Enhanced Performance Delay and Liveness Monitoring in Segment Routing Networks

draft-gandhi-spring-sr-enhanced-plm-02

Rakesh Gandhi - Cisco Systems (rgandhi@cisco.com) - Presenter
Clarence Filsfils - Cisco Systems (cfilsfil@cisco.com)
Navin Vaghamshi - Reliance (Navin.Vaghamshi@ril.com)
Moses Nagarajah - Telstra (Moses.Nagarajah@team.telstra.com)
Richard Foote - Nokia (footer.foote@nokia.com)

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Agenda

- Requirements and Scope
- Summary
- Next Steps

Requirements and Scope

Requirements:

- Performance Delay Monitoring & Liveness Monitoring in SR networks
    - ✓ End-to-end P2P/P2MP SR paths
    - ✓ Applicable to SR-MPLS/SRv6 data planes
- Running single protocol in SR networks
    - ✓ Simplify implementations and reduce development cost
    - ✓ Simplify deployment and reduce operational complexity
- No reflector dependency
    - ✓ Stateless on reflector (e.g. reflector unaware of the monitoring protocol)
        - ✓ State is in the probe message - spirit of SR
    - ✓ Higher scale and faster detection interval

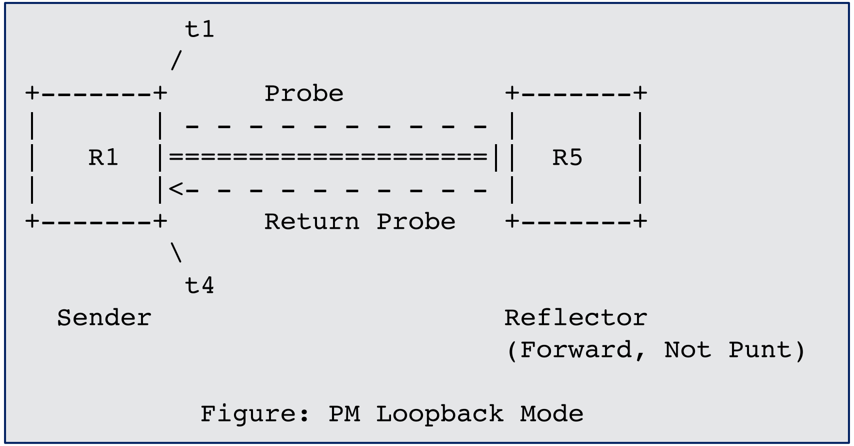
Scope:

- RFC 5357 (TWAMP Light) defined probe messages
- RFC 8762 (Simple TWAMP (STAMP)) defined probe messages

History of the Draft

- March 2020
  - Draft was published
- April 2020
  - Presented version 00 in IETF 107 Virtual MPLS WG Meeting
- July 2020
  - Presented version 02 in IETF 108 Online SPRING WG meeting

PM Probes in Loopback Mode for SR Policy

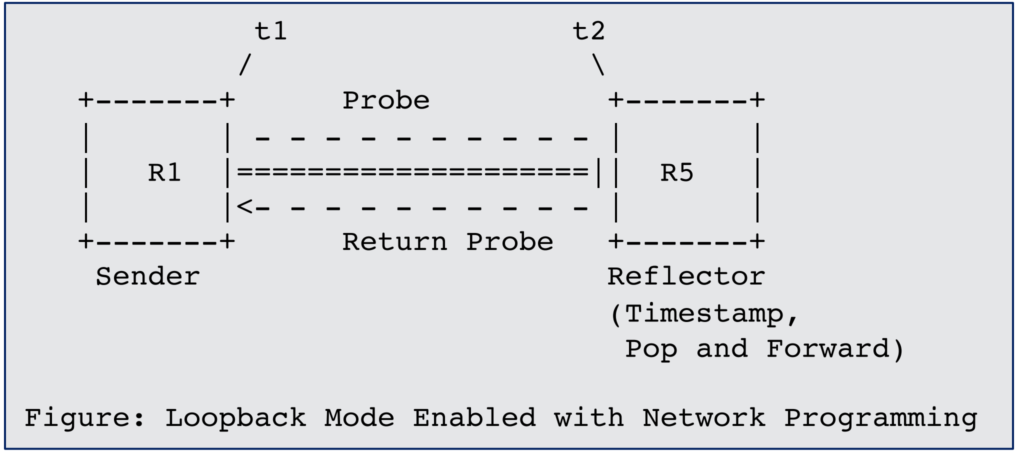


```
            t1
           /
+--------+       Probe          +--------+
|        | - - - - - - - - - -  |        |
|   R1   |====================||   R5    |
|        |<- - - - - - - - - -  |        |
+--------+       Return Probe   +--------+
           \
            t4
  Sender                        Reflector
                                (Forward, Not Punt)
```

