Enhanced Performance Measurement and Liveness Monitoring in Segment Routing Networks

draft-gandhi-spring-sr-enhanced-plm-00

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Agenda

- Requirements and Scope

- Summary

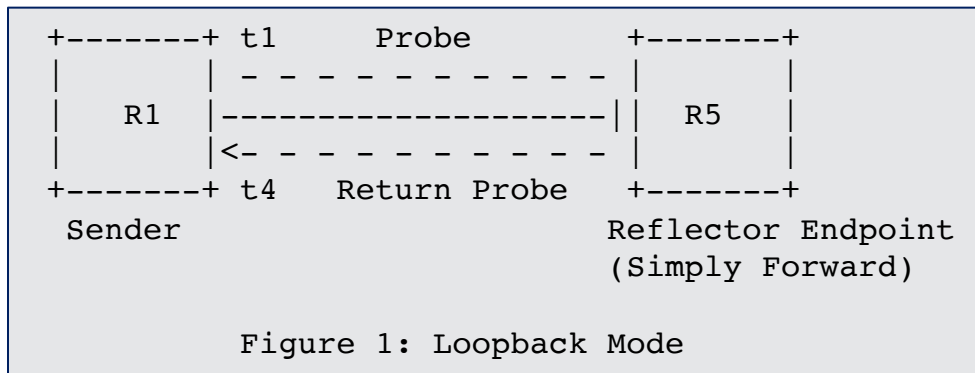- Next Steps

Requirements and Scope

Requirements:

- Performance Measurement & Liveness Monitoring
  - ✓ End-to-end P2P/P2MP SR Paths
  - ✓ Applicable to SR-MPLS/SRv6 data planes

Scope:

- RFC 5357 (TWAMP) defined probe messages - TWAMP Light
- RFC 8762 (STAMP) defined probe messages
- User-configured IP/UDP path for probe messages

Liveness Monitoring of SR Policy

```
+-------+ t1      Probe       +-------+
|       |  - - - - - - - - - -|       |
|   R1  |--------------------|| R5    |
|       |<- - - - - - - - - - |       |
+-------+ t4   Return Probe   +-------+
 Sender                       Reflector Endpoint
                              (Simply Forward)

            Figure 1: Loopback Mode
```

- Liveness monitoring for SR Policy uses PM probes (TWAMP Light/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 remote node (endpoint/reflector)
- Return path can be IP or SR
- Liveness failure is notified when consecutive N number of probe messages are not received back at the sender

