# P2MP Policy

draft-voyer-pim-sr-p2mp-policy

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# Update/Relevant Drafts

Multiple Vendors are in the mist of 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 109 or 110)

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

# SR P2MP Policy

- A Point-to-Multipoint (P2MP) Policy connects a Root node to a set of Leaf nodes.
- A P2MP segment contains Replication Segments, each providing forwarding instructions at Root, Transit Nodes and Leaf Nodes.
- It is identified via <ROOT, Tree-ID>
- 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 configure explicitly on the PCE or controller and programmed on the PCC

# SR P2MP Policy Details

- A P2MP Policy Contains:
  - One or More Candidate Paths (CP)
    - Only one CP can be active at a time
    - Each CP can setup based a certain TE parameters

- Each CP contain multiple Path Instances
  - Path Instances can be used for global optimization
  - Instances under a tree can be identified via an Instance-ID

# Replication Segment

- Is the forwarding instructions for the P2MP LSP
  - Label instructions
  - Next-Hop information
  - Fast Reroute instructions

- A Replication segment is 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;
  - Node-ID: The node this Replication Segment belongs too.
  - Instance-ID: Unique path-instance ID per <Root, Tree-ID>, it identifies a P2MP LSP.
  - **Replication-SID: Segment ID for this Replication Segment.**
  - **Replicaiton-SIDs can't be stacked as each replication segment can be a egress or transit.**
    - **There could be exceptions like using a shared replication segment for FRR**

- 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.
  - A tree has its own replication segment at its root.
  - 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.