Figure: PM Loopback Mode

- Using PM probes (TWAMP Light/Simple TWAMP (STAMP) delay measurement messages) in Loopback Mode
- Probe messages sent using Segment List(s) of the SR Policy Candidate Path(s)
- Probe messages are not punted on the reflector node out of fast-path in forwarding
- Reflector is agnostic of the monitoring protocol

Enhanced Performance Delay and Liveness Monitoring of SR Policy



```
                t1                  t2
               /                     \
    +--------+      Probe          +--------+
    |        | - - - - - - - - - - |        |
    |   R1   |====================||   R5   |
    |        |<- - - - - - - - - - |        |
    +--------+      Return Probe   +--------+
     Sender                        Reflector
                                   (Timestamp,
                                    Pop and Forward)
```

Figure: Loopback Mode Enabled with Network Programming

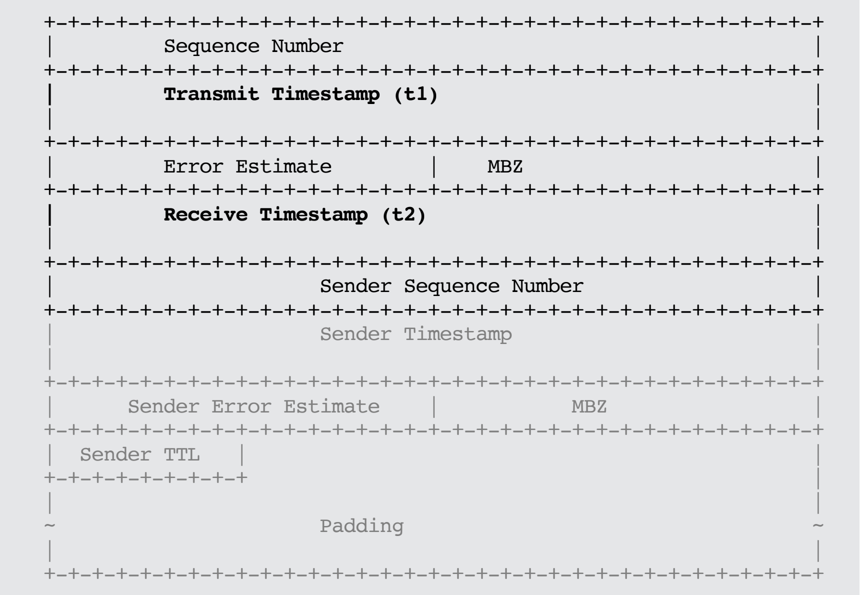
- Using PM probes in loopback mode enabled with network programming function
  - The network programming function optimizes the "operations of punt and inject the probe packet" on the reflector node
  - As probe packets are forwarded in fast-path, faster liveness failure detection is possible
- Reflector node adds the receive timestamp in the payload of the received probe message in the fast-path
  - Only adds the receive timestamp if the source address or destination address in the probe message matches the local node address
  - Ensure loopback probe packets return from the intended reflector node

