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Simple Two-Way Active Measurement Protocol (STAMP) Extensions for  
Reflecting STAMP Packet MPLS Extension Headers  
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## Abstract

The Simple Two-Way Active Measurement Protocol (STAMP) and its optional extensions can be used for Edge-To-Edge (E2E) active measurement. In Situ Operations, Administration, and Maintenance (IOAM) data fields can be used for recording and collecting Hop-by-Hop (HBH) and E2E operational and telemetry information. This document extends STAMP to reflect MPLS extension headers, including MPLS Network Action Sub-Stacks and Post-Stack Header, for HBH and E2E active measurements, for example, using IOAM data fields.

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## 1. Introduction

The Simple Two-Way Active Measurement Protocol (STAMP) provides capabilities for the measurement of various performance metrics in IP networks [RFC8762] without the use of a control channel to pre-signal session parameters. [RFC8972] defines optional extensions in the form of TLVs for STAMP. The STAMP test packets are transmitted along a path between a Session-Sender and a Session-Reflector to measure Edge-To-Edge (E2E) performance delay and packet loss along that path.

In Situ Operations, Administration, and Maintenance (IOAM) is used for recording and collecting operational and telemetry information while the packet traverses a path between two points in the network. The IOAM data fields are defined in [RFC9197]. Currently, there is no adopted method defined to reflect the collected IOAM data fields back to the Sender, where the Sender can use that information to support the hop-by-hop and edge-to-edge measurement use cases.

MPLS packets may carry MPLS Network Action (MNA) Sub-Stacks as defined in [I-D.ietf-mpls-mna-hdr] and Post-Stack Header (PSH) as defined in [I-D.ietf-mpls-mna-ps-hdr].

It may be desired to record and collect HBH and E2E operational and telemetry information using active measurement packets between two nodes in a network. This is achieved by augmenting STAMP [RFC8762], using optional STAMP extensions defined in [RFC8972], to reflect MPLS extension headers, including MNA Sub-Stacks and Post-Stack Header, as specified in this document. The procedure defined in this document leverages the existing implementations on the midpoint nodes with MPLS data plane, that support the MNA Sub-Stacks and Post-Stack Header used, without any additional requirements.

## 2. Conventions Used in This Document

### 2.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

### 2.2. Abbreviations

ECMP: Equal Cost Multi-Path

E2E: Edge-To-Edge

HBH: Hop-by-Hop

IOAM: In Situ Operations, Administration, and Maintenance

MNA: Multiprotocol Label Switching Network Action

MTU: Maximum Transmission Unit

PSH: Post-Stack Header

STAMP: Simple Two-way Active Measurement Protocol

TLV: Type-Length-Value

### 2.3. STAMP Reference Topology

In the "STAMP Reference Topology" shown in Figure 1, the STAMP Session-Sender S1 initiates a Session-Sender test packet, and the STAMP Session-Reflector R1 transmits a reply Session-Reflector test packet. Node M1 is a midpoint node that does not perform any STAMP processing.

T1 is a transmit timestamp, and T4 is a receive timestamp added by node S1. T2 is a receive timestamp, and T3 is a transmit timestamp added by node R1.

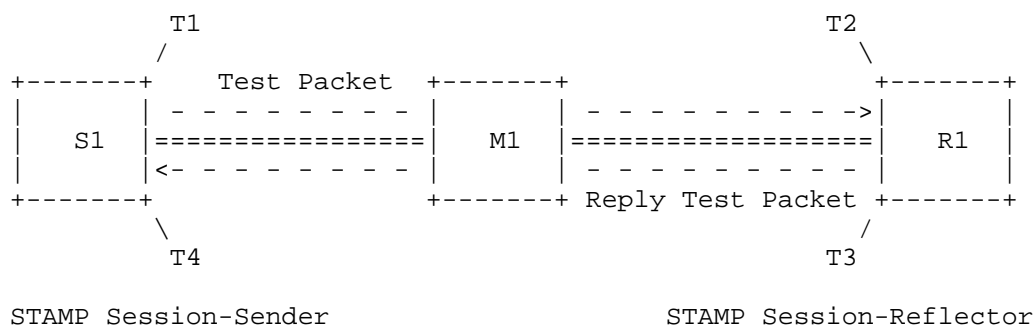


Figure 1: STAMP Reference Topology

### 3. Overview

[RFC8972] defines optional extensions for STAMP. The optional extensions are added to the base STAMP test packet defined in [RFC8762] in the form of TLVs. As specified in [RFC8972], both Session-Sender and Session-Reflector test packets are symmetric in size when including all optional TLVs. The Session-Reflector reflects all received STAMP TLVs from the Session-Sender test packets.

