figure 1, now there are multi-homing aspects that play a role in how each PIM router sees each other, and how DR election is performed.

PIM Router	List of Neighbor	DR
R1	R1,R2,R4	R1
R2	R2	R2
R3	R3, R1,R4	R1
R4	R4, R1,R2	R1

Table 2

Since all of the PIM routers do not have same visibility of the network, this may cause different DRs elected across the network. In Figure 2, there are two DRs.

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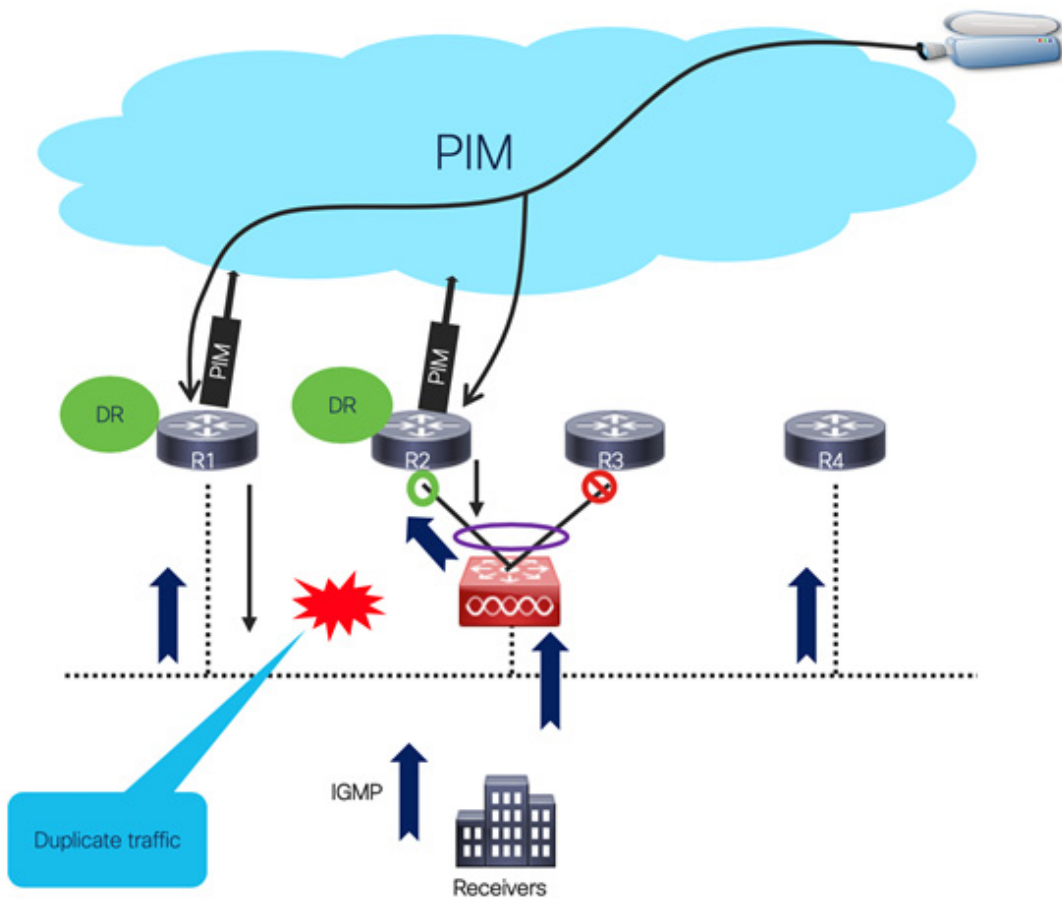
Impact of Two DRs on the LAN:

Figure 3

Figure 3 illustrates the impact on two DRs in the LAN.

Multicast receivers start sending membership requests. Some part of the network is the LAN, so R1 and R4 receive an Internet Group Management Protocol (IGMP) join. In the multi-homed part of network, the customer edge (CE) plays. Only one of the PEs receives the membership request (IGMP join).

Consider that the IGMP join gets hashed to R2. Using the mechanism defined in https://tools.ietf.org/html/draft-ietf-bess-evpn-igmp-mld-proxy-04#section-6.1 R2 can synchronize (sync) routes to R3.

