Enhanced Performance and Liveness Monitoring in Segment Routing Networks

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

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)
Richard Foote - Nokia (footer.foote@nokia.com)

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 scale and faster 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
```
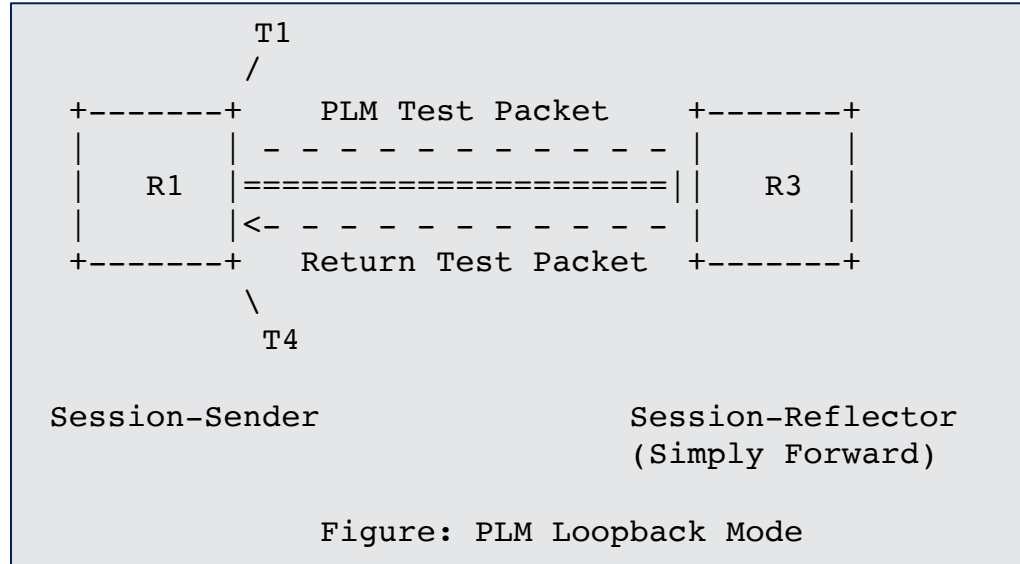
- PLM test packets in Loopback Mode
- PLM test packets are sent using Segment List(s) of the SR Policy Candidate Path(s)
- PLM test packets are not punted on the Session-Reflector node out of fast-path in forwarding
- Session-Reflector is agnostic to the performance monitoring protocol
- Round-trip delay = (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)
```
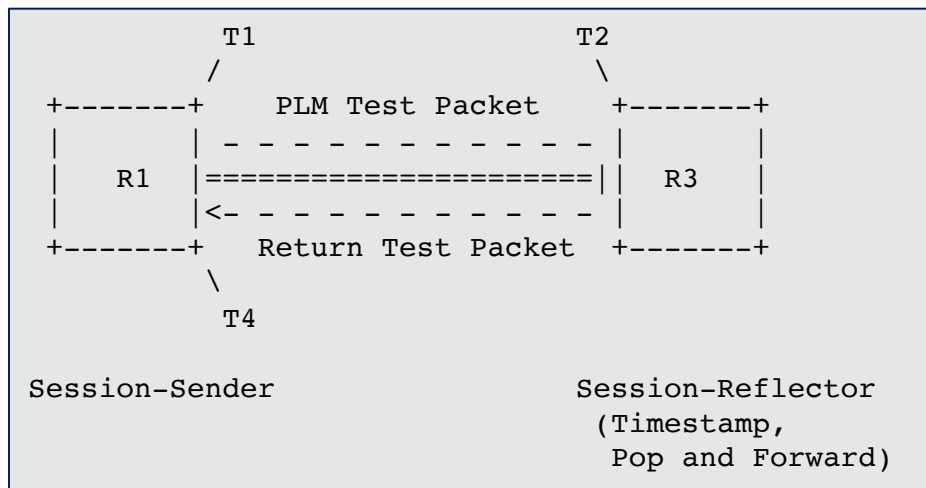
- PLM test packets sent in loopback mode enabled with network programming function
  - The network programming function optimizes the "operations of punt and inject the test packet" on the Session-Reflector
  - As PLM test packets are forwarded in fast-path, higher session scale with faster failure detection 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 node
- One-way delay = (T2 – T1)

