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Simple TWAMP (STAMP) Extensions for Segment Routing Networks
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Abstract

   Segment Routing (SR) leverages the source routing paradigm. SR is
   applicable to both Multiprotocol Label Switching (SR-MPLS) and IPv6
   (SRv6) data planes. This document specifies RFC 8762 (Simple Two-Way
   Active Measurement Protocol (STAMP)) extensions for SR networks, for
   both SR-MPLS and SRv6 data planes.

Status of This Memo

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

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   time. It is inappropriate to use Internet-Drafts as reference
   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on August 14, 2021.

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1. Introduction

   Segment Routing (SR) leverages the source routing paradigm and
   greatly simplifies network operations for Software Defined Networks
   (SDNs). SR is applicable to both Multiprotocol Label Switching (SR-
   MPLS) and IPv6 (SRv6) data planes [RFC8402]. SR Policies as defined
   in [I-D.ietf-spring-segment-routing-policy] are used to steer traffic
   through a specific, user-defined paths using a stack of Segments.
   Built-in SR Performance Measurement (PM) is one of the essential
   requirements to provide Service Level Agreements (SLAs).

   The Simple Two-way Active Measurement Protocol (STAMP) provides
   capabilities for the measurement of various performance metrics in IP
   networks [RFC8762]. It eliminates the need for control protocol by
   using configuration and management model to provision and manage test
   sessions. [RFC8972] defines optional extensions for STAMP.

   The STAMP supports two modes of STAMP Session-Reflector: Stateless
   and Stateful as described in Section 4 of [RFC8762]. In Stateless
   mode, maintenance of each STAMP test session on Session-Reflector is

avoided. In SR networks, as the state is in the packet, the
signaling of the parameters and creating extra states in the network
are undesired. Hence, Stateless mode of Session-Reflector is
preferred in SR networks.

For performance delay and packet loss measurement, STAMP Session-
Sender test packets are transmitted in-band on the same path as the
data traffic flow under measurement to measure the delay and packet
loss experienced by the data traffic flow. It is also desired in SR
networks that the Session-Reflector reply test packets are
transmitted in-band on the same path in the reverse direction. This
is achieved by using the STAMP extensions defined in this document.

This document specifies RFC 8762 (Simple Two-Way Active Measurement
Protocol (STAMP)) extensions for SR networks, for both SR-MPLS and
SRv6 data planes.

2. Conventions Used in This Document

2.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
document are to be interpreted as described in [RFC2119] [RFC8174]
when, and only when, they appear in all capitals, as shown here.

2.2. Abbreviations

MPLS: Multiprotocol Label Switching.

PM: Performance Measurement.

SID: Segment ID.

SL: Segment List.

SR: Segment Routing.

SR-MPLS: Segment Routing with MPLS data plane.

SRv6: Segment Routing with IPv6 data plane.

SSID: STAMP Session Identifier.

STAMP: Simple Two-way Active Measurement Protocol.

2.3. Reference Topology

   In the reference topology shown below, the STAMP Session-Sender R1
   initiates a STAMP test packet and the STAMP Session-Reflector R3
   transmits a reply test packet. The reply test packet is transmitted
   back to the STAMP Session-Sender R1 on the same path or a different
   path in the reverse direction.

   The nodes R1 and R3 may be connected via a link or there exists an SR
   path [RFC8402]. The link may be a physical interface, virtual link,
   or Link Aggregation Group (LAG) [IEEE802.1AX], or LAG member link.
   The SR path may be an SR Policy
   [I-D.ietf-spring-segment-routing-policy] on node R1 (called head-end)
   with destination to node R3 (called tail-end).

```
                     T1                   T2
                      /                    \
           +-------+      Test Packet    +-------+
           |       | - - - - - - - - - ->|       |
           |   R1  |====================|    R3  |
           |       |<- - - - - - - - - - |       |
           +-------+  Reply Test Packet  +-------+
                      \                    /
                      T4                   T3


           STAMP Session-Sender       STAMP Session-Reflector


                         Reference Topology
```
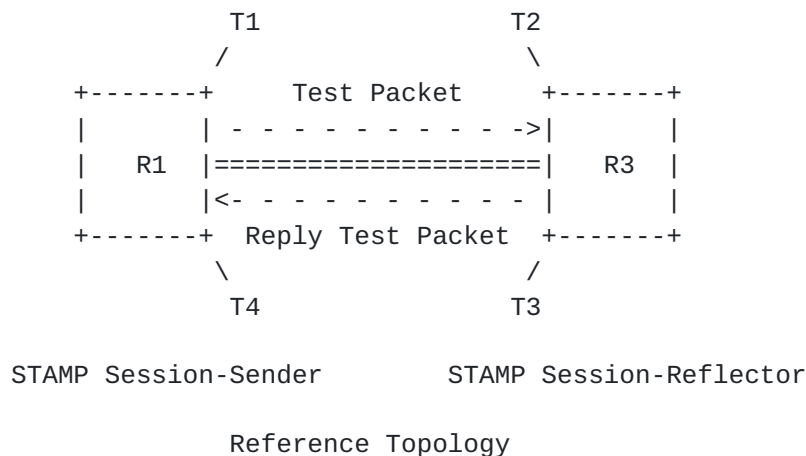
3. Destination Node Address TLV

