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:

- Performance & Liveness Monitoring 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)) Implementation in Hardware

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
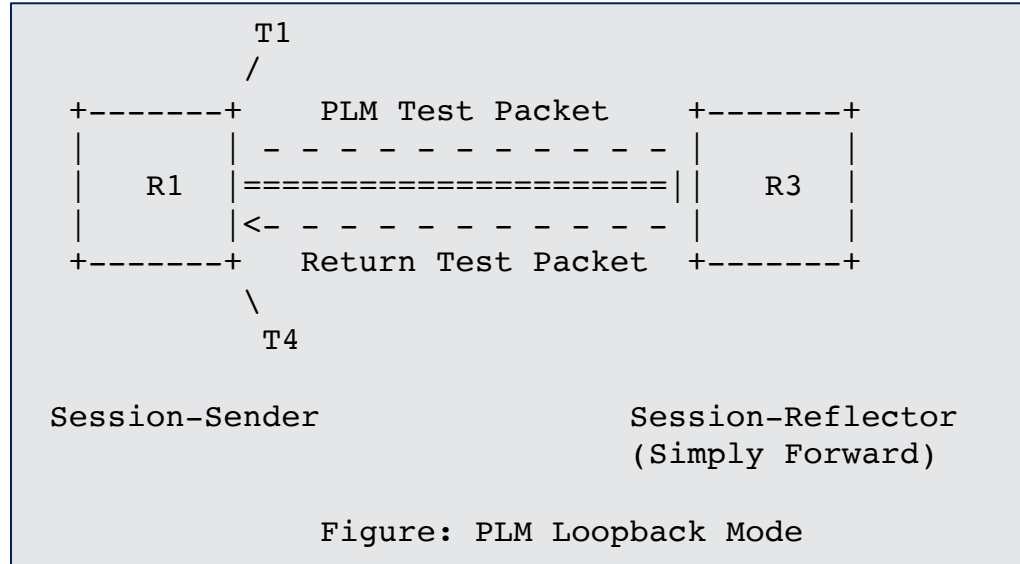
Updates Since IETF-108 (Version-02)

Updates:

