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Transparent Interconnection of Lots of Links (TRILL) Operations, Administration, and Maintenance (OAM) MIB

Abstract

This document specifies the MIB for the OAM (Operations, Administration, and Maintenance) objects for IETF TRILL (Transparent Interconnection of Lots of Links).

Status of This Memo

This is an Internet Standards Track document.

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). Further information on Internet Standards is available in Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc7784.

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1. Introduction

Overall, TRILL OAM meets the requirements given in [RFC6905]. The general framework for TRILL OAM is specified in [RFC7174]. The details of the Fault Management (FM) solution, conforming to that framework, are presented in [RFC7455]. The solution leverages the message format defined in Ethernet Connectivity Fault Management (CFM) [802.1Q] as the basis for the TRILL OAM message channel.

This document uses the CFM MIB modules defined in [802.1Q] as the basis for TRILL OAM MIB and augments the existing tables to add new TRILL managed objects required by TRILL. This document further specifies a new table with associated managed objects for TRILL OAM-specific capabilities.

2. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of RFC 3410 [RFC3410].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIv2, which is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].

3. Conventions

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].

Abbreviations used in the document include the following:

CCM - Continuity Check Message [802.1Q]

EMS - Element Management System [Q.840.1]

MEP - Maintenance End Point [RFC7174] [802.1Q]

MIP - Maintenance Intermediate Point [RFC7174] [802.1Q]

MP - Maintenance Point [RFC7174]

MTVM - Multi-destination Tree Verification Message [RFC7455]

MTVR - Multi-destination Tree Verification Reply [RFC7455]

NMS - Network Management System [Q.840.1]

PTM - Path Trace Message [RFC7455]

PTR - Path Trace Reply [RFC7455]

4. Overview

The TRILL OAM MIB module provides an overall framework for managing TRILL OAM. It leverages the IEEE8021-CFM-MIB and IEEE8021-CFM-V2-MIB modules defined in [802.1Q], and it augments the Maintenance End Point (MEP) and MEP Db entries. It also adds a new table for messages specific to TRILL OAM.

5. Structure of the MIB Module

Objects in this MIB module are arranged into subtrees. Each subtree is organized as a set of related objects. The various subtrees are shown below, supplemented with the required elements of the IEEE8021-CFM-MIB module.

5.1. Textual Conventions

Textual conventions are defined to represent object types relevant to the TRILL OAM MIB.

5.2. The TRILL OAM MIB Subtree

The TRILL OAM MIB tree described below consists of trilloamNotifications (Traps) and trillOamMibObjects. The trilloamNotifications are sent to the management entity whenever a MEP loses/restores contact with its peer flow MEPs.

The TRILL OAM MIB per MEP Objects are defined in the trillOamMepTable. The trillOamMepTable augments the dot1agCfmMepEntry (please see Section 6.1) defined in IEEE8021-CFM-MIB. It includes objects that are locally defined for an individual MEP and its associated flow.

```
TRILL-OAM-MIB

|--trillOamNotifications          (trillOamMib 0}

   |--trillOamFaultAlarm

|--trillOamMibObjects             {trillOamMib 1}

   |--trillOamMep                 {trillOamMibObjects 1}

      |--trillOamMepTable         {trillOamMep 1}  - Local TRLL config

      |--trillOamMepFlowCfgTable

      |--trillOamPtrTable

      |--trillOamMtvrTable

      |--trillOamMepDbTable
```

5.3.1. The Notifications Subtree

Notifications (fault alarms) are sent to the management entity with the OID of the MEP that has detected the fault. Notifications are generated whenever MEP loses/restores contact with its peer flow MEPs.

5.3.2. The Table Structures

The TRILL OAM MIB per MEP Objects are defined in the trillOamMepTable. The trillOamMepTable augments the dot1agCfmMepEntry (please see Section 6.1) defined in IEEE8021-CFM-MIB. It includes objects that are locally defined for an individual MEP and its associated flow.

5.3.2.1. trillOamMepTable Objects

This table is an extension of the dot1agCfmMepTable. Rows are automatically added or deleted from this table based upon row creation and destruction of the dot1agCfmMepTable.

This table represents the local MEP TRILL OAM configuration table. The primary purpose of this table is provide local parameters for the TRILL OAM function found in [RFC7455] and instantiated at a MEP.

5.3.2.2. trillOamMepFlowCfgTable Objects

Each row in this table represents a Flow Configuration Entry for the associated MEP. This table uses four indices. The first three indices are the indices of the Maintenance Domain, MANET, and MEP tables. The fourth index is the specific Flow Configuration Entry on the selected MEP. Some writable objects in this table are only applicable in certain cases (as described under each object below), and attempts to write values for them in other cases will be ignored.

5.3.2.3. trillOamPtrTable Objects

Each row in this table represents a Path Trace Reply Entry for the Defined MEP and Transaction. This table uses four indices. The first three indices identify the MEP and the fourth index specifies the Transaction Identifier. This Transaction Identifier uniquely identifies the response for a MEP, which can have multiple flows.

5.3.2.4. trillOamMtvrTable Objects

This table includes managed objects for the Multi-destination Reply. Each row in the table represents a Multi-destination Reply Entry for the defined MEP and Transaction. This table uses the following five indices: 1) Maintenance Domain, 2) MANET, 3) MEP tables, 4) Transaction Identifier of selected MEP, and 5) receive order of Multi-destination replies.

Some writable objects in this table are only applicable in certain cases (as described under each object below), and attempts to write a value for them in other cases will be ignored.

