

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

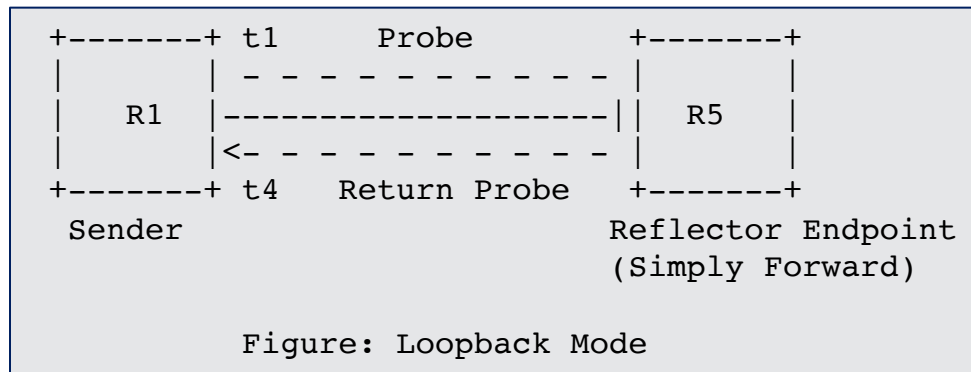
Requirements:

- Performance 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:

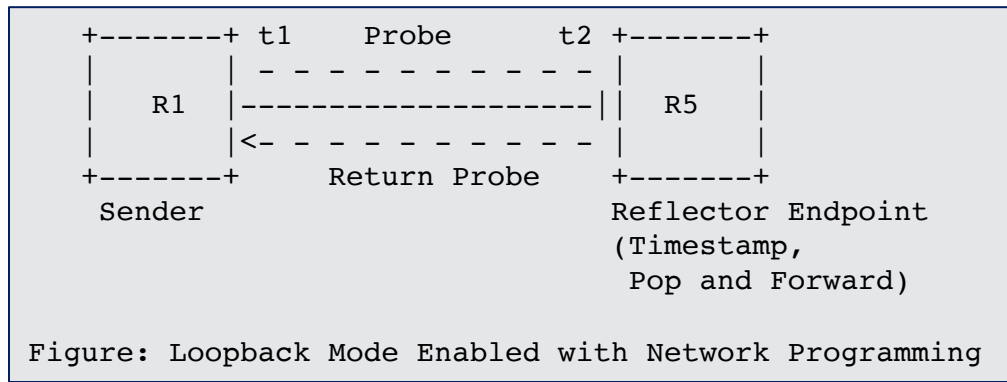
- RFC 5357 (TWAMP Light) defined probe messages
- RFC 8762 (STAMP) defined probe messages
- User-configured IP/UDP path for probe messages

Liveness Monitoring of SR Policy



- 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) 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

Enhanced Liveness Monitoring of SR Policy



- 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 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
- Liveness failure is notified when consecutive N number of probe messages are not received back at the sender
- Delay metrics are notified when consecutive N number of probe messages have delay values exceed the configured thresholds

