Enhanced Performance and Liveness Monitoring in Segment Routing Networks

draft-gandhi-spring-sr-enhanced-plm-04

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Agenda

- Requirements and Scope

- History and Summary of Updates

- Review of the Procedure

- Next Steps

Requirements and Scope

Requirements:

- In-band Performance and Liveness Monitoring (PLM) in SR networks
  - ✓ End-to-end 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 Session-Reflector dependency
  - ✓ Session-Reflector unaware of the monitoring protocol
    - ✓ State is in the test packet - spirit of SR
  - ✓ Higher test session scale and faster failure detection interval

Scope:

- Leverage RFC 8762 (Simple TWAMP (STAMP)) hardware implementation
  - Same location for timestamp fields in the new test packet formats

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
- September 2020
  - Presented version 02 in MPLS WG Interim meeting

Updates Since IETF-108 (Version-02)

Updates:

- ✓ Updated terminology
- ✓ Added authentication mode
- ✓ Added SRv6 Timestamp Endpoint assignment and Node Capability
- ✓ Added synthetic packet loss
- ✓ Updated IANA section
- ✓ Various editorial changes

Open Items:

- ▪ None

Loopback Mode for SR Policy

```
              T1
             /
 +-------+       PLM Test Packet     +-------+
 |       |  | - - - - - - - - - - |  |       |
 |   R1  |  |=====================||    R3   |
 |       |  |<- - - - - - - - - - |  |       |
 +-------+      Return Test Packet  +-------+
             \
              T4

 Session-Sender                Session-Reflector
                               (Simply Forward)

           Figure: PLM Loopback Mode
```
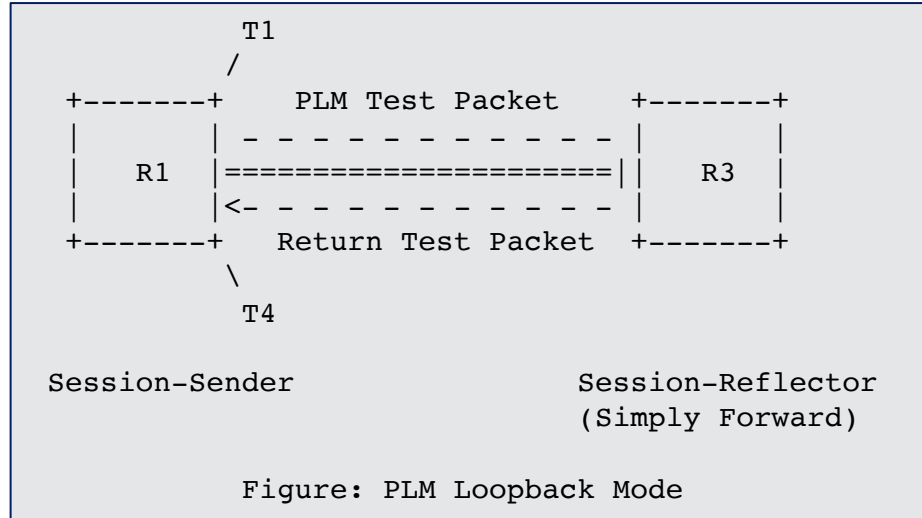
- PLM test packets in Loopback Mode

- PLM test packets are transmitted for each Segment List(s) of the SR Policy Candidate Path(s)

- PLM test packets are forwarded in fast-path just like data traffic on Session Reflector - not punted to slow-path

- Session-Reflector is agnostic to the PLM protocol

- Round-trip delay = (T4 - T1)