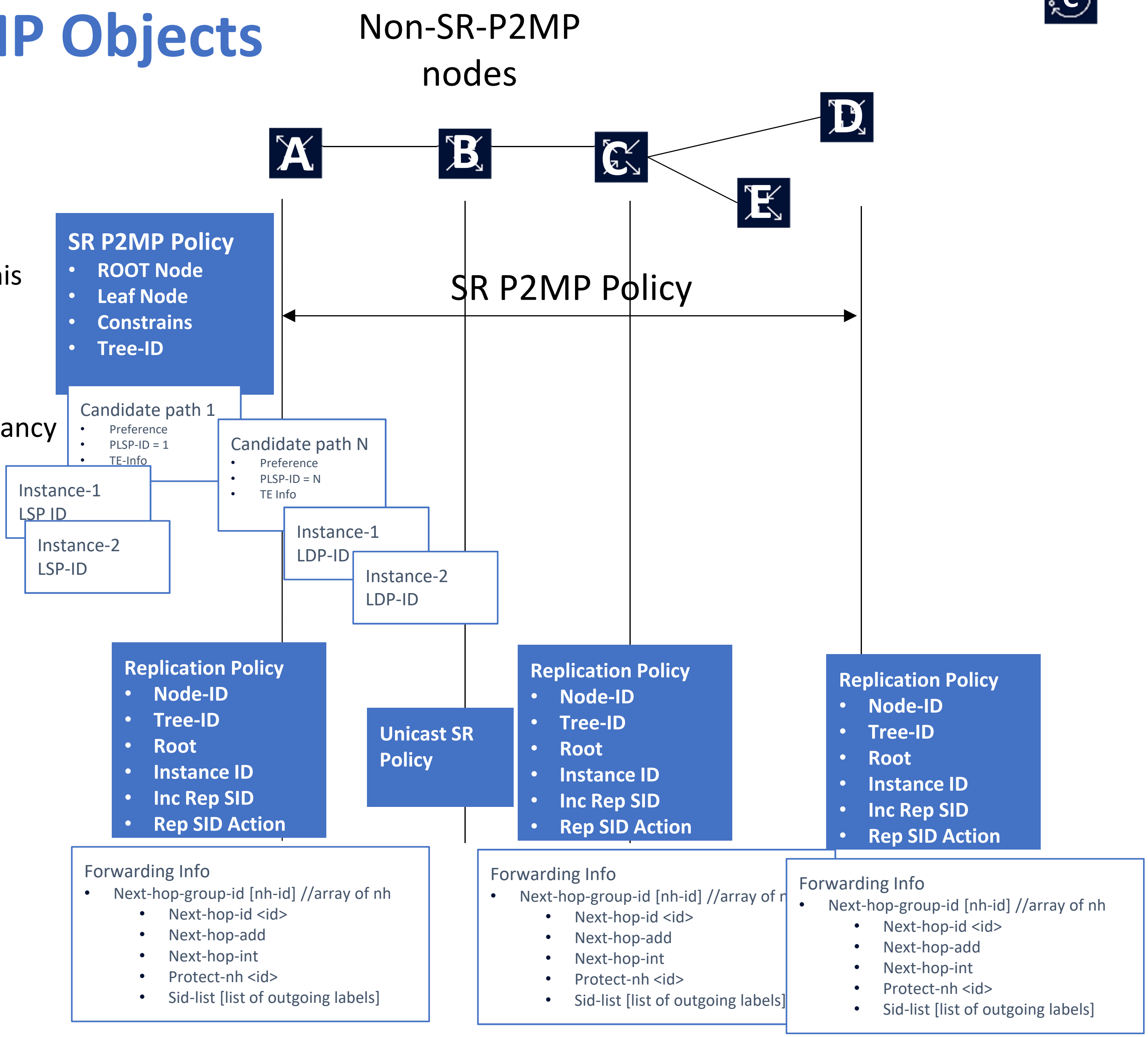
# SR P2MP Objects

SID, Forwarding instruction for this segment

P2MP LSP Redundancy

End to End Optimization

Forwarding info
Sid-List
Fast Reroute



Non-SR-P2MP nodes

**SR P2MP Policy**
- **ROOT Node**
- **Leaf Node**
- **Constrains**
- **Tree-ID**

Candidate path 1
- Preference
- PLSP-ID = 1
- TE-Info

Candidate path N
- Preference
- PLSP-ID = N
- TE Info

Instance-1
LSP ID

Instance-2
LSP-ID

Instance-1
LDP-ID

Instance-2
LDP-ID

**Replication Policy**
- **Node-ID**
- **Tree-ID**
- **Root**
- **Instance ID**
- **Inc Rep SID**
- **Rep SID Action**

**Unicast SR Policy**

**Replication Policy**
- **Node-ID**
- **Tree-ID**
- **Root**
- **Instance ID**
- **Inc Rep SID**
- **Rep SID Action**

**Replication Policy**
- **Node-ID**
- **Tree-ID**
- **Root**
- **Instance ID**
- **Inc Rep SID**
- **Rep SID Action**

Forwarding Info
- Next-hop-group-id [nh-id] //array of nh
  - Next-hop-id <id>
  - Next-hop-add
  - Next-hop-int
  - Protect-nh <id>
  - Sid-list [list of outgoing labels]

Forwarding Info
- Next-hop-group-id [nh-id] //array of n
  - Next-hop-id <id>
  - Next-hop-add
  - Next-hop-int
  - Protect-nh <id>
  - Sid-list [list of outgoing labels]

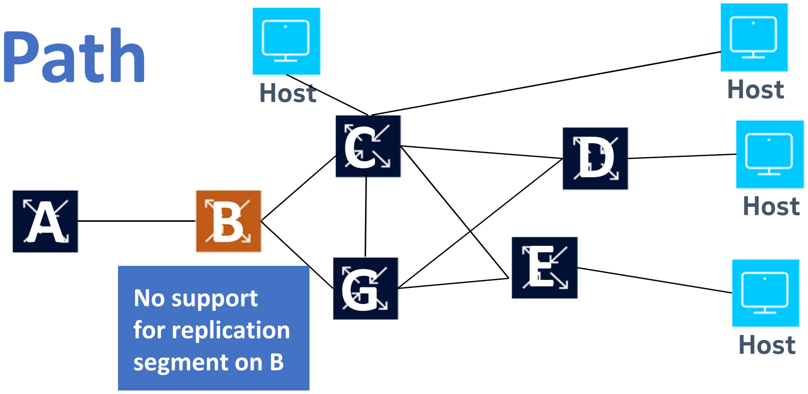
Forwarding Info
- Next-hop-group-id [nh-id] //array of nh
  - Next-hop-id <id>
  - Next-hop-add
  - Next-hop-int
  - Protect-nh <id>
  - Sid-list [list of outgoing labels]

