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# Path Maximum Transmission Unit Discovery (PMTUD) for Bit Index Explicit Replication (BIER) Layer

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## 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.

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## 1. Introduction

In packet switched networks when a host seeks to transmit a sizable amount of data to a target destination the data is transmitted as a set of datagrams. In most cases it is more efficient to use the largest possible datagrams but so that these datagrams do not have to be fragmented at any point along the path from the host to the destination in order to avoid performance degradation caused by fragmentation. Fragmentation occurs on hops along the route where an Maximum Transmission Unit (MTU) is smaller than the size of the datagram. To avoid such fragmentation the MTU for each hop along a path from a host to a destination must be known to select an appropriate datagram size. Such MTU determination along a specific path is referred to as path MTU discovery (PMTUD).

[I-D.ietf-bier-architecture] introduces and explains Bit Index Explicit Replication (BIER) architecture and how it supports 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 as BFR, forwards BIER encapsulated packets to BFERs, identified by respective BMPs, according to a Bit Index Forwarding Table (BIFT).

### 1.1. Conventions used in this document

#### 1.1.1. Terminology

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 [RFC2119].

## 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.kumarzheng-bier-ping] for use in BIER PMTUD solution.

Current PMTUD mechanisms [RFC1191], [RFC1981], 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 result, a transient node that cannot forward a probe packet that is bigger than its link MTU sends to the ingress node an error notification, otherwise the egress responds with a positive acknowledgement. Thus, through series of iterations, decreasing and increasing size of the probe packet, the ingress node discovers the MTU of the particular path.

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 acknowledgement. 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 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.

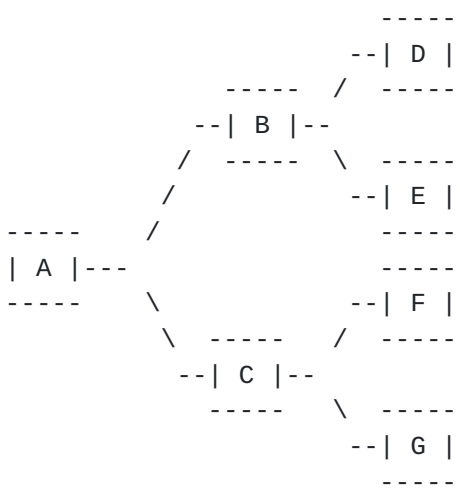


Figure 1: Multicast network

## 3. PMTUD Mechanism for BIER

A BFIR selects a set of BFERs for the specific multicast distribution. Such BFIR determines, by explicitly controlling subset of targeted BFERs and transmitting series of probe packets, the MTU of that multicast distribution path. 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 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.

[I-D.kumarzheng-bier-ping] introduced BIER Ping as transport-independent OAM mechanism to detect and localize failures in BIER

data plane. This document specifies how BIER Ping can be used to perform efficient PMTUD in BIER domain.

Consider network displayed in Figure 1 to be 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 been assumed in Section 2, MTUs of all links but 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 BIER Echo Request packet. BFR B MUST send BIER Echo Reply to BFIR A and MUST include Downstream Mapping TLV, defined in [I-D.kumarzheng-bier-ping] setting its fields in the following fashion:

- MTU SHOULD be set to minimal MTU value among all egress BIER links 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 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 such 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 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, if upon expiration of the Echo Request timer BFIR didn't receive any Echo Reply, then 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 MUST continue sending probes using BMS until the bit string is clear or the discovery is declared unsuccessful. In case of convergence of the procedure, the size of the last probe indicates the MTU 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.

### 3.1. Data TLV for BIER Ping

There need to be control of probe size in order to support the BIER PMTUD. Data TLV format is presented in Figure 2.

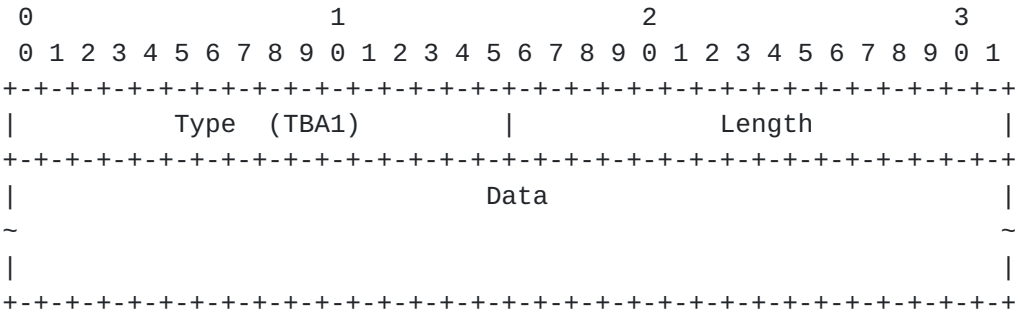


Figure 2: Data TLV format

- 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.

## 4. IANA Considerations

IANA is requested to assign 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.kumarzheng-bier-ping]

## 6. Acknowledgement

TBD

## 7. References

### 7.1. Normative References

[I-D.ietf-bier-architecture]
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[I-D.kumarzheng-bier-ping]
Kumar, N., Pignataro, C., Akiya, N., Zheng, L., Chen, M., and G. Mirsky, "BIER Ping and Trace", draft-kumarzheng-bier-ping-02 (work in progress), December 2015.

[RFC1191] Mogul, J. and S. Deering, "Path MTU discovery", RFC 1191, DOI 10.17487/RFC1191, November 1990, <http://www.rfc-editor.org/info/rfc1191>.

[RFC1981] McCann, J., Deering, S., and J. Mogul, "Path MTU Discovery for IP version 6", RFC 1981, DOI 10.17487/RFC1981, August 1996, <http://www.rfc-editor.org/info/rfc1981>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <http://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, <http://www.rfc-editor.org/info/rfc4821>.

### 7.2. Informative References

[I-D.ietf-bier-oam-requirements]
Mirsky, G., Nordmark, E., Pignataro, C., Kumar, N., Aldrin, S., Zheng, L., Chen, M., Akiya, N., and S. Pallagatti, "Operations, Administration and Maintenance (OAM) Requirements for Bit Index Explicit Replication (BIER) Layer", draft-ietf-bier-oam-requirements-01 (work in progress), March 2016.

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