Loopback Mode Enabled with Network Programming Function

```
                T1                        T2
                 /                          \
     +-------+        PLM Test Packet     +-------+
     |       |   | - - - - - - - - - - |  |       |
     |  R1   |   |=====================||   R3    |
     |       |   |<- - - - - - - - - - |  |       |
     +-------+        Return Test Packet +-------+
                 \
                T4

  Session-Sender                    Session-Reflector
                                     (Timestamp,
                                      Pop and Forward)
```
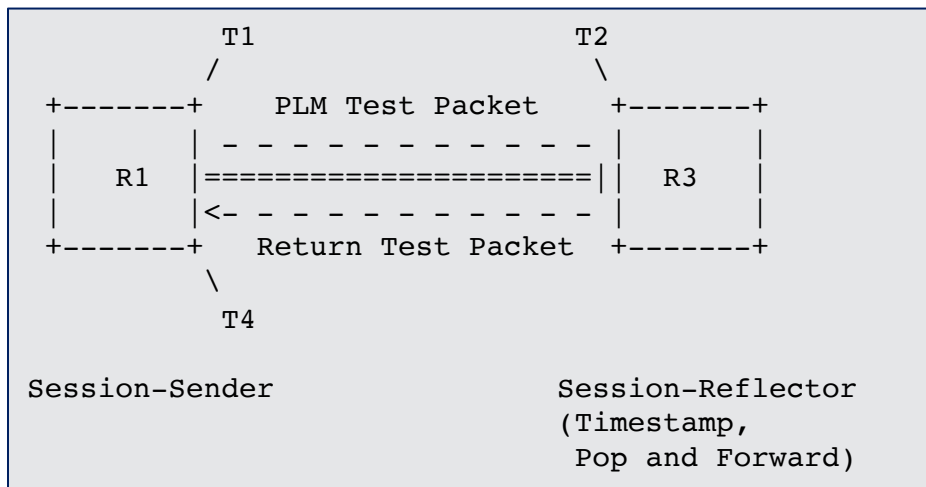
- PLM test packets transmitted in loopback mode enabled with network programming function
  - The network programming function optimizes the "operations of punt and generate the test packet" on Session-Reflector
  - As PLM test packets are forwarded in fast-path, higher session scale with faster failure detection interval is achieved
- Session-Reflector adds receive timestamp at a specific location in the payload of the received test packet in fast-path
  - Only adds the receive timestamp if the source address or destination address in the received test packet matches the local node address
  - Ensure loopback PLM test packets return from the intended Session-Reflector
- One-way delay = (T2 – T1)

