P2MP Policy
draft-hsd-pce-sr-p2mp-policy

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Update/Relevant Drafts

Multiple Vendors are implementing/finished implementing this draft.

draft-spring-sr-replication-segment (adopted)

draft-ietf-pim-sr-p2mp-policy (adopted)

draft-hb-spring-sr-p2mp-policy-yang-01 (should we move it to PIM WG?)

draft-Parekh-bess-mvpn-evpn-sr-p2mp-00 (Next for adaptation)

draft-hsd-pce-sr-p2mp-policy-01 (Will ask for adaptation call for IETF 109)

draft-hb-idr-sr-p2mp-policy-00 (Will ask for adaptation call for IETF 110)

draft-hb-pim-p2mp-policy-ping-00 (New)

Multicast Evolution

- There is a desire to simplify Next generation complex networks (i.e. 5G transport) from administration and protocol point of view.
- The controller provides an end-to-end view of the network and simplifies traffic engineering, slicing and monitoring of the end-to-end SLAs for each slice
- Protocols like SR simplify the underlay by removing the need of LDP/RSVP-TE protocols and use IGP/BGP to signal segments.
- **Multicast needs to follow suite**
- SR P2MP Policy removes legacy P2MP MPLS protocols like mLDP/RSVP-TE while providing traffic engineering via SR Policy attributes

SR P2MP Segment

- A Point-to-Multipoint (P2MP) segment connects a Root node to a set of Leaf nodes in segment routing domain.

- A Point-to-Multipoint Policy contains
  - Is identified via ROOT-ID and TREE-ID
  - A set of Leaves
  - Candidate paths used for P2MP Tree redundancy
  - Candidate paths contain Path-Instances used for Global Optimization

- PCC Initiated: Root and Leaves can be discovered via multicast procedures like NG-MVPN (RFC 6514, 6513) or PIM (Protocol Independent Multicast) on PCC and the relevant information send to the PCE

- PCE Initiated: Root and Leaves can be configured explicitly on the PCE or controller and programmed on the PCC

Replication Segment

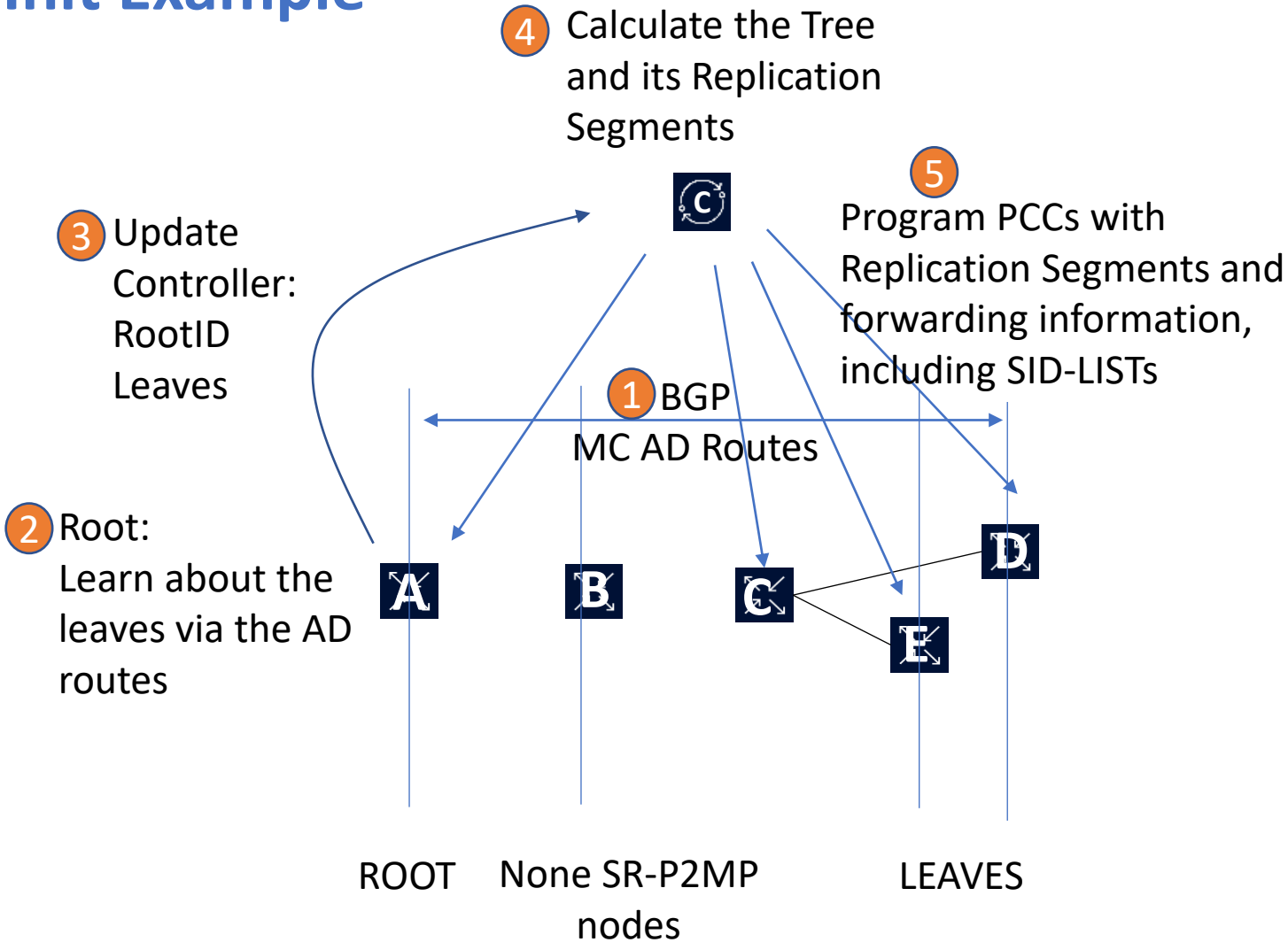
- Is the forwarding instructions for the P2MP LSP
  - Label instructions
  - Fast Reroute instructions
- A Replication segment can be defined via following
  - Root: The root of the P2MP segment that the replication segment is for;
  - Tree-ID: Tree that the replication segment is part of;
  - LSP-ID: LSP-ID is unique per <root and p2mp policy>

