Applicability of LDP Multi-Topology for Unicast Fast-reroute Using Maximally Redundant Trees
draft-li-rtgwg-ldp-mt-mrt-frr-01

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Introduction

- [I-D.ietf-rtgwg-mrt-frr-architecture] describes the architecture based on Maximally Redundant Trees (MRT) to provide 100% coverage for fast-reroute of unicast traffic.

- [I-D.ietf-mpls-ldp-multi-topology] has been proposed to provide unicast forwarding in the MRT FRR architecture.

- This informational draft is to provide the analysis of the applicability of LDP MT for MRT FRR

  - Procedures of LDP MT using for unicast MRT FRR
  - All possible scenarios are analyzed and typical examples are provided.
  - Applicability guidance is provided.

Procedures

- Routing Calculation: Consistency of all nodes in the network is the most important.

- Label Distribution: LDP will advertise label mapping message with corresponding MT-ID for the specific FEC. There are at least three label bindings for each FEC that are associated with default topology, red topology and blue topology.

- Forwarding Entry Creation: The route calculated based on MRT determines which label binding should be chosen for each FEC in a specific topology. There is not any MT information which should be processed in the forwarding plane.

- Switchover and Re-Convergence: The traffic switches when failure happens. The micro-loop may be produced during the course of re-convergence.

- Switchback: IGP-LDP synchronization can also be used for the default topology to prevent traffic loss.
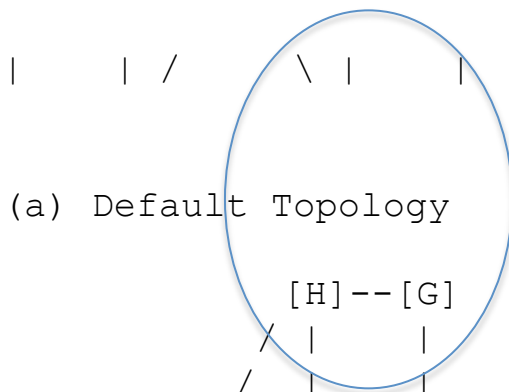
Considerations

- MRT MT-ID and LDP-MT ID Consistency:
  - The MRT MT-ID used in IGP is not for routing but just for forwarding and the application to use MRT results, so the application's (LDP-MT) MRT MT-ID should be same with IGP.

- Multiple IGP: Multiple IGPs deploy in one network.
  - It is highly desirable that in one network only one IGP protocol is deployed.

- Policy Control: Policy can be used to reducing labels' usage for MRT FRR.
  - For multi-service network based on VPN, policy can be applied to permit only host addresses to setup LSPs in the default topology.
  - Policy is not recommended to control on LSP in the blue topology and the red topology

Scenarios (1)

- 2-Connected Network: Detailed example shows how LDP MT works for MRT FRR and how tie-breaking policy works.

- Non-2-Connected Network: Highlights how label forwarding entry installs for cut-vertex.

- Proxy Node: Difference between two scenarios are identified.

  ➢ Inter-Area and Inter-AS: End-to-end LSPs

  ➢ Partial Deployment: Proxy egress LSPs

- IP-Only Network: It is recommended that LDP MT should be deployed incrementally for the fast-reroute usage

Scenarios (2)

