Enhanced Performance and Liveness Monitoring in Segment Routing Networks

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

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)

Agenda

- Requirements and Scope

- Summary

- Next Steps

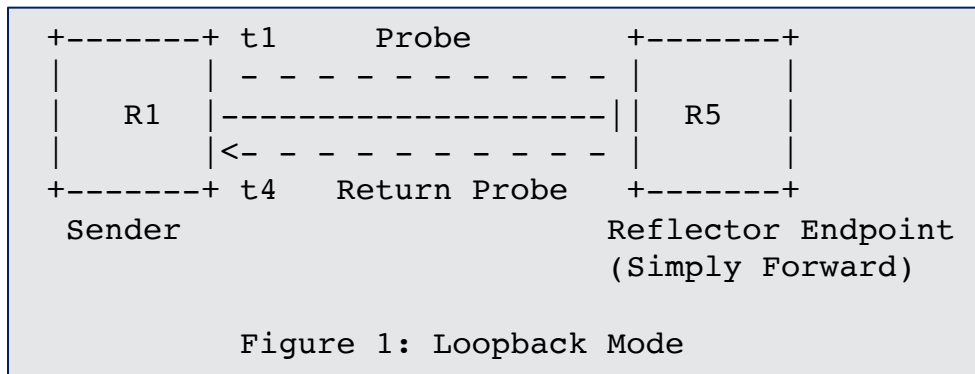# Requirements and Scope

Requirements:

- Performance Delay and Loss Measurement & Liveness Monitoring
    - ✓ End-to-end P2P/P2MP SR Policies
    - ✓ Links (Future)
    - ✓ 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 by default or SR path
- 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
```
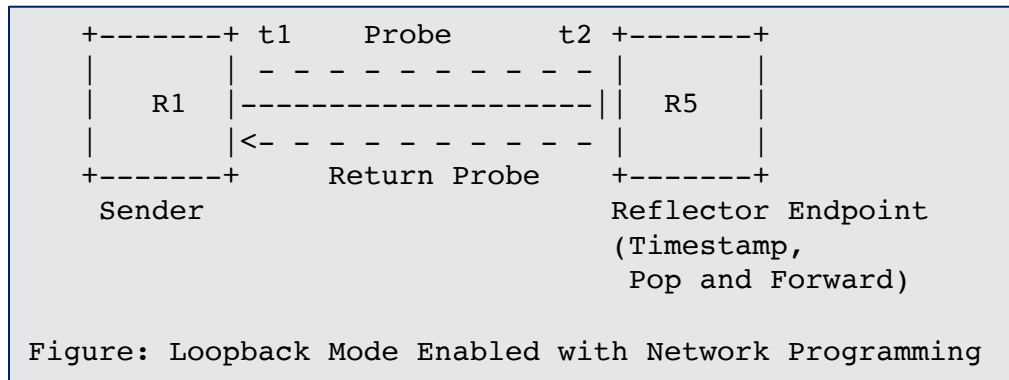
- Use PM probes in loopback mode enabled with network programming function.

  - 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 (at the fixed location locally provisioned consistently in the network) 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
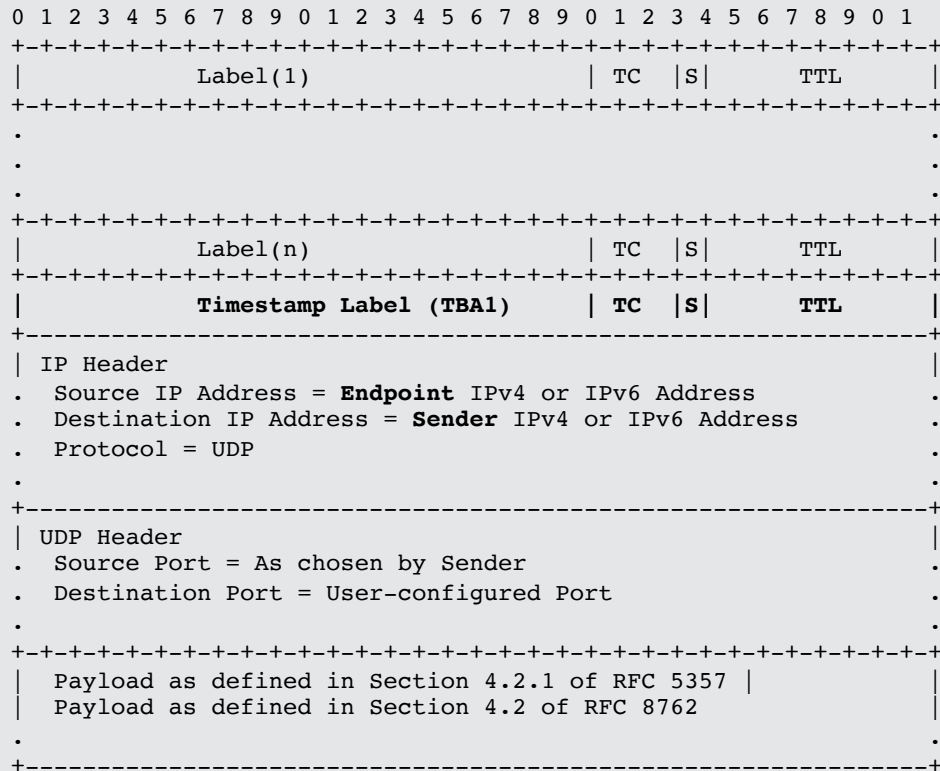
SR-MPLS with Timestamp Label