Notifications

- Delay metrics are notified when consecutive M number of probe messages have delay values exceed the configured thresholds
- Liveness failure (bring-down - loss of heart beats) is notified when consecutive N number of return probe messages are not received at the sender
- Liveness success (bring-up - success of heart beats) is notified as soon as one or more return probe messages are received at the sender

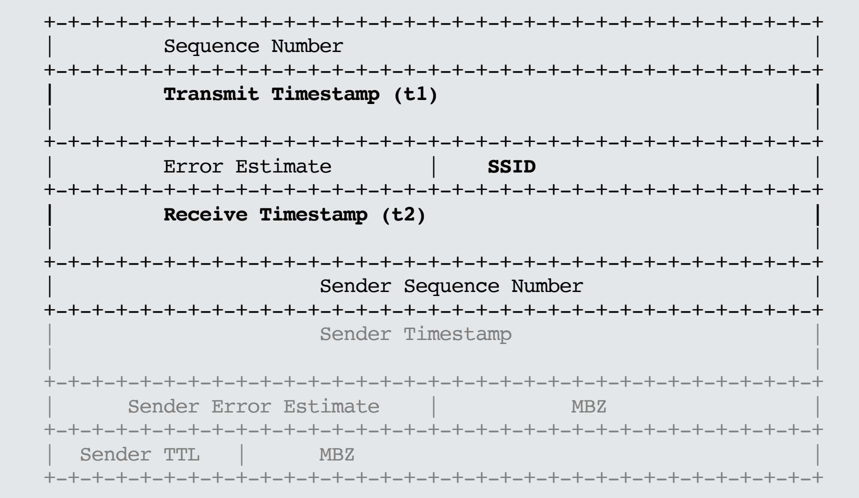
Probe Messages for Timestamp and Forward Function

- Leverage existing TWAMP implementations and deployments
- Sender adds Transmit Timestamp (t1)
- Reflector adds Receive Timestamp (t2) at fixed offset in payload locally provisioned (consistently in the network)
  - E.g. offset-byte 16 from the start of the TWAMP payload



```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Sequence Number                                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Transmit Timestamp (t1)                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Error Estimate        |    MBZ                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Receive Timestamp (t2)                                |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Sender Sequence Number                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Sender Timestamp                         |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Sender Error Estimate    |           MBZ                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Sender TTL   |                                               |
+-+-+-+-+-+-+-+-+                                               |
|                                                               |
~                      Padding                                  ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

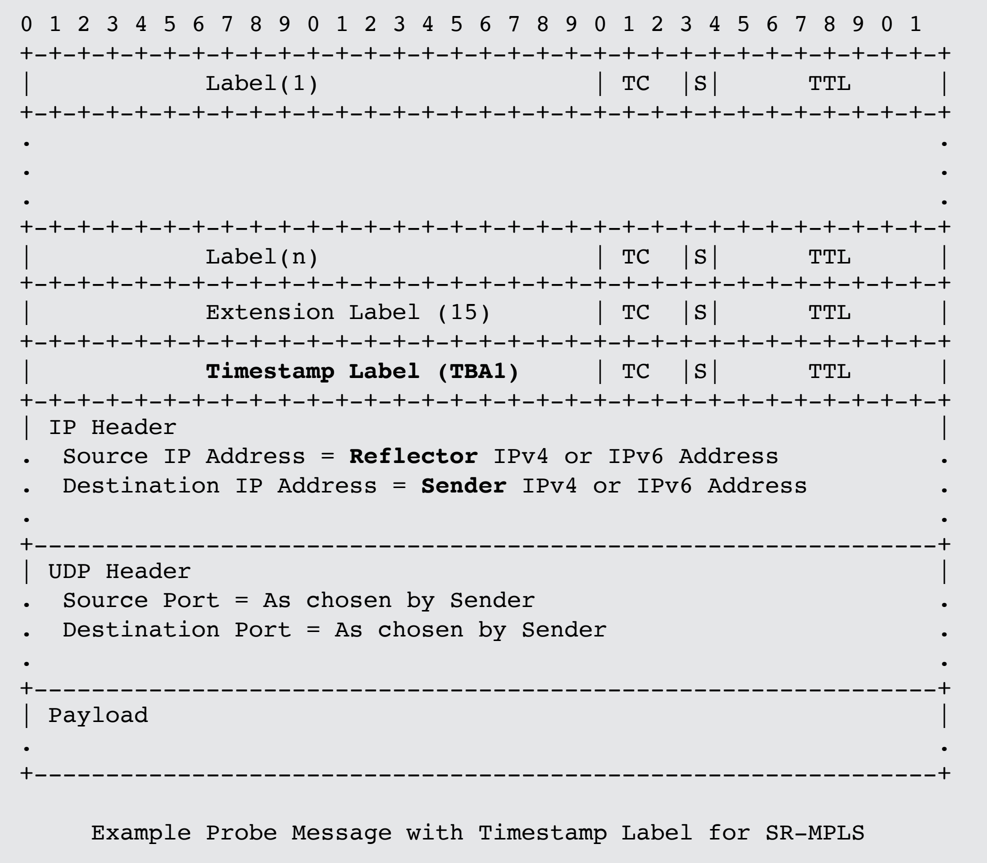
Figure: TWAMP Light Probe Message Format



