MVPN using P2MP/tree based BIER
draft-xie-bier-mvpn-mpls-p2mp-01

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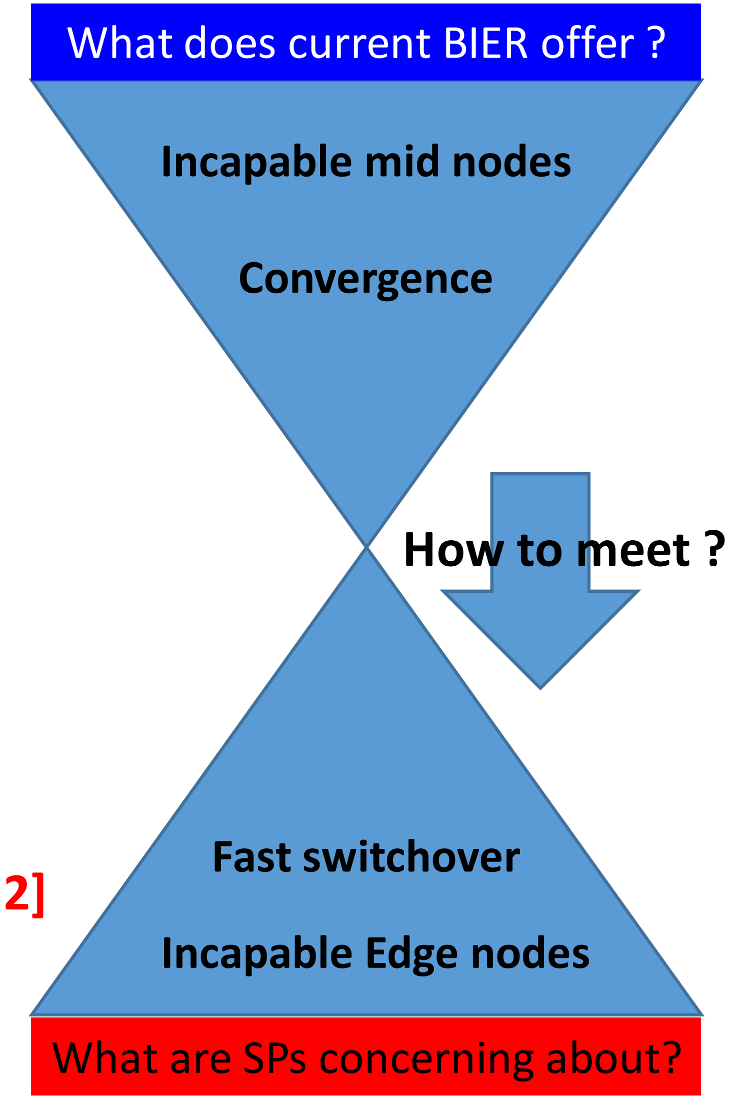
BIER Transition: Problem Statement

- **BIER offers a radical simplification over current IP multicast :**
  - **BIER packet forwarding/replication is along the unicast paths.**
  - **key operational benefits of BIER: deterministic convergence.**

- **Concerns from SP's perspective:**
  - **Convergence is not enough !**
    - **Fast/Lossless Switchover available ? ----[Problem 1]**
  - **Not only Mid Nodes !**
    - **Possible to Deploy with Incapable Edge nodes ? ----[Problem 2]**

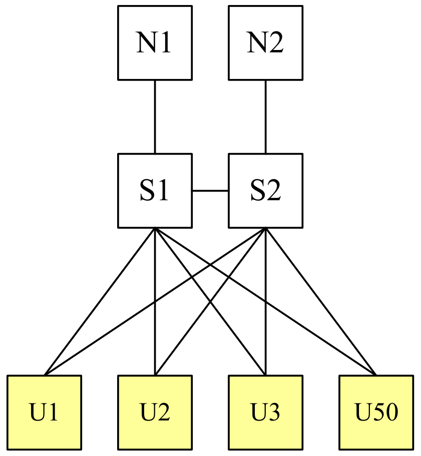


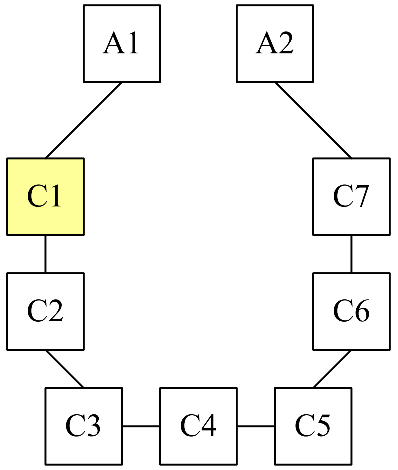
Problem 1

- **Current <draft-ietf-bier-mvpn> delivers a solution of MVPN using SPF based BIER.**
  - **many-to-many topology basis.**
  - **multicast is along with unicast path.**
  - **It can’t, however, support a multicast-specific path well, something common in legacy MVPN deployment:**
    - Live-Live Protection with two dis-joing paths:
      - RSVP-TE with explicit-path constrains.
      - PIM with explicit-rpf-vector
      - mLDP with static route.
      - MT provides similar function, but it needs more configuration, and support max 256 only.
  - **Transition from legacy MVPN, without losing the ease of many Live-Live dis-joint paths, is lacking.**