Enhanced Liveness Monitoring of SR Policy

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


Figure: Loopback Mode Enabled with Network Programming
```
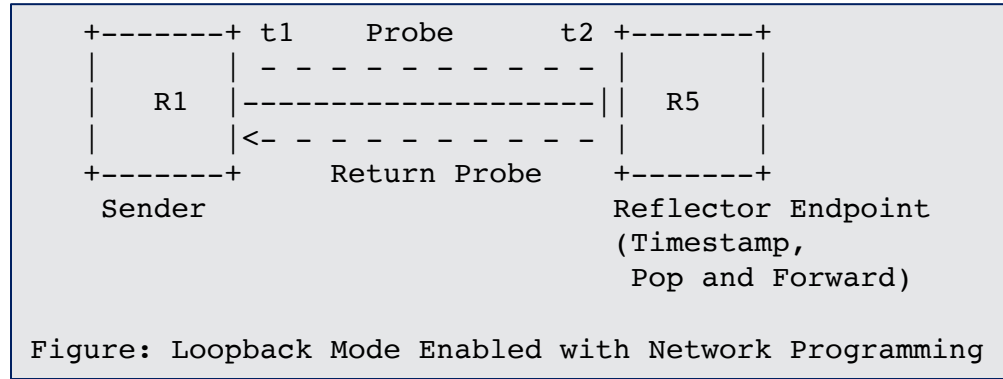
- Use PM probes in loopback mode enabled with network programming function.

  - The network programming function optimizes the "operations of punt, add receive timestamp and inject the probe packet" on the reflector node.

- The endpoint node adds the receive timestamp in the payload of the received TWAMP Light or STAMP probe message without punting the probe message.

  - Only add the receive timestamp if the source address in the probe message matches the local node address

- Liveness failure is notified when consecutive N number of probe messages are not received back at the sender

- Delay metrics are notified when consecutive N number of probe messages have delay values exceed the configured thresholds

TWAMP Light/STAMP Probe Message
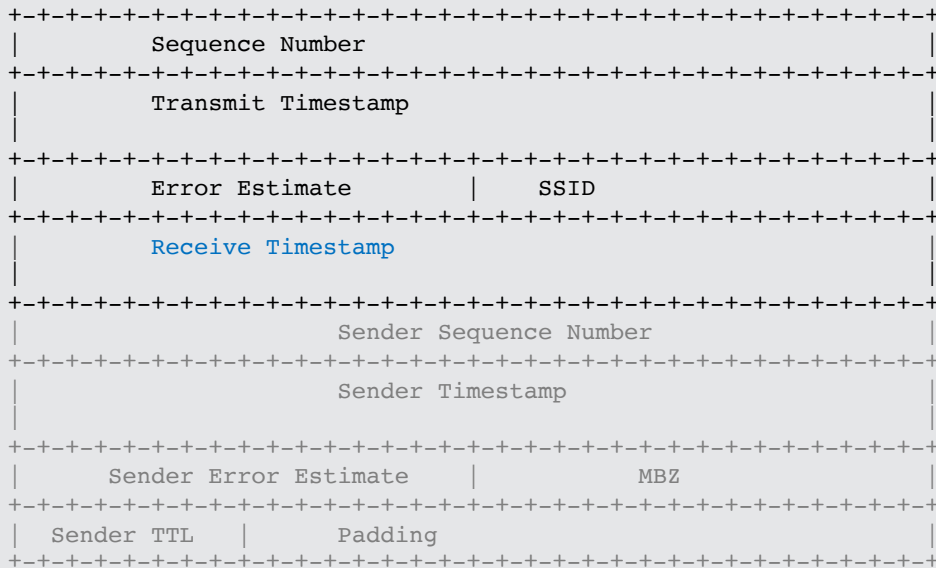
```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Sequence Number                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Transmit Timestamp                         |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Error Estimate         |           SSID                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Receive Timestamp                          |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Sender Sequence Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Sender Timestamp                           |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       Sender Error Estimate   |           MBZ                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Sender TTL   |       Padding                                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

         Figure: Probe Message Format
```

Enhanced Loopback Mode

- Sender adds the Transmit Timestamp
- Reflector adds the Receive Timestamp at fixed offset locally provisioned (consistently in the network)
  - For TWAMP Light and STAMP packets, it is at offset-byte 16 from the start of the payload
- Sender Sequence Number, Sender Timestamp, Sender Error Estimate and Sender TTL in the TWAMP Light and STAMP messages are not used.
  - Reflector does not copy them.

SR-MPLS with Timestamp Label

```
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       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Timestamp Label (TBA1)      | TC  |S|      TTL       |
+--------------------------------------------------------------+
| IP Header                                                    |
.  Source IP Address = Endpoint IPv4 or IPv6 Address           .
.  Destination IP Address = Sender IPv4 or IPv6 Address        .
.  Protocol = UDP                                              .
.                                                              .
+--------------------------------------------------------------+
| UDP Header                                                   |
.  Source Port = As chosen by Sender                           .
.  Destination Port = User-configured Port                     .
.                                                              .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Payload as defined in Section 4.2.1 of RFC 5357 |           |
|  Payload as defined in Section 4.2 of RFC 8762               |
.                                                              .
+--------------------------------------------------------------+

