Workgroup: Network Working Group
Internet-Draft: draft-ietf-bfd-stability-12
Published: 31 January 2024
Intended Status: Standards Track
Expires: 3 August 2024
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BFD Stability

Abstract

This document describes extensions to the Bidirectional Forwarding Detection (BFD) protocol to measure BFD stability. Specifically, it describes a mechanism for detection of BFD packet loss.

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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This Internet-Draft will expire on 3 August 2024.

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1. Introduction

The Bidirectional Forwarding Detection (BFD) [RFC5880] protocol operates by transmitting and receiving BFD control packets, generally at high frequency, over the datapath being monitored. In order to prevent significant data loss due to a datapath failure, BFD session detection time as defined in BFD [RFC5880] is set to the smallest feasible value.

This document proposes a mechanism to detect lost packets in a BFD session in addition to the datapath fault detection mechanisms of BFD. Such a mechanism presents significant value to measure the stability of BFD sessions and provides data to the operators for the cause of a BFD failure.

This document does not propose any BFD extension to measure data traffic loss or delay on a link or tunnel and the scope is limited to BFD packets.

2. Terminology

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 RFC 2119 [RFC2119] and RFC 8174 [RFC8174].

The reader is expected to be familiar with the BFD [RFC5880], Optimizing BFD Authentication [I-D.ietf-bfd-optimizing-authentication] and BFD Secure Sequence Numbers [I-D.ietf-bfd-secure-sequence-numbers].

3. Use Cases

Bidirectional Forwarding Detection as defined in BFD [RFC5880] cannot detect any BFD packet loss if the loss does not last for detection time. This document proposes a method to detect a dropped packet on the receiver. For example, if the receiver receives BFD control packet k at time t but receives packet k+3 at time t+10ms, and never receives packet k+1 and/or k+2, then it has experienced a drop.

This proposal enables BFD implementations to generate diagnostic information on the health of each BFD session that could be used to preempt a failure on a datapath that BFD was monitoring by allowing time for a corrective action to be taken.

In a faulty datapath scenario, an operator can use BFD health information to trigger delay and loss measurement OAM protocol (Connectivity Fault Management (CFM) or Loss Measurement (LM)-Delay Measurement (DM)) to further isolate the issue.

4. Functionality

The functionality proposed for BFD stability measurement is achieved by configuring the 'stability' flag in the attached YANG model in conjunction with BFD Meticulous Authentication.

5. Theory of Operation

This mechanism allows operators to measure the loss of BFD control packets.

When using MD5 or SHA authentication, BFD MUST use an authentication type (bfd.AuthType) that is of type meticulous. Similarly, if BFD uses the OPT bfd.AuthType as defined in Optimizing BFD Authentication [I-D.ietf-bfd-optimizing-authentication], the authentication method it chooses MUST be of type meticulous.

5.1. Loss Measurement

Loss measurement counts the number of BFD control packets missed at the receiver during any Detection Time period. The loss is detected by comparing the Sequence Number field in successive BFD control packets. The Sequence Number in each successive control packet generated on a BFD session by the transmitter is incremented by one.

This loss count can then be exposed using the YANG module defined in the subsequent section.

The first BFD authentication section with a non-zero sequence number, in a valid BFD control packet, processed by the receiver is used for bootstrapping the logic.