Problem 2

- **Current <RFC8279> provides a solution to support incapable Mid nodes.**
  - **However, it cannot support deployment on a network with incapable Edge nodes.**
  - **Unfortunately, it is common in some SP-networks that most of the nodes are Edge nodes.**
    - Example 1: A Hub-Spoken topology in Metro network.
    - Example 2: A Ring topology in backhaul network.





- **Transition from legacy MVPN, in networks with incapable edge nodes, is lacking.**

The Two Problems: Well-known ?

- **Benoit Claise's Discuss on draft-ietf-bier-architecture-07 (06 Jul 2017):**
  - https://www.ietf.org/mail-archive/web/bier/current/msg01275.html
  - Operational model which required two simultaneous M/C flows from separate sources. ---->[Problem 1]
- **BIER Algorithms, which cause controversy and confusing in BIER-WG:**
  - https://datatracker.ietf.org/doc/draft-zzhang-bier-algorithm/
  - Computing Maximum Disjoint Trees   ---->[Problem 1]
  - Handling BIER Incapable Routers, and Dealing with Ingress Replication Degradation. ---->[Problem 2]
- **mLDP Extensions for Multi-Topology Routing**
  - https://datatracker.ietf.org/doc/draft-wijnands-mpls-mldp-multi-topology/
  - Building a Multi-Point LSPs it can follow a particular topology and algorithm. ---->[Problem 1]

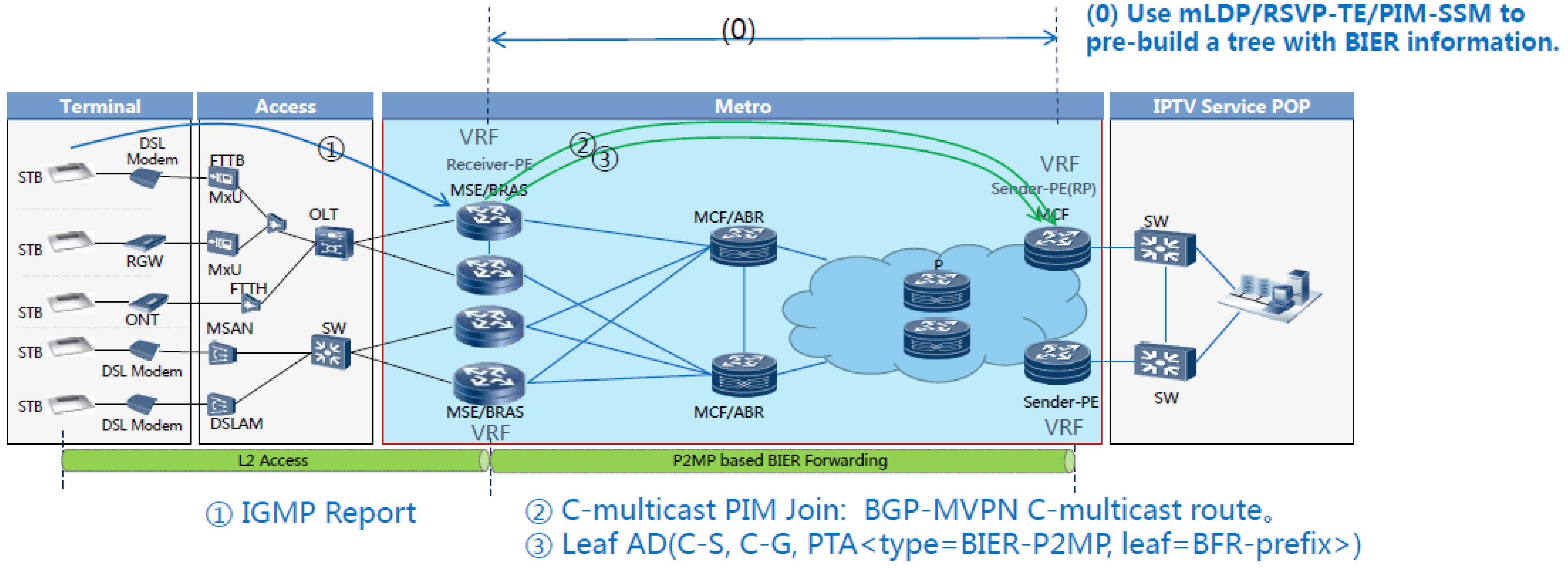
The Two Problems: what alternatives to solve ?