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However, with respect to PIM processing:

R1 -- Sends PIM join upstream since it is a DR

R2 - Sends PIM join upstream since it is a DR

R3 - Does not send PIM join since it is not a DR

R4 - Does not send PIM join since it is not a DR

Since R1 and R2 both send PIM joins upstream, both are going to receive multicast traffic, and forward it to the LAN segment. The end receiver would see duplicate traffic, which is not desirable.
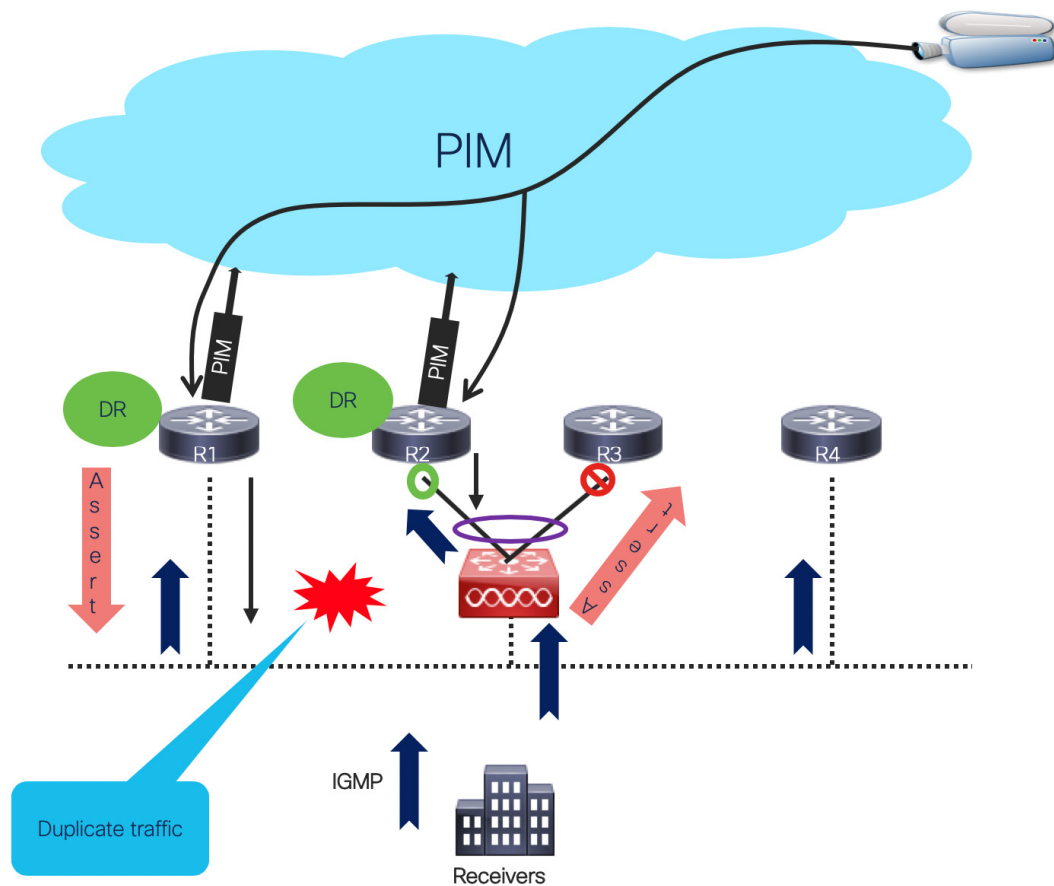
PIM Assert Procedure Cannot Solve this Problem:

Figure 4

R1 is going to receive the multicast traffic on its forwarding interface, which kicks in the PIM Assert mechanism (https://tools.ietf.org/html/rfc7761#section-4.6). Once the Assert message reaches the CE, the CE is going to hash it to either of the links. Assume it picks R3. R3 receives the Assert message, but it does not do anything as it is not forwarding traffic on the LAN. Since R1 does not hear any other Assert, it would be the winner and keep forwarding on the LAN. R2 has no clue that there is some other DR in the LAN and that is also forwarding traffic, which leaves things in a state where there is permanent duplicate traffic.

The problem described above is caused by inconsistency of information among PIM routers on the LAN. This leads the PIM routers to take decisions based on inconsistent information that leads to an undesirable result.

Presented herein are techniques to enhance existing Ethernet Virtual Private Networking (EVPN) infrastructure to accommodate multi-homing segment presence along with a non-multi-homing segment without leading to duplicate traffic on a LAN segment.