- LDP over TE
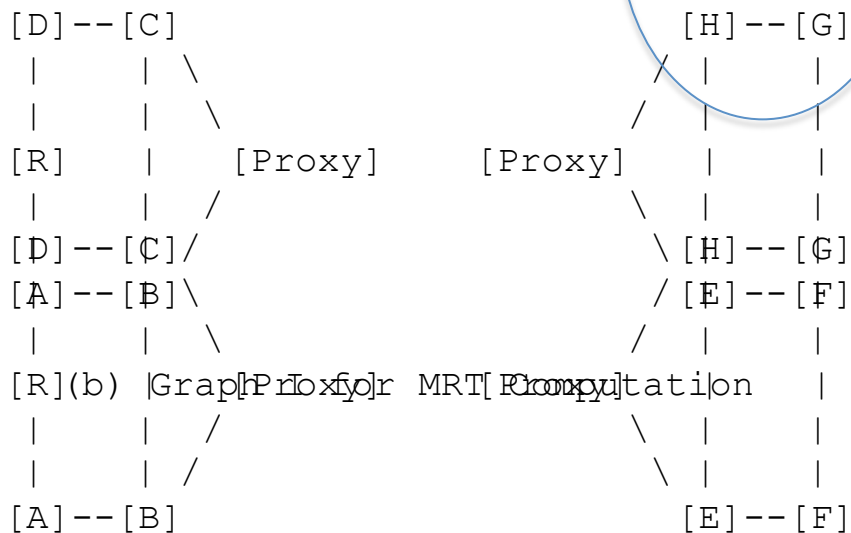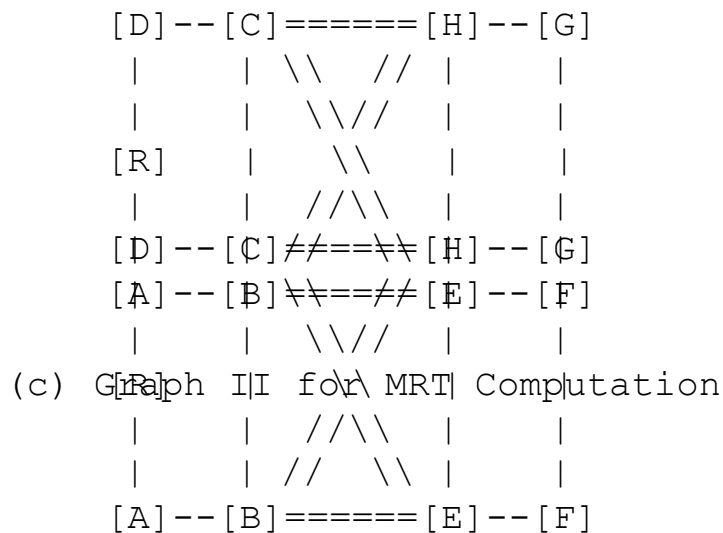
```
            |     | /        \ |     |



           (a) Default Topology


[D]--[C]                        [H]--[G]              [D]--[C]======[H]--[G]
 |     | \                    / |     |                |     | \\  // |     |
 |     |  \                  /  |     |                |     |  \\//  |     |
[R]    |   [Proxy]    [Proxy]   |     |               [R]    |   \\   |     |
 |     |  /                  \  |     |                |     |  //\\  |     |
[D]--[C]/                      \[H]--[G]              [D]--[C]===== [H]--[G]
[A]--[B]\                      /[E]--[F]              [A]--[B]===== [E]--[F]
 |     |  \                  /  |     |                |     |  \\//  |     |
[R](b) Graph I for MRT Computation   |               (c) Graph II for MRT Computation
 |     |  /                  \  |     |                |     |  //\\  |     |
 |     | /                    \ |     |                |     | //  \\ |     |
[A]--[B]                        [E]--[F]              [A]--[B]======[E]--[F]
   (b) Graph I for MRT Computation                    (c) Graph II for MRT Computation
```