```
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 for the Reverse direction path
- Optionally, Reverse direction SR path label stack can follow the Timestamp Label
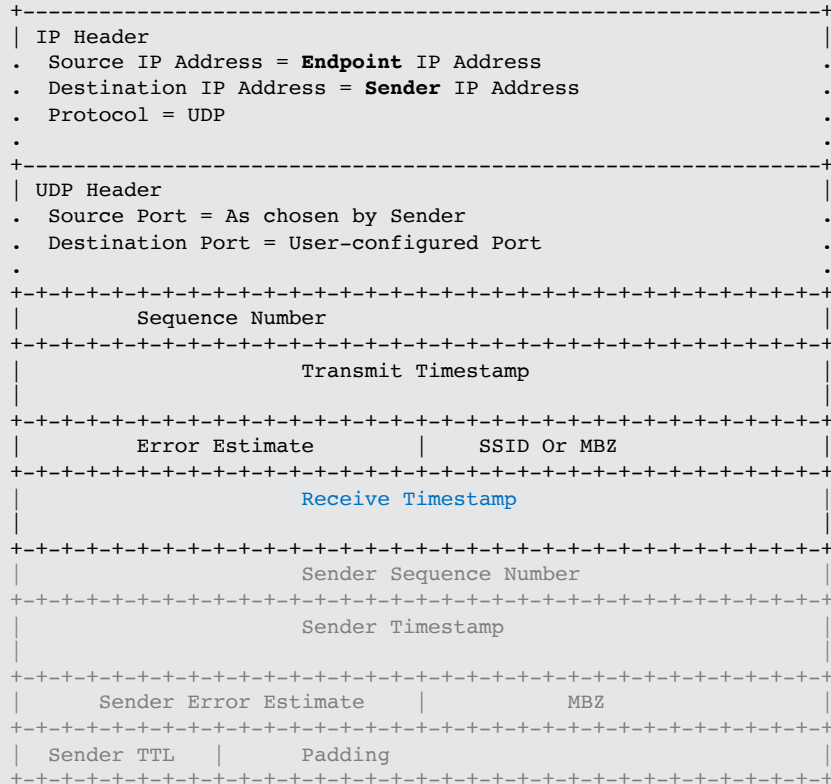
TWAMP Light/STAMP Message Format

```
+----------------------------------------------------------------+
| IP Header                                                      |
.  Source IP Address = Endpoint IP Address                       .
.  Destination IP Address = Sender IP Address                    .
.  Protocol = UDP                                                .
.                                                                .
+----------------------------------------------------------------+
| UDP Header                                                     |
.  Source Port = As chosen by Sender                             .
.  Destination Port = User-configured Port                       .
.                                                                .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Sequence Number                                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Transmit Timestamp                             |
|                                                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Error Estimate      |      SSID Or MBZ                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Receive Timestamp                              |
|                                                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|               Sender Sequence Number                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Sender Timestamp                               |