110th IETF Online

7

Example Provisioning Model

```
                          +------------+
                          | Controller |
                          +------------+
PLM Mode                       /     \        Timestamp Label/SRV6 EB
Loopback or Enhanced Mode     /       \          Timestamp Offset
Timestamp Label/SRv6 EB      /         \         Timestamp Format
  Timestamp Format          /           \
Missed Packet Count (N)    /             \
Delay Threshold/Count (T/M)  /             \
Packet Loss Threshold (XofY) /             \
                        v                   v
                   +-------+           +-------+
                   |       |           |       |
                   |  R1   |===========|  R3   |
                   |       |           |       |
                   +-------+           +-------+

             Session-Sender         Session-Reflector

             Figure: Example Provisioning Model
```
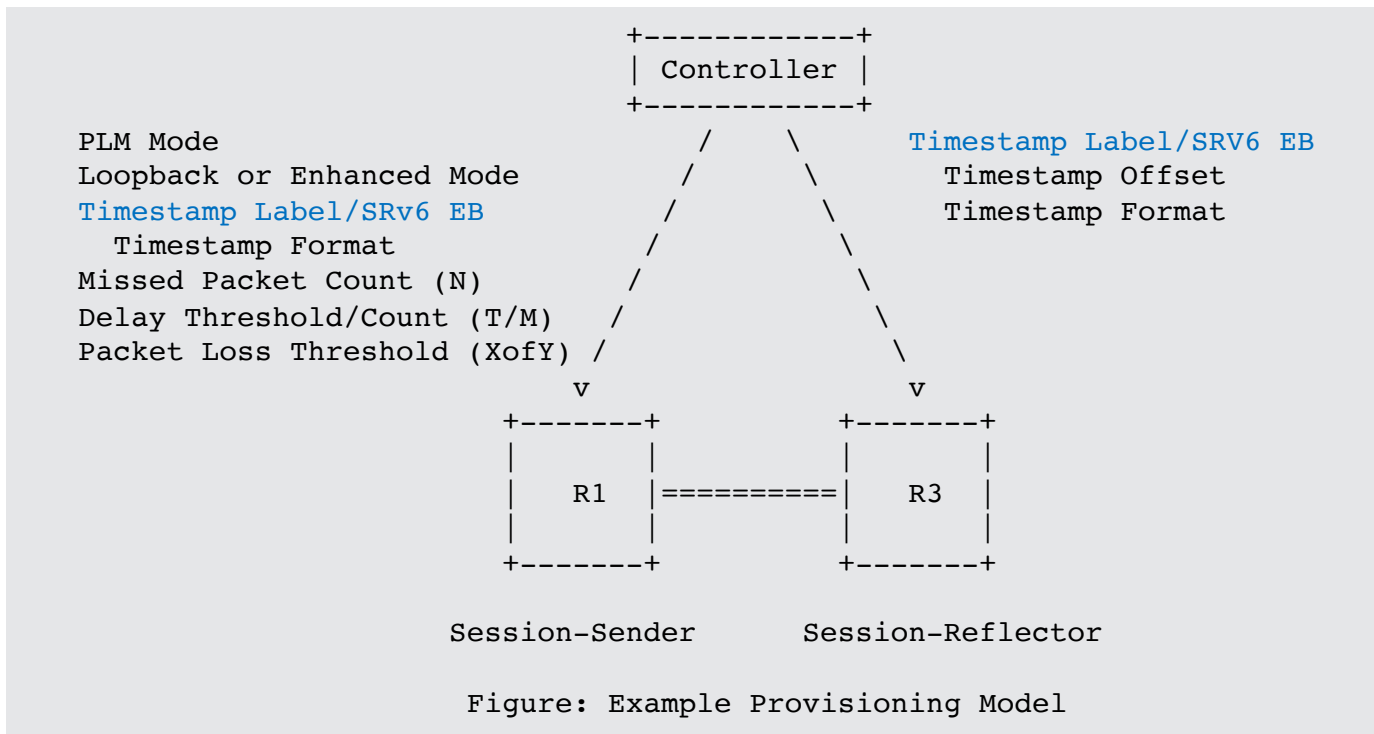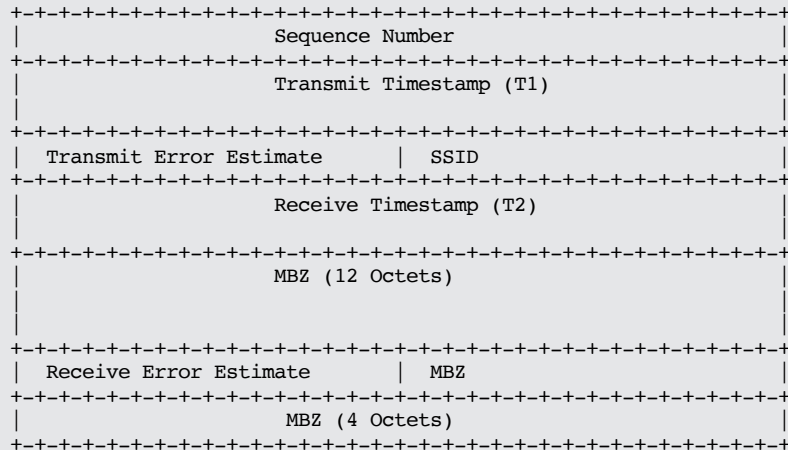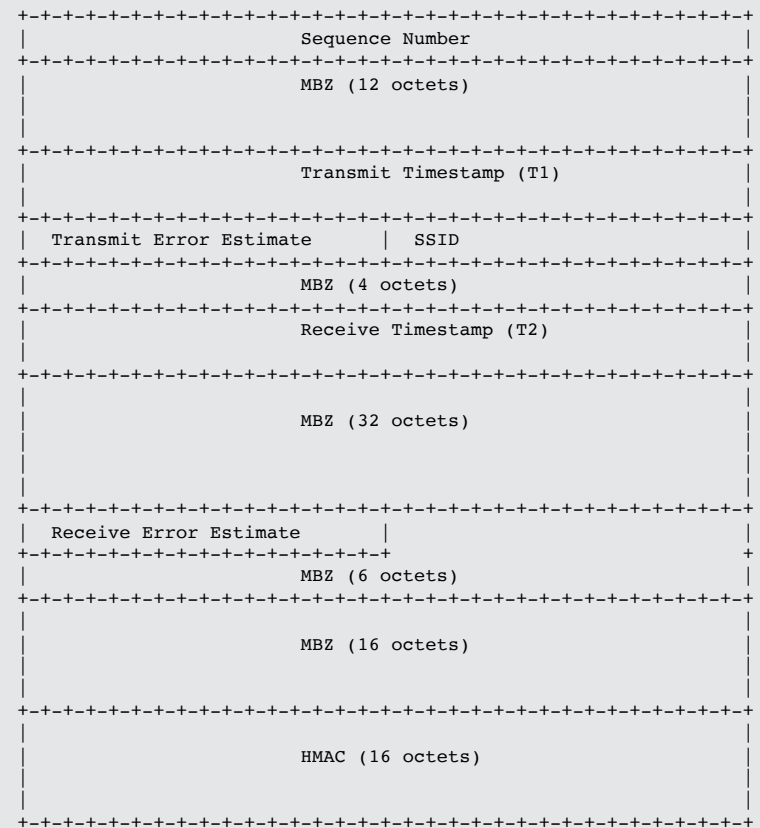
* Provisioned, Flooded/Signaled or IANA Allocated