2-Connected Network Example

```
[E]--[D]--[H]--[J]        [E]<-[D]<-[H]<-[J]        [E]->[D]->[H]->[J]
 |     |    |    |          |     ^    ^    ^         ^    |    |    |
 |     |    |    |          v     |    |    |         |    v    v    v
[R]   [C]  [G]--[I]        [R]   [C]  [G]->[I]       [R]  [C]  [G]<-[I]
 |     |    |    |          |     ^    ^    ^         ^    |    |    |
 |     |    |    |          v     |    |    |         |    v    v    |
[A]--[B]--[F]---|          [A]->[B]->[F]---|         [A]<-[B]<-[F]<--|

  (a)  Topology            (b)  Blue Topology         (c)  Red Topology
```
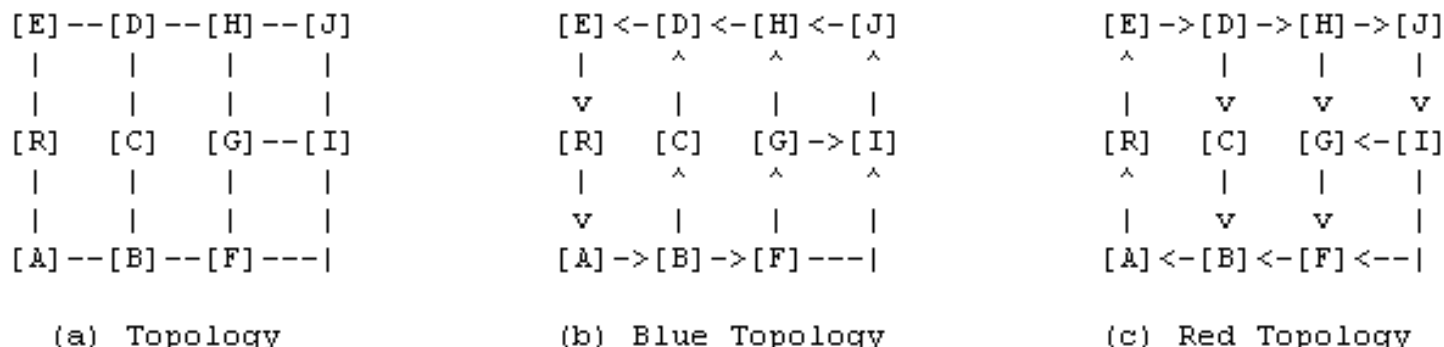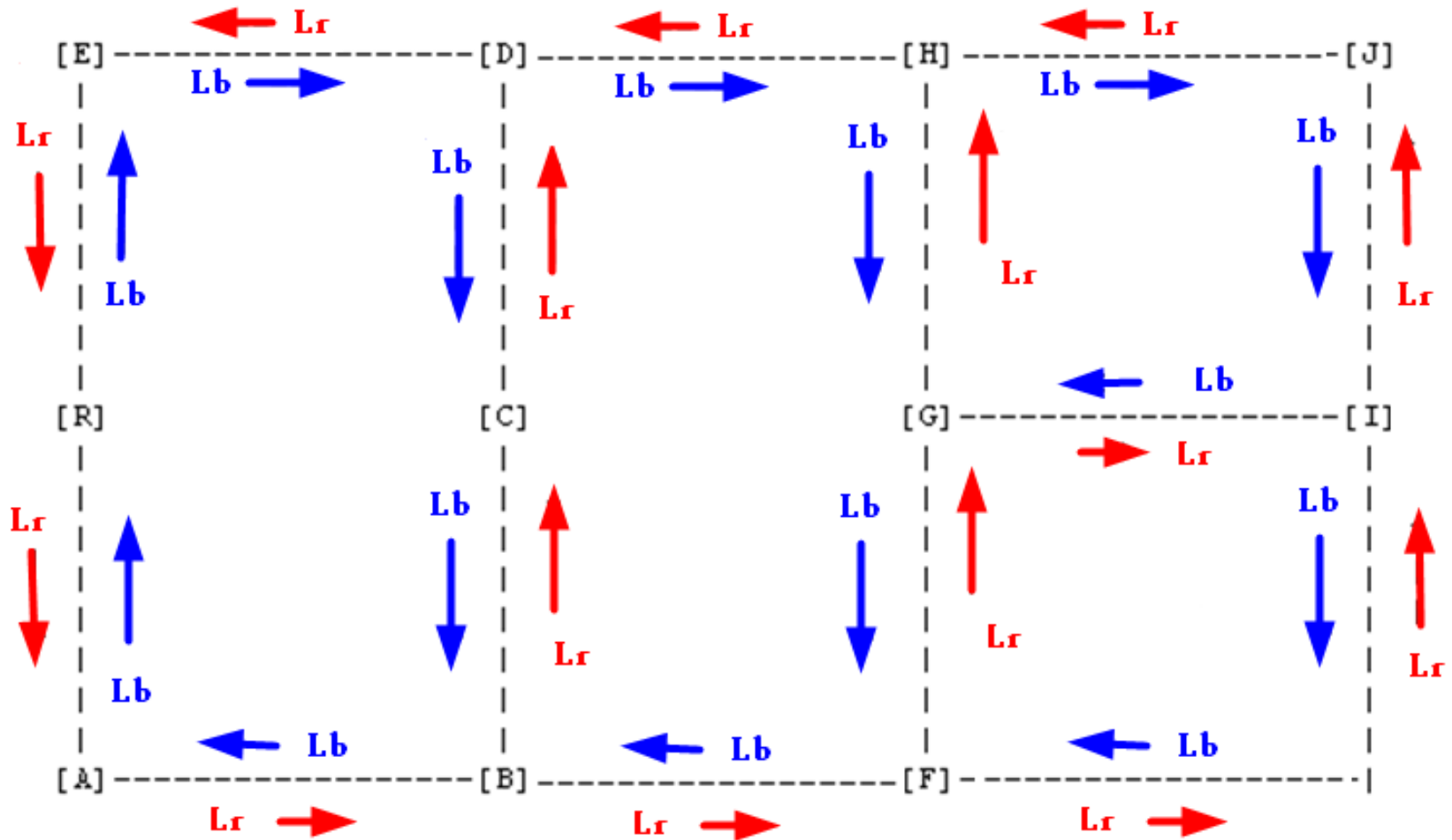
Figure 1: 2-Connected Network