```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Sequence Number                                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Transmit Timestamp (t1)                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Error Estimate        |    SSID                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Receive Timestamp (t2)                                |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Sender Sequence Number                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Sender Timestamp                         |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Sender Error Estimate    |           MBZ                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Sender TTL   |      MBZ                                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure: STAMP Probe Message Format

SR-MPLS with Timestamp and Forward Function

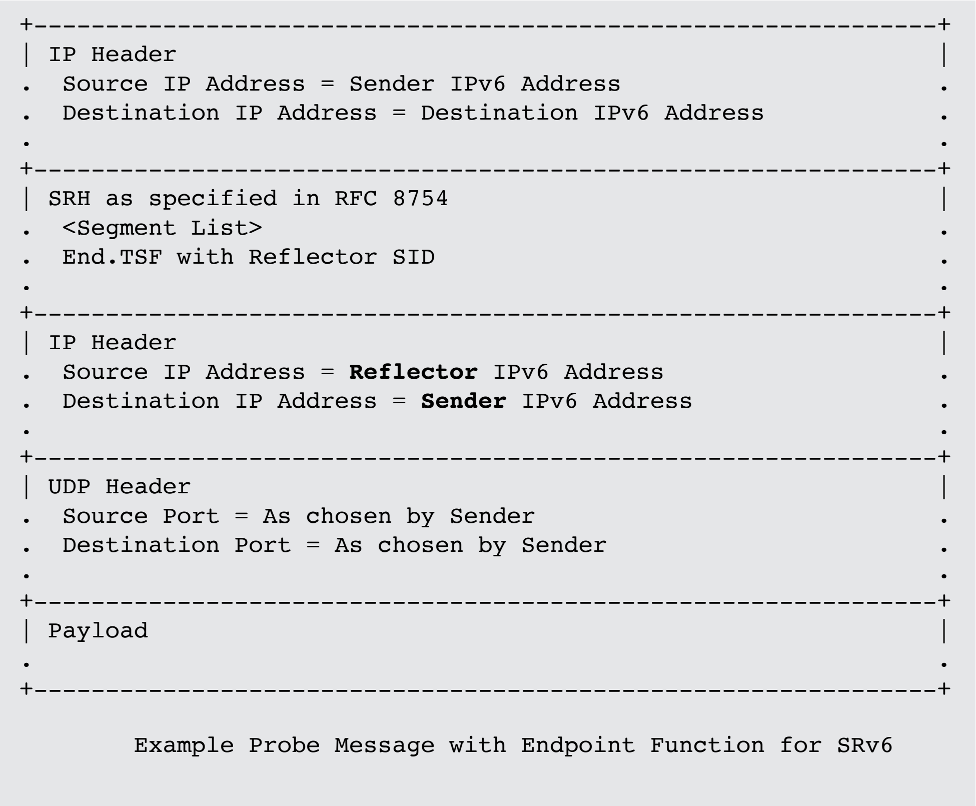


```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Label(1)                  | TC  |S|      TTL      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.                                                               .
.                                                               .
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Label(n)                  | TC  |S|      TTL      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Extension Label (15)      | TC  |S|      TTL      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Timestamp Label (TBA1)    | TC  |S|      TTL      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| IP Header                                                     |
.  Source IP Address = Reflector IPv4 or IPv6 Address           .
.  Destination IP Address = Sender IPv4 or IPv6 Address         .
.                                                               .
+---------------------------------------------------------------+
| UDP Header                                                    |
.  Source Port = As chosen by Sender                            .
.  Destination Port = As chosen by Sender                       .
.                                                               .
+---------------------------------------------------------------+
| Payload                                                       |
.                                                               .
+---------------------------------------------------------------+

     Example Probe Message with Timestamp Label for SR-MPLS
```