- ✓ Updated terminology – test packets, consistent terms for MPLS Timestamp Label and SRv6 Timestamp Endpoint
- ✓ Added authentication mode
- ✓ Added section on SRv6 Timestamp Endpoint function 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
```
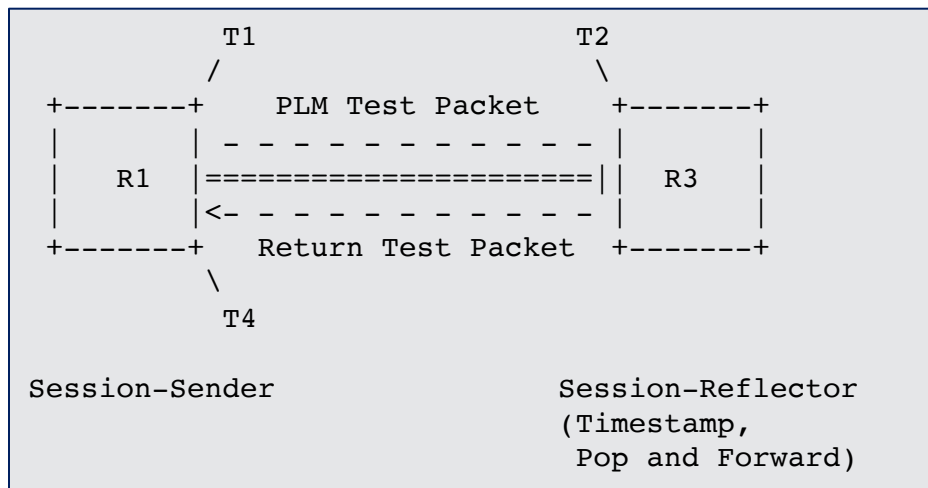
- PLM test packets in Loopback Mode

- PLM test packets are transmitted using 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 performance monitoring 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 inject the test packet" on Session-Reflector
  - As PLM test packets are forwarded in fast-path, higher session scale with faster failure detection interval is possible
- 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 test packet matches the local node address
  - Ensure loopback PLM test packets return from the intended Session-Reflector
- One-way delay = (T2 – T1)

Example Provisioning Model

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

                    Session-Sender        Session-Reflector


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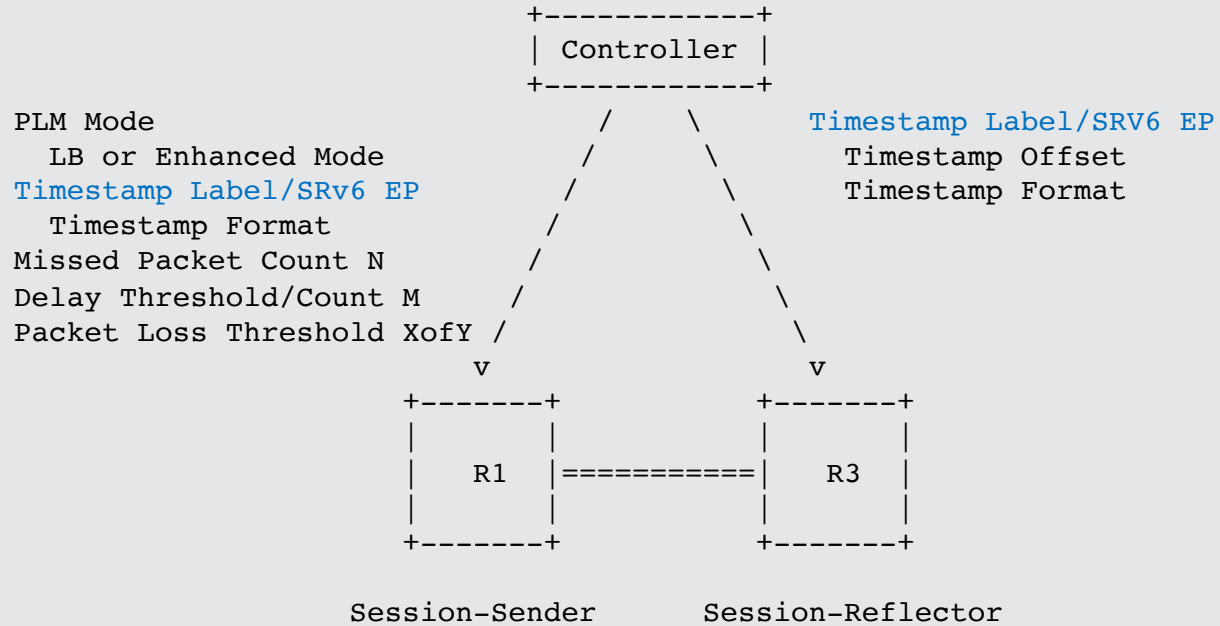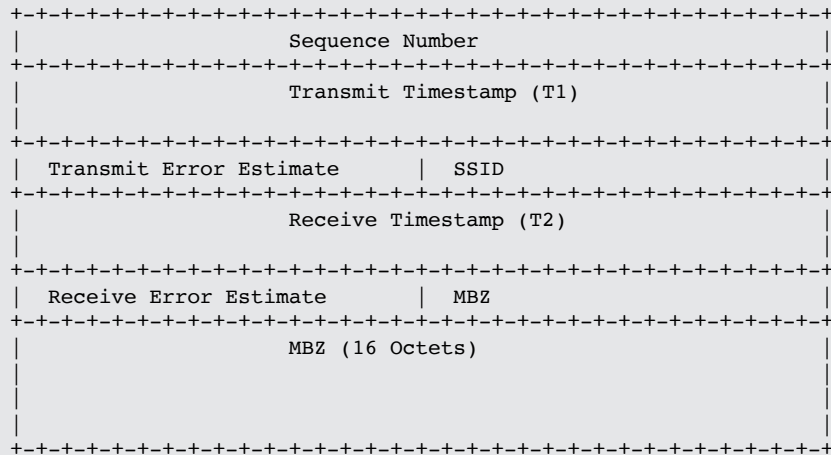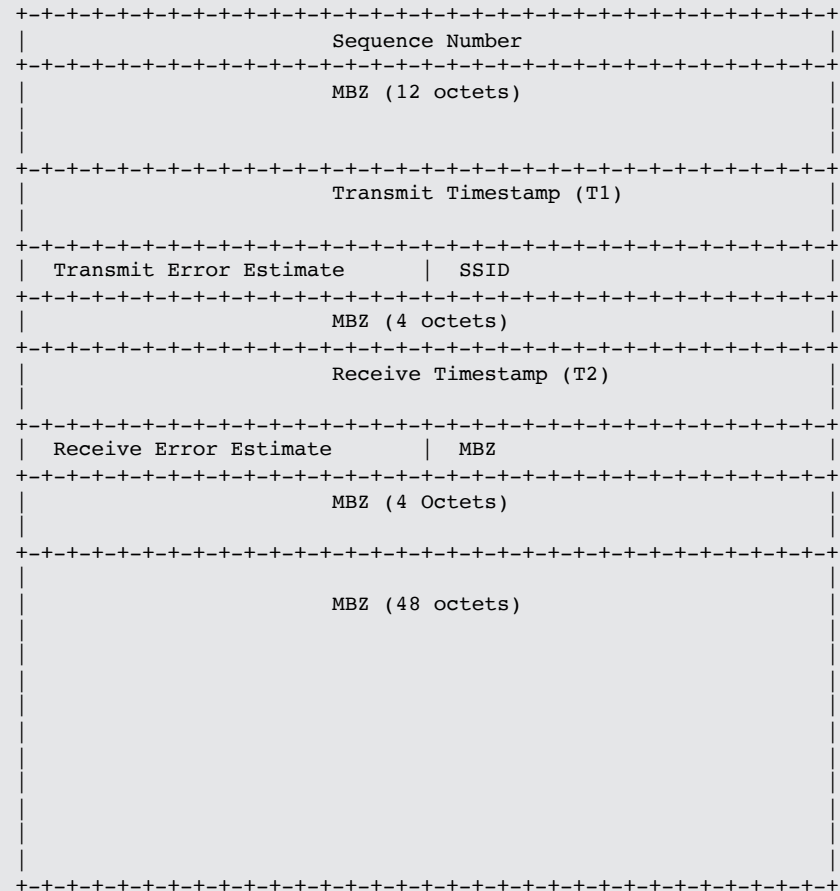
* Provisioned, Flooded/Signaled or IANA Allocated

PLM Test Packet Formats

- Leverage existing STAMP implementations in hardware
- 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)                     |
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Receive Error Estimate        |          MBZ                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      MBZ (16 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)                     |
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Receive Error Estimate        |          MBZ                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      MBZ (4 Octets)                          |
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                              |
|                                                              |
|                      MBZ (48 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              .
.                                                              .
+--------------------------------------------------------------+
| Payload                                                      |
.                                                              .
+--------------------------------------------------------------+

   Example PLM Test Packet with Timestamp Label for SR-MPLS
```