Figure 5: Probe Message Header for SR-MPLS with Timestamp Label
```
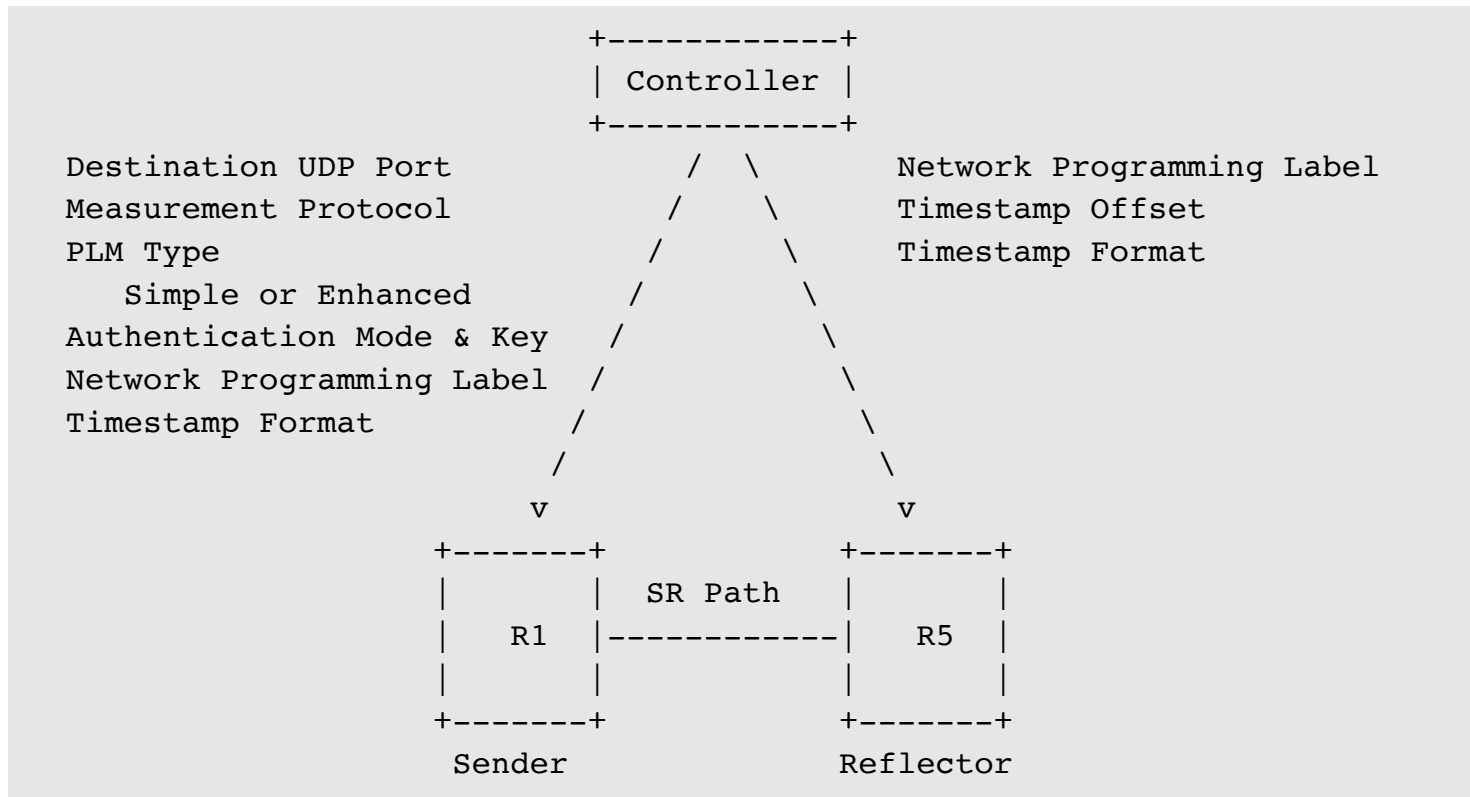
- Timestamp Label (TBA1) allocated by IANA from Extended Special-Purpose MPLS Label Values
    - Used for Timestamp, Pop and Forward network programing function
- Source and Destination Addresses are swapped for the Reverse direction path
- Optionally, Reverse direction SR path label stack can follow the Timestamp Label

ECMP Support for SR Policy

- SR Policy can have ECMP between the ingress and transit nodes, between transit nodes and between transit and egress nodes.
- Sending PM probe queries that can take advantage of the hashing function in forwarding plane.
- Existing forwarding mechanisms are applicable to PM probe messages:
  - For IPv4
    - Destination addresses in IPv4 header (e.g. 127/8) when return path is SR-MPLS
  - For IPv6
    - Destination addresses in IPv6 header (e.g. FFFF:7F00/104) when return path is SRv6
    - Flow label in IPv6 header

Example Provisioning Model