5.3.2.5. trillOamMepDbTable Objects

This table is an augmentation of the dot1agCfmMepDbTable, and rows are automatically added or deleted from this table based upon row creation and destruction of the dot1agCfmMepDbTable.

6. Relationship to Other MIB Modules

The IEEE8021-CFM-MIB [IEEE8021-CFM-MIB] and [LLDP-MIB] contain objects that are relevant to the TRILL OAM MIB. Management objects contained in these modules are not duplicated here, to reduce overlap to the extent possible. From the IEEE8021-CFM-MIB, the following objects are imported:

- o dot1agCfmMdIndex
- o dot1agCfmMaIndex

- o dot1agCfmMepIdentifier
- o dot1agCfmMepEntry
- o dot1agCfmMepDbEntry
- o Dot1agCfmIngressActionFieldValue
- o Dot1agCfmEgressActionFieldValue
- o Dot1agCfmRemoteMepState

From the [LLDP-MIB], the following objects are imported:

- o LldpChassisId
- o LldpChassisIdSubtype
- o LldpPortId

6.1. Relationship to the IEEE8021-TC-MIB

In TRILL, traffic labeling can be done using either a 12-bit VLAN or a 24-bit Fine-Grained Label (FGL) [RFC7172].

The IEEE8021-TC-MIB definition of IEEE8021ServiceSelectorType includes the following two values:

- 1 representing a vlanId, and
- 2 representing a 24-bit isid

We have chosen to use value 2 for TRILL's FGL. As such, TRILL OAM MIB will import IEEE8021ServiceSelectorType, IEEE8021ServiceSelectorValueOrNone, and IEEE8021ServiceSelectorValue from IEEE8021-TC-MIB.

6.2. Relationship to the IEEE8021-CFM-MIB

trillOamMepTable augments dot1agCfmMepEntry. Implementation of IEEE8021-CFM-MIB is required as we are augmenting the IEEE-CFM-MIB Table. Objects/Tables that are not applicable to a TRILL implementation have to be handled by the TRILL implementation backend, and appropriate default values, as described in IEEE8021-CFM-MIB, have to be returned.

The TRILL OAM implementation doesn't support the Link Trace Message or Link Trace Reply, since, as described in RFC 7455, the Path Trace Message and Reply for unicast traffic and Multi-destination Tree verification Message and Reply for multicast traffic have been substituted for them. Statistics for these messages should default as per IEEE8021-CFM-MIB.

6.3. MIB Modules Required for IMPORTS

The following MIB module IMPORTS objects from SNMPv2-SMI [RFC2578], SNMPv2-TC [RFC2579], SNMPv2-CONF [RFC2580], IEEE-8021-CFM-MIB, and LLDP-MIB.

7. Definitions

```
TRILL-OAM-MIB DEFINITIONS ::= BEGIN

IMPORTS

    MODULE-IDENTITY,
    OBJECT-TYPE,
    Counter32,
    Unsigned32,
    Integer32,
    mib-2,
    NOTIFICATION-TYPE
       FROM SNMPv2-SMI
    RowStatus,
    TruthValue,
    TimeStamp,
    MacAddress
        FROM SNMPv2-TC
    OBJECT-GROUP,
    NOTIFICATION-GROUP,
    MODULE-COMPLIANCE
        FROM SNMPv2-CONF
    dot1agCfmMdIndex,
    dot1agCfmMaIndex,
    dot1agCfmMepIdentifier,
    dot1agCfmMepEntry,
    dot1agCfmMepDbEntry,
    Dot1agCfmIngressActionFieldValue,
    Dot1agCfmEgressActionFieldValue,
    Dot1agCfmRemoteMepState
        FROM IEEE8021-CFM-MIB
    LldpChassisId,
    LldpChassisIdSubtype,
    LldpPortId,
```

```
       LldpPortIdSubtype
           FROM LLDP-MIB;

   trillOamMib MODULE-IDENTITY
       LAST-UPDATED    "201601141200Z"
       ORGANIZATION    "IETF TRILL WG"
       CONTACT-INFO
               "Email: trill@ietf.org"
       DESCRIPTION
           "This MIB module contains the management objects for the
           management of TRILL Services Operations, Administration
           and Maintenance.
           Initial version.  Published as RFC 7784.

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```

```
        ------------------------------------------------------------

        Abbreviations Used

        Term         Definition

        CFM          Connectivity Fault Management
        IEEE         Institute of Electrical and Electronics
                     Engineers
        IETF         Internet Engineering Task Force
        ITU-T        International Telecommunication Union -
                     Telecommunication Standardization Bureau
        FCOI         The Final, Cross-Connect Error, Out-of-band,
                     and In-band flags from the TRILL OAM Application
                     Identifier TLV.
        LBM          Loopback Message
        MA           Maintenance Association (equivalent to a MEG)
        MAC          Media Access Control
        MD           Maintenance Domain (equivalent to an OAM
                     Domain in Metro Ethernet Forum (MEF) 17)
        MEG          Maintenance Entity Group (equivalent to a MA)
        MEG Level    Maintenance Entity Group Level (equivalent to
                     MD Level)
        MEP          Maintenance Association End Point
        MIB          Management Information Base
        MIP          Maintenance Domain Intermediate Point
        MTVM         Multi-destination Tree Verification Message
        MTVR         Multi-destination Tree Verification Reply
        OAM          Operations, Administration, and Maintenance
                     On-Demand OAM actions that are initiated via
                     manual intervention for a limited time to carry
                     out diagnostics.  On-demand OAM can result in
                     singular or periodic OAM actions during the
                     diagnostic time interval.
        PTM          Path Trace Message
        PTR          Path Trace Reply
        RFC          Request for Comments
        SNMP         Simple Network Management Protocol
        TLV          Type-Length-Value, a method of encoding Objects
        TRILL        Transparent Interconnection of Lots of Links
        VLAN         Virtual LAN"