   The STAMP Session-Sender may need to transmit test packets to the
   STAMP Session-Reflector with a different destination address (for
   example IPv4 address from 127/8 range). In an error condition, the
   STAMP test packet may not reach the intended STAMP Session-Reflector,
   an un-intended node may transmit reply test packets resulting in
   reporting of invalid measurement metrics.

   [RFC8972] defines STAMP test packets that can include one or more
   optional TLVs. In this document, Destination Node Address TLV (Type
   TBA1) is defined for STAMP test packet [RFC8972] and has the
   following format shown in Figure 1:

```
 0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|STAMP TLV Flags| Type=TBA1     |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Reserved                      | Address Family                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.                              Address                          .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
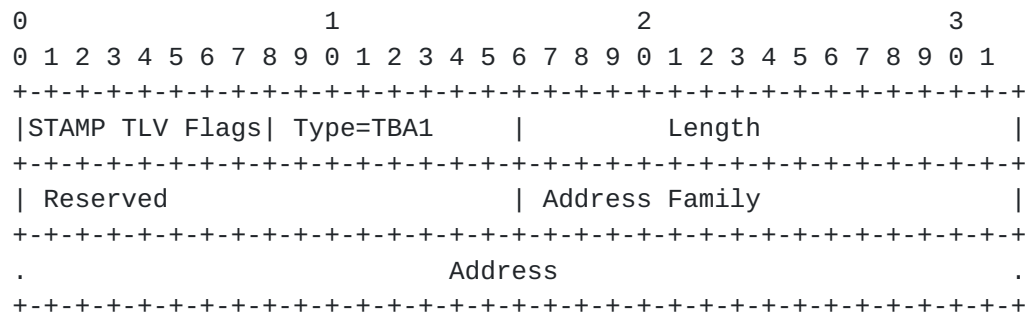
                Figure 1: Destination Node Address TLV Format

   The Address Family field indicates the type of the address, and it
   SHALL be set to one of the assigned values in the "IANA Address
   Family Numbers" registry.

   The STAMP TLV Flags are set using the procedures described in
   [RFC8972].

   The Destination Node Address TLV is optional. The Destination Node
   Address TLV indicates the address of the intended destination node of
   the test packet. The STAMP Session-Reflector that supports this TLV,
   MUST NOT transmit reply test packet if it is not the intended
   destination node of the received test packet.

4. Return Path TLV

   For end-to-end SR paths, the STAMP Session-Reflector may need to
   transmit the reply test packet on a specific return path. The STAMP
   Session-Sender can request this in the test packet to the STAMP
   Session-Reflector using a Return Path TLV. With this TLV carried in
   the STAMP Session-Sender test packet, the STAMP Session-Reflector
   (Stateless mode) does not require signaling and maintaining any
   additional dynamic state for the STAMP sessions for the end-to-end SR
   paths.

   For links, the STAMP Session-Reflector may need to transmit the reply
   test packet on the same incoming link in the reverse direction. The
   STAMP Session-Sender can request this in the test packet to the STAMP
   Session-Reflector using a Return Path TLV. With this TLV carried in
   the STAMP Session-Sender test packet, the STAMP Session-Reflector
   (Stateless mode) does not require maintenance of any additional state
   for the STAMP sessions for the links.

   [RFC8972] defines STAMP test packets that can include one or more
   optional TLVs. In this document, the TLV Type (value TBA2) is
   defined for the Return Path TLV that carries the return path for the

STAMP Session-Sender test packet. The format of the Return Path TLV
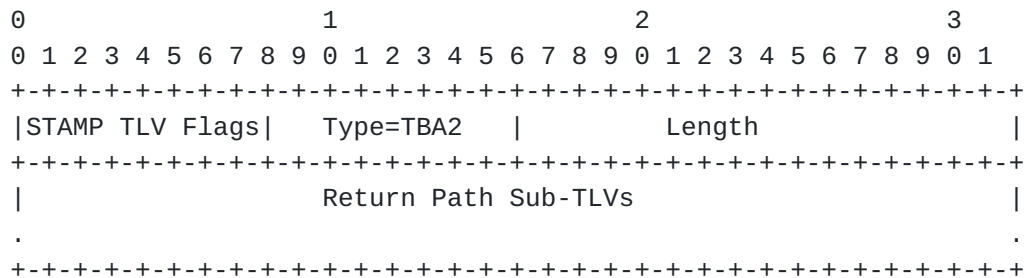is shown in Figure 2:

```
0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|STAMP TLV Flags|   Type=TBA2   |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Return Path Sub-TLVs                      |
.                                                              .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: Return Path TLV

The STAMP TLV Flags are set using the procedures described in
[RFC8972].

The Return Path TLV is optional. The STAMP Session-Sender MUST only
insert one Return Path TLV in the STAMP test packet. The STAMP
Session-Reflector that supports this TLV, MUST only process the first
Return Path TLV in the test packet and ignore other Return Path TLVs
if present, and it MUST NOT add Return Path TLV in the reply test
packet.

4.1. Return Path Sub-TLVs

The Return Path TLV contains one or more Sub-TLVs to carry the
information for the requested return path. A Return Path Sub-TLV can
either carry Return Path Control Code, Return Path IP Address or
Return Path Segment List.

The STAMP Sub-TLV Flags are set using the procedures described in
[RFC8972].

When Return Path Sub-TLV is present in the Session-Sender test
packet, the STAMP Session-Reflector that supports this TLV, MUST
transmit reply test packet using the return path information
specified in the Return Path Sub-TLV.

4.1.1. Return Path Control Code Sub-TLV

The format of the Return Path Control Code Sub-TLV is shown in
Figure 3. The Type of the Return Path Control Code Sub-TLV is
defined as following:

o Type (value 1): Return Path Control Code. The STAMP Session-
   Sender can request the STAMP Session-Reflector to transmit the

reply test packet based on the flags defined in the Control Code
field.

```
 0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|STAMP TLV Flags|   Type        |          Length               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Control Code                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
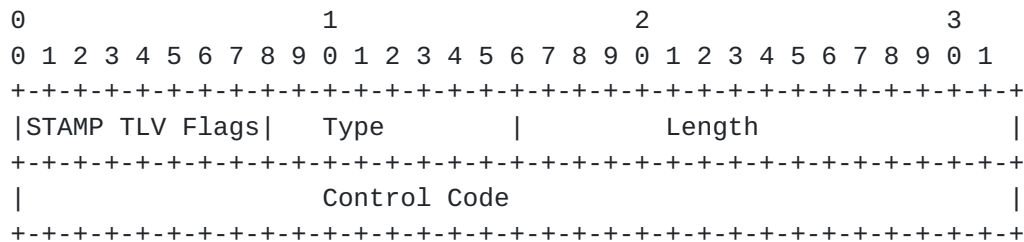
Figure 3: Control Code Sub-TLV in Return Path TLV

Control Code Flags (32-bit): Defined as follows.

    0x0: No Reply Requested.

    0x1: In-band Reply Requested.

When Control Code flag is set to 0x0 in the STAMP Session-Sender test
packet, the Session-Reflector does not transmit reply test packet to
the Session-Sender and terminates the STAMP test packet. Optionally,
the Session-Reflector may locally stream performance metrics via
telemetry using the information from the received test packet. All
other Return Path Sub-TLVs are ignored in this case.

When Control Code flag is set to 0x1 in the STAMP Session-Sender test
packet, the Session-Reflector transmits the reply test packet in-band
over the same incoming link where the test packet is received in the
reverse direction.

4.1.2. Return Address Sub-TLV

The STAMP reply test packet may be transmitted to a different node
than the Session-Sender (e.g. to a controller for telemetry use-
cases). For this, the Session-Sender can specify in the test packet
the receiving destination node address for the Session-Reflector
reply test packet.

The format of the Return Address Sub-TLV is shown in Figure 4. The
Address Family field indicates the type of the address, and it SHALL
be set to one of the assigned values in the "IANA Address Family
Numbers" registry. The Type of the Return Address Sub-TLV is defined
as following:

o Type (value 2): Return Address. Destination node address of the
   STAMP Session-Reflector reply test packet different than the
   Source Address in the Session-Sender test packet.