- **Problem 1: Two Disjoint Trees :**
    - **Computing & Algorithming, And then ?**
        - **Just Computing & computing & computing ?**
        - **Just Build it ? ----This draft is determined to Just Build it ! See following pages.**
- **Problem 2: Incapable Edge node:**
    - **RFC8279 has clarified, Ingress replication do not fit to incapable Edge nodes.**
        - **Why ?**
        - **What's the alternatives ? ----This draft introduces some. See following pages.**

Applicability Statement

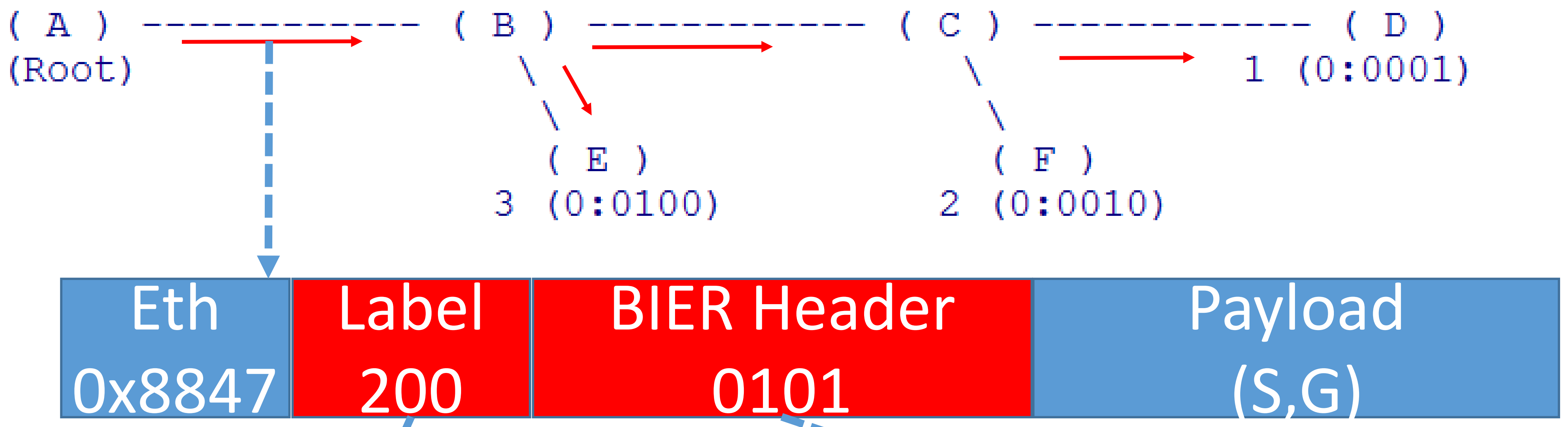
- **This document introduces:**
  - A seamless transition mechanism from legacy ng-MVPN. -->[Problem 1]
    - By applying a BIER encapsulation in data-plane to eliminate per-flow states.
    - While preserving existing features, such as Live-Live dis-joint paths, by using existing protocols.
  - Seamless Live-Live protection developed from Live-Live protection -->[Problem 1]
    - Considering the ECMP/Entropy feature is not supported in P2MP (see RFC6790)
    - The Entropy field of BIER Header is useless, so re-use it as a per-flow sequence-number.
  - Seamless deployment on networks with Incapable Edge nodes -->[Problem 2]
    - Exploring of P2MP/tree based BIER forwarding in detail. This is mentioned but not explored in RFC8279.
    - Support incapable Edge nodes, which is not support by RFC8279.
    - Support incapable Mid nodes, without using the P2P replication in RFC8279.

MVPN using P2MP based BIER : The Whole picture


(0)
(0) Use mLDP/RSVP-TE/PIM-SSM to pre-build a tree with BIER information.
Terminal
Access
Metro
IPTV Service POP
STB
DSL Modem
RGW
ONT
FTTB
MxU
FTTH
OLT
MSAN
SW
DSLAM
VRF
Receiver-PE
MSE/BRAS
MCF/ABR
P
Sender-PE(RP)
MCF
Sender-PE
L2 Access
P2MP based BIER Forwarding
① IGMP Report
② C-multicast PIM Join: BGP-MVPN C-multicast route。
③ Leaf AD(C-S, C-G, PTA<type=BIER-P2MP, leaf=BFR-prefix>)

- **Main part of Transition Step: to borrow the BIER MPLS encapsulation to eliminate per-flow states.**
- **Most of the existing remains: MVPN/IPTV service, Live-Live Protection with dis-joint paths. -->Problem 1.**
- **Still deployable when there are some Mid/Edge nodes do not support BIER. -->Problem 2.**

MVPN using P2MP based BIER : The Data-plane



P2MP/BIER-Label
Changes hop-by-hop

BitString inside
Unchanges hop-by-hop

Underlay protocols to support P2MP based BIER

- draft-xie-mpls-ldp-bier-extensions-00
- draft-xie-mpls-rsvp-bier-extensions-00
- draft-xie-pim-bier-extensions-00

- Configuring and Computing on **Edge**.
- Let one of these protocols to go and run an errand, to Build the tree !