6. Stability YANG Module

6.1. Data Model Overview

This YANG module augments the "ietf-bfd" module to add a flag 'stability' to enable this feature. The feature statement 'stability' needs to be enabled to indicate that BFD Stability is supported by the implementation. In addition, a loss count per-session or lsp for BFD packets that are lost has also been added in this model.

```
module: ietf-bfd-stability

  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/bfd:bfd/bfd-ip-sh:ip-sh
            /bfd-ip-sh:sessions/bfd-ip-sh:session:
    +--rw stability?   boolean {stability}?
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/bfd:bfd/bfd-ip-mh:ip-mh
            /bfd-ip-mh:session-groups/bfd-ip-mh:session-group:
    +--rw stability?   boolean {stability}?
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/bfd:bfd/bfd-lag:lag
            /bfd-lag:sessions/bfd-lag:session:
    +--rw stability?   boolean {stability}?
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/bfd:bfd/bfd-mpls:mpls
            /bfd-mpls:session-groups/bfd-mpls:session-group:
    +--rw stability?   boolean {stability}?
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/bfd:bfd/bfd-ip-sh:ip-sh
            /bfd-ip-sh:sessions/bfd-ip-sh:session
            /bfd-ip-sh:session-statistics:
    +--ro lost-packet-count?   yang:counter32
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/bfd:bfd/bfd-ip-mh:ip-mh
            /bfd-ip-mh:session-groups/bfd-ip-mh:session-group
            /bfd-ip-mh:sessions/bfd-ip-mh:session-statistics:
    +--ro lost-packet-count?   yang:counter32
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/bfd:bfd/bfd-lag:lag
            /bfd-lag:sessions/bfd-lag:session/bfd-lag:member-links
            /bfd-lag:micro-bfd-ipv4/bfd-lag:session-statistics:
    +--ro lost-packet-count?   yang:counter32
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/bfd:bfd/bfd-mpls:mpls
            /bfd-mpls:session-groups/bfd-mpls:session-group
            /bfd-mpls:sessions/bfd-mpls:session-statistics:
    +--ro lost-packet-count?   yang:counter32
```