- Extended Special-purpose label (TBA1) is defined for Timestamp and Forward network programming
- Reverse Path can be IP or SR-MPLS
- Source and Destination Addresses are swapped that represent the Reverse direction path

SRv6 with Timestamp and Forward SID Function



```
+---------------------------------------------------------------+
| IP Header                                                     |
.  Source IP Address = Sender IPv6 Address                      .
.  Destination IP Address = Destination IPv6 Address            .
.                                                               .
+---------------------------------------------------------------+
| SRH as specified in RFC 8754                                  |
.  <Segment List>                                               .
.  End.TSF with Reflector SID                                   .
.                                                               .
+---------------------------------------------------------------+
| IP Header                                                     |
.  Source IP Address = Reflector IPv6 Address                   .
.  Destination IP Address = Sender IPv6 Address                 .
.                                                               .
+---------------------------------------------------------------+
| UDP Header                                                    |
.  Source Port = As chosen by Sender                            .
.  Destination Port = As chosen by Sender                       .
.                                                               .
+---------------------------------------------------------------+
| Payload                                                       |
.                                                               .
+---------------------------------------------------------------+
```

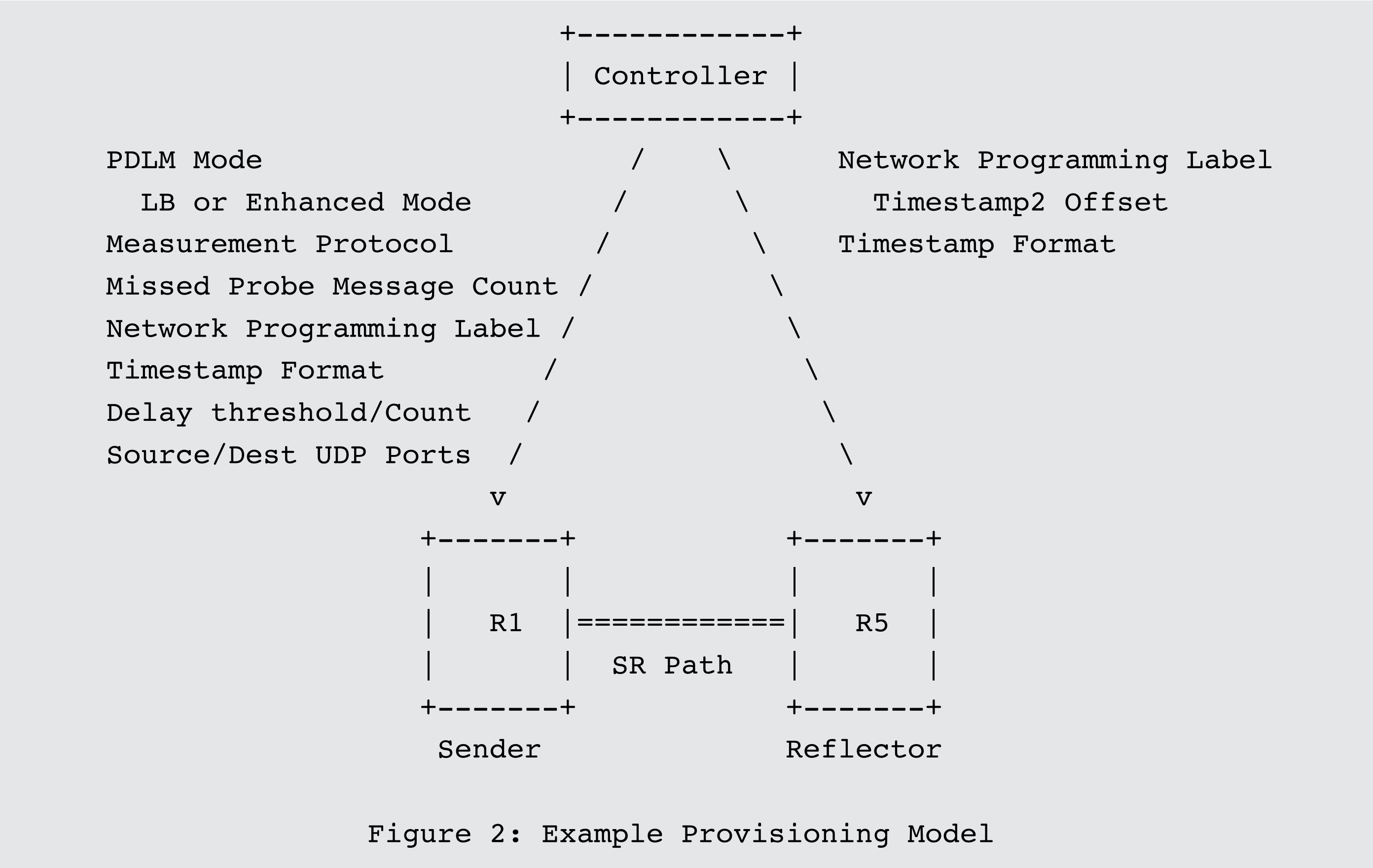