# 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



No support for replication segment on B

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

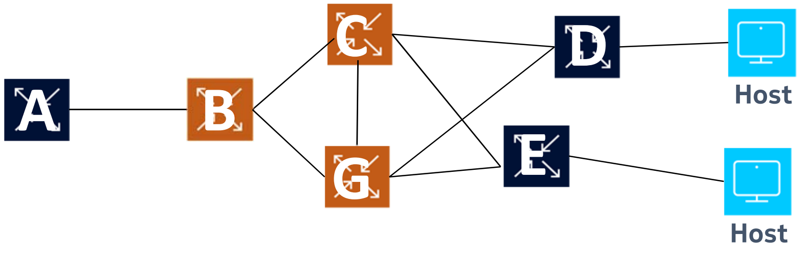
**Replication Policy E**
- **Tree-ID =1**
- **Root = A**
- **Instance ID = 1**
- **Inc Rep SID = E**

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>

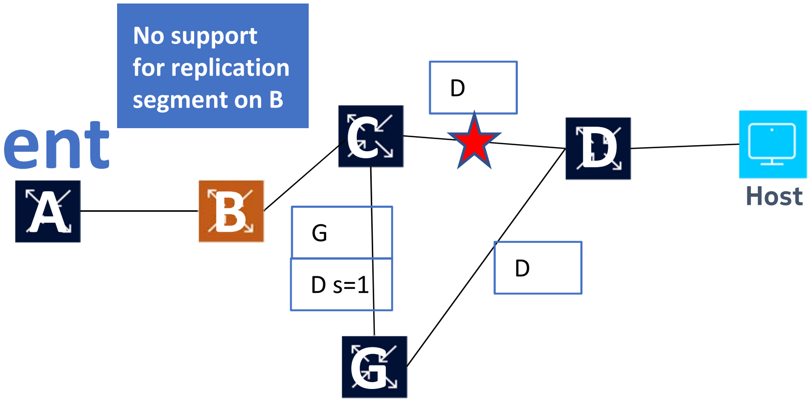
**Replication Policy D**
- **Tree-ID =1**
- **Root = A**
- **Instance ID = 1**
- **Inc Rep SID = D**

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


No support for replication segment on B

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>

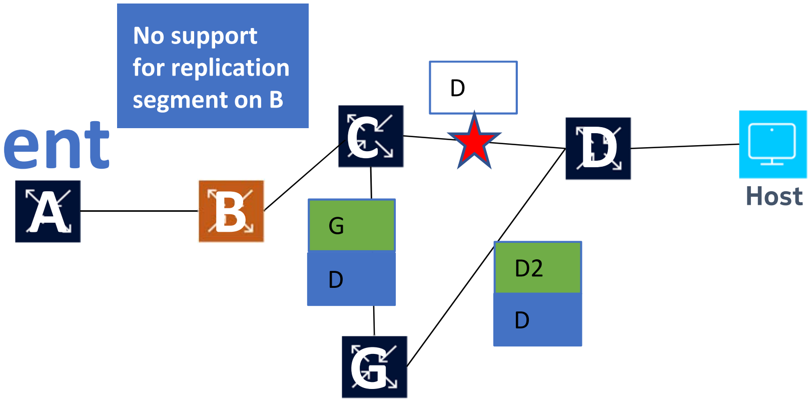
**Replication Policy G**
- **Tree-ID = 100**
- **Root = 0**
- **Instance ID = 1**
- **Inc Rep SID = G**

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

# 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.

**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 <D2>

**Replication Policy D2**
- **Tree-ID =1**
- **Root = A**
- **Instance ID = 1**
- **Inc Rep SID = D2**

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

**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

- Looking for adaptation in PIM WG, prior to Spring WG, for obvious reasons.