  OR
  - node-address
  - Replicatoin-id
  - **Replication-SID: Segment ID for this Replication Segment.**
  - **Replicaiton-SIDs can't be stacked as each replication segment can be a egress or transit.**
- Two Replication Segments can be connected directly via adjacent nodes or they can be non-adjacent and connected via a SID List (Unicast)

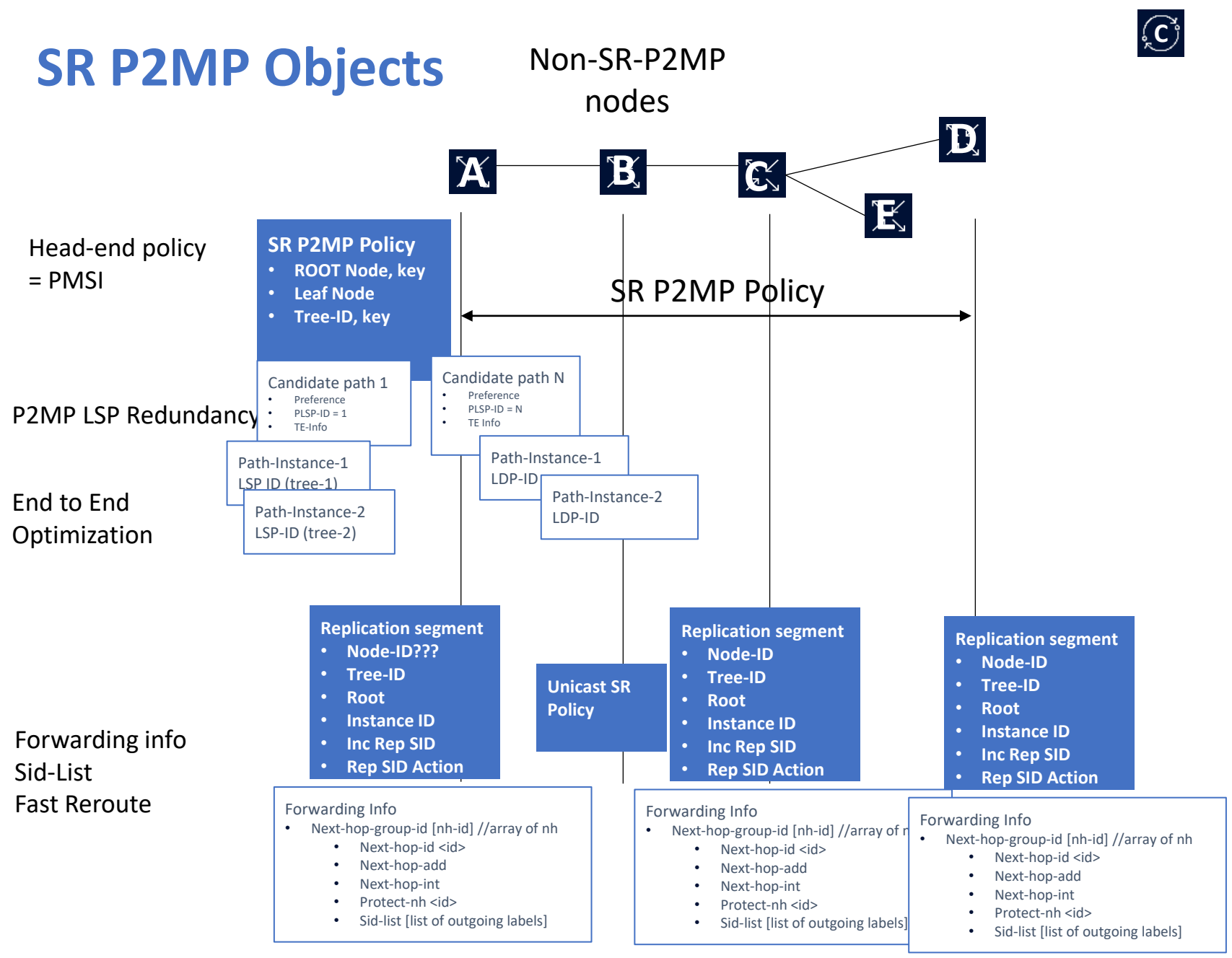
Shared Replication Segment

- Shared Replication segment is defined via following
  - Two or more P2MP trees May share a replication segment.
  - Replication segment may be identified with Zero ROOT-ID, a unique Replication-ID (for the Tree-ID) and the Node-ID
  - As an example it can be used for Facility FRR when the by-pass tunnel is made of only Replication Segments to protect a nexthop. i.e. LFA or TI-LFA is not sued.

PCC Init Example



SR P2MP Objects

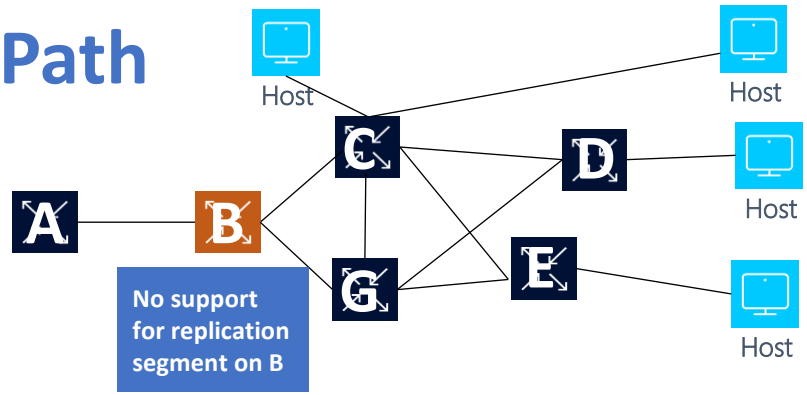


SR P2MP YANG Model

```
+--rw p2mp-traffic-engiineering!
     +--rw p2mp-policy* [root-address tree-id]
     |  +--rw root-address       inet:ip-address
     |  +--rw tree-id            uint32
     |  +--rw p2mp-policy-name?   string
     |  +--rw admin-state?       enumeration
     |  +--ro oper-state?        enumeration
     |  +--rw leaf-list* [leaf-address]
     |  |  +--rw leaf-address    inet:ip-address
     |  |  +--rw admin-state?    enumeration
     |  +--rw candidate-path* [protocol-id originator discriminator]
     |     +--rw protocol-id          enumeration
     |     +--rw originator           inet:ip-address
     |     +--rw discriminator        uint32
     |     +--rw candidate-path-name?   string
     |     +--rw admin-state?         enumeration
     |     +--ro oper-state?          enumeration
     |     +--rw preference?          uint32
