Enhanced Performance and Liveness Monitoring in Segment Routing Networks

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

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Agenda

- Requirements and Scope

- Summary

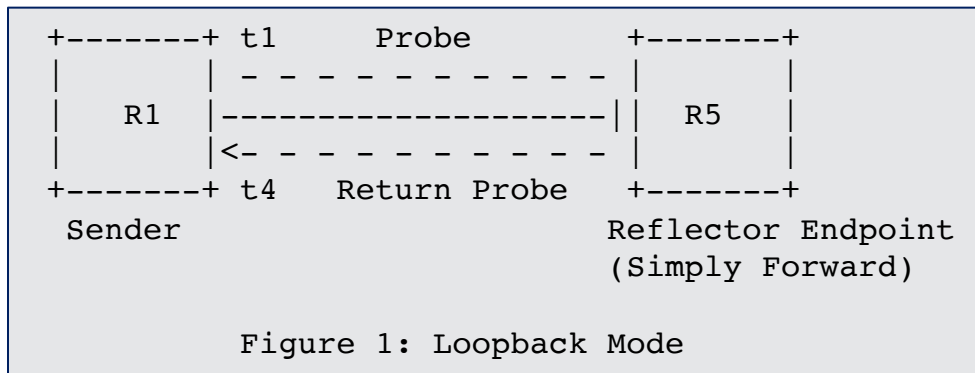- Next Steps

Requirements and Scope

Requirements:

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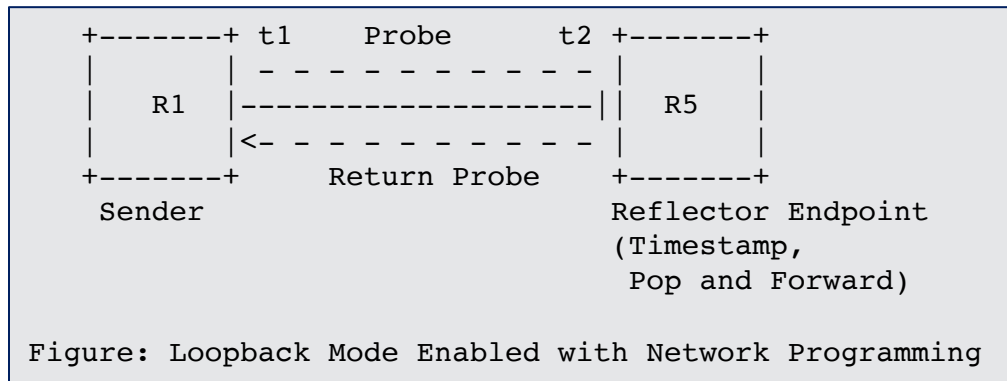 - ✓ Applicable to SR-MPLS/SRv6 data planes

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.

  - Timestamp at the fixed location locally provisioned consistently in the network

  - Only add the receive timestamp if the source address in the probe message matches the local node address
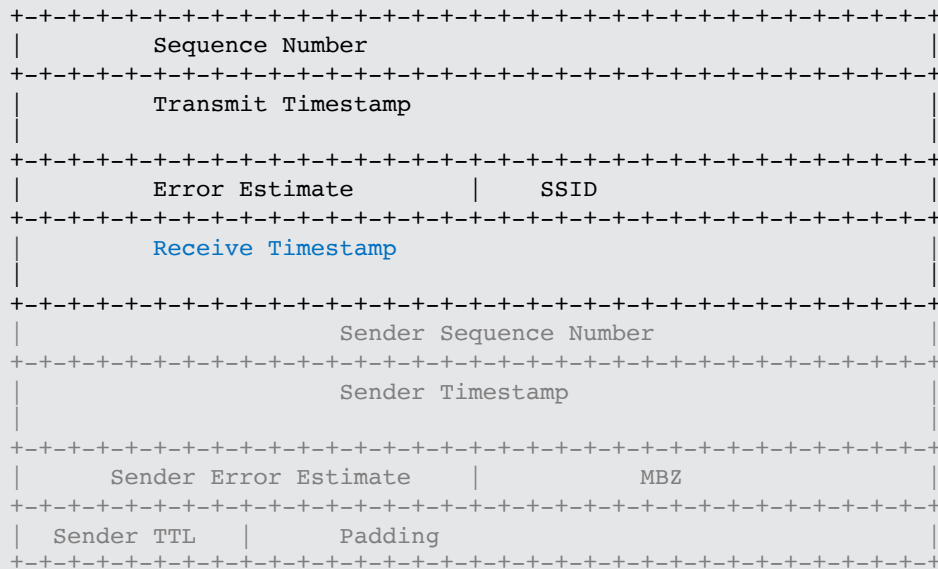
TWAMP Light/STAMP Probe Message

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|               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
  - For TWAMP Light and STAMP packets, it is at offset-byte 16 from the start of the payload
- Reflector does not copy Sender Sequence Number, Sender Timestamp, Sender Error Estimate and Sender TTL in response message
  - I.e. Sender Sequence Number, Sender Timestamp, Sender Error Estimate and Sender TTL in the TWAMP Light and STAMP messages are not used.

