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# RFC 9974
# Operations, Administration, and Maintenance (OAM) Requirements for the Bit Index Explicit Replication (BIER) Layer

## Abstract

This document specifies a list of functional requirements for Operations, Administration, and Maintenance mechanisms, protocols, and tools that support operations in the Bit Index Explicit Replication layer of a network.

## Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Not all documents approved by the IESG are candidates for any level of Internet Standard; see Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc9974.

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# 1. Introduction

[RFC8279] specifies a Bit Index Explicit Replication (BIER) architecture and how it supports forwarding of multicast data packets.

This document lists the Operations, Administration, and Maintenance (OAM) requirements for the BIER layer (see Section 4.2 of [RFC8279]) of the multicast domain. The list can further be used for gap analysis of available OAM tools to identify whether possible enhancements of existing or new OAM tools are required to support proactive and on-demand path monitoring and service validation.

## 1.1. Conventions Used in This Document

### 1.1.1. Terminology

The reader is expected to be familiar with:

- [RFC7799], particularly definitions of Active, Passive, and Hybrid measurement methods and metrics.
- The definitions and calculation of performance metrics, e.g., throughput, loss, delay, and delay variation metrics, are defined in [RFC6374].
- The definitions, applicability, and examples of the Continuity Check and Connectivity Verification mechanisms, components of the Fault Management OAM, can be found in [RFC5860], [RFC6371], and [RFC7276].
- A multicast domain is a network segment that defines the scope for multicast traffic, allowing it to be exchanged only among systems within the domain [RFC8279].
- The term "BIER OAM" is used in this document interchangeably with "a set of OAM protocols, methods, and tools for the BIER layer".
- Downstream is the direction from the ingress toward the egress endpoints of a multicast distribution tree.
- Egress endpoint is a router to which the packet needs to be sent [RFC8279].
- Ingress endpoint is a router that encapsulates a packet in a BIER header [RFC8279].
- A BIER OAM session is a communication established between Bit-Forwarding Routers (BFR) to perform OAM functions like fault detection, performance monitoring, and localization [RFC7276]. These sessions can be proactive (continuous, persistent configuration) or on-demand (manual, temporary diagnostics).

### 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.

The requirements language is used in Section 2 and applies to implementations of BIER OAM conformant to the listed requirements.

### 1.1.3. Acronyms

BFD: Bidirectional Forwarding Detection [RFC8562]

BFR: Bit-Forwarding Router [RFC8279]

BFER: Bit-Forwarding Egress Router [RFC8279]

BIER: Bit Index Explicit Replication [RFC8279]

OAM: Operations, Administration, and Maintenance [RFC6291]

PMTUD: Path Maximum Transmission Unit Discovery [RFC1191]

P2MP: Point-to-Multipoint [RFC8562]

RDI: Remote Defect Indication [RFC6428]

STAMP: Simple Two-way Active Measurement Protocol [RFC8762]

## 2. Requirements

This section lists the requirements for OAM of the BIER layer:

1. The listed requirements **MUST** be supported with any routing underlay [RFC8279] over which the BIER layer can be realized.
2. It **MUST** be possible to initialize a BIER OAM session from any BFR of the given BIER domain.
3. It **MUST** be possible to initialize a BIER OAM session from a controller.
4. BIER OAM **MUST** support proactive OAM monitoring and measurement methods.
5. BIER OAM **MUST** support on-demand OAM monitoring and measurement methods.
6. BIER OAM **MUST** support active performance measurement methods [RFC7799].
7. BIER OAM **MUST** support passive performance measurement methods [RFC7799].
8. BIER OAM **MUST** support the ability of any BFR in the given BIER domain to proactively monitor Bit-Forwarding Egress Router (BFER) availability.

   This requirement provides helpful clarification to the combination of Requirements 2 and 4. The P2MP BFD with active tail support [RFC9780] is an example of a protocol that provides notifications about the loss of connectivity in a multicast distribution tree.
9. BIER OAM **MUST** support downstream path continuity checking.