     |     +--rw constraints* [index]
     |     |  +--rw index       uint32
     |     |  +--rw attributes?   uint32
     |     +--rw explicit-routing* [index]
     |     |  +--rw index       uint32
     |     |  +--rw attributes?   uint32
     |     +--rw path-instances* [index]
     |        +--rw index        uint32
     |        +--rw instance-id?
     |             -> ../../../../replication-segment/replication-id
     |        +--ro oper-state?    enumeration
     +--rw replication-segment* [node-address replication-id]
...
```

```
+--rw replication-segment* [node-address replication-id]
      +--rw node-address       inet:ipv4-address
      +--rw replication-id     uint32
      +--rw admin-state?       enumeration
      +--ro oper-state?        enumeration
      +--rw root-address?   inet:ipv4-address
      +--rw tree-id?       uint32
      +--rw instance-id?    uint32
      +--rw replication-sid?    uint32
      +--rw downstream-nodes* [downstream-index]
        +--rw downstream-index          uint32
        +--rw next-hop-address?         inet:ip-address
        +--rw next-hop-interface-name?   if:interface-ref
        +--rw protecting-next-hop?      boolean
        +--rw protect-nexthop-id?       uint32
        +--rw (label)?
          +--:(sid-list)
          |  +--rw sid-list* [index]
          |     +--rw index            uint32
          |     +--rw sid-segment-type?   uint32
          +--:(sr-policy)
          |  +--rw sr-policy* [replication-sid]
          |     +--rw replication-sid    uint32
          |     +--rw sr-policy?         string
          +--:(rsvp-te)
            +--rw rsvp-te* [replication-sid]
               +--rw replication-sid     uint32
               +--rw rsvp-te-tunnel-id?   uint32
```