- Timestamp label (TBA1) is 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

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            .
.                                                            .
+------------------------------------------------------------+
| Payload                                                    |
.                                                            .
+------------------------------------------------------------+

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

- Timestamp Endpoint Function End.TSF (TBA3) 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 (connectivity Up - success of heart beats) initially is notified as soon as one or more PLM return test packets are received at the Session-Sender

- Liveness failure (connectivity loss - 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

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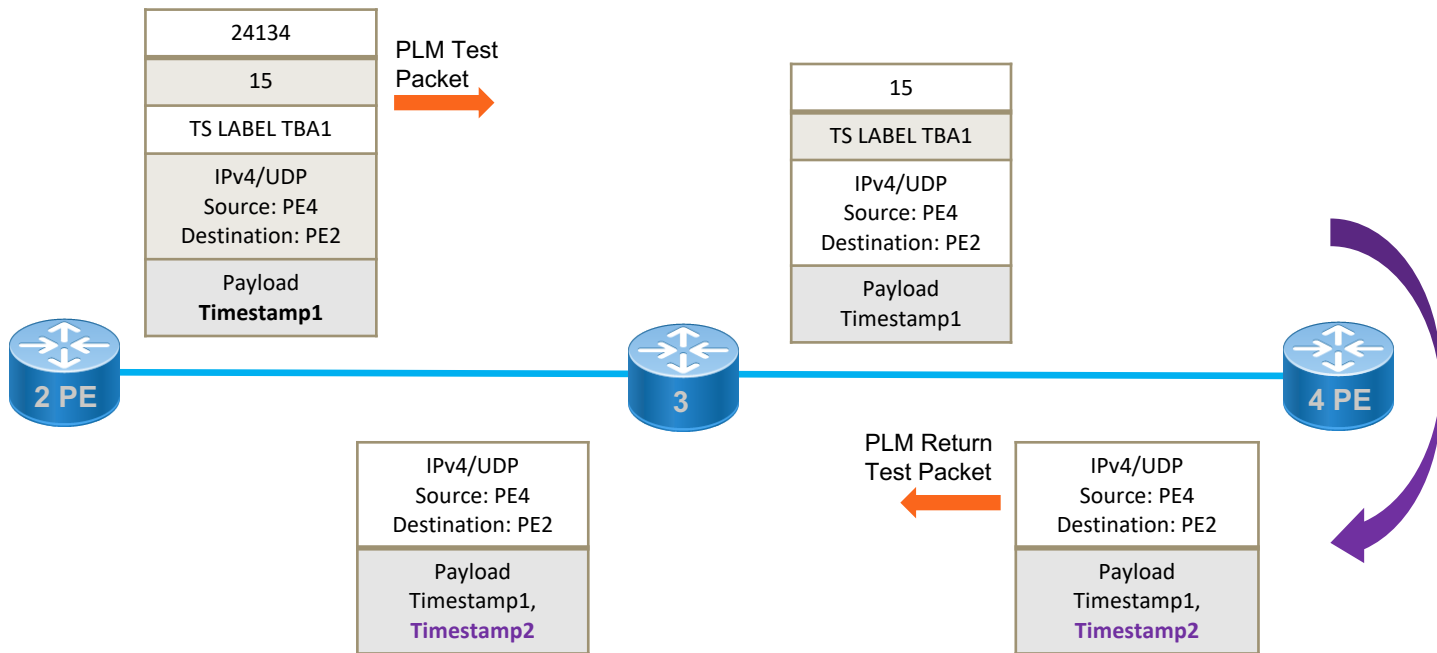
Next Steps

- Welcome your comments and suggestions
- Requesting SPRING WG adoption

Thank you

Backup

Loopback Mode with Timestamp and Forward for SR-MPLS Policy

Thank you