IP/LDP Fast-Reroute Using Maximally Redundant Trees

draft-atlas-rtgwg-mrt-frr-architecture-01

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Goals Met

- Guaranteed 100% Coverage in an IGP area/ level for single link/node failure.
- Provide fast-reroute for IP Unicast, LDP Unicast, IP Multicast and LDP Multicast
- Provide a live-live Multicast solution
- Support Incremental Deployment.

Solve the IP/LDP Fast-Reroute Problem Fully

Some Benefits of 100% Coverage

- Networks frequently have maintenance events and other changes – so network topology is frequently not the complete designed architecture.
  - Coverage is not dependent on specific architecture.
- Allows for Micro-Forwarding Loop Prevention techniques (which inevitably delay convergence) to be used without traffic loss.

Costs to Meet Goal

- Tag Packets to indicate *topology* being used
  - In MPLS networks, can basically allocate 2 additional labels per router loopback in area/level
- IGP Capabilities signaling
  - Learn what routers support MRT FRR for which forwarding and type of traffic.
- New Algorithm – MRTs computation
  - Computational complexity similar to a few SPFs
  - Routers need to implement same algorithm/result

Forwarding

To go beyond LFA, it is necessary to use an additional forwarding mechanism.

Multi-Topology

MRT

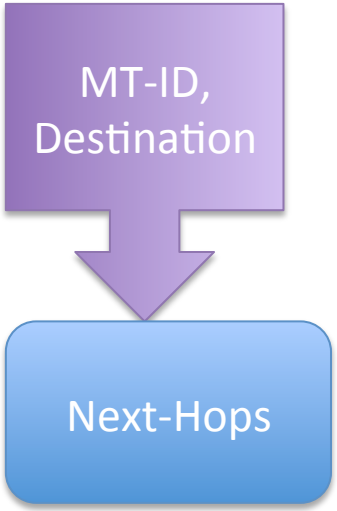
Explicit Tunnels

NotVia,
Remote LFA

Interface-Specific Forwarding

U-turn alternates

- Multi-Topology forwarding includes the topology (MT-ID) with the destination to find the next-hops.
- For each topology for each destination, need to compute next-hops.



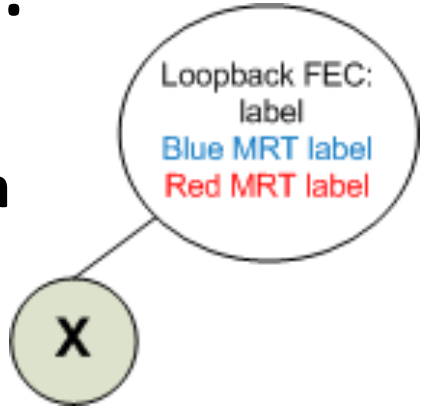
MRT FRR: Multiple Forwarding Topologies – 1 Network Topology

Fast-Reroute with MRT uses 3 forwarding topologies:

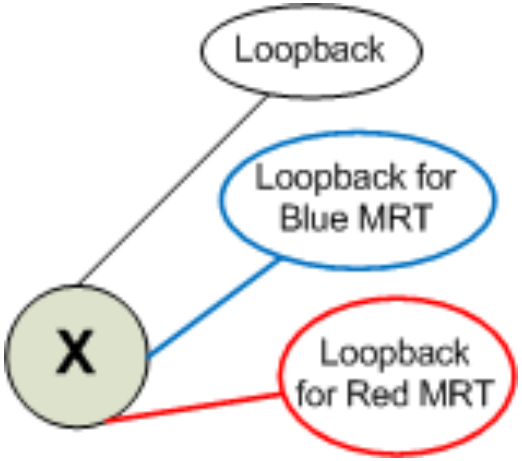
1. current default topology – next-hops computed by SPF
2. Blue MRT topology - MRTs computes next-hops
3. Red MRT - MRTs computes next-hops

Same network topology used as input to the SPF and MRT algorithms. Just different next-hops are computed as a result of different algorithms.

MRT Unicast Forwarding: For Want of 2 bits…



- **IP and LDP Unicast – Recommended Minimum**
  - Simple and basic solution – no label-stacking needed
  - MPLS label distributed by LDP to indicate FEC and MT-ID
  - **"Just works"** with MPLS hardware.



- **Other Options Exist**
  - Topology-ID label
    - Can reuse MPLS context-label space hardware
  - IP-in-IP with different loopbacks

Use of MRT FRR for Unicast Fast-Reroute

1) Before failure:
   a) Compute & Use Shortest-Path Tree Next-Hops
   b) Compute MRTs and LFAs. Select alternates for each primary next-hop for each destination.
   c) Install alternates into forwarding plane.
   d) Install MRT next-hops into forwarding plane.

2) At failure: PLR moves traffic to alternates.

3) After failure:
   a) Compute SPT next-hops and alternates. Install in forwarding plane.
   b) Wait until network converged.
   c) Install MRT next-hops into forwarding plane.

Incremental Deployment

- Before computing MRTs, prune out routers that don't support MRT FRR – determine the local island.

- Benefits possible as soon as two neighboring routers both support MRT FRR.
  - Easy way to make long rings work.

Next Application: Multicast Fast-Reroute

- Traffic-Handling: A router only forwards alternate traffic when its upstream primary link(s) are down.

- Link-Protection: PLR replication into tunnels using unicast alternate to reach next-hops.

- Node-Protection: Do we need it?
  a) PLR replication with tunnels
  b) Distributed replication via alternate trees per (PLR, failure-point) – complexity and scaling…

Next Application: Multicast Live-Live

- Identify the MT-ID (Blue MRT or Red MRT) when signaling an (S,G) or mLDP.
  - Separate G for each MT-ID
  - Traffic can be distinguished on common link because of different G or MPLS label.

- Receivers join both the (S,G-blue) on the Blue MRT and (S,G-red) on the Red MRT.
  - Receivers determine which packets to keep

- MRT natural fit for Multicast Live-Live
  - MRTs rooted at the Multicast Source
  - Automatically computes maximally disjoint trees.

Summary

- Meets 100% coverage goals.
- Describes applications beyond unicast fast-reroute.
- Control-plane computation and alternate selection has been implemented for examining behavior on different topologies.
- Forwarding Plane is simple and no changes.
- Control Plane – complexity confined to deterministic algorithm.
- Good way forward to finish IP/LDP fast-reroute.

Ready to become a WG draft?