Example 1
Single Candidate Path



1. The primary path (candidate path 1) is A to C to LEAF D and LEAF E with C being a BUD node
2. B does not support Replication Segment

SR P2MP Policy
- ROOT Node=A
- Leaf Node=D,E
- Tree-ID=1

Candidate path 1
- Preference = 1000

Instance-1
LSP ID = 1

Replication Policy A
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = B
  - Sid-list B,C <C is bottom of Stack>

Replication Policy C
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID = C

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = D
  - Sid-list <D>
- Next-hop-group-id 1
  - Next-hop-add = E
  - Sid-list <E>
- Next-hop-group-id 2
  - Next-hop-add = 127.0.0.1 (Bud)

Replication Policy D
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID = D

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = 127.0.0.1

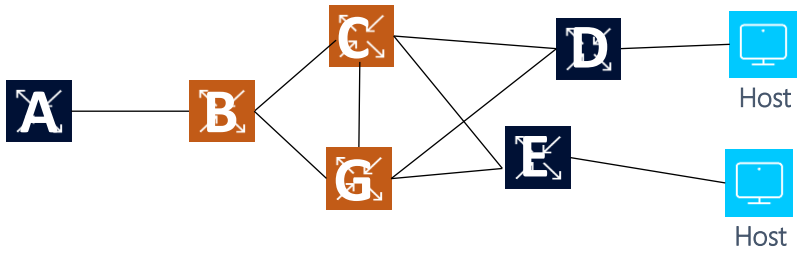
Replication Policy E
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID = E

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = 127.0.0.1

Example 2

No support for replication segment on B

No support for replication segment on B



1. Ingress Replication from A to D and A to E
2. Root and Leaves need to support Replication Policy.
3. B, C, G don't support P2MP Policy and are part of the unicast SR.
4. All SR resiliency functionality can be used in unicast SR domain.

SR P2MP Policy
- ROOT Node=A
- Leaf Node=D,E
- Tree-ID=1

Candidate path 1
- Preference = 1000

Instance-1
LSP ID = 1

Replication Policy A
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = B
  - Sid-list B,C,D <D is bottom of Stack>
- Next-hop-group-id 1
  - Next-hop-add = B
  - Sid-list B,G,E <E is bottom of Stack>

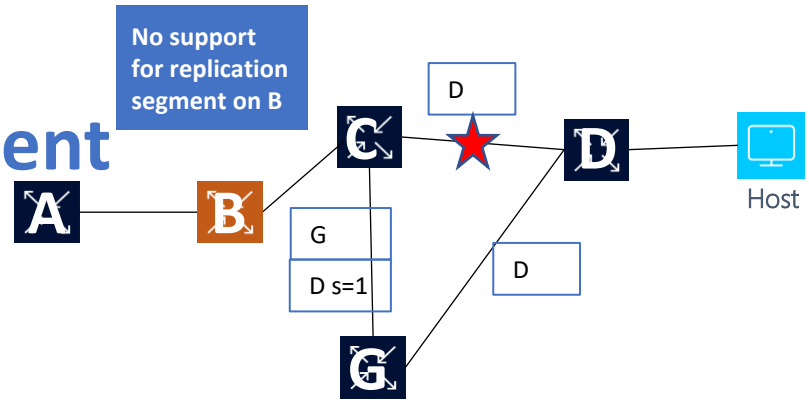
Replication Policy D
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID = D

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = na

Replication Policy E
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID = E

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = na

Example 3
FRR via Shared Replication Segment



1. The primary path is A to C to LEAF D
2. Link between C and D is cut, FRR Nexthop Protection via G
3. G can use a Shared RS to act as a facility bypass for multiple trees.
4. G Pops bypass label (Implicit Null and forwards D).

SR P2MP Policy
- ROOT Node=A
- Leaf Node=D,E
- Tree-ID=1

Candidate path 1
- Preference = 1000

Instance-1
LSP ID = 1

Replication Policy A
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = B
  - Sid-list B,C <C is bottom of Stack>

Replication Policy C
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID = C

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = D
  - Sid-list <D>
  - Prot NH 1
- Next-hop-group-id 1
  - Next-hop-add = G
  - Sid-list <G>

Replication Policy G
- Tree-ID = 100
- Root = 0
- Instance ID = 1
- Inc Rep SID = G

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = D
  - Sid-list <impl-null>

Replication Policy D
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID = D

Forwarding Info
- Next-hop-group-id 0
  - Next-hop-add = na

Next Steps

- Asking for adaptation of this draft

Thank you!