```
 0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|STAMP TLV Flags|     Type      |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Reserved                      | Address Family                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.                             Address                           .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

           Figure 4: Return Address Sub-TLV in Return Path TLV

4.1.3. Return Segment List Sub-TLVs

The format of the Segment List Sub-TLVs in the Return Path TLV is
shown in Figure 5. The segment entries MUST be in network order.
The Segment List Sub-TLV can be one of the following Types:

o Type (value 3): SR-MPLS Label Stack of the Return Path

o Type (value 4): SR-MPLS Binding SID
   [I-D.ietf-pce-binding-label-sid] of the Return SR Policy

o Type (value 5): SRv6 Segment List of the Return Path

o Type (value 6): SRv6 Binding SID [I-D.ietf-pce-binding-label-sid]
   of the Return SR Policy

```
 0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|STAMP TLV Flags|     Type      |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Segment(1)                             |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.                                                               .
.                                                               .
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Segment(n) (bottom of stack)                 |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

           Figure 5: Segment List Sub-TLV in Return Path TLV

The STAMP Session-Sender MUST only insert one Segment List Return
Path Sub-TLV in the test packet. The STAMP Session-Reflector MUST

only process the first Segment List Return Path Sub-TLV in the test
packet and ignore other Segment List Return Path Sub-TLVs if present.

5. Security Considerations

The performance measurement is intended for deployment in well-
managed private and service provider networks. As such, it assumes
that a node involved in a measurement operation has previously
verified the integrity of the path and the identity of the STAMP
Session-Reflector.

If desired, attacks can be mitigated by performing basic validation
and sanity checks, at the STAMP Session-Sender, of the timestamp
fields in received measurement reply packets. The minimal state
associated with these protocols also limits the extent of measurement
disruption that can be caused by a corrupt or invalid packet to a
single test cycle.

The security considerations specified in [RFC8762] and [RFC8972] also
apply to the extensions defined in this document.

6. IANA Considerations

IANA will create a "STAMP TLV Type" registry for [RFC8972]. IANA is
requested to allocate a value for the following Destination Address
TLV Type from the IETF Review TLV range of this registry. This TLV
is to be carried in the STAMP test packets.

o Type TBA1: Destination Node Address TLV

IANA is also requested to allocate a value for the following Return
Path TLV Type from the IETF Review TLV range of the same registry.
This TLV is to be carried in the STAMP test packets.

o Type TBA2: Return Path TLV

IANA is requested to create a sub-registry for "Return Path Sub-TLV
Type". All code points in the range 1 through 175 in this registry
shall be allocated according to the "IETF Review" procedure as
specified in [RFC8126]. Code points in the range 176 through 239 in
this registry shall be allocated according to the "First Come First
Served" procedure as specified in [RFC8126]. Remaining code points
are allocated according to Table 1:

```
+-----------+-------------+--------------+
| Value     | Description | Reference    |
+-----------+-------------+--------------+
| 0         |    Reserved | This document |
| 1 - 175   |  Unassigned | This document |
| 176 - 239 |  Unassigned | This document |
| 240 - 251 | Experimental | This document |
| 252 - 254 | Private Use | This document |
| 255       |    Reserved | This document |
+-----------+-------------+--------------+
```

Table 1: Return Path Sub-TLV Type Registry

IANA is requested to allocate the values for the following Sub-TLV
Types from this registry.

o Type (value 1): Return Path Control Code

o Type (value 2): Return Address

o Type (value 3): SR-MPLS Label Stack of the Return Path

o Type (value 4): SR-MPLS Binding SID of the Return SR Policy

o Type (value 5): SRv6 Segment List of the Return Path

o Type (value 6): SRv6 Binding SID of the Return SR Policy

7. References

7.1. Normative References

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