Enhanced Performance Measurement Using Simple TWAMP in Segment Routing Networks

draft-gandhi-spring-enhanced-srpm-04

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Agenda

• Requirements and Scope
• Summary of the Solution
  – SR-MPLS
  – SRv6
• Next Steps
Requirements and Scope

Requirements:
- Performance Measurement in SR networks
  - SR paths, including SR Policies
  - Applicable to SR-MPLS/SRv6 data planes

Goals:
- No Session-Reflector dependency for STAMP protocol
  - State is in the packet - spirit of SR
- Higher STAMP session scale and faster measurement interval

Scope:
- Using RFC 8762 (Simple TWAMP (STAMP))
- Extension of [draft-ietf-spring-stamp-srpm]
Recap from [draft-ietf-spring-stamp-srpm]

[draft-ietf-spring-stamp-srpm] describes 3 measurement modes in SR networks:

1. One-way measurement mode [RFC8762]
   - One-way delay = (T2 – T1) -> (Requires clock sync between Sender and Reflector)

2. Two-way measurement mode [RFC8762]
   - Round-trip delay = (T4 – T1) – (T3 – T2)

3. Loopback measurement mode [draft-ietf-spring-stamp-srpm]
   - This mode is enhanced in [draft-gandhi-spring-enhanced-srpm]
Loopback measurement mode is defined in [draft-ietf-spring-stamp-srpm] as:

- STAMP test packets transmitted on SR Path (e.g., Segment List of SR Policy)
- Session-Reflector forwards STAMP test packets in fast-path just like data traffic
  - does not perform STAMP test packet processing (and no punt/re-inject)
- Loopback delay = (T4 - T1)
Enhanced Loopback Mode Enabled with Network Programming Function

- STAMP test packets transmitted in enhanced loopback mode
  - Network programming function to optimize "operations of punt and generate return test packet" on Session-Reflector
  - Higher STAMP session scale and faster measurement interval can be achieved
- Session-Reflector adds receive timestamp **T2** at a specific location in the payload of the received STAMP test packet in fast-path
- One-way delay = \((T2 - T1)\)  
  (Note: assumes the clocks on the Session-Sender and Session-Reflector are synchronized)

Figure: STAMP Enhanced Loopback Mode
STAMP Test Packets

- Using STAMP Session-Sender test packets defined in RFC 8762/8972
- Session-Sender adds Transmit Timestamp (T1)
- Session-Reflector adds Receive Timestamp (T2) at offset location from the start of the payload
  - offset 16 bytes in unauthenticated mode, or
  - offset 32 bytes in authenticated mode

```
<table>
<thead>
<tr>
<th>Sequence Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>+------------------------------+</td>
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<td></td>
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<tr>
<td>+-------------------------------+</td>
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<td>+-------------------------------+</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>+------------------------------+</td>
</tr>
<tr>
<td>STAMP Test Packet Format in Unauthentication Mode</td>
</tr>
<tr>
<td>STAMP Test Packet Format in Authentication Mode</td>
</tr>
</tbody>
</table>
```
SRv6 with Timestamp and Forward Endpoint Function

- **SRv6 Endpoint Function (End.TSF) for Timestamp and Forward is carried with the Session-Reflector node Locator SID**
- **SRv6 uSID behaviors End.\textit{uTSF16} for offset-16 and End.\textit{uTSF32} for offset-32 statically defined on the Session-Reflector**
- **Reverse path can be IPv6/UDP**
  - Inner IPv6 header carry the reverse path (DA is the Session-Sender)
  - Session-Reflector removes outer IPv6/SRH encapsulation
- **Reverse path can be SRv6**
  - Reverse direction SRv6 path segment-list carried in IPv6/SRH encapsulation

---

```plaintext
| IP Header                     |
| . Source IP Address = Session-Sender IPv6 Address |
| . Destination IP Address = Destination IPv6 Address |
| +---------------------------------------------------------------+
| SRH as specified in RFC 8754                     |
| . <Segment List>                                     |
| . <\textit{End.uTSF16 or End.uTSF32 with Session-Reflector Node SID}> |
| +---------------------------------------------------------------+
| IP Header                     |
| . Source IP Address = Session-Sender 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 |
| +---------------------------------------------------------------+
| STAMP Test Packet [RFC8762]                                      |
| +---------------------------------------------------------------+

Example STAMP Test Packet with SRv6 Timestamp and Forward Endpoint Function
```
SR-MPLS with Timestamp and Forward Network Action