TWAMP Light Probe Message

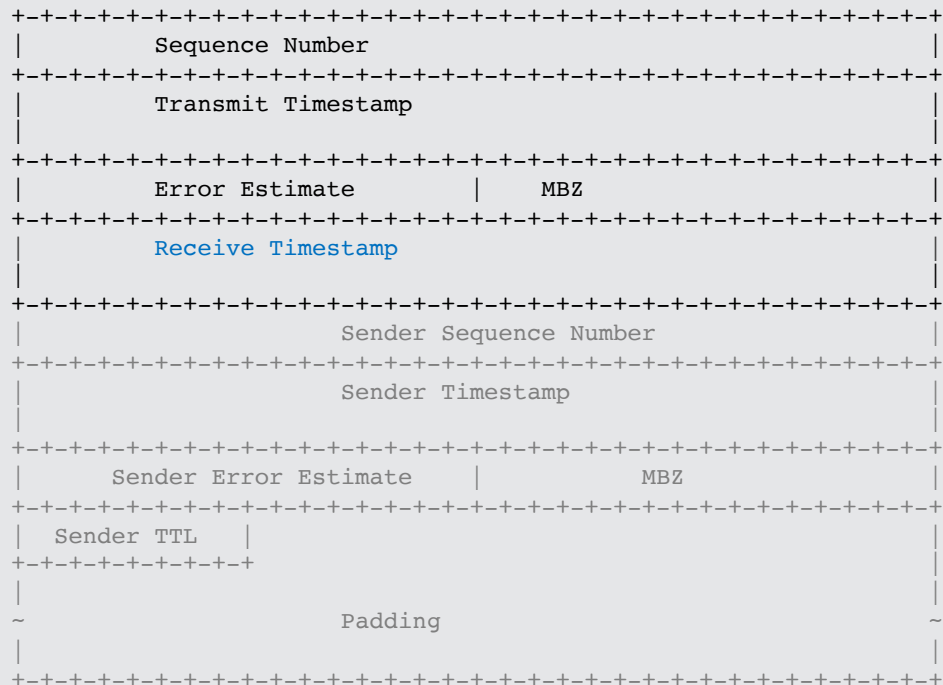


Figure: TWAMP Light Probe Message Format

Enhanced Loopback Mode

- Sender adds the Transmit Timestamp
- Reflector adds the Receive Timestamp at fixed offset locally provisioned (consistently in the network)
 - For TWAMP Light packets, it is at offset-byte 16 from the start of the payload
- Sender Sequence Number, Sender Timestamp, Sender Error Estimate and Sender TTL in the TWAMP Light messages are not used
 - Reflector does not copy them

STAMP Probe Message



Figure: STAMP Probe Message Format

Enhanced Loopback Mode

- Sender adds the Transmit Timestamp
- Reflector adds the Receive Timestamp at fixed offset locally provisioned (consistently in the network)
 - For STAMP packets, it is at offset-byte 16 from the start of the payload
- Sender Sequence Number, Sender Timestamp, Sender Error Estimate and Sender TTL in the STAMP messages are not used
 - Reflector does not copy them

SR-MPLS with Timestamp Label Example

```

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
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                                     | TC | S |          TTL          |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
.
.
.
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                                     | TC | S |          TTL          |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                                     | 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   |                      |
.
+-----+-----+-----+-----+-----+-----+-----+-----+

