P2MP Policy

Draft-hb-idr-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

draft-ietf-bess-mvpn-evpn-sr-p2mp-02 (adopted)

draft-hsd-pce-sr-p2mp-policy-03 (Has asked for Adaptation, WG discussions)

draft-hb-idr-sr-p2mp-policy-02 (Will ask for adaptation ietf 111)

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

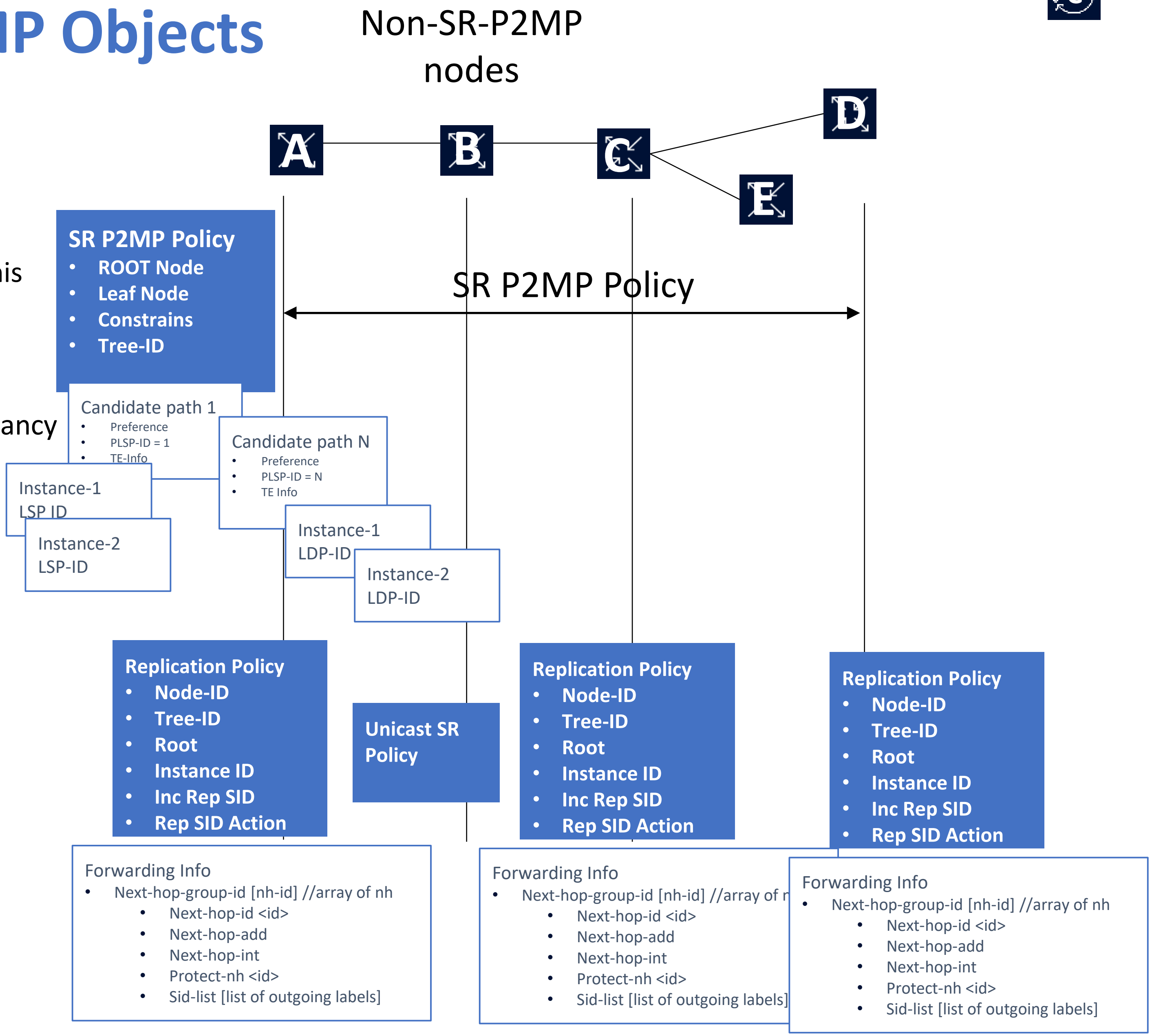
- A P2MP Policy Contains:
  - One or More Candidate Paths (CP)
    - Only one CP can be active at a time
    - Each CP can setup based a certain TE parameters

- 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)

SR P2MP Objects



SID, Forwarding instruction for this segment

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

P2MP LSP Redundancy

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

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

End to End Optimization

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
Sid-List
Fast Reroute

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 r
  - 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]

New BGP NLRI and Route Types

- New BGP NLRI, called the P2MP-POLICY NLRI
- A new SAFI is defined: the SR P2MP Policy SAFI, (Codepoint tbd assigned by IANA)
- Route Types
    - P2MP Policy route
    - Replication segment route

```
+----------------------------------------+
|               route type               | 1 octet
+----------------------------------------+
|                 length                 | 1 octet
+----------------------------------------+
|  route type specific (variable)  |
+----------------------------------------+
```

P2MP Policy route

```
+-----------------------------------+
~              Root-ID              ~ 4 or 16 octets (ipv4/ipv6)
+-----------------------------------+
|              Tree-ID              | 4 octets
+-----------------------------------+
|           Distinguisher           | 4 octets
+-----------------------------------+
```