6.2. YANG Module

This YANG module imports Common YANG Types [RFC6991], A YANG Data Model for Routing [RFC8349], and YANG Data Model for Bidirectional Forwading Detection (BFD) [RFC9314].

```
<CODE BEGINS> file "ietf-bfd-stability@2024-01-31.yang"

module ietf-bfd-stability {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-bfd-stability";
  prefix "bfds";

  import ietf-yang-types {
    prefix "yang";
    reference
      "RFC 6991: Common YANG Data Types";
  }

  import ietf-routing {
    prefix "rt";
    reference
      "RFC 8349: A YANG Data Model for Routing Management
       (NMDA version)";
  }

  import ietf-bfd {
    prefix bfd;
    reference
      "RFC 9314: YANG Data Model for Bidirectional
       Forwarding Detection.";
  }

  import ietf-bfd-ip-sh {
    prefix bfd-ip-sh;
    reference
      "RFC 9314: YANG Data Model for Bidirectional
       Forwarding Detection.";
  }

  import ietf-bfd-ip-mh {
    prefix bfd-ip-mh;
    reference
      "RFC 9314: YANG Data Model for Bidirectional
       Forwarding Detection.";
  }

  import ietf-bfd-lag {
    prefix bfd-lag;
    reference
      "RFC 9314: YANG Data Model for Bidirectional
       Forwarding Detection.";
  }

  import ietf-bfd-mpls {
    prefix bfd-mpls;
```

```
  reference
    "RFC 9314: YANG Data Model for Bidirectional
     Forwarding Detection.";
}

organization
  "IETF BFD Working Group";

contact
  "WG Web:   <http://tools.ietf.org/wg/bfd>
   WG List:  <rtg-bfd@ietf.org>

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            Peng Fan (fanp08@gmail.com).";


description
  "This YANG module augments the base BFD YANG model to add
   attributes related to BFD Stability. In particular it adds a
   a per session count for BFD packets that are lost.

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   forth in Section 4.c of the IETF Trust's Legal Provisions
   Relating to IETF Documents
   (https://trustee.ietf.org/license-info).

   This version of this YANG module is part of RFC XXXX
   (https://www.rfc-editor.org/info/rfcXXXX); see the RFC itself
   for full legal notices.

   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 (RFC 2119) (RFC 8174) when, and only when,
   they appear in all capitals, as shown here.";

revision "2024-01-31" {
  description
    "Initial Version.";
  reference
    "RFC XXXX, BFD Stability.";
```

```
}

feature stability {
  description
    "If supported, the feature allows for BFD sessions to be
     monitored for frames lost.";
}

augment "/rt:routing/rt:control-plane-protocols/" +
        "rt:control-plane-protocol/bfd:bfd/bfd-ip-sh:ip-sh/" +
        "bfd-ip-sh:sessions/bfd-ip-sh:session" {
  leaf stability {
    if-feature "stability";
    type boolean;
    must "../bfd-ip-sh:authentication/bfd-ip-sh:meticulous = " +
         "'true'";
    default false;
    description
      "If set to true, this enables the BFD session to monitor
       for stability; i.e., to watch how many frames are getting
       dropped.";
  }
  description
    "Augment the 'bfd' container to add attributes related to BFD
     stability.";
}

augment "/rt:routing/rt:control-plane-protocols/" +
        "rt:control-plane-protocol/bfd:bfd/bfd-ip-mh:ip-mh/" +
        "bfd-ip-mh:session-groups/bfd-ip-mh:session-group" {
  leaf stability {
    if-feature "stability";
    type boolean;
    must "../bfd-ip-mh:authentication/bfd-ip-mh:meticulous = " +
         "'true'";
    default false;
    description
      "If set to true, this enables the BFD session to monitor
       for stability; i.e., to watch how many frames are getting
       dropped.";
  }
  description
    "Augment the 'bfd' container to add attributes related to BFD
     stability.";
}

augment "/rt:routing/rt:control-plane-protocols/" +
        "rt:control-plane-protocol/bfd:bfd/bfd-lag:lag/" +
        "bfd-lag:sessions/bfd-lag:session" {
```

```
  leaf stability {
    if-feature "stability";
    type boolean;
    must "../bfd-lag:authentication/bfd-lag:meticulous = " +
         "'true'";
    default false;
    description
      "If set to true, this enables the BFD session to monitor
       for stability; i.e., to watch how many frames are getting
       dropped.";
  }
  description
    "Augment the 'bfd' container to add attributes related to BFD
     stability.";
}

augment "/rt:routing/rt:control-plane-protocols/" +
        "rt:control-plane-protocol/bfd:bfd/bfd-mpls:mpls/" +
  "bfd-mpls:session-groups/bfd-mpls:session-group" {
  leaf stability {
    if-feature "stability";
    type boolean;
    must "../bfd-mpls:authentication/bfd-mpls:meticulous = " +
         "'true'";
    default false;
    description
      "If set to true, this enables the BFD session to monitor
       for stability; i.e., to watch how many frames are getting
       dropped.";
  }
  description
    "Augment the 'bfd' container to add attributes related to BFD
     stability.";
}

augment "/rt:routing/rt:control-plane-protocols/" +
        "rt:control-plane-protocol/bfd:bfd/bfd-ip-sh:ip-sh/" +
        "bfd-ip-sh:sessions/bfd-ip-sh:session/" +
        "bfd-ip-sh:session-statistics" {
  leaf lost-packet-count {
    type yang:counter32;
    description
      "Number of BFD packets that were lost without bringing the
       session down. This counter should be present only if
       stability is configured.";
  }
  description
    "Augment the 'bfd' container to add attributes related to BFD
     stability.";
```

```
}

augment "/rt:routing/rt:control-plane-protocols/" +
        "rt:control-plane-protocol/bfd:bfd/bfd-ip-mh:ip-mh/" +
        "bfd-ip-mh:session-groups/bfd-ip-mh:session-group/" +
        "bfd-ip-mh:sessions/bfd-ip-mh:session-statistics" {
  leaf lost-packet-count {
    type yang:counter32;
    description
      "Number of BFD packets that were lost without bringing the
       session down. This counter should be present only if
       stability is configured.";
  }
  description
    "Augment the 'bfd' container to add attributes related to BFD
     stability.";
}

augment "/rt:routing/rt:control-plane-protocols/" +
        "rt:control-plane-protocol/bfd:bfd/bfd-lag:lag/" +
        "bfd-lag:sessions/bfd-lag:session/bfd-lag:member-links/" +
        "bfd-lag:micro-bfd-ipv4/bfd-lag:session-statistics" {
  leaf lost-packet-count {
    type yang:counter32;
    description
      "Number of BFD packets that were lost without bringing the
       session down. This counter should be present only if
       stability is configured.";
  }
  description
    "Augment the 'bfd' container to add attributes related to BFD
     stability.";
}

augment "/rt:routing/rt:control-plane-protocols/" +
        "rt:control-plane-protocol/bfd:bfd/bfd-mpls:mpls/" +
        "bfd-mpls:session-groups/bfd-mpls:session-group/" +
        "bfd-mpls:sessions/bfd-mpls:session-statistics" {
  leaf lost-packet-count {
    type yang:counter32;
    description
      "Number of BFD packets that were lost without bringing the
       session down. This counter should be present only if
       stability is configured.";
  }
  description
    "Augment the 'bfd' container to add attributes related to BFD
     stability.";
}
```

```
}
```