```
                          +------------+
                          | Controller |
                          +------------+
Destination UDP Port            / \        Network Programming Label
Measurement Protocol           /   \       Timestamp Offset
PLM Type                      /     \      Timestamp Format
   Simple or Enhanced        /       \
Authentication Mode & Key   /         \
Network Programming Label  /           \
Timestamp Format          /             \
                         /               \
             v                            v
       +-------+                    +-------+
       |       |  SR Path           |       |
       |  R1   |------------|  R5   |
       |       |                    |       |
       +-------+                    +-------+
         Sender                      Reflector
```

Next Steps

- Welcome your comments and suggestions
- Requesting WG adoption

Thank you

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Backup

SRv6 with Timestamp and Forward Function

```
+---------------------------------------------------------------+
|                         SRH                                   |
.                        <Segment List>                         .
.                        END.TSF with Target SID                .
+---------------------------------------------------------------+
| IP Header                                                     |
.   Source IP Address = Endpoint IPv6 Address                   .
.   Destination IP Address = Sender IPv6 Address                .
.   Protocol = UDP                                              .
.                                                               .
+---------------------------------------------------------------+
| UDP Header                                                    |
.   Source Port = As chosen by Sender                           .
.   Destination Port = User-configured Port                     .
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Payload as defined in Section 4.2.1 of RFC 5357 |           |
|   Payload as defined in Section 4.2 of RFC 8762              |
.                                                               .
+---------------------------------------------------------------+