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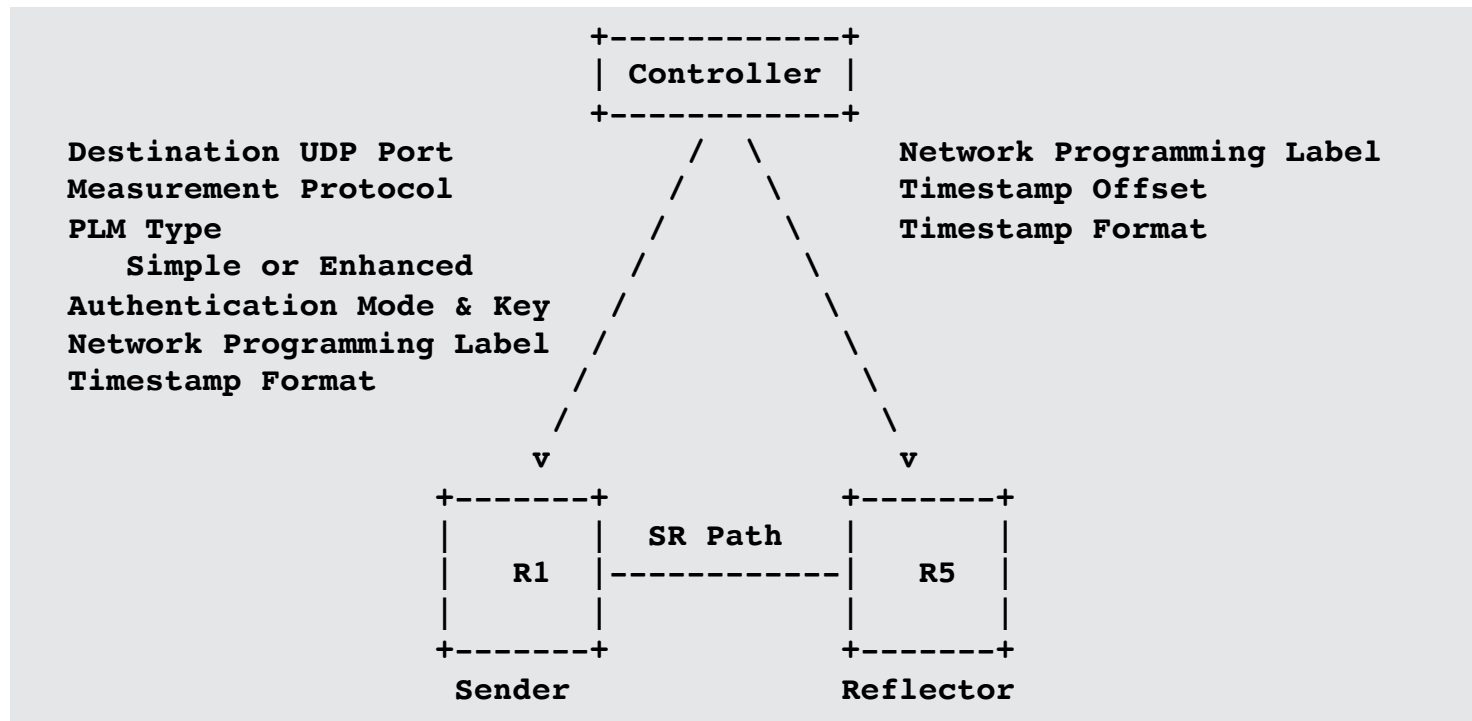
- Timestamp Label (TBA1) allocated by IANA from Extended Special-Purpose MPLS Label Values
  - Used for Timestamp, Pop and Forward network programing function
- Source and Destination Addresses swapped for the Reverse direction path
- Optionally, Reverse direction SR path label stack can follow the Timestamp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

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 swapped for the Reverse direction path in the inner IPv6 header

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

Thank you

IETF MPLS WG Interim – April 2020