As specified in [RFC8762], STAMP test packets are transmitted with IP/UDP headers. Since midpoint nodes do not process the UDP headers in the packets, they are agnostic to the STAMP test packets in the payload.

This document also defines a new TLV option for STAMP, called "Reflected MPLS Header MNA Data" (value TBA1). When a STAMP Session-Sender adds an MNA Sub-Stack in the test packet, it also adds a "Reflected MPLS Header MNA Data" STAMP TLV in the Session-Sender test packet with the length set to the MNA Sub-Stack length (NASL) and the value field in the TLV initialized to zeros, in order to receive a copy of that MNA Sub-Stack back in the STAMP TLV. When adding

multiple MNA Sub-Stacks in the Session-Sender test packet, corresponding "Reflected MPLS Header MNA Data" STAMP TLVs MUST be added, matching the length of the MNA Sub-Stack and Ancillary Data and in the same order, in order to receive a copy of that MNA Sub-Stack.

Similarly, when a STAMP Session-Sender adds MNA Post-Stack Header in the test packet, it also adds corresponding "Reflected MPLS Header MNA Data" STAMP TLV, with the matching length, in order to receive a copy of that MNA Post-Stack Header.

As the procedure defined in this document leverages the existing implementations on the midpoint nodes for the MNA Sub-Stacks and Post-Stack Header, no additional requirements are specified when carrying MNA Sub-Stacks and Post-Stack Header in STAMP. MNA Sub-Stacks and Post-Stack Header are processed by the nodes using the same procedures specified in the document that defined them.

An example STAMP test packet for the MPLS data plane, carrying MNA Sub-Stacks and Post-Stack Header and reflected MNA header data in STAMP TLVs, is shown in Figure 2.