Figure 6: Probe Message Header for SRv6 with Endpoint Function
```
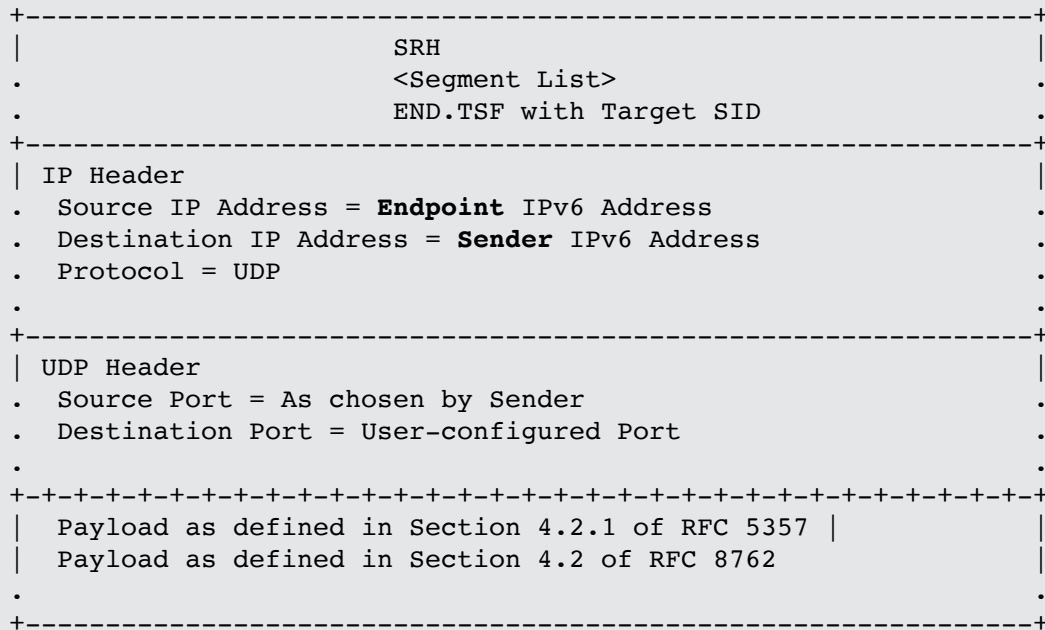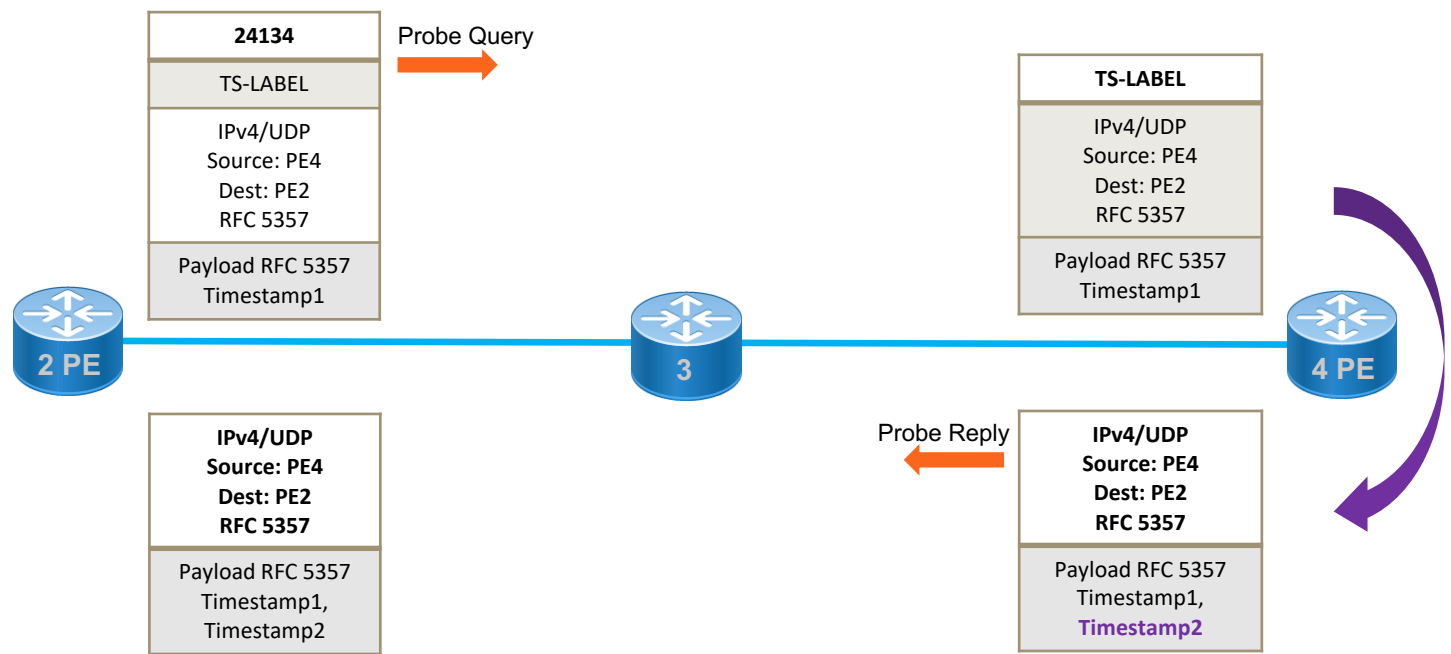
- Endpoint Function END.TSF is defined for Timestamp and Forward

- Source and Destination Addresses are swapped for the Reverse direction path in the inner IPv6 header

- Optionally, Reverse direction SR path can be carried in SRH

Thank you

Enhanced Loopback Mode for SR-MPLS Policy - IP/UDP Return Path

| 24134 |
| TS-LABEL |
| IPv4/UDP Source: PE4 Dest: PE2 RFC 5357 |
| Payload RFC 5357 Timestamp1 |

Probe Query

| TS-LABEL |
| IPv4/UDP Source: PE4 Dest: PE2 RFC 5357 |
| Payload RFC 5357 Timestamp1 |

| IPv4/UDP Source: PE4 Dest: PE2 RFC 5357 |
| Payload RFC 5357 Timestamp1, Timestamp2 |

Probe Reply

| IPv4/UDP Source: PE4 Dest: PE2 RFC 5357 |
| Payload RFC 5357 Timestamp1, Timestamp2 |

2 PE   3   4 PE

Enhanced Loopback Mode for SR-MPLS Policy – SR Return Path

24134
TS-LABEL
16002 NODE-SID
IPv4/UDP Source: PE4 Dest: PE2 RFC 5357
Payload RFC 5357 Timestamp1

Probe Query →

TS-LABEL
NODE-SID 16002
IPv4/UDP Source: PE4 Dest: PE2 RFC 5357
Payload RFC 5357 Timestamp1

NODE-SID 16002
IPv4/UDP Source: PE4 Dest: PE2 RFC 5357
Payload RFC 5357 Timestamp1, Timestamp2

← Probe Reply

NODE-SID 16002
IPv4/UDP Source: PE4 Dest: PE2 RFC 5357
Payload RFC 5357 Timestamp1, Timestamp2

2 PE — 3 — 4 PE

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