According to the MRT calculation, for a specific destination H, there
are following paths in different topologies for other nodes,

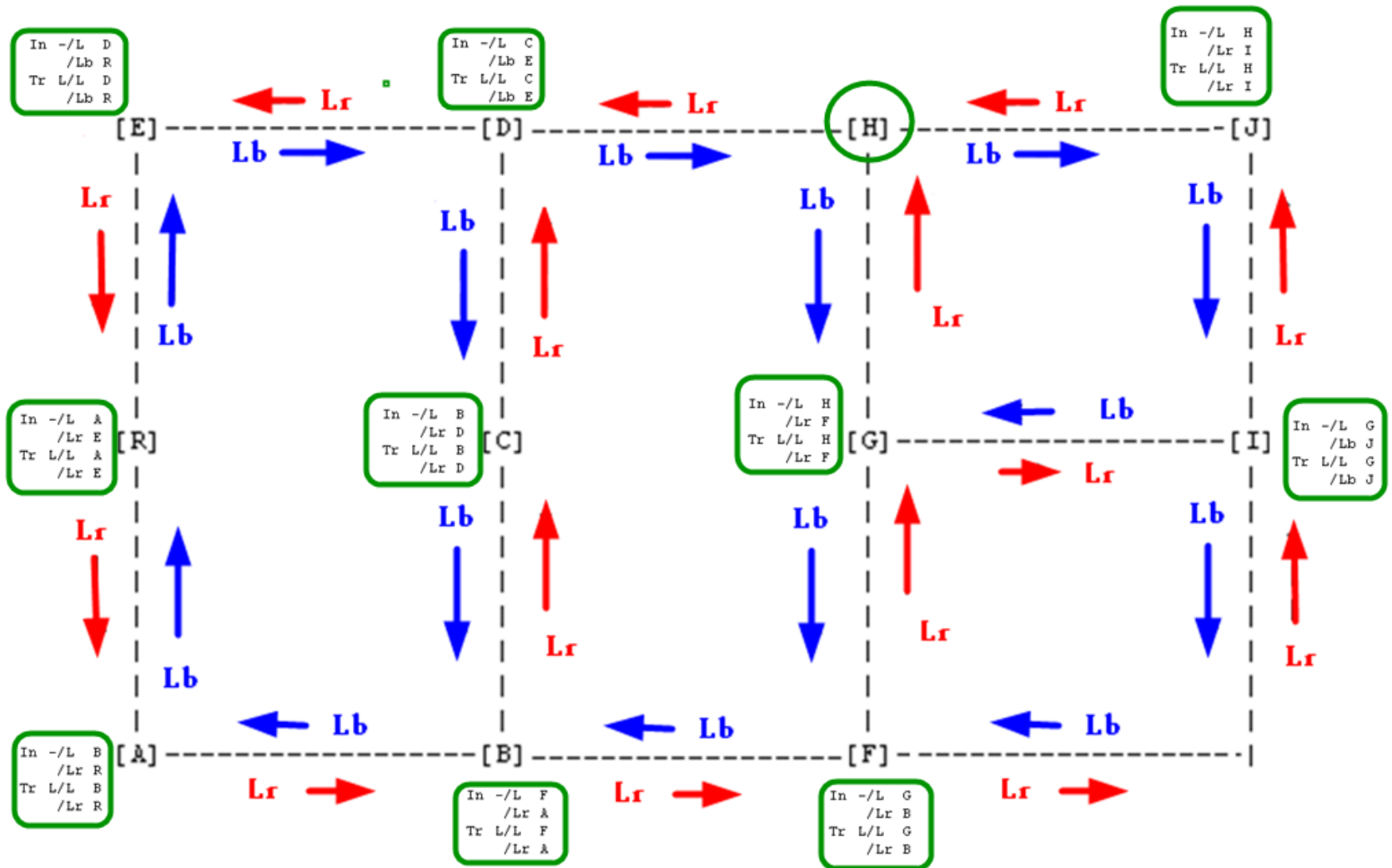|	Default Topology	Blue Topology	Red Topology
R	R->A->B->F->G->H	R->A->B->F->G->H	R->E->D->H
A	A->B->F->G->H	A->B->F->G->H	A->R->E->D->H
B	B->F->G->H	B->F->G->H	B->A->R->E->D->H
C	C->B->F->G->H	C->B->F->G->H	C->D->H
D	D->C->B->F->G->H	D->E->R->A->B->F	D->H
E	E->D->C->B->F->G->H	E->R->A->B->F->G->H	E->D->H
F	F->G->H	F->G->H	F->B->A->R->E->D->H
G	G->H	G->H	G->F->B->A->R->E->D->H
I	I->G->H	I->J->H	I->G->F->B->A->R->E->D->H
J	J->H	J->H	J->I->G->F->B->A->R->E->D->H