   Bidirectional Forwarding Detection (BFD) [RFC8562] is an example of a protocol that monitors the continuity of a multicast distribution tree.
10. BIER OAM **MUST** support downstream performance measurement.

    Simple Two-way Active Measurement Protocol (STAMP) [RFC8762] is an example of a protocol that supports measurement of performance metrics, e.g., packet loss ratio, delay, and delay variation.
11. In the downstream direction, a BIER OAM solution **MUST** support transmission of OAM packets to traverse the same set of nodes and links and receive the same forwarding treatment (including QoS) as the monitored BIER flow.

    In some cases, e.g., when monitoring a composite data flow that includes several sub-flows characterized by different Class-of-Service (CoS) marking, an operator may choose to monitor the continuity of the path at the highest CoS, not at every CoS value in the data flow. In that case, BIER OAM packets traverse the same set of nodes and links as the composite data flow while receiving the same forwarding treatment as the highest CoS sub-flow. In this scenario, the state of path continuity for lower CoS sub-flows can be derived from the state of the highest CoS, as determined by the BIER OAM protocol performing continuity verification (e.g., BFD).

12. BIER OAM **MUST** support bidirectional OAM methods. In the downstream direction, these methods of monitoring or measurement **MUST** conform to Requirement 11. In the reverse direction (i.e., from the egress toward the ingress endpoint of the BIER OAM test session), BIER OAM packets **MAY** deviate from traversing the same set of nodes and links, or receive a different forwarding treatment (including QoS) as the monitored BIER flow.

    Point-to-Multipoint (P2MP) BFD with active tail [RFC9780] is an example of the bidirectional mechanism of continuity checking.

13. BIER OAM **MUST** support Path Maximum Transmission Unit Discovery (PMTUD).

    The PMTUD using ICMP [RFC1191] is an example of the mechanism.

14. BIER OAM **MUST** support an RDI mechanism to notify the BFR, the source of the continuity checking by BFERs.

    The Diagnostic field in P2MP BFD with active tail support, as described in Section 5 of [RFC9780], is an example of the RDI mechanism.

15. BIER OAM **MUST** support downstream performance measurement method(s) that (together) calculate performance metrics, e.g., throughput, loss, delay, and delay variation metrics [RFC6374].

    STAMP ([RFC8762] and [RFC8972]) is an example of an active performance measurement method of performance metrics that may be applied in a BIER domain. The Alternate-Marking Method, described in [RFC9341] and [RFC9342], is an example of a hybrid measurement method [RFC7799] that may be applied in a BIER domain.

16. BIER OAM **MUST** support defect notification mechanism(s).

    Alarm Indication Signal [RFC6427] is an example of the defect notification mechanism.

17. BIER OAM **MUST** support a way for any BFR in the given BIER domain to originate a fault management message addressed to any subset of BFRs within the domain.

    [RFC6427] provides an example of a Fault Management messaging mechanism.

18. BIER OAM **MUST** support methods to enable the survivability of a BIER layer.

    Protection switching and restoration are examples of survivability methods.

## 3. IANA Considerations

This document has no IANA actions.

## 4. Security Considerations

This document lists the OAM requirements for a BIER-enabled domain and it thus inherits the security considerations discussed in [RFC8279] and [RFC8296]. Another general security aspect results from using active OAM protocols [RFC7799] in a multicast network.

Active OAM protocols inject specially constructed test packets. Some active OAM protocols are based on the echo request/reply principle of using those test packets. In the multicast network, test packets are replicated as data packets, thus creating a possible amplification effect of multiple echo replies being transmitted to the sender of the echo request. Therefore, the following security-related requirements are defined for BIER OAM:

- A BIER OAM solution **MUST** protect the control plane by controlling the rate of echo request transmission.
- A BIER OAM solution **MUST** provide control of the number of BIER OAM messages sent to the control plane.

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