Two extensions are presented:

1. Multi-homing peer sending proxy Hello for all peers.
2. Syncing Assert information.

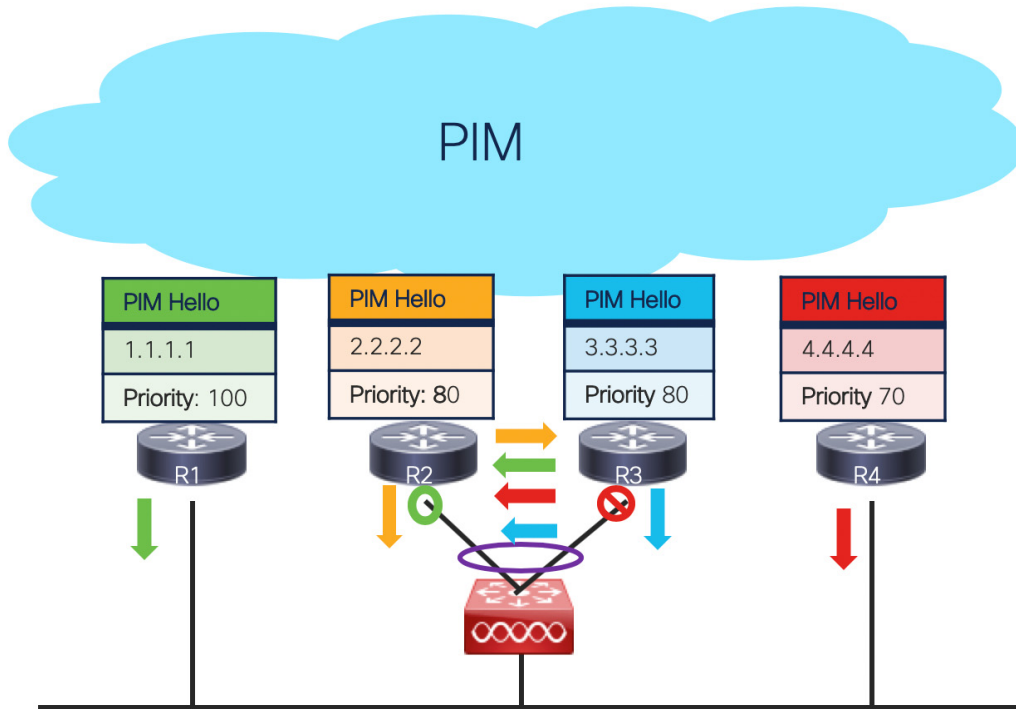Multi-homing Peer Sending Proxy Hello:

Figure 5

Each of multi-home peers will sync the PIM Hello attribute to its neighbor. As a result, both of the peers have exact same visibility with respect to neighbors.

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PIM Router	List of Neighbor	Note
R1	R1,R2,R4	Hello from R3 was dropped due to nDF state
R2	R2,R1,R4	All Hellos are hashed to R3 but R3 sends it via BGP
R3	R3,R1,R4	R2 hello are not coming back
R4	R4,R1,R2	

Table 3

Table 3 above set forth the PIM neighbor list after an EVPN update. This list does not show multi-home peers as neighbors. Since multi-home peers are sending their own Hellos, these Hellos are to be treated differently and should not be part of PIM DR election procedure.

Case 1 (Multi-home peer eligible to be DR): Consider that after receiving all Hellos, it is apparent that the multi-home peers are eligible to be the DR. In that case, whichever PIM router is the designated forwarder (DF) MUST take over as PIM DR as well.

Case 2 (Non-multi-home peer eligible to be DR): In this case, the multi-home peers do not need to take any action.

PIM Router	List of Neighbor	DR
R1	R1,R2,R4	R1
R2	R2,R1,R4	R1
R3	R3,R1,R4	R1
R4	R4,R1,R2	R1