Example Probe Message with Endpoint Function for SRv6

- Endpoint SID Function End.TSF is defined for Timestamp and Forward network programming and is carried for the Reflector node SID
- Reverse path can be IP
  - Reflector node removes SRH
- Reverse path can be SR
  - Reverse direction SR path Segment-list carried in SRH
  - Reflector node does not remove the SRH
- Source and Destination Addresses are swapped that represent the Reverse direction path in the inner IPv6 header

ECMP Support for SR Paths

- SR Paths can have ECMP between the ingress and transit nodes, between transit nodes and between transit and egress nodes.
- PM probe messages can take advantage of the hashing function in forwarding plane.
- Existing forwarding mechanisms are applicable to PM probe messages. Examples are:
  - For IPv4 when return path is also SR-MPLS
    - Sweeping destination address in IPv4 header (e.g. 127/8)
  - For IPv6
    - Sweeping flow label in IPv6 header

Example Provisioning Model



```
                          +------------+
                          | Controller |
                          +------------+
PDLM Mode                     /    \      Network Programming Label
  LB or Enhanced Mode        /      \       Timestamp2 Offset
Measurement Protocol        /        \    Timestamp Format
Missed Probe Message Count /          \
Network Programming Label /            \
Timestamp Format         /              \
Delay threshold/Count   /                \
Source/Dest UDP Ports  /                  \
                      v                    v
                  +-------+            +-------+
                  |       |            |       |
                  |   R1  |============|   R5  |
                  |       |  SR Path   |       |
                  +-------+            +-------+
                   Sender              Reflector
```