|                                                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Sender Error Estimate     |         MBZ                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Sender TTL   |      Padding                                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

         Figure: TWAMP Light Message Format
```
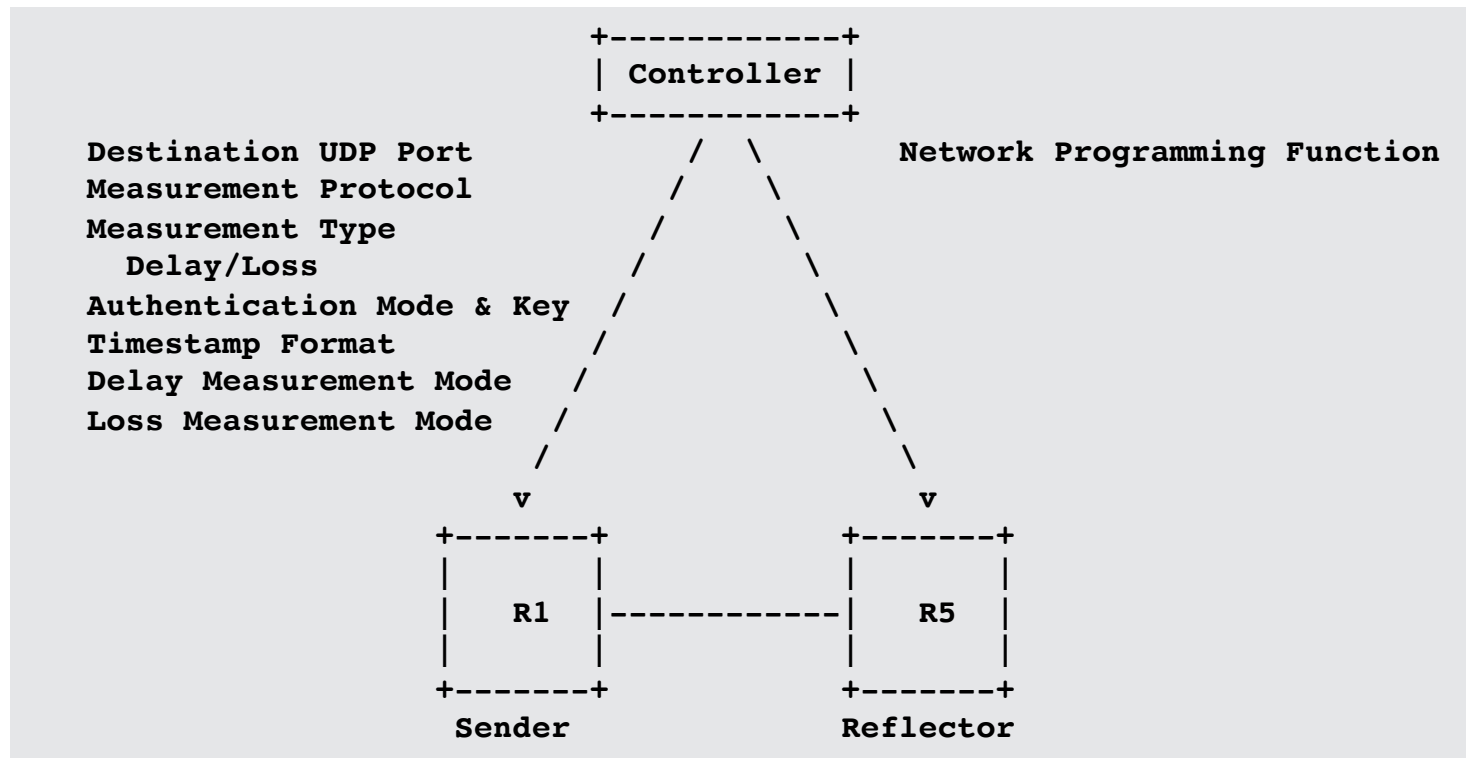
Enhanced Loopback Mode

- 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

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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
    - For IPv6
        - Destination addresses in IPv6 header (e.g. FFFF:7F00/104) when return path is SR
        - Flow label in IPv6 header

Example Provisioning Model

```
                        +-----------+
                        | Controller |
                        +-----------+
Destination UDP Port         / \         Network Programming Function
Measurement Protocol        /   \
Measurement Type           /     \
   Delay/Loss             /       \
Authentication Mode & Key /         \
Timestamp Format         /           \
Delay Measurement Mode  /             \
Loss Measurement Mode  /               \
                      /                 \
                     v                   v
              +-------+           +-------+
              |       |           |       |
              |  R1   |-----------|  R5   |
              |       |           |       |
              +-------+           +-------+
               Sender              Reflector
```

Next Steps

- Welcome your comments and suggestions

- Implementation exists

- 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 for the Reverse direction path in the inner IPv6 header

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

Thank you