PLM Test Packet Formats

- Leverage existing STAMP implementations in hardware for timestamp field locations
- Session-Sender adds Transmit Timestamp (T1)
- Session-Reflector adds Receive Timestamp (T2) at offset-byte location in payload, for example,
  - offset-byte 16 from the start of the payload in unauthenticated mode, or
  - offset-byte 32 from the start of the payload in authenticated mode, or
  - locally provisioned location (consistently in the network)

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Sequence Number                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transmit Timestamp (T1)                   |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Transmit Error Estimate       |       SSID                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Receive Timestamp (T2)                   |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        MBZ (12 Octets)                        |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Receive Error Estimate        |        MBZ                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        MBZ (4 Octets)                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

      PLM Test Packet Format in Unauthentication Mode
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Sequence Number                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        MBZ (12 octets)                        |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transmit Timestamp (T1)                   |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Transmit Error Estimate       |       SSID                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        MBZ (4 octets)                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Receive Timestamp (T2)                   |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                        MBZ (32 octets)                        |
|                                                               |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Receive Error Estimate        |                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+                              +
|                        MBZ (6 octets)                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                        MBZ (16 octets)                        |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                        HMAC (16 octets)                       |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

    PLM Test Packet Format in Authentication Mode
```

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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Extension Label (15)          | TC  |S|       TTL      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Timestamp Label (TBA1 or TBA2)   | TC  |S|       TTL      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| IP Header                                                      |
.  Source IP Address = Session-Reflector IPv4 or IPv6 Address   .
.  Destination IP Address = Session-Sender IPv4 or IPv6 Address .
.                                                                .
+----------------------------------------------------------------+
| UDP Header                                                     |
.  Source Port = As chosen by Session-Sender                    .
.  Destination Port = As chosen by Session-Sender               .
.                                                                .
+----------------------------------------------------------------+
| PLM Test Packet                                               |
.                                                                .
+----------------------------------------------------------------+

   Example PLM Test Packet with Timestamp Label for SR-MPLS
```
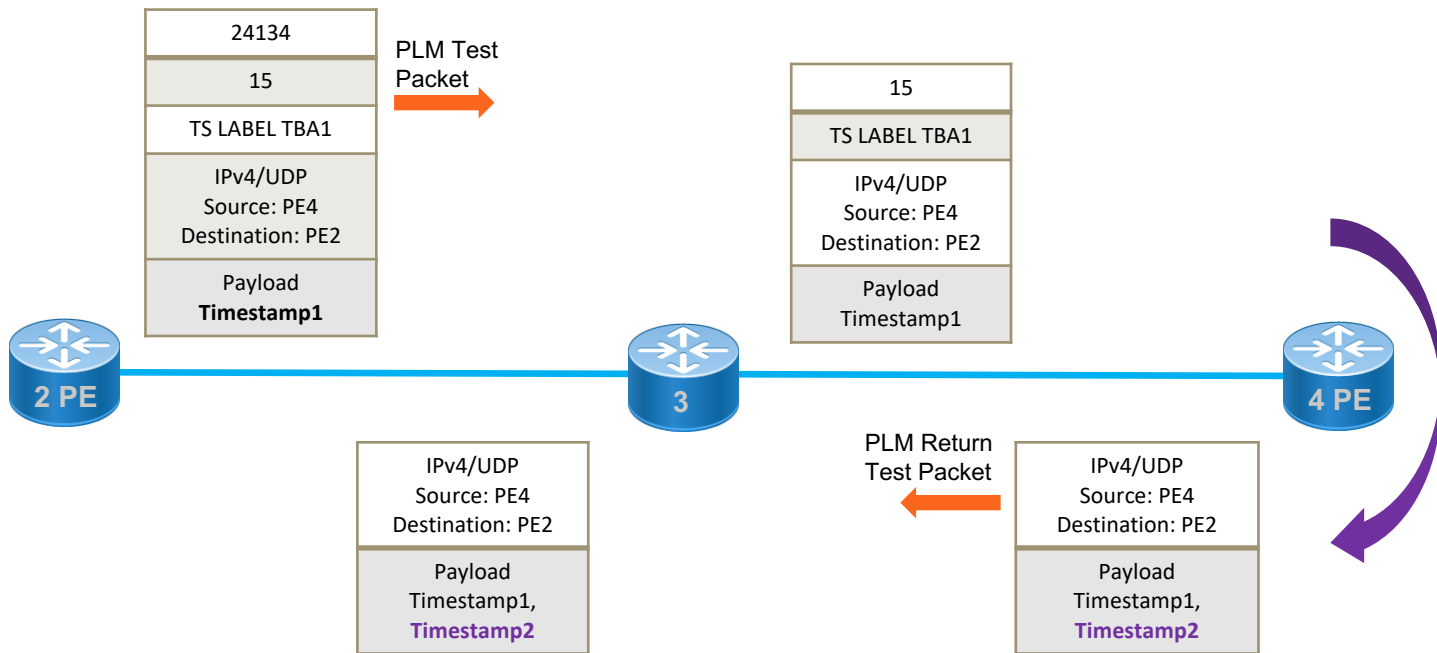
- Timestamp labels (TBA1 and TBA2) are defined for Timestamp, Pop and Forward function
- Reverse Path can be IP or SR-MPLS
- Source and Destination Addresses are swapped that represent the Reverse direction path