    REVISION        "201601141200Z"
    DESCRIPTION
        "Initial version.  Published as RFC 7784."
    ::= { mib-2 238 }
--
```

```
-- ****************************************************************
-- Object Definitions in the TRILL OAM MIB Module
-- ****************************************************************

trillOamNotifications  OBJECT IDENTIFIER
    ::= { trillOamMib 0 }

trillOamMibObjects  OBJECT IDENTIFIER
    ::= { trillOamMib 1 }

trillOamMibConformance  OBJECT IDENTIFIER
    ::= { trillOamMib 2 }

-- ****************************************************************
-- Groups in the TRILL OAM MIB Module
-- ****************************************************************

trillOamMep  OBJECT IDENTIFIER
    ::= { trillOamMibObjects 1 }

-- ****************************************************************
-- TRILL OAM MEP Configuration
-- ****************************************************************

trillOamMepTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF TrillOamMepEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "This table is an extension of the dot1agCfmMepTable and
         rows are automatically added or deleted from this table
         based upon row creation and destruction of the
         dot1agCfmMepTable.

        This table represents the local MEP TRILL OAM
        configuration table.  The primary purpose of this table
        is provide local parameters for the TRILL OAM function
        found in RFC 7455 and instantiated at a MEP."
    REFERENCE "RFC 7455"
    ::= { trillOamMep 1 }
trillOamMepEntry OBJECT-TYPE
    SYNTAX          TrillOamMepEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "The conceptual row of trillOamMepTable."
    AUGMENTS           { dot1agCfmMepEntry  }
    ::= { trillOamMepTable 1 }
```

```
   TrillOamMepEntry ::= SEQUENCE {
           trillOamMepRName               Unsigned32,
           trillOamMepNextPtmTId          Counter32,
           trillOamMepNextMtvmTId         Counter32,
           trillOamMepPtrIn               Counter32,
           trillOamMepPtrInOutofOrder     Counter32,
           trillOamMepPtrOut              Counter32,
           trillOamMepMtvrIn              Counter32,
           trillOamMepMtvrInOutofOrder    Counter32,
           trillOamMepMtvrOut             Counter32,
           trillOamMepTxLbmDestRName      Unsigned32,
           trillOamMepTxLbmHC             Unsigned32,
           trillOamMepTxLbmReplyModeOob   TruthValue,
           trillOamMepTransmitLbmReplyIp  OCTET STRING,
           trillOamMepTxLbmFlowEntropy    OCTET STRING,
           trillOamMepTxPtmDestRName      Unsigned32,
           trillOamMepTxPtmHC             Unsigned32,
           trillOamMepTxPtmReplyModeOob   TruthValue,
           trillOamMepTransmitPtmReplyIp  OCTET STRING,
           trillOamMepTxPtmFlowEntropy    OCTET STRING,
           trillOamMepTxPtmStatus         TruthValue,
           trillOamMepTxPtmResultOK       TruthValue,
           trillOamMepTxPtmSeqNumber      Unsigned32,
           trillOamMepTxPtmMessages       Integer32,
           trillOamMepTxMtvmTree          Unsigned32,
           trillOamMepTxMtvmHC            Unsigned32,
           trillOamMepTxMtvmReplyModeOob  TruthValue,
           trillOamMepTransmitMtvmReplyIp OCTET STRING,
           trillOamMepTxMtvmFlowEntropy   OCTET STRING,
           trillOamMepTxMtvmStatus        TruthValue,
           trillOamMepTxMtvmResultOK      TruthValue,
           trillOamMepTxMtvmMessages      Integer32,
           trillOamMepTxMtvmSeqNumber     Unsigned32,
           trillOamMepTxMtvmScopeList     OCTET STRING,
           trillOamMepDiscontinuityTime   TimeStamp
   }

   trillOamMepRName OBJECT-TYPE
       SYNTAX          Unsigned32 (0..65471)
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "This object contains the RBridge Nickname field
           of the TRILL RBridge as defined in RFC 6325,
           Section 3.7."
       REFERENCE "RFC 7455 and RFC 6325, Section 3.7"
       ::= { trillOamMepEntry 1 }
```

```
   trillOamMepNextPtmTId OBJECT-TYPE
       SYNTAX          Counter32
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Next Sequence Number / Transaction Identifier to be sent in
            a Multi-destination message.  This Sequence Number can be
            zero because it wraps around.  Implementation of this
            identifier should be should provide a unique code value in
            order to identify the Transaction Identifier for a MEP with
            multiple flows."
       REFERENCE "RFC 7455, Section 10.1.1"
       ::= { trillOamMepEntry 2 }

   trillOamMepNextMtvmTId OBJECT-TYPE
       SYNTAX          Counter32
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Next Sequence Number / Transaction Identifier to be sent
           in a Multi-destination message.  This Sequence Number can
           be zero because it wraps around.  An implementation should
           be unique to identify Transaction Identifier for a MEP with
           multiple flows."
       REFERENCE "RFC 7455, Section 11.2.1"
       ::= { trillOamMepEntry 3 }

   trillOamMepPtrIn OBJECT-TYPE
       SYNTAX          Counter32
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Total number of valid, in-order Path Trace Replies
            received."
       REFERENCE "RFC 7455, Section 10"
       ::= { trillOamMepEntry 4 }

   trillOamMepPtrInOutofOrder OBJECT-TYPE
       SYNTAX          Counter32
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Total number of valid, out-of-order Path Trace Replies
            received."
       REFERENCE "RFC 7455, Section 10"
       ::= { trillOamMepEntry 5 }
```