Figure 2: Paths in Different Topologies for H

2-Connected Network Example (cont)

2-Connected Network Example (cont)

2-Connected Network Example (cont)

		Default Topology	Blue Topology	Red Topology
R	Ingress	--/L A		
		/Lr E		
	Transit	L/L A	Lb/Lb A	Lr/Lr E
		/Lr E	/Lr E	
A	Ingress	--/L B		
		/Lr R		
	Transit	L/L B	Lb/Lb B	Lr/Lr R
		/Lr R	/Lr R	
B	Ingress	--/L F		
		/Lr A		
	Transit	L/L F	Lb/Lb F	Lr/Lr A

		Default Topology	Blue Topology	Red Topology
R	Ingress	--/L A		
		/Lr E		
	Transit	L/L A	Lb/Lb A	Lr/Lr E
		/Lr E	/Lr E	

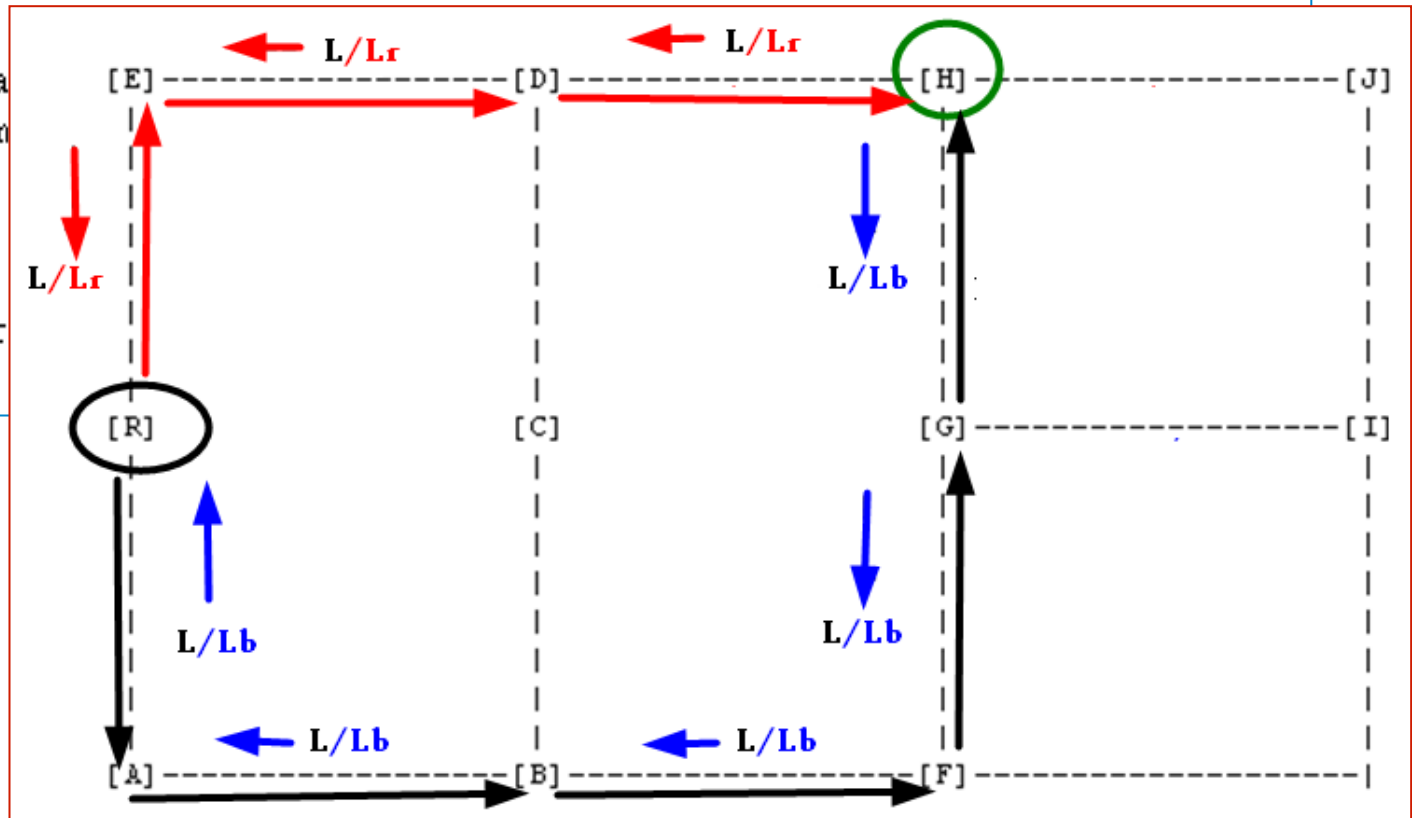|		Default Topology	Blue Topology	Red Topology
		/Lb R		
	Transit	L/L D	Lb/Lb R	Lr/Lr D
		/Lb R	/Lr D	
F	Ingress	--/L G		
		/Lr B		
	Transit	L/L G	Lb/Lb G	Lr/Lr B
		/Lr B	/Lr B	
G	Ingress	--/L H		
		/Lr F		
	Transit	L/L H	Lb/Lb H	Lr/Lr F
		/Lr F	/Lr F	
I	Ingress	--/L G		
		/Lb J		
	Transit	L/L G	Lb/Lb J	Lr/Lr G
		/Lb J	/Lr G	
J	Ingress	--/L H		
		/Lr I		
	Transit	L/L H	Lb/Lb H	Lr/Lr I
		/Lr I	/Lr I	

2-Connected Network Example (cont)

