BIER Working Group G. Mirsky

Internet-Draft ZTE Corp.

Intended status: Standards Track T. Przygienda

Expires: 1 October 2021 Juniper Networks

A. Dolganow

Individual contributor

30 March 2021

Path Maximum Transmission Unit Discovery (PMTUD) for Bit Index Explicit

Replication (BIER) Layer

draft-ietf-bier-path-mtu-discovery-10

Abstract

This document describes Path Maximum Transmission Unit Discovery

(PMTUD) in Bit Indexed Explicit Replication (BIER) layer.

Status of This Memo

This Internet-Draft is submitted in full conformance with the

provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering

Task Force (IETF). Note that other groups may also distribute

working documents as Internet-Drafts. The list of current Internet-

Drafts is at https://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months

and may be updated, replaced, or obsoleted by other documents at any

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 1 October 2021.

Copyright Notice

Copyright (c) 2021 IETF Trust and the persons identified as the

document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust's Legal

Provisions Relating to IETF Documents (https://trustee.ietf.org/

license-info) in effect on the date of publication of this document.

Please review these documents carefully, as they describe your rights

and restrictions with respect to this document. Code Components

extracted from this document must include Simplified BSD License text

as described in Section 4.e of the Trust Legal Provisions and are

provided without warranty as described in the Simplified BSD License.

Mirsky, et al. Expires 1 October 2021 [Page 1]

Internet-Draft PMTUD for BIER March 2021

Table of Contents

1. Introduction . . . . . . . . . . . . . . . . . . . . . . . . 2

1.1. Conventions used in this document . . . . . . . . . . . . 3

1.1.1. Acronyms . . . . . . . . . . . . . . . . . . . . . . 3

1.1.2. Requirements Language . . . . . . . . . . . . . . . . 3

2. Problem Statement . . . . . . . . . . . . . . . . . . . . . . 3

3. PMTUD Mechanism for BIER . . . . . . . . . . . . . . . . . . 4

3.1. Data TLV for BIER Ping . . . . . . . . . . . . . . . . . 6

4. IANA Considerations . . . . . . . . . . . . . . . . . . . . . 7

5. Security Considerations . . . . . . . . . . . . . . . . . . . 7

6. Acknowledgment . . . . . . . . . . . . . . . . . . . . . . . 7

7. References . . . . . . . . . . . . . . . . . . . . . . . . . 7

7.1. Normative References . . . . . . . . . . . . . . . . . . 7

7.2. Informative References . . . . . . . . . . . . . . . . . 8

Authors' Addresses . . . . . . . . . . . . . . . . . . . . . . . 8

1. Introduction

In packet switched networks, when a host seeks to transmit data to a

target destination, the data is transmitted as a set of packets. In

many cases, it is more efficient to use the largest size packets that

are less than or equal to the least Maximum Transmission Unit (MTU)

for any forwarding device along the routed path to the IP destination

for these packets. Such "least MTU" is known as Path MTU (PMTU).

Fragmentation or packet drop, silent or not, may occur on hops along

the route where an MTU is smaller than the size of the datagram. To

avoid any of the listed above behaviors, the packet source must find

the value of the least MTU, i.e., PMTU, that will be encountered

along the route that a set of packets will follow to reach the given

set of destinations. Such MTU determination along a specific path is

referred to as path MTU discovery (PMTUD).

[RFC8279] introduces and explains Bit Index Explicit Replication

(BIER) architecture and how it supports the forwarding of multicast

data packets. A BIER domain consists of Bit-Forwarding Routers

(BFRs) that are uniquely identified by their respective BFR-ids. An

ingress border router (acting as a Bit Forwarding Ingress Router

(BFIR)) inserts a Forwarding Bit Mask (F-BM) into a packet. Each

targeted egress node (referred to as a Bit Forwarding Egress Router

(BFER)) is represented by Bit Mask Position (BMP) in the BMS. A

transit or intermediate BIER node, referred to as BFR, forwards BIER

encapsulated packets to BFERs, identified by respective BMPs,

according to a Bit Index Forwarding Table (BIFT).

Mirsky, et al. Expires 1 October 2021 [Page 2]

Internet-Draft PMTUD for BIER March 2021

1.1. Conventions used in this document

1.1.1. Acronyms

BFR: Bit-Forwarding Router

BFER: Bit-Forwarding Egress Router

BFIR: Bit-Forwarding Ingress Router

BIER: Bit Index Explicit Replication

BIFT: Bit Index Forwarding Tree

F-BM: Forwarding Bit Mask

MTU: Maximum Transmission Unit

OAM: Operations, Administration and Maintenance

PMTUD: Path MTU Discovery

1.1.2. 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.

2. Problem Statement

[I-D.ietf-bier-oam-requirements] sets forth the requirement to define

PMTUD protocol for BIER domain. This document describes the

extension to [I-D.ietf-bier-ping] for use in the BIER PMTUD solution.