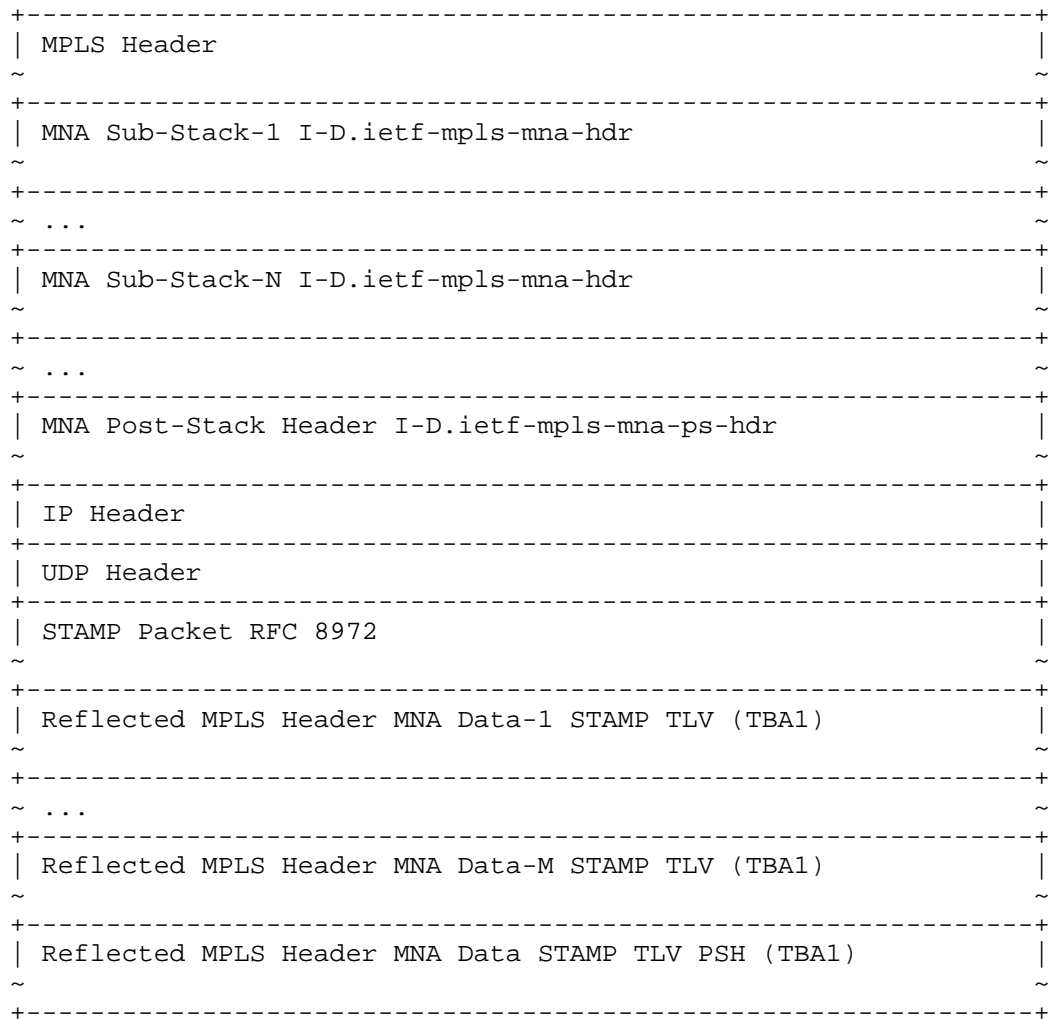


Figure 2: Example STAMP Test Packet with Reflected MPLS Header  
MNA Data STAMP TLV

When the Session-Reflector receives a STAMP test packet with an MNA and a STAMP TLV "Reflected MPLS Header MNA Data," the Session-Reflector that supports this STAMP TLV MUST copy the entire MNA Sub-Stack, including the Ancillary Data and header, into the "Reflected MPLS Header MNA Data" TLV in the Session-Reflector payload. When there are multiple MNA Sub-Stacks in the Session-Sender test packet, each MNA Sub-Stack, including Ancillary Data MUST be processed, in order from the top of the label stack, and copied into the corresponding STAMP TLV, if that STAMP TLV exists. Similarly, the

Session-Reflector MUST process MNA Post-Stack Header and copy the entire header and the Ancillary Data into the corresponding STAMP TLV, if that STAMP TLV exists.

When the Session-Reflector receives a STAMP test packet with an MNA Sub-Stack or PSH but without corresponding "Reflected MPLS Header MNA Data" STAMP TLV, the Session-Reflector does not copy that MNA Sub-Stack or PSH into the Session-Reflector test packet.

When the Session-Sender test packets carry an MNA Sub-Stack or PSH that it does not require the Session-Reflector to reflect in the Session-Reflector test packet, it does not add the matching "Reflected MPLS Header MNA Data" STAMP TLV in the Session-Sender test packet.

If the Session-Reflector receives Session-Sender test packets with non-zero values in the first 8 bytes (excluding the Ancillary Data field that may change) in the value field of the "Reflected MPLS Header MNA Data" STAMP TLV, it MUST match the values in the corresponding MNA Sub-Stack and PSH in the MPLS header before copying data into the STAMP TLV. This mechanism is employed in case of ambiguity when there are multiple MNA Sub-Stacks and PSH in the MPLS header with the same length present and not all need to be copied and reflected in the STAMP TLVs.

The Session-Sender and Session-Reflector test packets are symmetric in size, and hence the Session-Sender and Session-Reflector MUST ensure that the resulting test packets do not exceed the MPLS MTU after adding the Reflected Data STAMP TLVs. If necessary, Reflected Data STAMP TLVs can be removed to avoid violating the MPLS MTU limit.

If, for any reason, the Session-Reflector does not use the received "Reflected MPLS Header MNA Data" STAMP TLV for reflecting data, it MUST return the STAMP TLV as unrecognized, i.e., with the U flag (Unrecognized) set in the STAMP TLV Flags using the procedure defined in [RFC8972].

The Session-Reflector adds the matching MNA Sub-Stacks and PSH, including Ancillary Data, in the Session-Reflector test packet in the same order for the reverse direction measurements as described in Section 5.2.

Note that the use case where the MNA Sub-Stack and PSH length changes in the Session-Sender test packets along the path is outside the scope of this document. Also, the use case where MNA Sub-Stacks and PSH are added or removed in the Session-Sender test packets along the path is outside the scope of this document.

### 3.1. Receiving MPLS Header on the Session-Reflector

As specified in Section 9.3, "Penultimate Node Responsibilities" of [I-D.ietf-mpls-mna-hdr], and Section 6.3, "Penultimate Node Responsibilities" of [I-D.ietf-mpls-mna-ps-hdr], for "HBH" and "I2E" scopes, the MNA Sub-Stacks and the MNA Post-Stack Header MUST NOT be removed by the penultimate node, and hence they will be received by the egress node of the MPLS LSP. Note that the MNA Sub-Stack and the corresponding MNA Post-Stack Header for the "Select" scope are removed from the packets on the transit node where the MNA Sub-Stack is processed, and hence they will not be received by the egress node of the MPLS LSP.

