Enhanced Performance Measurement and Liveness Monitoring in Segment Routing Networks

draft-gandhi-spring-sr-enhanced-plm-01

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Agenda

- Requirements and Scope

- Summary

- Next Steps

Requirements and Scope

Requirements:

- Performance Delay Measurement & Liveness Monitoring in SR networks
    - ✓ End-to-end P2P/P2MP SR paths
    - ✓ Applicable to SR-MPLS/SRv6 data planes
    - ✓ Support ECMP SR paths
- Running single protocol for liveness detection and performance measurement in SR networks
    - ✓ Simplify deployment and reduce operational complexity
- No endpoint dependency
    - ✓ Stateless on endpoint (e.g. endpoint unaware of the probe protocol)
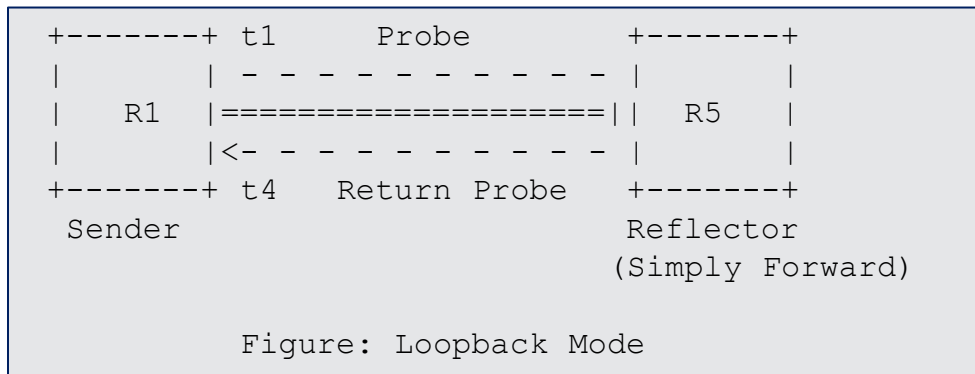   - ✓ Higher scale and faster detection interval (e.g. packets not punted out of fast-path)

Scope:

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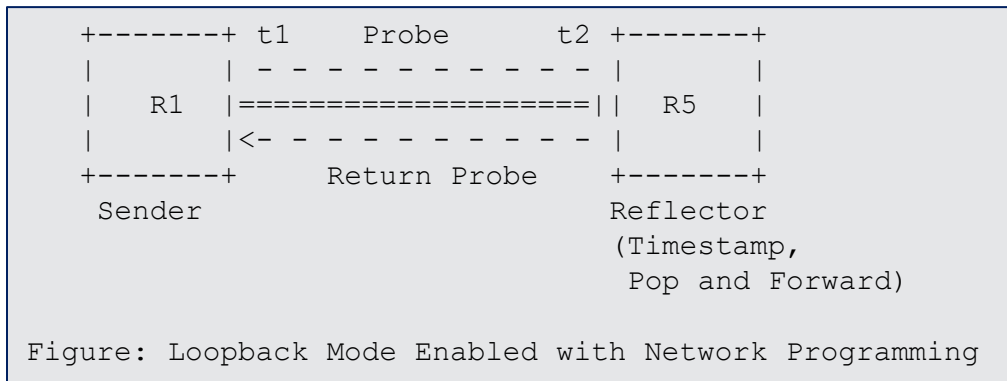
History of the Draft

- March 2020
  - Draft was published
- April 2020
  - Presented *version 00* in IETF MPLS WG Virtual Meeting

Liveness and Performance Monitoring of SR Policy

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

          Figure: Loopback Mode
```

- Use 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 reflector out of fast-path
- 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
- Round-trip delay metrics are notified when consecutive M number of probe messages have delay values exceed the configured thresholds

Enhanced Liveness and Performance Monitoring of SR Policy

```
+-------+ t1     Probe      t2 +-------+
|       | - - - - - - - - - - |       |
|  R1   |====================|| R5    |
|       |<- - - - - - - - - - |       |
+-------+    Return Probe     +-------+
 Sender                        Reflector
                               (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 reflector node adds the receive timestamp in the payload of the received TWAMP Light or STAMP probe message without punting the probe message

  - Only adds 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

- One-way delay metrics are notified when consecutive M number of probe messages have delay values exceed the configured thresholds

Probe Message – Enhanced Loopback Mode

- Sender adds the Transmit Timestamp
- Reflector adds the Receive Timestamp at fixed offset locally provisioned (consistently in the network)
  - E.g. offset-byte 16 from the start of the payload

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

            Figure: TWAMP Light Probe Message Format
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Sequence Number                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Transmit Timestamp                        |
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Error Estimate         |          SSID             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Receive Timestamp                                   |
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Sender Sequence Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   Sender Timestamp                           |
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       Sender Error Estimate       |          MBZ            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Sender TTL   |        Padding                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

              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       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Timestamp Label (TBA1)       | TC  |S|     TTL       |
+--------------------------------------------------------------+
| IP Header                                                    |
.  Source IP Address = Reflector 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              |
.                                                              .
+--------------------------------------------------------------+