Replication segment route

```
+-----------------------------------+
|              Root-ID              | 4 or 16 octets (ipv4/ipv6)
+-----------------------------------+
|              Tree-ID              | 4 octets
+-----------------------------------+
|            instance-ID            | 2 octets
+-----------------------------------+
|           Distinguisher           | 4 octets
+-----------------------------------+
|              Node-ID              | 2 octets
+-----------------------------------+
```

BGP SR P2MP Policy

```
SR P2MP Policy SAFI NLRI: <route-type p2mp-policy>
    Attributes:
      Tunnel Encaps Attribute (23)
        Tunnel Type: (TBD, P2MP-Policy)
           Preference
           Policy Name
           Policy Candidate Path Name
           leaf-list (optional)
               remote-end point
               remote-end point
               ...
           path-instance
              active-instance-id
              instance-id
              instance-id
              ...
```

BGP SR P2MP Policy

```
replication segment SAFI NLRI: <route-type non-sahred/shared
                    tree replication-segment>
   Attributes:
     Tunnel Encaps Attribute (23)
       Tunnel Type: (TBD Replication-Segment)
         replication-sid (equivalent to binding Sid)
         SRv6 replication-sid (equivalent to SRv6 Binding SID)
         downstream-nodes (can be protection enabled via a flag)
           segment-list (can be one or many i.e. ECMP, FRR)
             weight (optional)
             protection <protected 1, segment id 1, protection segment id 3>
             segment
             segment
             ...
           segment-list (used for ECMP)
             weight (optional)
             protection <protected 0, segment id 2, protection segment id 0>
             segment
             segment
             ...
           segment-list (protection segment list)
             protection <protected 0, segment id 3, protection segment id 0>
             segment
             segment
             ...
           ...
         ...
```

- Downstream-node: is a MC OIF
- Segment-lists: used for ECMP or FRR to each downstream-node
- Weight: optional used for ECMP, weighted ECMP
- Protection: optional, needs to be present if downstream-node is a protected downstream-node. A protection segment-list can not be part of ECMP group.

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
```

Next Steps

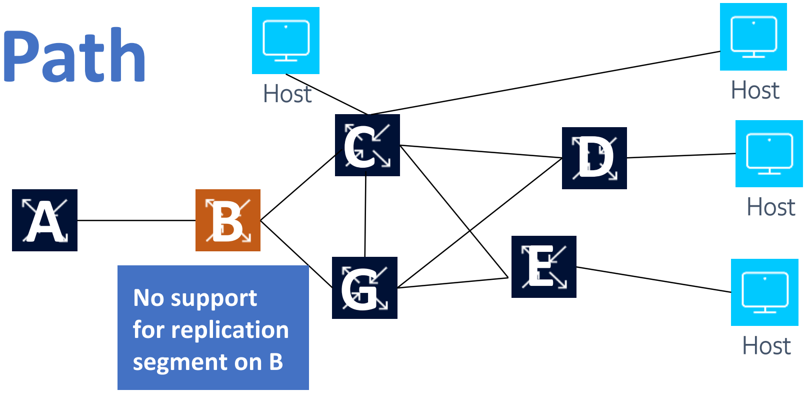
- Asking for Comments and WG adaptation

Thank You!

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.

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

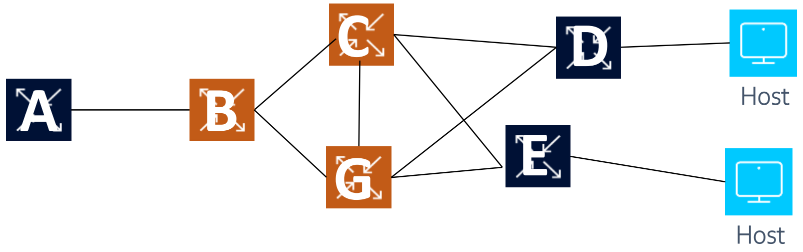
Replication Policy E
- **Tree-ID =1**
- **Root = A**
- **Instance ID = 1**
- **Inc Rep SID = E**

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>

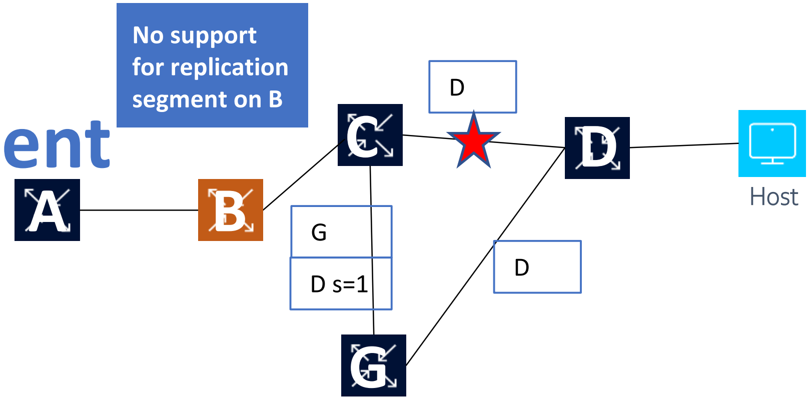
Replication Policy D
- Tree-ID =1
- Root = A
- Instance ID = 1
- Inc Rep SID = D

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



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 Comments and WG adaptation

Thank You!