- **MPLS Network Action (MNA) Sub-Stack** [draft-ietf-mpls-mna-hdr] containing:
  - 7-bit Label (bSPL value TBA1)
  - 7-bit opcode (value TBA2) for Timestamp and Forward (TSF) In-Stack Network Action
  - 10-bit data for T2 timestamp offset (e.g., 16 or 32)
  - 3-bit data for T2 timestamp format (e.g., 0x0 for 64-bit PTPv2 or 0x1 for 64-bit NTP)
  - U Flag - Unknown Action Handling is set to 0 for “Skip to the next Network Action”
  - Network Action Sub-Stack Length (NASL) is set 0 if no additional LSE added after this
  - Session-Reflector removes the MNA Sub-Stack

- **IP header carries Reverse path (DA is the Session-Sender)**

- **Reverse path can be IP/UDP**
  - Session-Reflector removes the MPLS encapsulation
  - IHS field scope is set to “I2E (Ingress-To-Egress)”
  - MNA Sub-Stack added at the bottom of the stack

- **Reverse path can be SR-MPLS**
  - Reverse direction SR-MPLS path label stack carried in the MPLS Header
  - IHS field scope is set to “SELECT”
  - MNA Sub-Stack added before the reverse label stack

---

Example STAMP Test Packet with MNA TSF Opcode for SR-MPLS

```
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 |
| Label(1)                    | TC | S | TTL |
+-----------------------------| TC | S | TTL |
| Label(n)                    | MNA Label (value TBA1) | TC | S | TTL |
+-----------------------------| TC | S | TTL |
| 7b Opcode=TSF | 10b TS Offset | FMT | P | IHS | S | RES | U | NASL=0 |
| MNA Label (value TBA1)      | TC | S | TTL |
| IP Header                   | TC | S | TTL |
  | Source IP Address = Session-Sender IP Address |
  | Destination IP Address = Session-Sender IP Address |
| UDP Header                  | TC | S | TTL |
  | Source Port = As chosen by Session-Sender |
  | Destination Port = As chosen by Session-Sender |
| STAMP Test Packet [RFC8762] | TC | S | TTL |
  | Example STAMP Test Packet with MNA TSF Opcode for SR-MPLS |
```
Next Steps

• Welcome your review comments and suggestions
• Requesting working group adoption
• Should we add in [draft-ietf-spring-stamp-srpm]?
  1. One-way measurement mode [RFC8762]
  2. Two-way measurement mode [RFC8762]
  3. Loopback measurement mode [draft-ietf-spring-stamp-srpm]
     ➢ Enhanced loopback measurement mode [draft-gandhi-spring-enhanced-srpm]
Thank you
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviations</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD</td>
<td>Ancillary Data</td>
</tr>
<tr>
<td>BOS</td>
<td>Bottom of Stack</td>
</tr>
<tr>
<td>bSPL</td>
<td>Base Special Purpose Label</td>
</tr>
<tr>
<td>E2E</td>
<td>Edge To Edge</td>
</tr>
<tr>
<td>HBH</td>
<td>Hop By Hop</td>
</tr>
<tr>
<td>IHS</td>
<td>Ingress-To-Egress, Hop-By-Hop or Select Processing Scope</td>
</tr>
<tr>
<td>ISD</td>
<td>In-Stack Data</td>
</tr>
<tr>
<td>MNA</td>
<td>MPLS Network Action</td>
</tr>
<tr>
<td>MSD</td>
<td>Maximum Stack Depth</td>
</tr>
<tr>
<td>NAI</td>
<td>Network Action Indicator</td>
</tr>
<tr>
<td>NAI-OP</td>
<td>Network Action Indicator Opcode</td>
</tr>
<tr>
<td>NAS</td>
<td>Network Action Sub-Stack</td>
</tr>
<tr>
<td>PSD</td>
<td>Post-Stack Data</td>
</tr>
<tr>
<td>TSF</td>
<td>Timestamp and Forward</td>
</tr>
</tbody>
</table>
Loopback Mode with Timestamp and Forward for SR-MPLS Policy

IPv4/UDP
Source: PE2
Destination: PE2
Payload
TX Timestamp1
STAMP Test Packet

MNA Label (TBA1)
Opcode: TSF (TBA2), Data: T2 TS-Offset, Format
IPv4/UDP
Source: PE2
Destination: PE2
Payload
TX Timestamp1

IPv4/UDP
Source: PE2
Destination: PE2
Payload
TX Timestamp1

STAMP Return Test Packet
IPv4/UDP
Source: PE2
Destination: PE2
Payload
TX Timestamp1, RX Timestamp2

IPv4/UDP
Source: PE2
Destination: PE2
Payload
TX Timestamp1, RX Timestamp2

117th IETF
Thank you