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

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

SRv6 with Timestamp and Forward Function

```
+---------------------------------------------------------------+
| IP Header                                                     |
.   Source IP Address = Sender IPv6 Address                     .
.   Destination IP Address = Next IPv6 Address                  .
.                                                               .
+---------------------------------------------------------------+
|  SRH as specified in RFC 8754                                 |
.    <Segment List>                                             .
.  END.TSF with Target 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 = User-configured Port                     .
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Payload as defined in Section 4.2.1 of RFC 5357 |           |
|  Payload as defined in Section 4.2 of RFC 8762   |           |
.                                                               .
+---------------------------------------------------------------+

       Example Probe Message for SRv6 with Endpoint Function
```
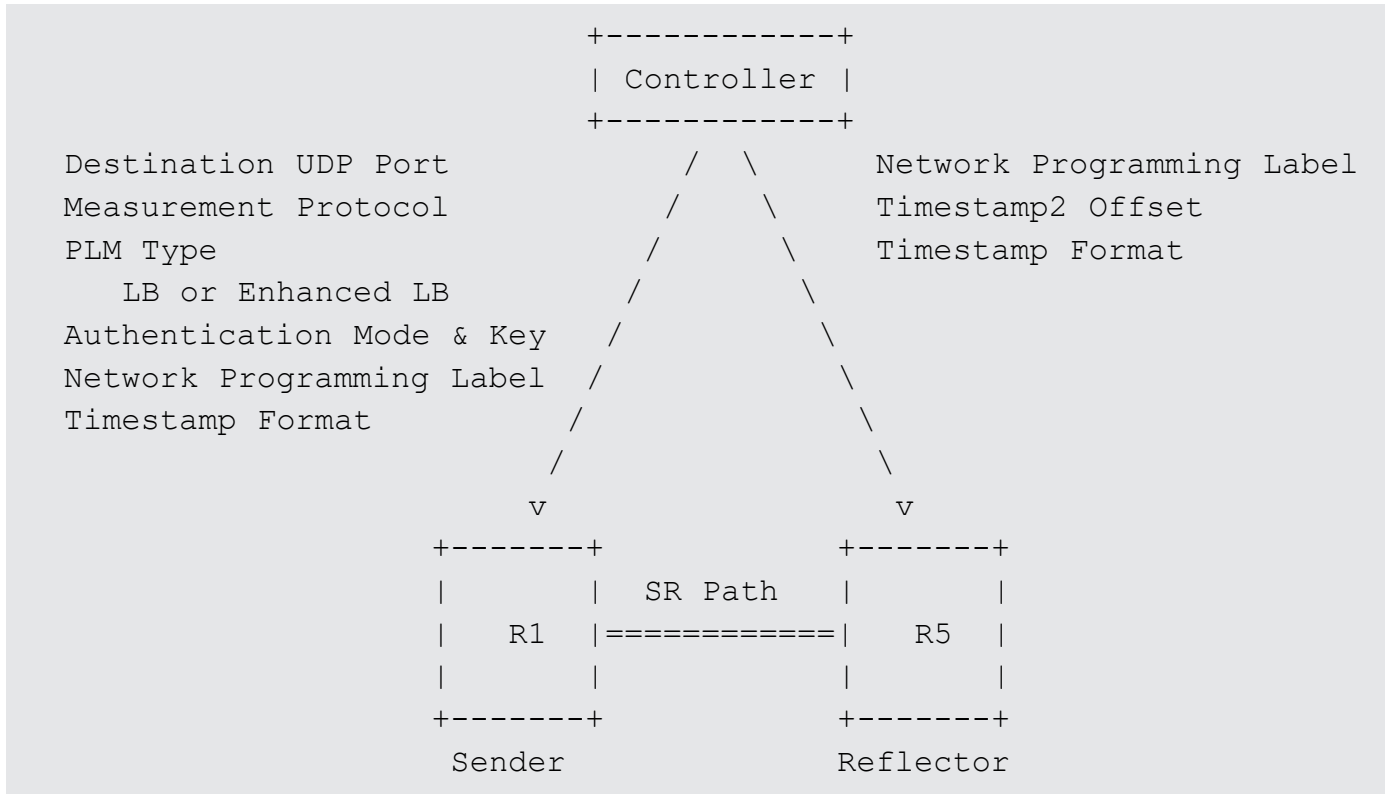
- Endpoint Function END.TSF is defined for Timestamp and Forward and carried for the Reflector node SID
- Reverse path can be IP
  - Reflector node removes SRH
- Reverse path can be SR
  - Reverse direction SR path carried in SRH
  - Reflector node does not remove the SRH
- Source and Destination Addresses are swapped to 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.

- Sending PM probe queries that can take advantage of the hashing function in forwarding plane.

- Existing forwarding mechanisms are applicable to PM probe messages. Examples are:
  - For IPv4
    - Sweeping destination address in IPv4 header (e.g. 127/8) if return path is SR-MPLS
  - For IPv6
    - Sweeping flow label in IPv6 header

Example Provisioning Model

```
                        +------------+
                        | Controller |
                        +------------+
Destination UDP Port              / \        Network Programming Label
Measurement Protocol             /   \       Timestamp2 Offset
PLM Type                        /     \       Timestamp Format
   LB or Enhanced LB           /       \
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