```
   trillOamMepPtrOut OBJECT-TYPE
       SYNTAX          Counter32
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Total number of valid, Path Trace Replies
            transmitted."
       REFERENCE "RFC 7455, Section 10"
       ::= { trillOamMepEntry 6 }

   trillOamMepMtvrIn OBJECT-TYPE
       SYNTAX          Counter32
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Total number of valid, in-order Multi-destination
            Replies received."
       REFERENCE "RFC 7455, Section 11"
       ::= { trillOamMepEntry 7 }

   trillOamMepMtvrInOutofOrder OBJECT-TYPE
       SYNTAX          Counter32
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Total number of valid, out-of-order Multi-destination
            Replies received."
       REFERENCE "RFC 7455, Section 11"
       ::= { trillOamMepEntry 8 }

   trillOamMepMtvrOut OBJECT-TYPE
       SYNTAX          Counter32
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Total number of valid, Multi-destination Replies
           transmitted."
       REFERENCE "RFC 7455, Section 11"
       ::= { trillOamMepEntry 9 }

   trillOamMepTxLbmDestRName OBJECT-TYPE
       SYNTAX          Unsigned32 (0..65471)
       MAX-ACCESS      read-create
       STATUS          current
       DESCRIPTION
           "The Target Destination RBridge Nickname field, as
           defined in RFC 6325, Section 3.7, to be transmitted."
       REFERENCE "RFC 7455 and RFC 6325, Section 3.7"
```

```
        ::= { trillOamMepEntry 10 }

    trillOamMepTxLbmHC OBJECT-TYPE
        SYNTAX          Unsigned32(1..63)
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The Hop Count field to be transmitted."
        REFERENCE "RFC 7455, Sections 3 and 9"
        ::= { trillOamMepEntry 11 }

    trillOamMepTxLbmReplyModeOob OBJECT-TYPE
        SYNTAX          TruthValue
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "True indicates that the Reply to an LBM is out of
            band and the out-of-band IP Address TLV is to be
            transmitted.  False indicates that in-band reply is
            transmitted."
        REFERENCE "RFC 7455, Section 9.2.1"
        ::= { trillOamMepEntry 12 }

    trillOamMepTransmitLbmReplyIp OBJECT-TYPE
        SYNTAX          OCTET STRING (SIZE  (4..16))
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The IP address for an out-of-band IP Address TLV
             that is to be transmitted.  Maximum length for IPv6
             is 16 octets and IPv4 is 4 octets."
        REFERENCE "RFC 7455, Section 3"
        ::= { trillOamMepEntry 13 }

    trillOamMepTxLbmFlowEntropy OBJECT-TYPE
        SYNTAX          OCTET STRING (SIZE  (96))
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "96-byte Flow Entropy, as defined in RFC 7455, to
             be transmitted."
        REFERENCE "RFC 7455, Section 3"
        ::= { trillOamMepEntry 14 }

    trillOamMepTxPtmDestRName OBJECT-TYPE
        SYNTAX          Unsigned32 (0..65471)
        MAX-ACCESS      read-create
        STATUS          current
```

```
        DESCRIPTION
            "The Target Destination RBridge Nickname field,
            as defined in RFC 6325, Section 3.7, to be transmitted."
        REFERENCE "RFC 7455 and RFC 6325, Section 3.7"
        ::= { trillOamMepEntry 15 }

    trillOamMepTxPtmHC OBJECT-TYPE
        SYNTAX          Unsigned32 (1..63)
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The Hop Count field to be transmitted."
        REFERENCE "RFC 7455, Section 3"
        ::= { trillOamMepEntry 16 }

    trillOamMepTxPtmReplyModeOob OBJECT-TYPE
        SYNTAX          TruthValue
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "True indicates that a Reply to a PTM will be
             out of band and the out-of-band IP Address TLV
             is to be transmitted.  False indicates that an
             in-band reply  is transmitted."
        REFERENCE "RFC 7455, Section 10"
        DEFVAL          { false }
        ::= { trillOamMepEntry 17 }

    trillOamMepTransmitPtmReplyIp OBJECT-TYPE
        SYNTAX          OCTET STRING (SIZE  (4..16))
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The IP address for an out-of-band IP Address TLV
             to be transmitted.  The maximum length for an
             IPv6 address is 16 octets.  The maximum length
             for an  IPv4 address is 4 octets."
        REFERENCE "RFC 7455, Sections 3 and 10"
        ::= { trillOamMepEntry 18 }

    trillOamMepTxPtmFlowEntropy OBJECT-TYPE
        SYNTAX          OCTET STRING (SIZE  (96))
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "96-byte Flow Entropy, as defined in RFC 7455, to be
             transmitted."
        REFERENCE "RFC 7455, Section 3"
```