Loopback Mode with Timestamp and Forward for SR-MPLS Policy

SRv6 with Timestamp Endpoint Function

```
+------------------------------------------------------------+
| IP Header                                                  |
.  Source IP Address = Session-Sender IPv6 Address           .
.  Destination IP Address = Destination IPv6 Address         .
.                                                            .
+------------------------------------------------------------+
| SRH as specified in RFC 8754                               |
.  <Segment List>                                            .
.  End.TSF (TBA3 or TBA4) with Session-Reflector SID         .
.                                                            .
+------------------------------------------------------------+
| IP Header                                                  |
.  Source IP Address = Session-Reflector IPv6 Address        .
.  Destination IP Address = Session-Sender IPv6 Address      .
.                                                            .
+------------------------------------------------------------+
| UDP Header                                                 |
.  Source Port = As chosen by Session-Sender                 .
.  Destination Port = As chosen by Session-Sender            .
.                                                            .
+------------------------------------------------------------+
| PLM Test Packet                                            |
.                                                            .
+------------------------------------------------------------+

Example PLM Test Packet with Timestamp Endpoint Function for SRv6
```

- Timestamp Endpoint Functions End.TSF (TBA3 and TBA4) is defined for Timestamp and Forward and is carried with the Session-Reflector node SID
- Reverse path can be IP
  - Session-Reflector removes SRH
- Reverse path can be SR
  - Reverse direction SR path Segment-list carried in SRH
  - Session-Reflector does not remove the SRH
- Source and Destination Addresses are swapped that represent the Reverse direction path in the inner IPv6 header

Performance Metric Notifications

- Liveness success (success of heart beats) is initially notified as soon as one or more PLM return test packets are received at the Session-Sender

- Liveness failure (loss of heart beats) is notified when consecutive N number of PLM return test packets are not received at the Session-Sender

- Synthetic packet loss is notified when X number of PLM return test packets not received at the Session-Sender out of last Y PLM test packets transmitted (with configured XofY threshold)

- Delay metrics are notified as an example, when consecutive M number of PLM test packets have delay values exceed the configured thresholds (absolute/percentage)

Next Steps

- Welcome your comments and suggestions
- Requesting SPRING WG adoption

Thank you