The STAMP test packets, carrying the MPLS header with the MNA Sub-Stacks and the MNA Post-Stack Headers for "HBH" and "I2E" scopes for HBH and E2E performance measurement, respectively, will be received by the egress node of the MPLS LSP that has the Session-Reflector. When the received STAMP test packets are processed by the data plane on the egress node of the MPLS LSP that has the Session-Reflector, the data plane MUST provide the received MNA data from the test packets to the Session-Reflector on the node.

Note that the procedure defined in this document for HBH and E2E performance measurement is not applicable when using the MNA Sub-Stack and MNA Post-Stack Header with the "Select" scope.

## 4. Use Case of Reflecting IOAM Data Fields

In Situ Operations, Administration, and Maintenance (IOAM) is used for recording and collecting operational and telemetry information while the packet traverses a path between two points in the network. The IOAM data fields are defined in [RFC9197]. Examples of data recorded by IOAM Trace Options include per-hop information, such as node ID, timestamp, queue depth, interface ID, interface load, etc. The information collected can be used for monitoring ECMP paths, proof-of-transit, and troubleshooting failures in the network. IOAM can be used with STAMP test packets for active measurement. The procedure and STAMP extensions defined in this document can be used to reflect the collected IOAM data fields back to the Sender, where the Sender can use that information to support the hop-by-hop and edge-to-edge measurement use cases.

[I-D.ietf-mpls-mna-ioam] defines extensions using MNA to carry IOAM data that may be carried in MNA Sub-Stack [I-D.ietf-mpls-mna-hdr] or in MNA Post-Stack Header [I-D.ietf-mpls-mna-ps-hdr]. The STAMP Session-Sender and Session-Reflector test packets can carry an MNA Sub-Stack and PSH for HBH and E2E operational and telemetry information for active measurement, as shown in Figure 3, as an example.

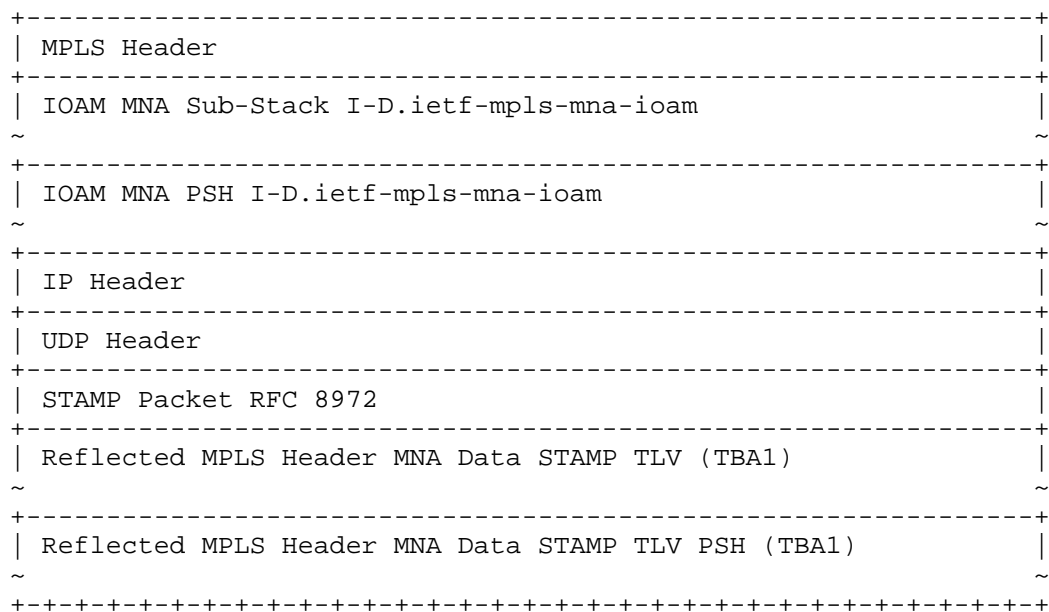


Figure 3: Example STAMP Test Packet for IOAM with Reflected MPLS Header MNA Data TLV

## 5. STAMP Extensions

### 5.1. Reflected MPLS Header MNA Data STAMP TLV

The "Reflected MPLS Header MNA Data" STAMP TLV is carried by Session-Sender and Session-Reflector test packets. STAMP test packets may carry multiple TLVs of this type. The format of the "Reflected MPLS Header MNA Data" TLV is shown in Figure 4.