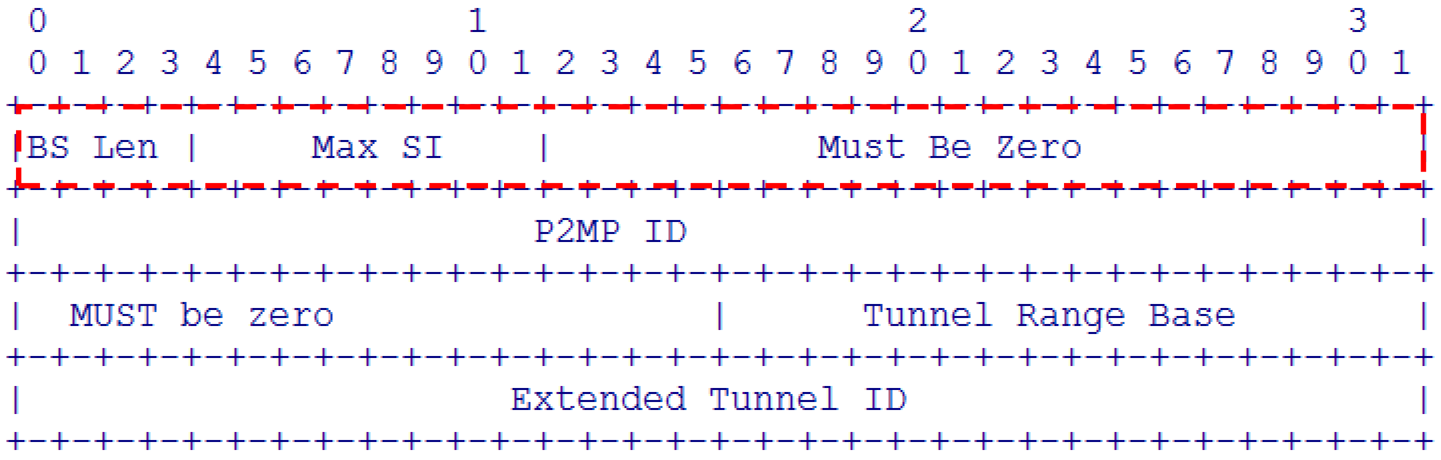
Summary

- The 2 Problems: Live-Live protection / BIER-incapable Edge nodes.
- Abstract of the 3 seamless points: Combination of P2MP / BIER.
- The Philosophy: Need a tree, then build it !
- The Applicability: BIER transition from ng-MVPN.
- The focus Question since IETF100: Simplification or complication?
  - From the **BIER transition perspective:**
  - it makes the deployment indecisive/complicated when using current IGP BIER.
    - some valuable things such as Live-Live lost, though some running protocol removed.
    - many Edge nodes are required to upgrade HW, though some running protocol removed.
  - it makes the deployment determined/simplification to introduce a tree into BIER.
    - Main BIER benefits got, while existing features preserved, and edge nodes un-upgraded.
    - One more thing, BIER configuration on Edge only will be a simplification+, as chap 6 stated.

Some common comments/concerns.

- Q1: Why you bring the complication of tree-building protocol back ?
  - From a transition or brownfield-deployment view, philosophy of “just build the tree” is simple. See slides page 11.
- Q2: BIER over P2MP, or P2MP over BIER ?
  - It is a combination of P2MP/BIER. Name of “BIER over P2MP” is more reasonable. See page 9.
- Q3: Will this lead to per-flow states ?
  - Never. A per-IngressPE tree can be shared by many VRFs and (S,G)s. See draft chapter 6.
- Q4: What is the motivation of this draft ?
  - BIER Transition from ng-MVPN. See slides page 7.
- Q5: Is the forwarding procedure compatible with the BIER Arch ?
  - It is a customization of BIER on a tree rather than on a more generic topology. See page 17~20.
- Q6: The changing of Entropy Field meaning is architecturally misplaced ?
  - Each layer is responsible for its own reliability and so does bier. See page 16.
- Q99: More Questions and Comments are welcome !
  - Please send mail to me/mail-list if I lose any of your comments. And some bit-level stuff in the following pages…

MVPN using P2MP based BIER(RSVP-TE)