Figure 2: Example Provisioning Model

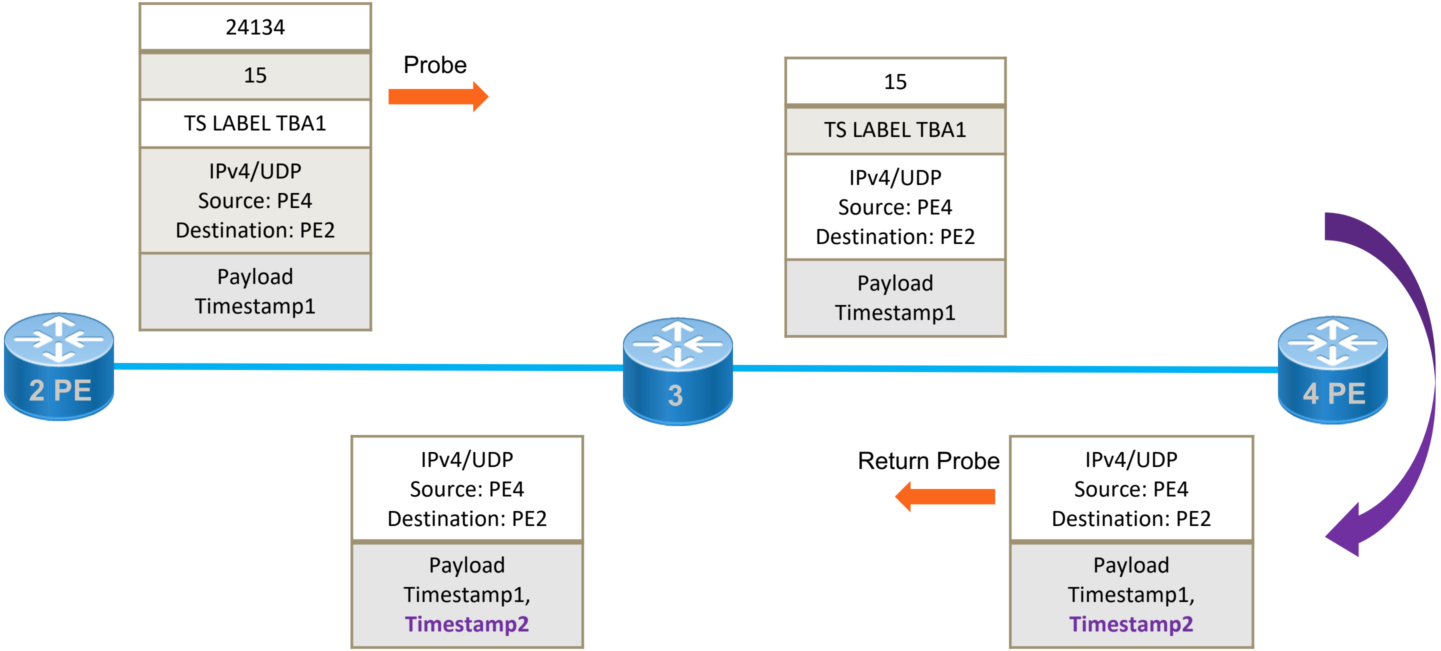
Next Steps

- Welcome your comments and suggestions
- Requesting SPRING WG adoption

Thank you

Backup

Loopback Mode with Timestamp and Forward for SR-MPLS Policy



24134
15
TS LABEL TBA1
IPv4/UDP
Source: PE4
Destination: PE2
Payload
Timestamp1

Probe

15
TS LABEL TBA1
IPv4/UDP
Source: PE4
Destination: PE2
Payload
Timestamp1

IPv4/UDP
Source: PE4
Destination: PE2
Payload
Timestamp1,
Timestamp2

Return Probe

IPv4/UDP
Source: PE4
Destination: PE2
Payload
Timestamp1,
Timestamp2

Thank you