1. For an ingress label forwarding entry as follows, when forward, L will be pushed and sent to the next hop A. If failure happens, Lr will be pushed and sent to the next hop E.
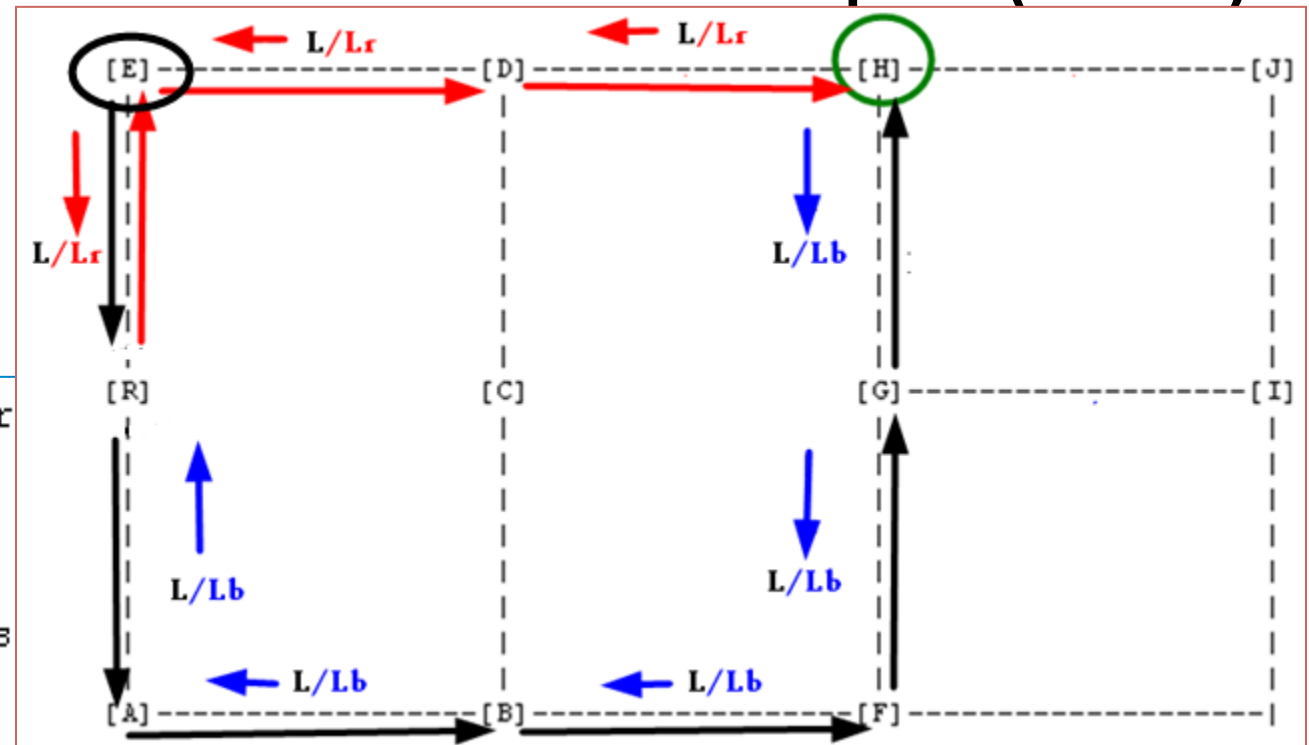
```
Ingress      --/L   A
              /Lr  E
```

2. For a
the incom
next hop
the next

Tr

2-Connected Network Example (cont)

```
            ← L/Lr              ← L/Lr
   [E]─ ─ ─ ─ ─ ─ ─ ─[D]─ ─ ─ ─ ─ ─ ─[H]─ ─ ─ ─ ─ ─ ─ ─[J]
                                                   │
L/Lr│                           L/Lb│
                                                   │
   [R]          [C]          [G]─ ─ ─ ─ ─ ─[I]


          L/Lb                      L/Lb


   [A]─ ─ ─ ─ ─ ─ ─ ─[B]─ ─ ─ ─ ─ ─ ─[F]─ ─ ─ ─ ─ ─ ─ ─
          ← L/Lb              ← L/Lb
```

1. For an ingr
will be pushed
will be pushed

         Ingress

2. For a transit label forwarding entry as follows, when packet with
the incoming label L arrives, L will be swapped to L and sent to the
next hop A. If failure happens, L will be swapped to Lr and sent to
the next hop E.

         Transit   L/L   A
                        /Lr E

Summary

- LDP MT can work well in different scenarios for MRT FRR.

- When LDP MT is combined with MRT FRR, follow advantages can be proposed:

    - Simplify operation and management with few additional configurations and states introduced.

    - Inherit procedures of LDP to achieve high scalability

    - Propose no additional change on label forwarding behavior in the forwarding plane to facilitate incremental deployment

Next Steps

- Get comments on mailing list
- More scenarios will be taken into account.