```
        ::= { trillOamMepEntry 19 }

    trillOamMepTxPtmStatus OBJECT-TYPE
        SYNTAX          TruthValue
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "A Boolean flag set to TRUE by the MEP Path Trace Initiator
            State Machine or a MIB manager to indicate that another PTM
            is being transmitted.  This is reset to FALSE by the MEP
            Initiator State Machine.  The PTM managed objects in the MEP
            table are used in a manner similar to that described for LBM
            transmission in the dot1agCfmMepTable.  As per RFC 7455,
            Section 10, operation of the Path Trace Message is identical
            to the Loopback message except that it is first transmitted
            with a TRILL Header Hop Count field value of 1 and then
            retransmitted with an incrementing Hop Count until a
            response is received from the destination RBridge, or the
            Hop Count reaches a configured maximum value.  The
            trillOamMepTxPtmStatus status is reset to FALSE by
            the initiator when the last PTM is transmitted."
        REFERENCE "RFC 7455, Section 10"
        DEFVAL          { false }
        ::= { trillOamMepEntry 20 }

    trillOamMepTxPtmResultOK OBJECT-TYPE
        SYNTAX          TruthValue
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "Indicates the following results of the operation:
            - true indicates the Path Trace Message(s) will be
              (or has been) sent.
            - false indicates the Path Trace Message(s) will not
              be sent."
        REFERENCE "RFC 7455, Section 10"
        DEFVAL          { true }
        ::= { trillOamMepEntry 21 }

    trillOamMepTxPtmSeqNumber OBJECT-TYPE
        SYNTAX          Unsigned32
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The Path Trace Transaction Identifier of the first
             PTM (to be) sent.  The value returned is
             undefined if trillOamMepTxPtmResultOK is false."
        REFERENCE "RFC 7455, Section 10"
```

```
        ::= { trillOamMepEntry 22 }

    trillOamMepTxPtmMessages OBJECT-TYPE
        SYNTAX          Integer32 (1..1024)
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The number of Path Trace messages to be transmitted.
             As per RFC 7455, Section 10, the first Path Trace
             Message is transmitted with a Hop Count of 1; an
             RBridge may continue to retransmit the request at
             periodic intervals with an incrementing Hop Count
             until a response is received from the destination
             RBridge or the Hop Count reaches a configured
             maximum value.  The event of the Destination
             response being received or the Hop Count reaching
             its maximum is treated as a single Counter
             increment of this object."
        REFERENCE "RFC 7455, Section 10"
        ::= { trillOamMepEntry 23 }

    trillOamMepTxMtvmTree OBJECT-TYPE
        SYNTAX          Unsigned32
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The Multi-destination Tree identifier, as
             defined in RFC 6325, for an MTVM."
        ::= { trillOamMepEntry 24 }

    trillOamMepTxMtvmHC OBJECT-TYPE
        SYNTAX          Unsigned32(1..63)
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The Hop Count field to be transmitted.
            "
        REFERENCE "RFC 7455, Section 3, and RFC 6325, Section 3"
        ::= { trillOamMepEntry 25 }

    trillOamMepTxMtvmReplyModeOob OBJECT-TYPE
        SYNTAX          TruthValue
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "True indicates that the reply to an MTVM is out of
            band and this out-of-band IP Address TLV is where the
            reply is to be transmitted.
```

```
            False indicates that an in-band reply is transmitted."
        REFERENCE "RFC 7455, Section 11"
        ::= { trillOamMepEntry 26 }

    trillOamMepTransmitMtvmReplyIp OBJECT-TYPE
        SYNTAX          OCTET STRING (SIZE  (4..16))
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "IP address for an out-of-band IP Address TLV that is
             to be transmitted.  The maximum length for IPv6 is 16
             octets and IPv4 is 4 octets."
        REFERENCE "RFC 7455, Section 11"
        ::= { trillOamMepEntry 27 }

    trillOamMepTxMtvmFlowEntropy OBJECT-TYPE
        SYNTAX          OCTET STRING (SIZE  (96))
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "96-byte Flow Entropy, as defined in RFC 7455, to be
             transmitted."
        REFERENCE "RFC 7455, Section 3"
        ::= { trillOamMepEntry 28 }

    trillOamMepTxMtvmStatus OBJECT-TYPE
        SYNTAX          TruthValue
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "A Boolean flag set to TRUE by the MEP Multi-destination
            Initiator State Machine or a MIB manager to indicate
            that another MTVM is being transmitted.
            Reset to FALSE by the MEP Initiator State Machine.
            The MTVM-managed objects in the MEP table are used
            in a manner similar to that described for LBM
            transmission in the dot1agCfmMepTable.  As per RFC 7455,
            Section 11, operation of the MTVM is
            identical to the Loopback message except that it is
            first transmitted with a TRILL Header Hop Count
            field value of 1 and it is retransmitted incrementing
            the Hop Count until a response is received from the
            destination RBridge or the Hop Count reaches a
            configured maximum value.  The trillOamMepTxMtvmStatus
            Status is reset to FALSE by the initiator when the last
            MTVM is transmitted."
        REFERENCE "RFC 7455, Section 11"
        DEFVAL          { false }
```

```
        ::= { trillOamMepEntry 29 }

    trillOamMepTxMtvmResultOK OBJECT-TYPE
        SYNTAX          TruthValue
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "Indicates the result of the operation in
             the following way:
            - true indicates the Multi-destination Message(s) will be
              (or has been) sent.
            - false indicates the Multi-destination Message(s) will not
              be sent."
        REFERENCE "RFC 7455, Section 11"
        DEFVAL          { true }
        ::= { trillOamMepEntry 30 }

    trillOamMepTxMtvmMessages OBJECT-TYPE
        SYNTAX          Integer32 (1..1024)
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The number of Multi-destination messages to be transmitted.
             The RBridge transmit the Multi-destination message
             incrementing the session Identification Number at periodic
             interval until this count expires."
        REFERENCE "RFC 7455, Section 11"
        ::= { trillOamMepEntry 31 }

    trillOamMepTxMtvmSeqNumber OBJECT-TYPE
        SYNTAX          Unsigned32
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The Multi-destination Transaction Identifier of the
            first MTVM (to be)
            sent.  The value returned is undefined if
            trillOamMepTxMtvmResultOK is false."
        REFERENCE "RFC 7455, Section 11"
        ::= { trillOamMepEntry 32 }

    trillOamMepTxMtvmScopeList OBJECT-TYPE
        SYNTAX          OCTET STRING
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "The Multi-destination RBridge Scope list, which
               requires 2 octets per RBridge."
```