```

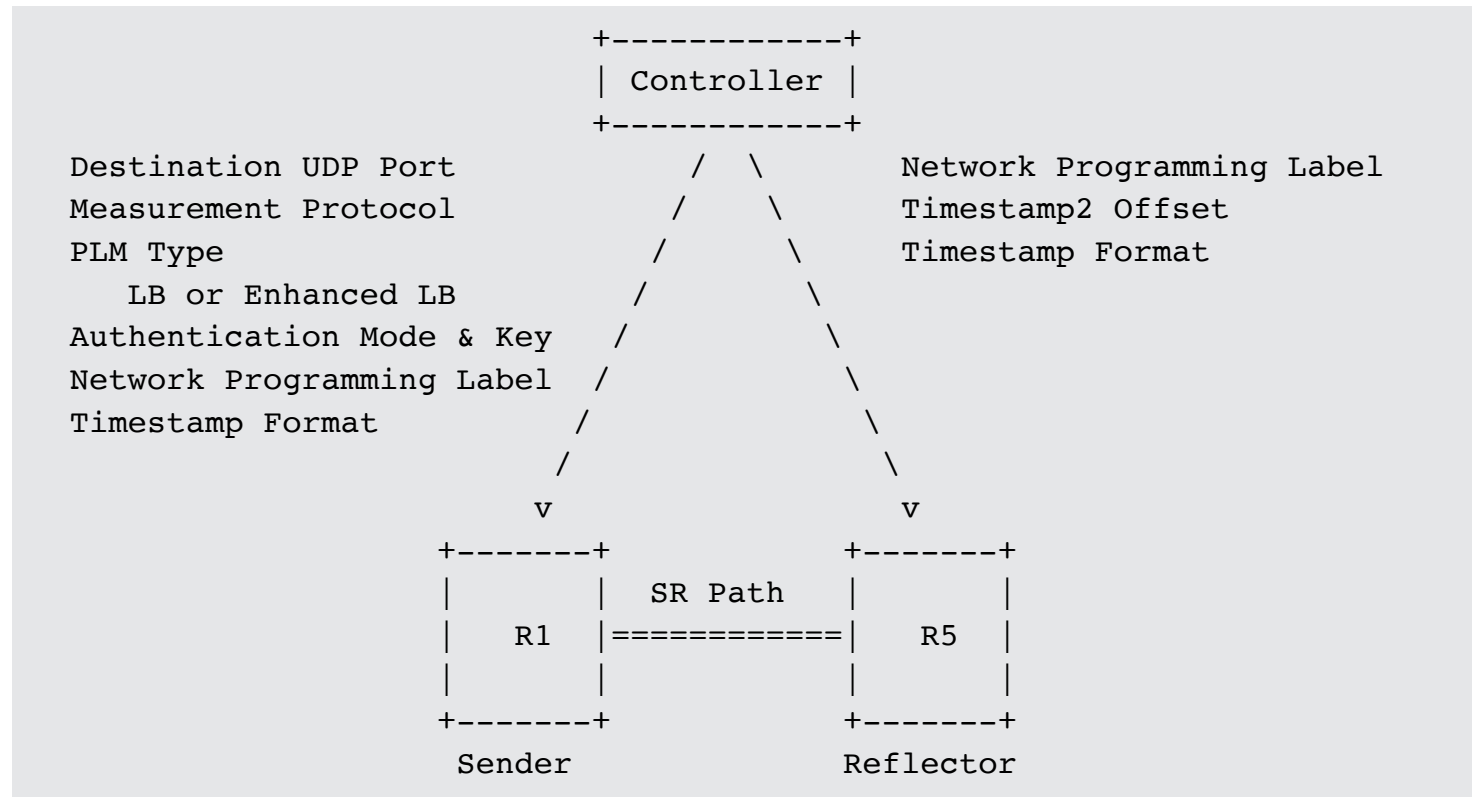
Figure: Example Probe Message for SR-MPLS with Timestamp Label

- Timestamp Label (TBA1) allocated by IANA from Extended Special-Purpose MPLS Label Values
 - Used for Timestamp, Pop and Forward network programming function
 - I.e. Timestamp Label (TBA1) is popped by the reflector node
- Source and Destination Addresses are swapped - represent Reverse direction path
- Optionally, Reverse direction SR path label stack can follow the Timestamp Label TBA1

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:
 - For IPv4
 - Destination addresses in IPv4 header (e.g. 127/8) when return path is SR-MPLS
 - For IPv6
 - Destination addresses in IPv6 header (e.g. ::FFFF:127/104) when return path is SRv6
 - Flow label in IPv6 header