Example Provisioning Model

```
                        +------------+
                        | Controller |
                        +------------+
PLM Mode                    /    \          Timestamp Label/SRV6 EP
  LB or Enhanced Mode      /      \           Timestamp2 Offset
Delay Threshold/Count M   /        \          Timestamp Format
Missed Test Packet Count N /        \
Packet Loss XofY          /          \
Timestamp Label/SRv6 EP  /            \
  Timestamp Format       /             \
                        v               v
                  +-------+        +-------+
                  |       |        |       |
                  |  R1   |========|   R3  |
                  |       |        |       |
                  +-------+        +-------+

              Session-Sender        Session-Reflector

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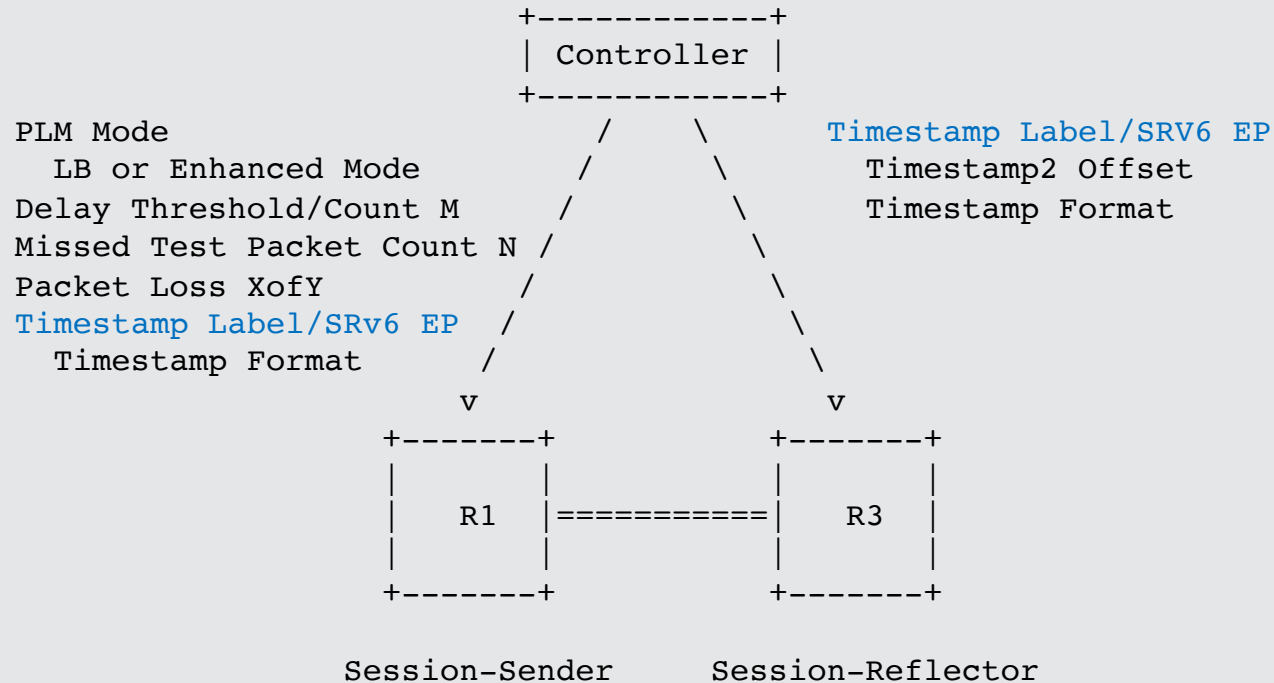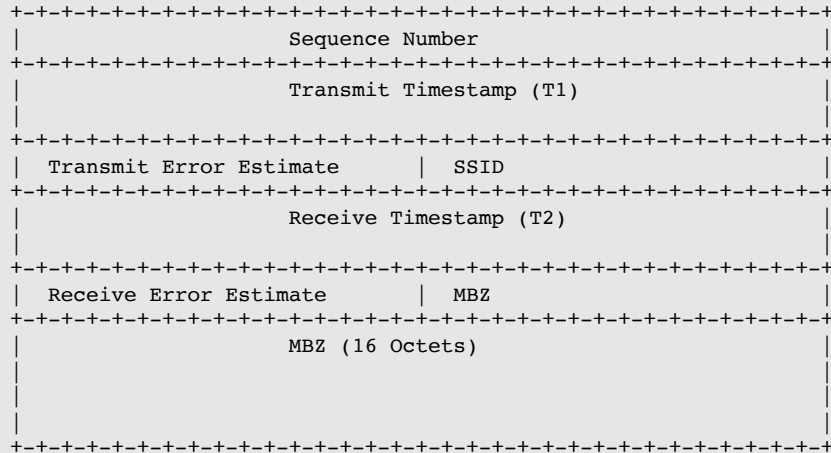
* Provisioned,
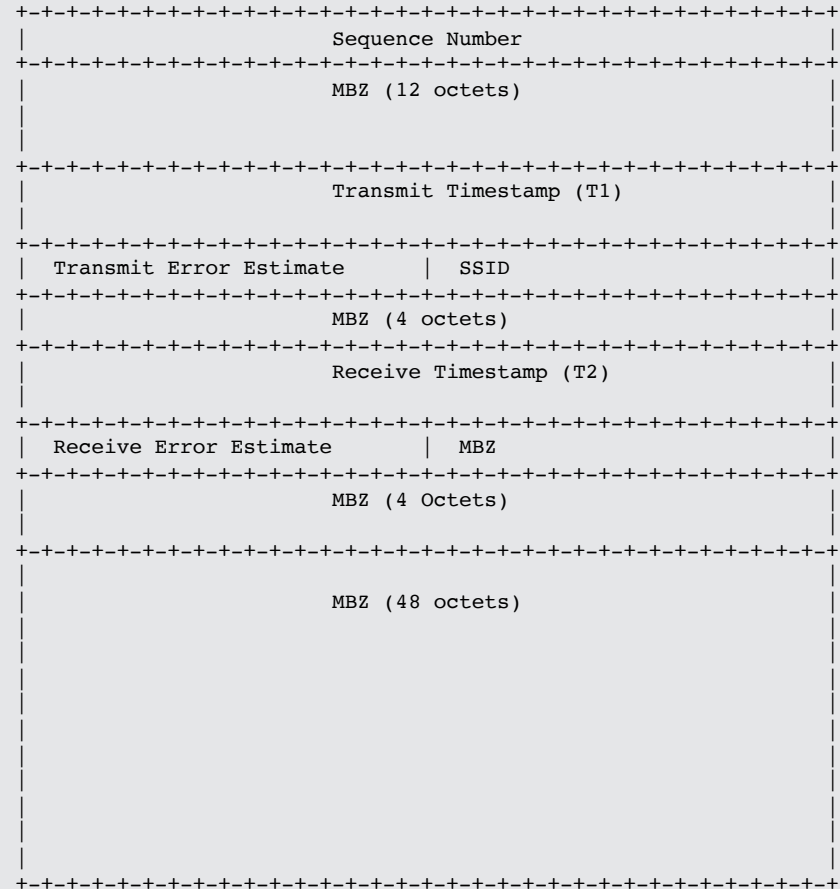Flooded/Signaled
or IANA Allocated

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
  - offset-byte 16 from the start of the payload in unauthenticated 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
```