```
        REFERENCE "RFC 7455, Section 11"
        ::= { trillOamMepEntry 33 }

    trillOamMepDiscontinuityTime OBJECT-TYPE
        SYNTAX          TimeStamp
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "Snapshot of the value of the sysUpTime object at the
             beginning of the latest period of continuity of the
             statistical counters associated with this MEP."
        ::= { trillOamMepEntry 34 }

    -- ****************************************************************
    -- TRILL OAM Tx Measurement Configuration Table
    -- ****************************************************************

    trillOamMepFlowCfgTable OBJECT-TYPE
        SYNTAX          SEQUENCE OF TrillOamMepFlowCfgEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION
            "This table includes configuration objects and operations
             for the TRILL OAM facilities in RFC 7455.

             Each row in the table represents a Flow Configuration
             Entry for the defined MEP.  This table uses four indices.
             The first three indices are the indices of the Maintenance
             Domain, MANET, and MEP tables.  The fourth index is the
             specific Flow Configuration Entry on the selected MEP.

            Some writable objects in this table are only applicable in
            certain cases (as described under each object), and
            attempts to write values for them in other cases
            will be ignored."
        REFERENCE       "RFC 7455"
        ::= { trillOamMep 2 }

    trillOamMepFlowCfgEntry OBJECT-TYPE
        SYNTAX          TrillOamMepFlowCfgEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION
            "The conceptual row of trillOamMepFlowCfgTable."
        INDEX           {
                            dot1agCfmMdIndex,
                            dot1agCfmMaIndex,
                            dot1agCfmMepIdentifier,
```

```
                        trillOamMepFlowCfgIndex
                    }
    ::= { trillOamMepFlowCfgTable 1 }

TrillOamMepFlowCfgEntry ::= SEQUENCE {
        trillOamMepFlowCfgIndex       Unsigned32,
        trillOamMepFlowCfgFlowEntropy OCTET STRING,
        trillOamMepFlowCfgDestRName   Unsigned32,
        trillOamMepFlowCfgFlowHC      Unsigned32,
        trillOamMepFlowCfgRowStatus   RowStatus
        }

trillOamMepFlowCfgIndex OBJECT-TYPE
    SYNTAX          Unsigned32 (1..65535)
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "An index to the TRILL OAM MEP Flow Configuration table,
        which indicates the specific flow for the MEP.

        The index is never reused for other flow sessions on the
        same MEP while this session is active.  The index value
        keeps increasing until it wraps to 0.  This value can also be
        used in the flow-identifier TLV RFC 7455."
    REFERENCE "RFC 7455"
    ::= { trillOamMepFlowCfgEntry 1 }

trillOamMepFlowCfgFlowEntropy OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE  (96))
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION
        "This is 96 bytes of Flow Entropy as described in
        TRILL OAM, RFC 7455."
    REFERENCE "RFC 7455, Section 3"
    ::= { trillOamMepFlowCfgEntry 2 }

trillOamMepFlowCfgDestRName OBJECT-TYPE
    SYNTAX          Unsigned32 (0..65471)
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION
        "The Target Destination RBridge Nickname field, as
        defined in RFC 6325, Section 3.7, to be transmitted."
    REFERENCE "RFC 7455, Section 3, and RFC 6325, Section 3.7"
    ::= { trillOamMepFlowCfgEntry 3 }
```

```
   trillOamMepFlowCfgFlowHC OBJECT-TYPE
       SYNTAX          Unsigned32 (1..63)
       MAX-ACCESS      read-create
       STATUS          current
       DESCRIPTION
           "The Hop Count field to be transmitted."
       REFERENCE "RFC 7455, Section 3, and RFC 6325, Section 3.6"
       ::= { trillOamMepFlowCfgEntry 4 }

   trillOamMepFlowCfgRowStatus OBJECT-TYPE
       SYNTAX          RowStatus
       MAX-ACCESS      read-create
       STATUS          current
       DESCRIPTION
           "The status of the row.

           The writable columns in a row cannot be changed if the row
           is active.  All columns MUST have a valid value before a row
           can be activated."
       ::= { trillOamMepFlowCfgEntry 5 }

   -- ********************************************************************
   -- TRILL OAM Path Trace Reply Table
   -- ********************************************************************

   trillOamPtrTable OBJECT-TYPE
       SYNTAX          SEQUENCE OF TrillOamPtrEntry
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
           "This table includes Path Trace Reply objects and
            operations for the TRILL OAM facilities as described
            in RFC 7455.

           Each row in the table represents a Path Trace Reply Entry for
           the defined MEP and Transaction.  This table uses four
           indices.  The first three indices are the indices of the
           Maintenance Domain,
           MANET, and MEP tables.  The fourth index is the specific
           Transaction Identifier on the selected MEP.