Current PMTUD mechanisms ([RFC1191], [RFC8201], and [RFC4821]) are

primarily targeted to work on point-to-point, i.e. unicast paths.

These mechanisms use packet fragmentation control by disabling

fragmentation of the probe packet. As a result, a transient node

that cannot forward a probe packet that is bigger than its link MTU

sends to the packet source an error notification, otherwise the

packet destination may respond with a positive acknowledgment. Thus,

possibly through a series of iterations, varying the size of the

probe packet, the packet source discovers the PMTU of the particular

path.

Mirsky, et al. Expires 1 October 2021 [Page 3]

Internet-Draft PMTUD for BIER March 2021

Thus applied such existing PMTUD solutions are inefficient for point-

to-multipoint paths constructed for multicast traffic. Probe packets

must be flooded through the whole set of multicast distribution paths

over and over again until the very last egress responds with a

positive acknowledgment. Consider without loss of generality an

example multicast network presented in Figure 1, where MTU on all

links but one (B, D) is the same. If MTU on the link (B, D) is

smaller than the MTU on the other links, using existing PMTUD

mechanism probes will unnecessary flood to leaf nodes E, F, and G for

the second and consecutive times and positive responses will be

generated and received by root A repeatedly.

-----

--| D |

----- / -----

--| B |--

/ ----- \ -----

/ --| E |

----- / -----

| A |--- -----

----- \ --| F |

\ ----- / -----

--| C |--

----- \ -----

--| G |

-----

Figure 1: Multicast network

3. PMTUD Mechanism for BIER

A BFIR selects a set of BFERs for the specific multicast

distribution. Such a BFIR determines, by explicitly controlling a

subset of targeted BFERs and transmitting a series of probe packets,

the MTU of that multicast distribution tree. In the case of ECMP,

BFIR MAY test each path by variating the value in the Entropy field.

The critical step is that in case of failure at an intermediate BFR

to forward towards the subset of targeted downstream BFERs, the BFR

responds with a partial (compared to the one it received in the

request) bitmask towards the originating BFIR in error notification.

That allows for retransmission of the next probe with a smaller MTU

address only towards the failed downstream BFERs instead of all BFERs

addressed in the previous probe. In the scenario discussed in

Section 2 the second and all following (if needed) probes will be

sent only to the node D since MTU discovery of E, F, and G has been

completed already by the first probe successfully.

Mirsky, et al. Expires 1 October 2021 [Page 4]

Internet-Draft PMTUD for BIER March 2021

[I-D.ietf-bier-ping] introduced BIER Ping as a transport-independent

OAM mechanism to detect and localize failures in the BIER data plane.

This document specifies how BIER Ping can be used to perform

efficient PMTUD in the BIER domain.

Consider the network displayed in Figure 1 to be a presentation of a

BIER domain and all nodes to be BFRs. To discover MTU over BIER

domain to BFERs D, F, E, and G BFIR A will use BIER Ping with Data

TLV, defined in Section 3.1. Size of the first probe set to M\_max

determined as minimal MTU value of BFIR's links to BIER domain. As

has been assumed in Section 2, MTUs of all links but the link (B, D)

are the same. Thus BFERs E, F, and G would receive BIER Echo Request

and will send their respective replies to BFIR A. BFR B may pass the

packet which is too large to forward over egress link (B, D) to the

appropriate network layer for error processing where it would be

recognized as a BIER Echo Request packet. BFR B MUST send BIER Echo

Reply to BFIR A and MUST include Downstream Mapping TLV, defined in

[I-D.ietf-bier-ping] setting its fields in the following fashion:

\* MTU SHOULD be set to the minimal MTU value among all egress BIER

links, logical links between this and downstream BFRs, that could

be used to reach B's downstream BFERs;

\* Address Type MUST be set to 0 [Ed.note: we need to define 0 as

valid value for the Address Type field with the specific semantics

to "Ignore" it.]

\* I flag MUST be cleared;

\* Downstream Interface Address field (4 octets) MUST be zeroed and

MUST include in the Egress Bitstring sub-TLV the list of all BFERs

that cannot be reached because the attempted MTU turned out to be

too small.