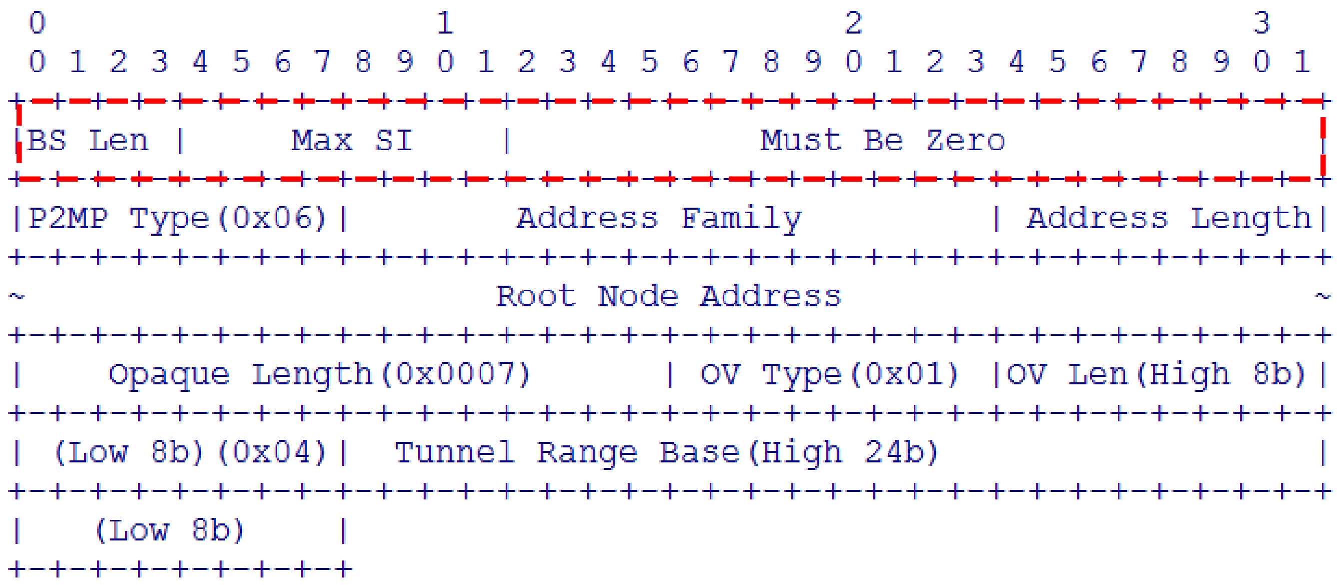


```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|BS Len |      Max SI     |           Must Be Zero               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           P2MP ID                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  MUST be zero               |      Tunnel Range Base          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Extended Tunnel ID                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: PTA of RSVP-TE built P2MP BIER

- One fixed BSL used. E.g. 256
- Existing feature such as RSVP-TE explicit path can be inherited.
- A batch of 'RSVP-TE P2MP' tunnels identified by (Tunnel Number, Tunnel Range Base)
  - R1…R256 join 'RSVP-TE P2MP' tunnel identified by <P2MP ID, Tunnel Range Base, Ext Tunnel ID>
  - R257…R512 join 'RSVP-TE P2MP' tunnel identified by <P2MP ID, Tunnel Range Base + 1, Ext Tunnel ID>
  - ……

MVPN using P2MP based BIER (mLDP)



```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|BS Len |      Max SI    |            Must Be Zero               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|P2MP Type(0x06)|        Address Family         | Address Length|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                       Root Node Address                       ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Opaque Length(0x0007)      | OV Type(0x01) |OV Len(High 8b)|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| (Low 8b)(0x04)|  Tunnel Range Base(High 24b)                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   (Low 8b)    |
+-+-+-+-+-+-+-+-+
```

Figure 2: PTA of MLDP built P2MP BIER

- One fixed BSL used. E.g 256
- Existing feature such as mLDP using static route can be inherited.
- A batch of ‘mLDP P2MP’ tunnels identified by (Tunnel Number, Tunnel Range Base)
  - R1…R256 join ‘mLDP P2MP’ tunnel identified by FEC<Root Node Address, Tunnel Range Base>
  - R257…R512 join ‘mLDP P2MP’ tunnel identified by FEC<Root Node Address, Tunnel Range Base + 1>
  - ……

MVPN using P2MP based BIER (PIM)

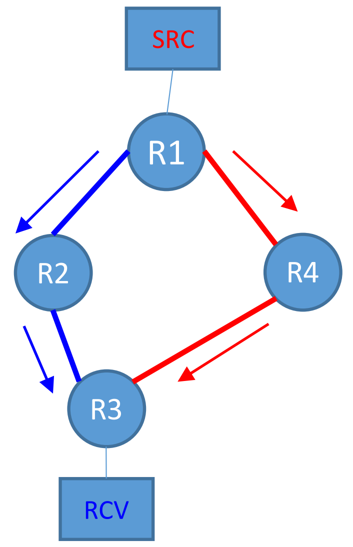
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|BS Len |      Max SI       |            Must Be Zero             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                  P-Root Node Address                          ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                P-Multicast Group Base                         ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

          Figure 3: PTA of PIMSSM built P2MP BIER
```