           Some writable objects in this table are only applicable in
           certain cases (as described under each object),
           and attempts to
           write values for them in other cases will be ignored."
       REFERENCE       "RFC 7455"
       ::= { trillOamMep 3 }
```

```
   trillOamPtrEntry OBJECT-TYPE
       SYNTAX          TrillOamPtrEntry
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
           "The conceptual row of trillOamPtrTable."
       INDEX           {
                           dot1agCfmMdIndex,
                           dot1agCfmMaIndex,
                           dot1agCfmMepIdentifier,
                           trillOamMepPtrTransactionId
                       }
       ::= { trillOamPtrTable 1 }

   TrillOamPtrEntry ::= SEQUENCE {
           trillOamMepPtrTransactionId           Unsigned32,
           trillOamMepPtrHC                      Unsigned32,
           trillOamMepPtrFlag                    Unsigned32,
           trillOamMepPtrErrorCode               Unsigned32,
           trillOamMepPtrTerminalMep             TruthValue,
           trillOamMepPtrLastEgressId            Unsigned32,
           trillOamMepPtrIngress       Dot1agCfmIngressActionFieldValue,
           trillOamMepPtrIngressMac              MacAddress,
           trillOamMepPtrIngressPortIdSubtype    LldpPortIdSubtype,
           trillOamMepPtrIngressPortId           LldpPortId,
           trillOamMepPtrEgress        Dot1agCfmEgressActionFieldValue,
           trillOamMepPtrEgressMac               MacAddress,
           trillOamMepPtrEgressPortIdSubtype     LldpPortIdSubtype,
           trillOamMepPtrEgressPortId            LldpPortId,
           trillOamMepPtrChassisIdSubtype        LldpChassisIdSubtype,
           trillOamMepPtrChassisId               LldpChassisId,
           trillOamMepPtrOrganizationSpecificTlv OCTET STRING,
           trillOamMepPtrNextHopNicknames        OCTET STRING
   }

   trillOamMepPtrTransactionId OBJECT-TYPE
       SYNTAX          Unsigned32 (0..4294967295)
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
           "Sequence Number / Transaction Identifier returned by a
            previous transmit path trace message command,
            indicating which PTM's response is going to be returned."
       REFERENCE       "RFC 7455, Section 10"
       ::= { trillOamPtrEntry 1 }
```

```
   trillOamMepPtrHC  OBJECT-TYPE
       SYNTAX          Unsigned32 (1..63)
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Hop Count field value for a returned PTR."
       REFERENCE       "RFC 7455"
       ::= { trillOamPtrEntry 2 }

   trillOamMepPtrFlag OBJECT-TYPE
       SYNTAX          Unsigned32 (0..15)
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "FCOI (TRILL OAM Message TLV) field value for a
            returned PTR."
       REFERENCE       "RFC 7455, Section 8.4.3"
       ::= { trillOamPtrEntry 3 }

   trillOamMepPtrErrorCode OBJECT-TYPE
       SYNTAX          Unsigned32 (0..65535)
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Return Code and Return Sub-code value for a returned PTR."
       REFERENCE       "RFC 7455, Section 8.4.3"
       ::= { trillOamPtrEntry 4 }

   trillOamMepPtrTerminalMep OBJECT-TYPE
       SYNTAX          TruthValue
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "A boolean value stating whether the forwarded PTM reached a
           MEP enclosing its MA, as returned in the Terminal MEP flag of
           the Flags field."
       REFERENCE       "RFC 7455"
       ::= { trillOamPtrEntry 5 }

   trillOamMepPtrLastEgressId OBJECT-TYPE
       SYNTAX          Unsigned32 (0..65535)
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "An Integer field holding the Last Egress Identifier returned
           in the PTR Upstream RBridge Nickname TLV of the PTR.
           The Last Egress Identifier identifies the Upstream Nickname."
       REFERENCE       "RFC 7455, Section 8.4.1"
```

```
        ::= { trillOamPtrEntry 6 }

    trillOamMepPtrIngress OBJECT-TYPE
        SYNTAX          Dot1agCfmIngressActionFieldValue
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "The value returned in the Ingress Action field of the PTR.
            The value ingNoTlv(0) indicates that no Reply Ingress TLV was
            returned in the PTM."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamPtrEntry 7 }

    trillOamMepPtrIngressMac OBJECT-TYPE
        SYNTAX          MacAddress
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "MAC address returned in the ingress MAC address field."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamPtrEntry 8 }

    trillOamMepPtrIngressPortIdSubtype OBJECT-TYPE
        SYNTAX          LldpPortIdSubtype
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "Ingress Port ID.  The format of this object is determined by
            the value of the trillOamMepPtrIngressPortIdSubtype object."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamPtrEntry 9 }

    trillOamMepPtrIngressPortId OBJECT-TYPE
        SYNTAX          LldpPortId
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "Ingress Port ID.  The format of this object is determined by
            the value of the trillOamMepPtrIngressPortId object."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamPtrEntry 10 }

    trillOamMepPtrEgress OBJECT-TYPE
        SYNTAX          Dot1agCfmEgressActionFieldValue
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "The value returned in the Egress Action field of the PTR.
```