TF Or

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)       |   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) 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 node removes SRH
- Reverse path can be SR
  - Reverse direction SR path Segment-list carried in SRH
  - Session-Reflector node 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

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

- 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 node

- 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 node

- Synthetic packet loss is notified when X number of PLM return test packets not received at the Session-Sender node out of last Y PLM test packets sent
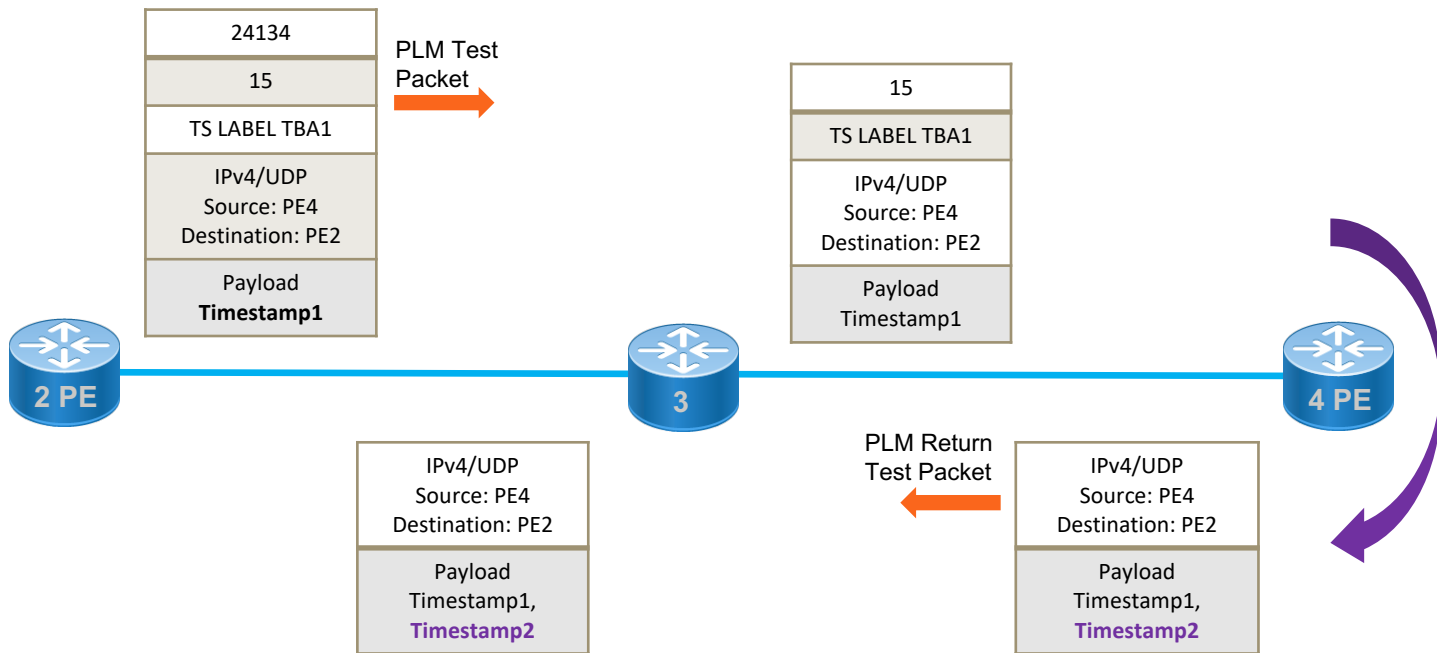
Next Steps

- Welcome your comments and suggestions
- Requesting SPRING WG adoption

Thank you

Backup

Loopback Mode with Timestamp and Forward for SR-MPLS Policy

| 24134 |
| 15 |
| TS LABEL TBA1 |
| IPv4/UDP
Source: PE4
Destination: PE2 |
| Payload
Timestamp1 |

PLM Test Packet

| 15 |
| TS LABEL TBA1 |
| IPv4/UDP
Source: PE4
Destination: PE2 |
| Payload
Timestamp1 |

| IPv4/UDP
Source: PE4
Destination: PE2 |
| Payload
Timestamp1,
Timestamp2 |

PLM Return Test Packet

| IPv4/UDP
Source: PE4
Destination: PE2 |
| Payload
Timestamp1,
Timestamp2 |

2 PE

3

4 PE

Thank you