- One fixed BSL used. E.g 256
- Existing feature such as PIM explicit rpf vector can be inherited.
- A batch of 'PIM-SSM trees' identified by (P-Root Node Address, P-Multicast Group Base)
  - R1…R256 join 'PIM-SSM tree' identified by (P-Root Node Address, P-Multicast Group Base)
  - R257…R512 join 'PIM-SSM tree' identified by (P-Root Node Address, P-Multicast Group Base + 1)
  - ……

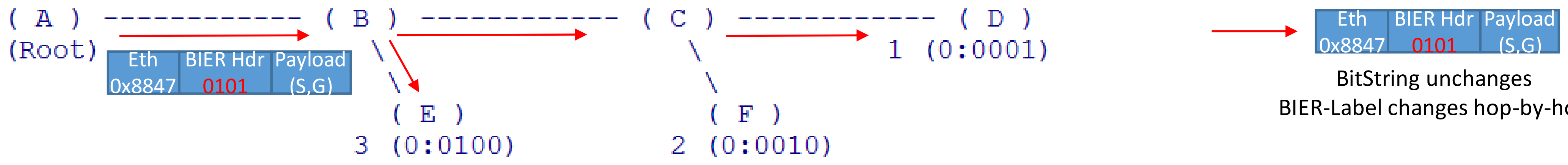
Seamless Live-Live protection

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              BIFT-id                  | TC  |S|     TTL       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Nibble |  Ver  |  BSL  |              Entropy                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|OAM|Rsv|    DSCP   |   Proto   |            BFIR-id            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                BitString  (first 32 bits)                     ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                BitString  (last 32 bits)                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```



- Re-Use Entropy as per-flow sequence-number.
- **Ingress PE (R1):** imposes a sequence-number in the Entropy subfield, per-flow per-packet.
- **Transit PE (R2/R4):** not need to care about Entropy.
- **Egress PE(R3):** brings the sequence-number out, check with the following IP(S,G), on a per-flow basis.
- Which Level is this function belonging to ?
  - RTP has been doing similar thing for decades. And IEEE 802.3ab is doing similar thing.
  - Each layer is responsible for its own reliability and so does bier. So it seems to be an Edge specific BIER Layer function, and it seems to be harmless and competitive.

P2MP/tree based BIER forwarding procedure(1)



BitString unchanges
BIER-Label changes hop-by-hop

Forwarding Table on A (FTN and NHLFE)	
FTN	(S,G, TreeID, Flag=CheckBS|Root, BSL)
NHLFE1	(TreeID, OutInterface<toB>, OutLabel<alloc by B>, F-BM<0111>)

Forwarding Table on B (ILM and NHLFE)	
ILM	(inLabel<alloc by B>, action<Rep to TreeID>, Flag=CheckBS|Branch, BSL)
NHLFE1	(TreeID, outInterface<to C>, outLabel<alloc by C>, **F-BM<0011>)**
NHLFE2	(TreeID, outInterface<to E>, outLabel<alloc by E>, **F-BM<0100>)**

Forwarding Table on E (ILM and LEAF)	
ILM	(inLabel<alloc by D>, action<Rep to TreeID>, Flag=CheckBS|Leaf, BSL)
LEAF	(TreeID, **F-BM<0100>, flag=PopBIERincluding**)

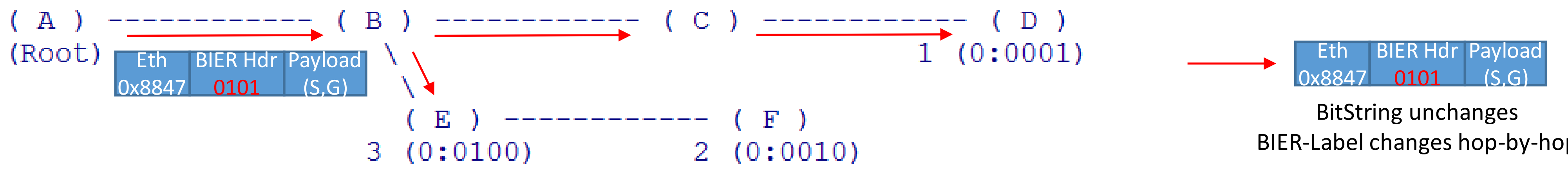
Forwarding Table on C (ILM and NHLFE)	
ILM	(inLabel<alloc by C>, action<Rep to TreeID>, Flag=CheckBS|Branch, BSL)
NHLFE1	(TreeID, outInterface<to D>, outLabel<alloc by D>, **F-BM<0001>**
NHLFE2	(TreeID, outInterface<to F>, outLabel<alloc by F>, **F-BM<0010>**

Forwarding Table on D (ILM and LEAF)	
ILM	(inLabel<alloc by D>, action<Rep to TreeID>, Flag=CheckBS|Leaf, BSL)
LEAF	(TreeID,**F-BM<0001>, flag=PopBIERincluding**)