<CODE ENDS>

7. IANA Considerations

7.1. The "IETF XML" Registry

This document registers one URIs in the "ns" subregistry of the "IETF XML" registry [RFC3688]. Following the format in [RFC3688], the following registration is requested:

```
URI: urn:ietf:params:xml:ns:yang:ietf-bfd-stability
Registrant Contact: The IESG
XML: N/A, the requested URI is an XML namespace.
```

7.2. The "YANG Module Names" Registry

This document registers one YANG modules in the "YANG Module Names" registry [RFC6020]. Following the format in [RFC6020], the following registrations are requested:

```
name:         ietf-bfd-stability
namespace:    urn:ietf:params:xml:ns:yang:ietf-bfd-stability
prefix:       bfds
reference:    RFC XXXX
```

8. Security Consideration

The YANG module specified in this document defines a schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446]. The NETCONF Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

The YANG module does not define any writeable/creatable/deletable data nodes that can have an adverse impact on a BFD session.

The only readable data nodes in YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes.

The model defines a read-only variables to indicate the number of packets that were lost. Access to this information may allow a malicious user information on which links are experiencing issues.

The YANG module does not define any RPC operations.

9. Contributors

The authors of this document would like to acknowledge Jeff Haas as a contributor to this document. Jeff played a role not only as a shepherd but also actively contributed to the improvement of the document. In addition, Manav Bhatia also contributed to this document.

10. Acknowledgements

Authors would like to thank Nobo Akiya, Jeffery Haas, Dileep Singh, Basil Saji, Sagar Soni, Albert Fu and Mallik Mudigonda who also contributed to this document.

11. Normative References

[I-D.ietf-bfd-optimizing-authentication]
Jethanandani, M., Mishra, A., Saxena, A., and M. Bhatia, "Optimizing BFD Authentication", Work in Progress, Internet-Draft, draft-ietf-bfd-optimizing-authentication-13, 1 August 2021, <https://datatracker.ietf.org/doc/html/draft-ietf-bfd-optimizing-authentication-13>.

[I-D.ietf-bfd-secure-sequence-numbers]
DeKok, A., Jethanandani, M., Agarwal, S., Mishra, A., and A. Saxena, "Secure BFD Sequence Numbers", Work in Progress, Internet-Draft, draft-ietf-bfd-secure-sequence-numbers-12, 29 November 2023, <https://datatracker.ietf.org/doc/html/draft-ietf-bfd-secure-sequence-numbers-12>.

[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>.

[RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <https://www.rfc-editor.org/info/rfc3688>.

[RFC5880] Katz, D. and D. Ward, "Bidirectional Forwarding Detection (BFD)", RFC 5880, DOI 10.17487/RFC5880, June 2010, <https://www.rfc-editor.org/info/rfc5880>.

[RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <https://www.rfc-editor.org/info/rfc6020>.

[RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <https://www.rfc-editor.org/info/rfc6241>.