Table 4

Table 4 sets forth a new set of PIM neighbor list information. All of the routers select a consistent PIM DR on the LAN.
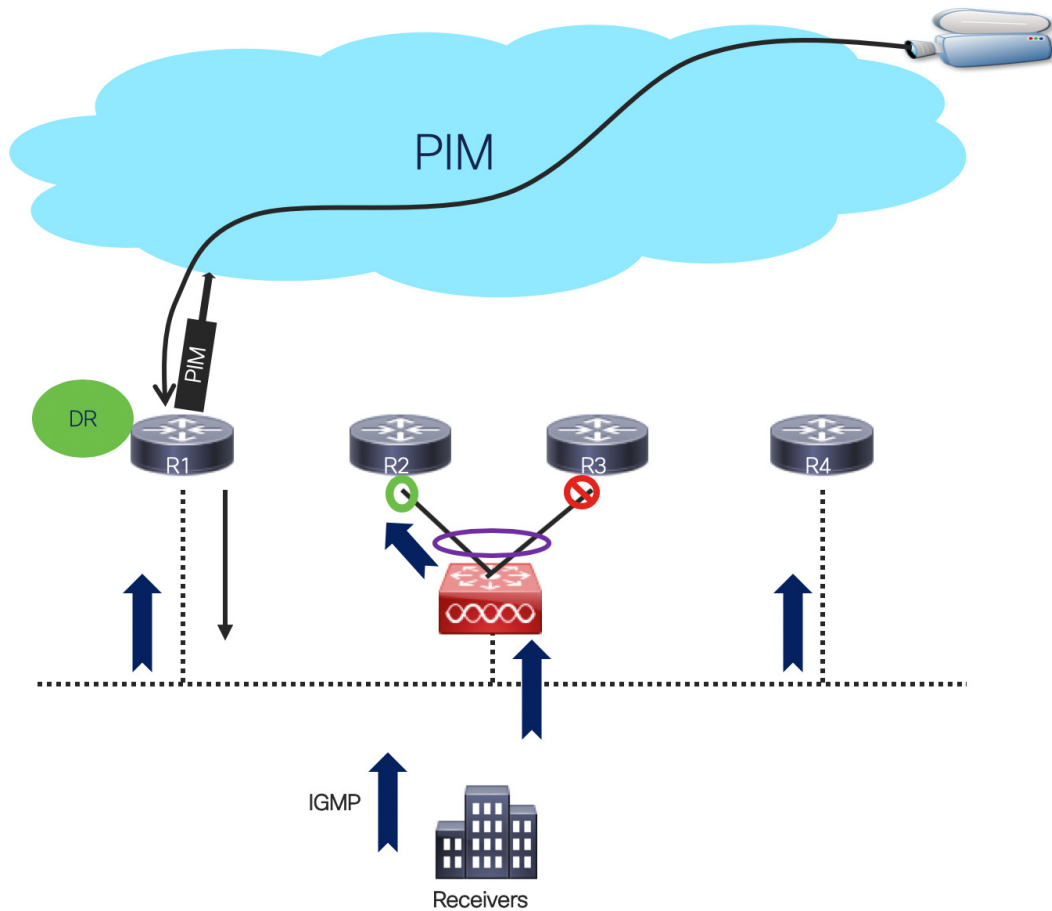

Figure 6

As shown in Figure 6, with the new DR election procedure, only one of the PIM routers sends the PIM join upstream and a single copy of multicast traffic is directed to the LAN.

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PIM Assert Sync:

It is important to ensure consistent DR election across multi-homed and non-multi-homed peers. There are possible transient cases where the PIM Assert mechanism kicks in. If the PIM Assert goes to a peer which is not forwarding traffic, the Assert will not work as expected. A mechanism is provided to sync PIM Assert to a peer so that the Assert mechanism can work as expected.

Figure 7

Referring to Figure 7, when R3 receives the PIM Assert, even though it is not forwarding multicast traffic on the Ethernet Segment (ES), it sends the Assert over the EVPN Border Gateway Protocol (BGP) address family to the peer which is part of same ES / EVI.

R2 now considers this Assert as if it came from the LAN and performs the Assert election as well as sends the Assert into the LAN. After Assert winner election, one of the peers will stop forwarding multicast traffic.

To summarize, mechanisms are provided to ensure the PIM Assert mechanism works in the presence of EVPN multi-homing in a network. This mechanism synchronizes PIM Assert information across multi-home peers, processes the PIM assert received via EVPN routes, and generates a PIM Assert based on the PIM assert received over EVPN. In addition, a mechanism is provided for deterministic PIM DR election between multi-homed and non-multi-homed peers in a LAN. PIM Hellos are synchronized to have the same list of neighbors across multi-home peers. A procedure is provided to have DR election in case one of the EVPN multi-home peer is eligible to be PIM DR. These solutions keep PIM neighbors list consistent between multi-home and non-multi-home peers.