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Bit Index Explicit Replication (BIER) Encapsulation for In-situ OAM (IOAM) Data
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Abstract

In-situ Operations, Administration, and Maintenance (IOAM) collects operational and telemetry information while the packet traverses a particular network domain. Bit Index Explicit Replication (BIER) is an architecture that provides optimal multicast forwarding through a "multicast domain", without requiring intermediate routers to maintain any per-flow state or to engage in an explicit tree-building protocol. The BIER header contains a bit-string in which each bit represents exactly one egress router to forward the packet to. This document outlines the requirements to carry IOAM data in BIER header and specifies how IOAM data fields are encapsulated in BIER header.

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1. Introduction

In-situ Operations, Administration, and Maintenance (IOAM) collects operational and telemetry information while the packet traverses a particular network domain. [I-D.ietf-ippm-ioam-data] defines different IOAM data fields used to record various telemetry data from the transit nodes. The term "in-situ" refers to the fact that the IOAM data fields are added to the data packets rather than being sent within packets specifically dedicated to OAM.

Bit Index Explicit Replication (BIER), as defined in [RFC8279], is an architecture that provides optimal multicast forwarding through a "multicast domain", without requiring intermediate routers to maintain any per-flow state or to engage in an explicit tree-building

protocol. The BIER header, as defined in [RFC8296], contains a bit-string in which each bit represents exactly one egress router to forward the packet to.

This document outlines the requirements to carry IOAM data in BIER header and specifies how IOAM data fields are encapsulated in BIER header.

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

Abbreviations used in this document:

BFER: Bit Forwarding Egress Router

BFIR: Bit Forwarding Ingress Router

BIER: Bit Index Explicit Replication

GRE: Generic Routing Encapsulation

IOAM: In-situ Operations, Administration, and Maintenance

OAM: Operations, Administration, and Maintenance

3. Requirements to carry IOAM data in BIER header

[I-D.ietf-bier-use-cases] lists many use cases for BIER. There are many multicast flows in one network. Some of the flows are sensitive for packet loss, delay and other factors, such as live video, real-time meeting. The network administrator wants to know the real-time statistics for these flows, such as delay, sequence, the I/O interface, and the usage of buffer, and so on.

So a method need to be used for measuring the packet real-time transportation guarantee. OAM function defined in [I-D.ietf-bier-pmmm-oam] can be used for packet loss and delay detection. This document attempts to provide a way to achieve on-path telemetry information collection through in-situ OAM.

4. IOAM data fields encapsulation in BIER header

The BIER header is defined in [RFC8279]. The BIER OAM header that follows BIER header is defined in [I-D.ietf-bier-ping]. IOAM-Data-Fields can either be carried in BIER using a new type of OAM message which follows the BIER OAM header (referred to as option 1), or be carried in BIER using a new next protocol header which immediately follows the BIER header (referred to as option 2). In this document, option 2 is selected and the reason is discussed in Section 5.1. An IOAM header is added containing the different IOAM-Data-Fields defined in [I-D.ietf-ippm-ioam-data].

In an administrative domain where IOAM is used, insertion of the IOAM header in BIER is enabled at the BFIRs, which also serve as IOAM encapsulating nodes by means of configuration, deletion of the IOAM header in BIER is enabled at the BFERs, which also serve as IOAM decapsulating nodes by means of configuration.

The Encapsulation format for IOAM over BIER is defined as follows:

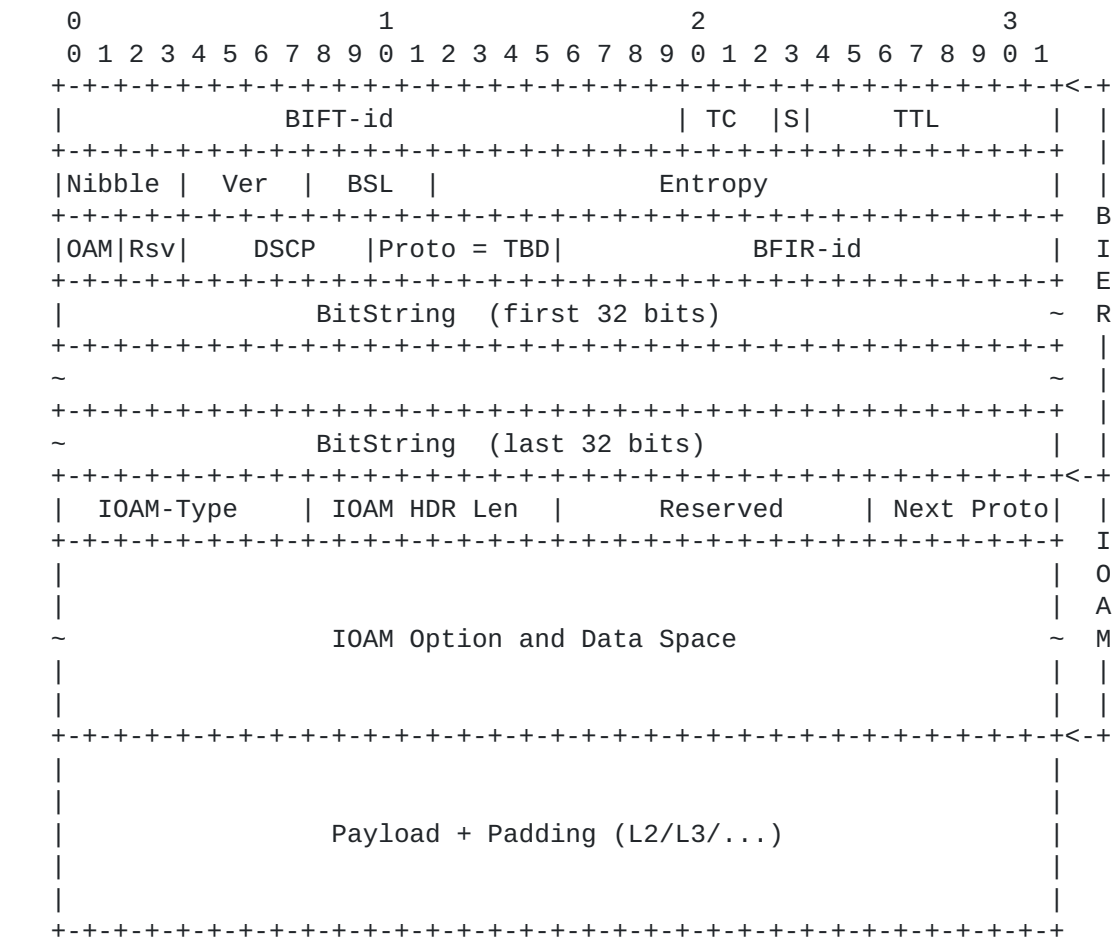

Figure 1: IOAM Encapsulation Format within BIER

The BIER header and fields are defined in [RFC8296]. Within the BIER header, a 6-bit field as "Proto" (Next Protocol) is used to identify the type of the payload immediately following the BIER header, The "Proto" value is set to TBD when the IOAM header is present.

The IOAM related fields in BIER are defined as follows:

IOAM-Type: 8-bit field defining the IOAM Option Type, as defined in Section 7.2 of [I-D.ietf-ippm-ioam-data].

IOAM HDR Len: 8-bit unsigned integer. Length of the IOAM header in 4-octet units.

Reserved: 10-bit reserved field MUST be set to zero upon transmission and ignored upon receipt.

Next Proto: 6-bit unsigned integer that identifies the type of payload immediately following this IOAM option. The semantics of this field are identical to the "Proto" field in [RFC8296].

IOAM Option and Data Space: IOAM option header and data is present as specified by the IOAM-Type field, and is defined in Section 4 of [I-D.ietf-ippm-ioam-data].

Multiple IOAM-Option-Types MAY be included within the BIER encapsulation. For example, if a BIER encapsulation contains two IOAM-Option-Types preceding a data payload, the Next Proto field of the first IOAM option will contain the value of TBD, while the Next Proto field of the second IOAM option will contain the "BIER Next Protocol" number indicating the type of the data payload. Each IOAM Option-Type MUST occur at most once within the same BIER encapsulation header.

5. Considerations

This section summarizes a set of considerations on the overall approach taken for IOAM data encapsulation in BIER, as well as deployment considerations.

5.1. Discussion of the encapsulation approach

Both the options described in section 4 are supposed to be feasible, nevertheless this document needs to select one as standardized encapsulation for IOAM over BIER. Considering the fact that the encapsulation format option 2 using a new next protocol header is more concise than option 1 using a new type of OAM message, and many other transport protocols, e.g. GRE, use a new next protocol header to encapsulate IOAM data, the encapsulation format option 2 is selected as the standardized one.

5.2. IOAM and the use of the BIER OAM bits

[RFC8296] defines a two-bits long field, referred to as OAM. [I-D.ietf-bier-pmmm-oam] describes how to use the two-bits OAM field for alternate marking performance measurement method. The BIER IOAM header and the BIER two-bits OAM field are orthogonal and can co-exist in the same packet header, i.e. a BIER packet with IOAM data can set the OAM field or not, and a BIER packet with OAM field set can also carry IOAM data or not.

6. Security Considerations

This document does not raise any additional security issues beyond those of the specifications referred to in the list of normative references.

7. IANA Considerations

In the "BIER Next Protocol Identifiers" registry defined in [RFC8296], a new Next Protocol Value for IOAM is requested from IANA as follows:

BIER Next Protocol Identifier	Description	Semantics Definition	Reference
TBD	In-situ OAM (IOAM)	Section 4	This Document

Table 1: New BIER Next Protocol Identifier for IOAM

8. Acknowledgements

The authors would like to acknowledge Greg Mirsky for his thorough review and very helpful comments.

9. References

9.1. Normative References

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