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Supporting In-Situ OAM Direct Export Using MPLS Network Actions

Abstract

In-Situ Operations, Administration, and Maintenance (IOAM), defined in RFC 9197, is an on-path telemetry method to collect and transport the operational state and telemetry information that can be used to calculate various performance metrics. IOAM Direct Export (IOAM-DEX) is one of the IOAM Option types, in which the operational state and telemetry information are collected according to the specified profile and exported in a manner and format defined by a local policy. MPLS Network Actions (MNA) techniques are meant to indicate actions to be performed on any combination of Label Switched Paths (LSPs), MPLS packets, and the node itself, and also to transfer data needed for these actions. This document explores the on-path operational state, and telemetry information can be collected using IOAM-DEX Option in combination with MNA.

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

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This Internet-Draft will expire on 29 September 2024.

Table of Contents

1. Introduction

In-Situ OAM (IOAM) [RFC9197] is an on-path telemetry method to collect and transport the operational state and telemetry information that can be used to calculate various performance metrics. Several IOAM Option types (e.g., Pre-allocated and Incremental) use the user packet to collect the operational state and telemetry information. Such a mechanism transports the collected information to an IOAM decapsulating node (typically located at the edge of the IOAM domain within the data packet). IOAM Direct Export (IOAM-DEX) [RFC9326] is an IOAM Option type. In IOAM-DEX, the operational state and telemetry information are collected according to the specified profile and exported in a manner and format defined by a local policy. MPLS Network Actions (MNA) techniques [I-D.ietf-mpls-mna-fwk] indicate actions to be performed on any combination of Label Switched Paths (LSPs), MPLS packets, the node itself, and also allow for the transfer of data needed for these actions.

This document describes how MNA can be used for collecting on-path operational state and telemetry information using IOAM-DEX Option.

Specifying the mechanism of exporting collected information is outside the scope of this document.

2. Conventions Used in this Document

2.1. Acronyms

IOAM: In-Situ OAM

IOAM-DEX: IOAM Direct Export

IOAM-DEX-MNA: IOAM Direct Export in MPLS Network Action

ISD: In-Stack Data

LSP: Label Switched Path

LSE: Label Stack Element

MPLS: Multiprotocol Label Switching

MNA: MPLS Network Action

NAI: Network Action Indicator

2.2. 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.

3. Applicability of IOAM Option Types in an MPLS Network

Pre-allocated, Incremental, and Edge-to-Edge IOAM Option types [RFC9197] use user packets to collect and transport the operational state and telemetry information. In some environments, for example, data center networks, this technique is useful as the available bandwidth and the use of jumbo frames can accommodate the increase of the packet payload. But for other use cases in which network resources are closely controlled, the use of in-band channels for collecting and transporting the telemetry information may noticeably decrease the cost-efficiency of network operations. Although the operational state and telemetry information are essential for network automation (Section 4 of [RFC8969]), its delivery is not as critical as user packets. As such, collecting and transporting the operational state and telemetry information out-of-band using the management plane is a viable option for some environments. IOAM-DEX [RFC9326] is used to collect IOAM data defined in [RFC9197]. The

processing and transport of the collected information are controlled by a local policy which is outside the scope of this specification. The performance considerations discussed in Section 5 of [RFC9326] are applicable here.

4. Realization of IOAM-DEX as an MPLS Network Action

4.1. IOAM-DEX Format for an MPLS Network

[I-D.ietf-mpls-mna-usecases] recognizes the importance of IOAM in MPLS networks and lists it as one of the use cases that might be supported using MNA techniques. [I-D.ietf-mpls-mna-fwk] defines the architectural elements that compose MNA. This document uses all the elements of the IOAM-DEX Option-Type format defined in [RFC9326] to support IOAM-DEX in an MPLS network using MPLS Network Action (MNA) framework [I-D.ietf-mpls-mna-fwk] and architecture as in-stack data (ISD) MNA [I-D.ietf-mpls-mna-hdr]. The format of IOAM-DEX in MNA is shown in Figure 1.