Example Provisioning Model

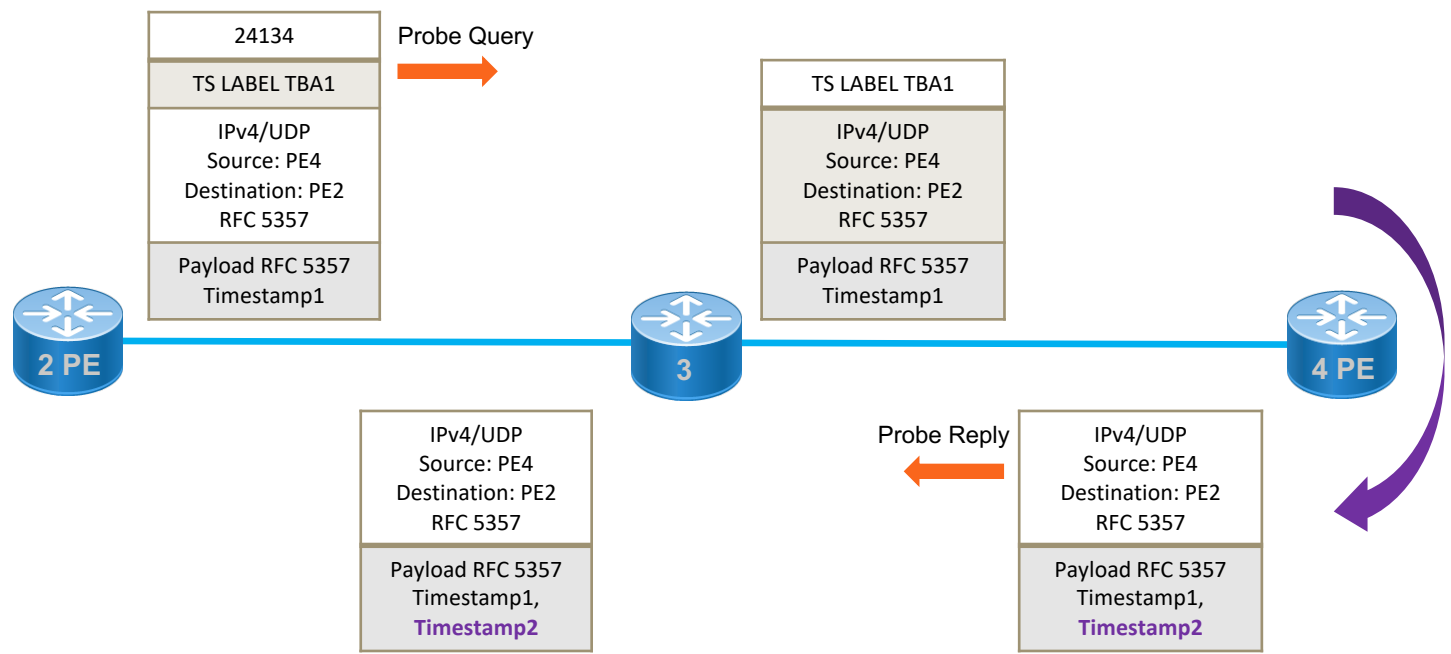


Next Steps

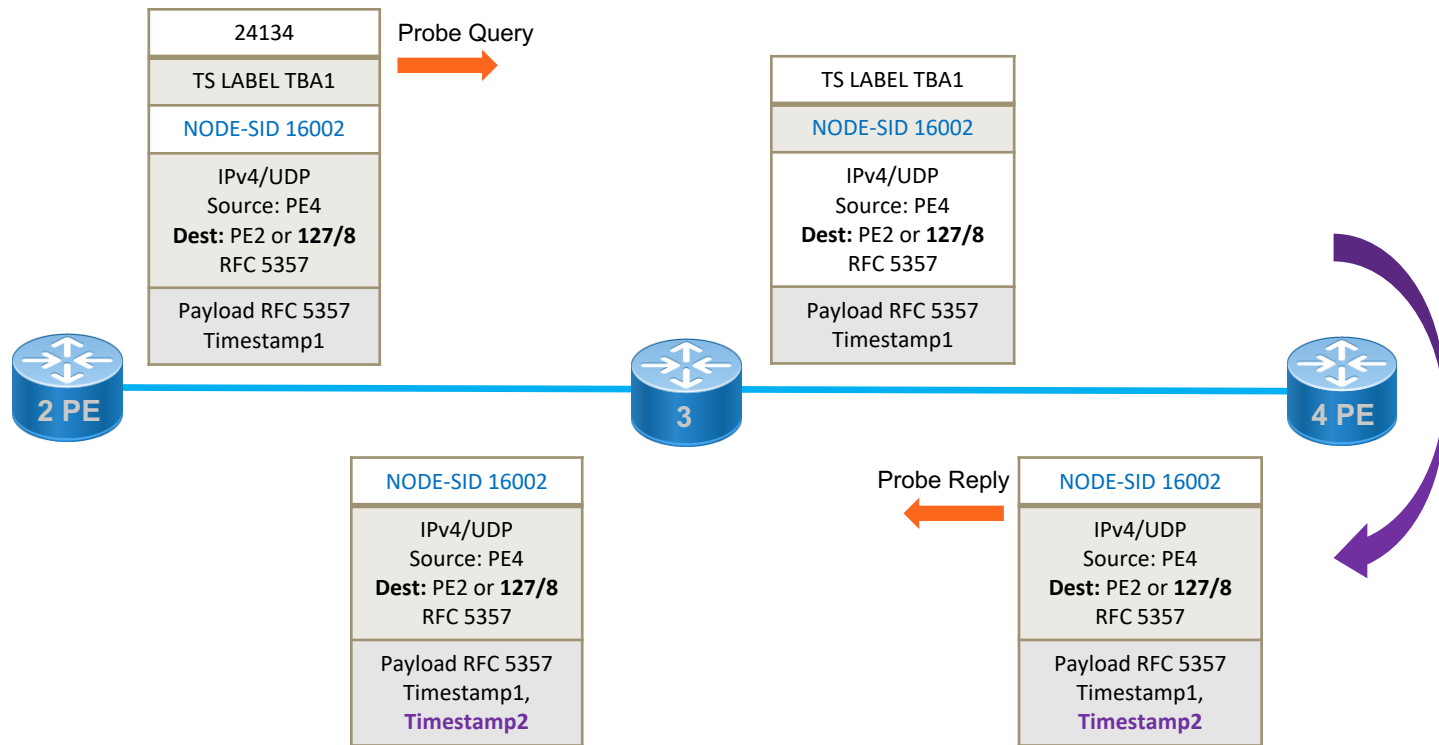
- Welcome your comments and suggestions
- Requesting WG adoption

Thank you

Enhanced Loopback Mode for SR-MPLS Policy - IP/UDP Return Path



Enhanced Loopback Mode for SR-MPLS Policy - SR Return Path



Thank you

Backup

SRv6 with Timestamp and Forward Function Example 1

```
+-----+
| Outer IP Header |
| . Source IP Address = Sender IPv6 Address |
| . Destination IP Address = Next IPv6 Address |
| . Next Header = 43 (Routing Header) |
| . |
+-----+
| SRH |
| . <Segment List> |
| . END.TSF with Target SID |
| . |
+-----+
| Inner 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 1: Probe Message for SRv6 with Endpoint Function IP Return Path

- Endpoint Function END.TSF is defined for Timestamp and Forward and carried for the Reflector node SID
- Reflector node removes SRH
- Reverse direction path is IP
- Source and Destination Addresses are swapped to represent the Reverse direction path in the **inner** IPv6 header

SRv6 with Timestamp and Forward Function Example 2

```

+-----+
| IP Header                                     |
+-----+
| . Source IP Address = Sender IPv6 Address   |
| . Destination IP Address = Next IPv6 Address |
| . Next Header = 43 (Routing Header)         |
| .                                           |
+-----+
| SRH                                         |
+-----+
| . <Segment List>                           |
| . END.TSF with Target SID                   |
| . Next Header = 17 (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 |
+-----+

```

- Endpoint Function END.TSF is defined for Timestamp and Forward and carried for the Reflector node SID
- Reflector node does not remove the SRH, Sender node will remove the SRH
- Reverse direction SR path carried in SRH

Example 2: Probe Message for SRv6 with Endpoint Function SR Return Path