Forwarding Table on F (ILM and LEAF)	
ILM	(inLabel<alloc by F>, action<Rep to TreeID>, Flag=CheckBS|Leaf, BSL)
LEAF	(TreeID,**F-BM<0010>, flag=PopBIERincluding**)

- CheckBS means, when Replicate to every NHLFE or LEAF of a Tree, Check the result by AND'ing the BitString in packet and the F-BM in the NHLFE/LEAF, Forward packet only when result is not zero. It is called **P-CAPABILITY**.
- PopBIERincluding(p16-p18)/PopBIERexcluding(p19) means, to pop the BIER header including/excluding the BIER Label in packet. It is called **D-CAPABILITY**.

P2MP/tree based BIER forwarding procedure(2)



BitString unchanges
BIER-Label changes hop-by-hop

Figure 5: P2MP-based BIER Topology with BUD nodes

Forwarding Table on A (FTN and NHLFE)	
FTN	(S,G, TreeID, Flag=CheckBS|Root, BSL)
NHLFE1	(TreeID, OutInterface<toB>, OutLabel<alloc by B>, F-BM<0111>)

Forwarding Table on B (ILM and NHLFE)	
ILM	(inLabel<alloc by B>, action<Rep to TreeID>, Flag=CheckBS|Branch, BSL)
NHLFE1	(TreeID, outInterface<to C>, outLabel<alloc by C>, **F-BM<0001>)**
NHLFE2	(TreeID, outInterface<to E>, outLabel<alloc by E>, **F-BM<0110>)**

Forwarding Table on E (ILM and NHLFE and LEAF)	
ILM	(inLabel<alloc by D>, action<Rep to TreeID>, Flag=CheckBS|Bud, BSL)
NHLFE1	(TreeID, outInterface<to F>, outLabel<alloc by F>, **F-BM<0010>)**
LEAF	(TreeID, **F-BM<0100>, flag=PopBIERincluding**)

Forwarding Table on C (ILM and NHLFE)	
ILM	(inLabel<alloc by C>, action<Rep to TreeID>, Flag=CheckBS|Branch, BSL)
NHLFE1	(TreeID, outInterface<to D>, outLabel<alloc by D>, **F-BM<0001>**

Forwarding Table on D (ILM and LEAF)	
ILM	(inLabel<alloc by D>, action<Rep to TreeID>, Flag=CheckBS|Leaf, BSL)
LEAF	(TreeID,**F-BM<0001>, flag=PopBIERincluding**)

Forwarding Table on F (ILM and LEAF)	
ILM	(inLabel<alloc by F>, action<Rep to TreeID>, Flag=CheckBS|Leaf, BSL)
LEAF	(TreeID,**F-BM<0010>, flag=PopBIERincluding**)

- A Leaf/BUD node need both P-CAPABILITY and D-CAPABILITY.
- A Branch node need P-CAPABILITY.

When Mid/Leaf/Bud Nodes don’t support P-CAPABILITY

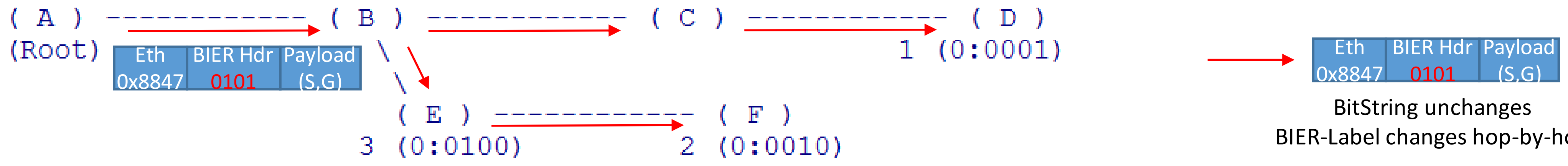


Figure 5: P2MP-based BIER Topology with BUD nodes

Forwarding Table on A (FTN and NHLFE)	
FTN	(S,G, TreeID, Flag=CheckBS|Root, BSL)
NHLFE1	(TreeID, OutInterface<toB>, OutLabel<alloc by B>, F-BM<0111>)

Forwarding Table on B (ILM and NHLFE)	
ILM	(inLabel<alloc by B>, action<Rep to TreeID>, Flag=Branch, BSL)
NHLFE1	(TreeID, outInterface<to C>, outLabel<alloc by C>**)**
NHLFE2	(TreeID, outInterface<to E>, outLabel<alloc by E>**)**

Forwarding Table on E (ILM and NHLFE and LEAF)	
ILM	(inLabel<alloc by D>, action<Rep to TreeID>, Flag=Bud, BSL)
NHLFE1	(TreeID, outInterface<to F>, outLabel<alloc by F>**)**
LEAF	(TreeID, **flag=PopBIERincluding)**