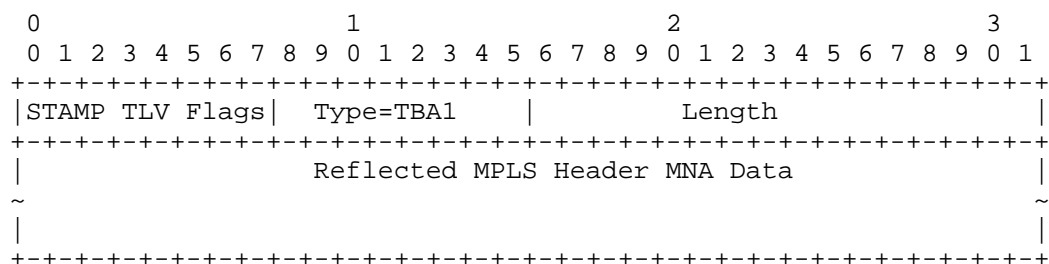


Figure 4: Reflected MPLS Header MNA Data STAMP TLV

The TLV fields are defined as follows:

Type: Type (value TBA1)

STAMP TLV Flags: The STAMP TLV Flags follow the procedures described in [RFC8972].

Length: A two-octet field equal to the length of the Data in octets.

The Session-Reflector MUST return an error as unrecognized (U flag) in the STAMP TLV Flags when it determines that the length of the TLV does not match the length of the corresponding MNA Sub-Stack or PSH when processing in the same order as the MNA Sub-Stacks and PSH in the MPLS header.

## 5.2. One-Way Measurement Using Reflected Data STAMP TLVs

Similarly, in the case of one-way HBH and E2E measurements for MPLS data plane, the Session-Reflector does not need to add MNA Sub-Stacks and PSH in the reply Session-Reflector test packets matching the received MNA Sub-Stacks and PSH.

In this document, the Sub-TLV "MNA Header Control" (Type TBA2) is defined for the STAMP TLV Type "Reflected Test Packet Control TLV" (Type TBA-ASYM) introduced in [I-D.ietf-ippm-asymmetrical-pkts].

When a Session-Sender test packet is received with the "MNA Header Control" Sub-TLV, the Session-Reflector does not add the received MNA Sub-Stacks and PSH in the MPLS header of the reply Session-Reflector STAMP test packet.

In the absence of this Sub-TLV in the received Session-Sender test packet, the Session-Reflector adds new MNA Sub-Stacks and PSH matching all received MNA Sub-Stacks and PSH in the MPLS header of the reply Session-Reflector test packet.

The MNA Sub-Stacks and PSH received in the Session-Sender test packets are still copied and reflected in STAMP TLVs to the Session-Sender.

## 6. Operational Considerations

The operational considerations specified in [RFC8762] and [I-D.ietf-mpls-mna-hdr] apply to the procedure and extensions defined in this document.

## 7. Security Considerations

The security considerations specified in [RFC8762], [RFC8972], [I-D.ietf-mpls-mna-hdr] and [I-D.ietf-mpls-mna-ps-hdr] apply to the procedure and extensions defined in this document. In addition, the security considerations specified in [RFC9197] and [I-D.ietf-mpls-mna-ioam] also apply when using the IOAM.

## 8. IANA Considerations

IANA has created the "STAMP TLV Types" registry for [RFC8972]. IANA is requested to allocate a value for the "Reflected MPLS Header MNA Data" TLV Type from the IETF Review TLV range of the same registry.

Value	Description	Reference
TBA1	Reflected MPLS Header MNA Data	This document

Table 1: STAMP TLV Type

IANA is requested to allocate a value for the Sub-TLV Type "MNA Header Control" (Type TBA2) for the STAMP TLV Type "Reflected Test Packet Control TLV" (Type TBA-ASYM) defined in [I-D.ietf-ippm-asymmetrical-pkts], from the "STAMP Sub-TLV Types" registry.

Value	Description	TLV Used	Reference
TBA2	MNA Header Control	Reflected Test Packet Control	This document

Table 2: Sub-TLV Type for Reflected Test Packet Control STAMP TLV

## 9. References

### 9.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
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## 9.2. Informative References

[RFC9197] Brockners, F., Ed., Bhandari, S., Ed., and T. Mizrahi, Ed., "Data Fields for In Situ Operations, Administration, and Maintenance (IOAM)", RFC 9197, DOI 10.17487/RFC9197, May 2022, <<https://www.rfc-editor.org/info/rfc9197>>.

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