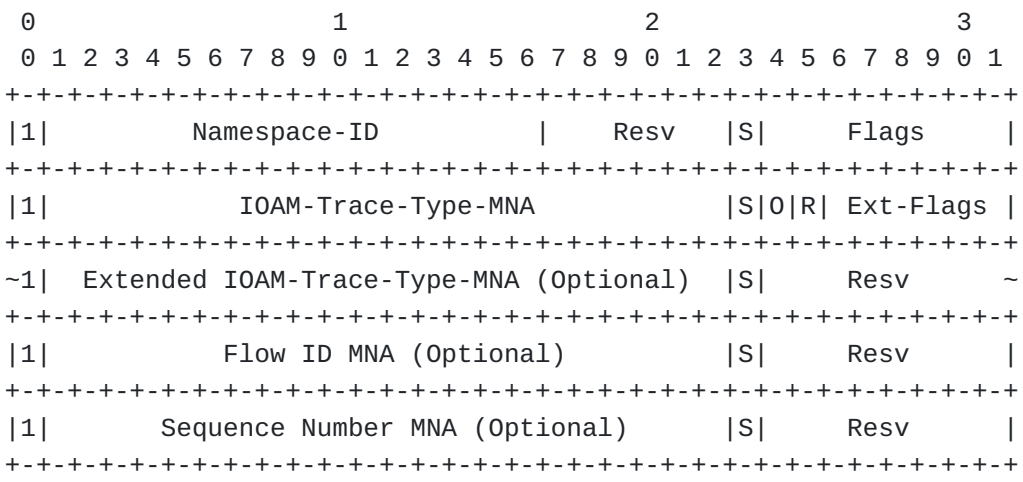

Figure 1: IOAM Direct Export Option Type Format in an MPLS Network Action Framework

Where fields are defined as follows:

- *Namespace-ID is a 16-bit identifier of the IOAM Namespace, as defined in [RFC9197].

- *S is a one-bit the Bottom of Stack [RFC3032].

- *Flags is an eight-bit field comprised of eight one-bit subfields. The subfields in the Flags field are allocated by IANA, as defined in Section 4.2 of [RFC9326].

*IOAM-Trace-Type-MNA is a 22-bit field. The interpretation of bit positions in the IOAM-Trace-Type-MNA is as specified in IANA's IOAM Trace-Type registry [IANA-IOAM-Trace-Type] from Bit 0 through Bit 21.

*O is the one-bit flag that is identical to the interpretation of Bit 22 variable-length Opaque State Snapshot in IANA's IOAM Trace-Type registry [IANA-IOAM-Trace-Type].

*R (Reserved) is a one-bit flag. It MUST be zeroed on the transmission and ignored on receipt. Similarly to [RFC9197], it is reserved to allow for future extensions of the IOAM-Trace-Type-MNA bit field.

*Ext-Flags is a six-bit field comprised of six one-bit subfields. The allocation of the subfields in the Ext-Flags field is according to Section 4.3 of [RFC9326]. The allocated flags indicate the presence of the optional Flow ID and/or Sequence Number fields in the IOAM-DEX-MNA header. Figure 2 displays the detailed format of the Ext-Flags field.

*Extended IOAM-Trace-Type-MNA is a 22-bit field. The interpretation of bit positions is according to IANA's IOAM Trace-Type registry. An IOAM-DEX-MNA encoding MAY include none, one, or more LSEs with the Extended IOAM-Trace-Type-MNA field.

*Flow ID MNA is an optional 22-bit field. The semantics of the Flow ID MNA field is as of the Flow ID field defined in Section 3.2 of [RFC9326].

*Sequence Number - is an optional 22-bit field. The semantics of the Sequence Number MNA field is as of the Sequence Number field defined in Section 3.2 of [RFC9326].