Forwarding Table on C (ILM and NHLFE)	
ILM	(inLabel<alloc by C>, action<Rep to TreeID>, Flag=Branch)
NHLFE1	(TreeID, outInterface<to D>, outLabel<alloc by D>)

Forwarding Table on D (ILM and LEAF)	
ILM	(inLabel<alloc by D>, action<Rep to TreeID>, Flag=Leaf, BSL)
LEAF	(TreeID, **flag=PopBIERincluding)**

Forwarding Table on F (ILM and LEAF)	
ILM	(inLabel<alloc by F>, action<Rep to TreeID>, Flag=Leaf, BSL)
LEAF	(TreeID, **flag=PopBIERincluding)**

- When any node (either Branch, Leaf or BUD node) don’t support P-CAPABILITY, just downshift to P2MP/tree forwarding without check the BitString of packet. It is a local behavior.
- Can apply as long as the edge nodes have D-CAPABILITY, which is supposed to be simple for a programmable HW.

When Leaf/Bud Nodes even don't support D-CAPABILITY

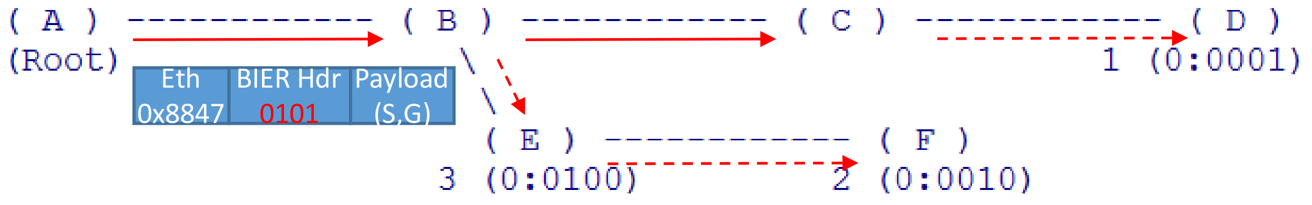
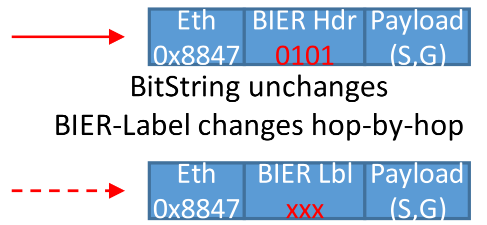


Figure 5: P2MP-based BIER Topology with BUD nodes



BIER-Label changes hop-by-hop

Forwarding Table on A (FTN and NHLFE)	
FTN	(S,G, TreeID, Flag=CheckBS|Root, BSL)
NHLFE1	(TreeID, OutInterface<toB>, OutLabel<alloc by B>, F-BM<0111>)

Forwarding Table on B (ILM and NHLFE)	
ILM	(inLabel<alloc by B>, action<Rep to TreeID>, Flag=CheckBS|Branch, BSL)
NHLFE1	(TreeID, outInterface<to C>, outLabel<alloc by C>, **F-BM<0001>)**
NHLFE2	(TreeID, outInterface<toE>, outLabel<byE>, **F-BM<0110>,** Flag=**PopBIERexcluding**)

Forwarding Table on E (ILM and NHLFE and LEAF)	
ILM	(inLabel<alloc by D>, action<Rep to TreeID>, Flag=Bud)
NHLFE1	(TreeID, outInterface<to F>, outLabel<alloc by F>)
LEAF	(TreeID, **flag=PopLabel)**

Forwarding Table on C (ILM and NHLFE)	
ILM	(inLabel<alloc by C>, action<Rep to TreeID>, Flag=CheckBS|Branch, BSL)
NHLFE1	(TreeID, outInterface<toD>, outLabel<byD>, **F-BM<0001>,** Flag=**PopBIERexcluding**)

Forwarding Table on D (ILM and LEAF)	
ILM	(inLabel<alloc by D>, action<Rep to TreeID>, Flag=Leaf)
LEAF	(TreeID, **flag=PopLabel)**

Forwarding Table on F (ILM and LEAF)	
ILM	(inLabel<alloc by F>, action<Rep to TreeID>, Flag=Leaf)
LEAF	(TreeID, **flag=PopLabel)**

- Node D don't support D-CAPABILITY, then configure on D to receive a Label packet rather than a BIER packet, and do a <PopBIERexcluding> when C send the replicated packet to D.
- Node E don't support D-CAPABILITY, then configure on E and F to receive a Label packet rather than a BIER packet, and do a <PopBIERexcluding> when B send the replicated packet to E.

1 Scenario: BIER Transition from ng-MVPN

2 Problems: Live-Live Disjoint trees, Incapable Edge nodes

Simple Solution: Just build the tree !

Thank you !