[RFC6242] Wasserman, M., "Using the NETCONF Protocol over Secure Shell (SSH)", RFC 6242, DOI 10.17487/RFC6242, June 2011, <https://www.rfc-editor.org/info/rfc6242>.

[RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <https://www.rfc-editor.org/info/rfc6991>.

[RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <https://www.rfc-editor.org/info/rfc8040>.

[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>.

[RFC8341] Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <https://www.rfc-editor.org/info/rfc8341>.

[RFC8349] Lhotka, L., Lindem, A., and Y. Qu, "A YANG Data Model for Routing Management (NMDA Version)", RFC 8349, DOI 10.17487/RFC8349, March 2018, <https://www.rfc-editor.org/info/rfc8349>.

[RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <https://www.rfc-editor.org/info/rfc8446>.

[RFC9314] Jethanandani, M., Ed., Rahman, R., Ed., Zheng, L., Ed., Pallagatti, S., and G. Mirsky, "YANG Data Model for Bidirectional Forwarding Detection (BFD)", RFC 9314, DOI 10.17487/RFC9314, September 2022, <https://www.rfc-editor.org/info/rfc9314>.

Appendix A. Examples

This section tries to show some examples in how the model can be configured for stability.

A.1. Single Hop BFD Configuration

This example demonstrates how a Single Hop BFD session can be configured to enable monitoring of a session for stability.

```
=============== NOTE: '\' line wrapping per RFC 8792 ===============

<?xml version="1.0" encoding="UTF-8"?>
<key-chains
    xmlns="urn:ietf:params:xml:ns:yang:ietf-key-chain"
    xmlns:kc="urn:ietf:params:xml:ns:yang:ietf-key-chain">
  <key-chain>
    <name>bfd-stability-config</name>
    <description>"An example for BFD Stabalized configuration."</de\
scription>
    <key>
      <key-id>55</key-id>
      <lifetime>
        <send-lifetime>
          <start-date-time>2017-01-01T00:00:00Z</start-date-time>
          <end-date-time>2017-02-01T00:00:00Z</end-date-time>
        </send-lifetime>
        <accept-lifetime>
          <start-date-time>2016-12-31T23:59:55Z</start-date-time>
          <end-date-time>2017-02-01T00:00:05Z</end-date-time>
        </accept-lifetime>
      </lifetime>
      <crypto-algorithm>kc:sha-1</crypto-algorithm>
    </key>
  </key-chain>
</key-chains>
<interfaces
    xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces"
    xmlns:if-type="urn:ietf:params:xml:ns:yang:iana-if-type">
  <interface>
    <name>eth0</name>
    <type>if-type:ethernetCsmacd</type>
  </interface>
</interfaces>
<routing
    xmlns="urn:ietf:params:xml:ns:yang:ietf-routing"
    xmlns:bfd-types="urn:ietf:params:xml:ns:yang:ietf-bfd-types"
    xmlns:stability="urn:ietf:params:xml:ns:yang:ietf-bfd-stability\
">
  <control-plane-protocols>
    <control-plane-protocol>
      <type>bfd-types:bfdv1</type>
      <name>name:BFD</name>
      <bfd xmlns="urn:ietf:params:xml:ns:yang:ietf-bfd">
        <ip-sh xmlns="urn:ietf:params:xml:ns:yang:ietf-bfd-ip-sh">
          <sessions>
            <session>
              <interface>eth0</interface>
              <dest-addr>2001:db8:0:113::101</dest-addr>
```

```
              <desired-min-tx-interval>10000</desired-min-tx-interv\
al>
              <required-min-rx-interval>
                10000
              </required-min-rx-interval>
              <stability:stability>true</stability:stability>
              <authentication>
                <key-chain>bfd-stability-config</key-chain>
                <meticulous>true</meticulous>
              </authentication>
            </session>
          </sessions>
        </ip-sh>
      </bfd>
    </control-plane-protocol>
  </control-plane-protocols>
</routing>
```

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