*Resv fields MUST be zeroed on transmit and ignored on receipt.

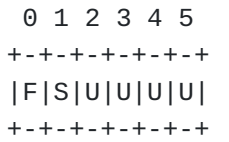

Figure 2: Ext-Flags Field Format

Where fields are defined as follows:

*F - one-bit flag. When the flag is set to 1, it indicates the presence of the Flow ID field in the IOAM-DEX-MNA header.

*S - one-bit flag. When the flag is set to 1, it indicates the presence of the Sequence Number field in the IOAM-DEX-MNA header.

*U - unassigned one-bit flag. It MUST be zeroed on transmission and the value MUST be ignored upon receipt.

4.2. IOAM-DEX-MNA Encoding as In-Stack Data MPLS Network Action

To support the direct export of the operational state and telemetry information, the IOAM-DEX-MNA blob (binary large object), as shown in Figure 1 can be placed as part of the ISD block in an MPLS label stack according to the MNA encoding principles defined in [I-D.ietf-mpls-mna-hdr]. Using the IHS field, the IOAM-DEX-MNA can be performed in Hop-by-Hop, Ingress-to-Egress, or Select modes [I-D.ietf-mpls-mna-fwk] of collecting the operational state and telemetry information, as MNA Opcode (Figure 3). Policies controlling the processing of the collected operational state and telemetry information, and its transport are outside the scope of this document.

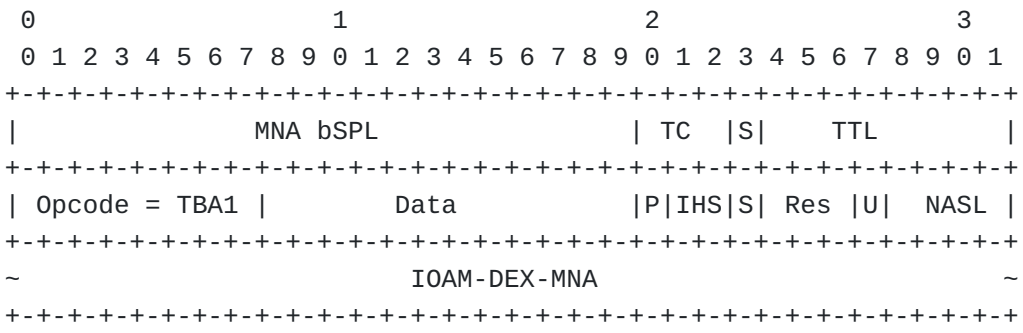

Figure 3: An Example of IOAM-DEX Encapsulation as an MNA Opcode

Where the enclosed elements are defined as follows:

*MNA bSPL is a base Special Purpose Label assigned by IANA per the request in [I-D.ietf-mpls-mna-hdr].

*S - the Bottom of Stack field [RFC3032].

*P, IHS, Res, U, and NASL fields are as specified in Section 4.2 of [I-D.ietf-mpls-mna-hdr].

*NASL - number of LSEs that compose the IOAM-DEX-MNA blob.

*Opcode is MNA-IOAM-DEX opcode (TBA1) assigned by IANA Section 5.1.

*IOAM-DEX-MNA - IOAM Direct Export in MPLS Network Action encoding

5. IANA Considerations

5.1. IOAM-DEX-MNA as an MPLS Network Action Opcode

IANA is requested to assign an IOAM-DEX-MNA codepoint (TBA1) from its Network Action Opcodes registry (creation requested in [I-D.ietf-mpls-mna-hdr]) as specified in Table 1.

Opcode	Description	Reference
TBA1	IOAM-DEX as MPLS Network Action Indicator	This document

Table 1: IOAM-DEX as MPLS Network Action Opcode

6. Security Considerations

Security considerations discussed in [RFC9197], [RFC9326], and [I-D.ietf-mpls-mna-fwk] apply to this document.

7. Acknowledgments

TBD

8. References

8.1. Normative References

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8.2. Informational References

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