The BFIR will receive either of the two types of packets:

\* a positive Echo Reply from one of BFERs to which the probe has

been sent. In this case, the bit corresponding to the BFER MUST

be cleared from the BMS;

\* a negative Echo Reply with bit string listing unreached BFERs and

recommended MTU value MTU'. The BFIR MUST add the bit string to

its BMS and set the size of the next probe as min(MTU, MTU')

If upon expiration of the Echo Request timer BFIR didn't receive any

Echo Replies, then the size of the probe SHOULD be decreased. There

are scenarios when an implementation of the PMTUD would not decrease

the size of the probe. For example, suppose upon expiration of the

Mirsky, et al. Expires 1 October 2021 [Page 5]

Internet-Draft PMTUD for BIER March 2021

Echo Request timer BFIR didn't receive any Echo Reply. In that case,

BFIR MAY continue to retransmit the probe using the initial size and

MAY apply probe delay retransmission procedures. The algorithm used

to delay retransmission procedures on BFIR is outside the scope of

this specification. The BFIR sends probes using BMS and locally

defined retransmission procedures until either the bit string is

clear, i.e., contains no set bits, or until the BFIR retransmission

procedure terminates and PMTU discovery is declared unsuccessful. In

the case of convergence of the procedure, the size of the last probe

indicates the PMTU size that can be used for all BFERs in the initial

BMS without incurring fragmentation.

Thus we conclude that in order to comply with the requirement in

[I-D.ietf-bier-oam-requirements]:

\* a BFR SHOULD support PMTUD;

\* a BFR MAY use defined per BIER sub-domain MTU value as initial MTU

value for discovery or use it as MTU for this BIER sub-domain to

reach BFERs;

\* a BFIR MUST have a locally defined PMTUD probe retransmission

procedure.

3.1. Data TLV for BIER Ping

There needs to be a control for probe size in order to support the

BIER PMTUD. Data TLV format is presented 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

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

| Type (TBA1) | Length |

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

| Data |

~ ~

| |

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

Figure 2: Data TLV format

\* Type: indicates Data TLV, to be allocated by IANA Section 4.

\* Length: the length of the Data field in octets.

\* Data: n octets (n = Length) of arbitrary data. The receiver

SHOULD ignore it.

Mirsky, et al. Expires 1 October 2021 [Page 6]

Internet-Draft PMTUD for BIER March 2021

4. IANA Considerations

IANA is requested to assign a new Type value for Data TLV Type from

its registry of TLV and sub-TLV Types of BIER Ping as follows:

+=======+=============+===============+

| Value | Description | Reference |

+=======+=============+===============+

| TBA1 | Data | This document |

+-------+-------------+---------------+

Table 1: Data TLV Type

5. Security Considerations

Routers that support PMTUD based on this document are subject to the

same security considerations as defined in [I-D.ietf-bier-ping]

6. Acknowledgment

Authors greatly appreciate thorough review and the most detailed

comments by Eric Gray.

7. References

7.1. Normative References

[I-D.ietf-bier-ping]

Kumar, N., Pignataro, C., Akiya, N., Zheng, L., Chen, M.,

and G. Mirsky, "BIER Ping and Trace", Work in Progress,

Internet-Draft, draft-ietf-bier-ping-07, 11 May 2020,

<https://tools.ietf.org/html/draft-ietf-bier-ping-07>.

[RFC1191] Mogul, J. and S. Deering, "Path MTU discovery", RFC 1191,

DOI 10.17487/RFC1191, November 1990,

<https://www.rfc-editor.org/info/rfc1191>.

[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>.

[RFC4821] Mathis, M. and J. Heffner, "Packetization Layer Path MTU

Discovery", RFC 4821, DOI 10.17487/RFC4821, March 2007,

<https://www.rfc-editor.org/info/rfc4821>.

Mirsky, et al. Expires 1 October 2021 [Page 7]

Internet-Draft PMTUD for BIER March 2021

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC

2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174,

May 2017, <https://www.rfc-editor.org/info/rfc8174>.

[RFC8201] McCann, J., Deering, S., Mogul, J., and R. Hinden, Ed.,

"Path MTU Discovery for IP version 6", STD 87, RFC 8201,

DOI 10.17487/RFC8201, July 2017,

<https://www.rfc-editor.org/info/rfc8201>.

7.2. Informative References

[I-D.ietf-bier-oam-requirements]

Mirsky, G., Kumar, N., Chen, M., and S. Pallagatti,

"Operations, Administration and Maintenance (OAM)

Requirements for Bit Index Explicit Replication (BIER)

Layer", Work in Progress, Internet-Draft, draft-ietf-bier-

oam-requirements-11, 15 November 2020,

<https://tools.ietf.org/html/draft-ietf-bier-oam-

requirements-11>.

[RFC8279] Wijnands, IJ., Ed., Rosen, E., Ed., Dolganow, A.,

Przygienda, T., and S. Aldrin, "Multicast Using Bit Index

Explicit Replication (BIER)", RFC 8279,

DOI 10.17487/RFC8279, November 2017,

<https://www.rfc-editor.org/info/rfc8279>.

Authors' Addresses

Greg Mirsky

ZTE Corp.

Email: gregimirsky@gmail.com, gregory.mirsky@ztetx.com

Tony Przygienda

Juniper Networks

Email: prz@juniper.net

Andrew Dolganow

Individual contributor

Email: adolgano@gmail.com

Mirsky, et al. Expires 1 October