```
            The value ingNoTlv(0) indicates that no Reply Egress TLV was
            returned in the PTM."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamPtrEntry 11 }

    trillOamMepPtrEgressMac OBJECT-TYPE
        SYNTAX          MacAddress
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "MAC address returned in the egress MAC address field."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamPtrEntry 12 }

    trillOamMepPtrEgressPortIdSubtype OBJECT-TYPE
        SYNTAX          LldpPortIdSubtype
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "Egress Port ID.  The format of this object is determined by
            the value of the trillOamMepPtrEgressPortIdSubtype object."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamPtrEntry 13 }

    trillOamMepPtrEgressPortId OBJECT-TYPE
        SYNTAX          LldpPortId
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "Egress Port ID.  The format of this object is determined by
            the value of the trillOamMepPtrEgressPortId object."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamPtrEntry 14 }

    trillOamMepPtrChassisIdSubtype OBJECT-TYPE
        SYNTAX          LldpChassisIdSubtype
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "This object specifies the format of the Chassis ID returned
            in the Sender ID TLV of the PTR, if any.  This value is
            meaningless if the trillOamMepPtrChassisId
            has a length of 0."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamPtrEntry 15 }
```

```
   trillOamMepPtrChassisId OBJECT-TYPE
       SYNTAX          LldpChassisId
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "The Chassis ID returned in the Sender ID TLV of the PTR, if
           any.  The format of this object is determined by the
           value of the trillOamMepPtrChassisIdSubtype object."
       REFERENCE       "RFC 7455, Section 8.4.1"
       ::= { trillOamPtrEntry 16 }

   trillOamMepPtrOrganizationSpecificTlv OBJECT-TYPE
       SYNTAX          OCTET STRING (SIZE  (0 | 4..1500))
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "All organization-specific TLVs returned in the PTR, if
           any.  Includes all octets including and following the TLV
           Length field of each TLV, concatenated together."
       REFERENCE       "RFC 7455, Section 8.4.1"
       ::= { trillOamPtrEntry 17 }

   trillOamMepPtrNextHopNicknames OBJECT-TYPE
       SYNTAX          OCTET STRING (SIZE  (0 | 4..1500))
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Next hop RBridge List TLV returned in the PTR, if
           any.  Includes all octets including and following the TLV
           Length field of each TLV, concatenated together."
       REFERENCE       "RFC 7455, Section 8.4.1"
       ::= { trillOamPtrEntry 18 }

   -- ********************************************************************
   -- TRILL OAM Multi-destination Reply Table
   -- ********************************************************************

   trillOamMtvrTable OBJECT-TYPE
       SYNTAX          SEQUENCE OF TrillOamMtvrEntry
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
           "This table includes Multi-destination Reply objects and
            operations for the TRILL OAM facilities described in
            RFC 7455.

           Each row in the table represents a Multi-destination Reply
           Entry for the defined MEP and Transaction.  This table uses
```

```
            five indices.  The first three indices are the indices of the
            Maintenance Domain, MANET, and MEP tables.  The fourth index
            is the specific Transaction Identifier on the selected MEP.
            The fifth index is the receive order of Multi-destination
            replies.

            Some writable objects in this table are only applicable in
            certain cases (as described under each object), and attempts
            to write values for them in other cases will be ignored."
        REFERENCE       "RFC 7455"
        ::= { trillOamMep 4 }

    trillOamMtvrEntry OBJECT-TYPE
        SYNTAX          TrillOamMtvrEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION
            "The conceptual row of trillOamMtvrTable."
        INDEX           {
                            dot1agCfmMdIndex,
                            dot1agCfmMaIndex,
                            dot1agCfmMepIdentifier,
                            trillOamMepPtrTransactionId,
                            trillOamMepMtvrReceiveOrder
                        }
        ::= { trillOamMtvrTable 1 }

    TrillOamMtvrEntry ::= SEQUENCE {
            trillOamMepMtvrTransactionId           Unsigned32,
            trillOamMepMtvrReceiveOrder            Unsigned32,
            trillOamMepMtvrFlag                    Unsigned32,
            trillOamMepMtvrErrorCode               Unsigned32,
            trillOamMepMtvrLastEgressId            Unsigned32,
            trillOamMepMtvrIngress    Dot1agCfmIngressActionFieldValue,
            trillOamMepMtvrIngressMac              MacAddress,
            trillOamMepMtvrIngressPortIdSubtype    LldpPortIdSubtype,
            trillOamMepMtvrIngressPortId           LldpPortId,
            trillOamMepMtvrEgress     Dot1agCfmEgressActionFieldValue,
            trillOamMepMtvrEgressMac               MacAddress,
            trillOamMepMtvrEgressPortIdSubtype     LldpPortIdSubtype,
            trillOamMepMtvrEgressPortId            LldpPortId,
            trillOamMepMtvrChassisIdSubtype        LldpChassisIdSubtype,
            trillOamMepMtvrChassisId               LldpChassisId,
            trillOamMepMtvrOrganizationSpecificTlv OCTET STRING,
            trillOamMepMtvrNextHopNicknames        OCTET STRING,
            trillOamMepMtvrReceiverAvailability    TruthValue,
            trillOamMepMtvrReceiverCount           TruthValue
    }
```

```
   trillOamMepMtvrTransactionId OBJECT-TYPE
       SYNTAX          Unsigned32 (0..4294967295)
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
           "Sequence Number / Transaction Identifier returned by a
           previously transmitted Multi-destination message command
           indicating which MTVM's response is going to be returned."
       REFERENCE       "RFC 7455, Section 11"
       ::= { trillOamMtvrEntry 1 }

   trillOamMepMtvrReceiveOrder OBJECT-TYPE
       SYNTAX          Unsigned32 (1..4294967295)
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
           "An index to distinguish among multiple MTVRs with same MTVR
            Transaction Identifier field value.
            trillOamMepMtvrReceiveOrder is assigned sequentially from 1,
            in the order that the Multi-destination Tree Initiator
            received the MTVRs."
       REFERENCE   "RFC 7455, Section 11"
       ::= { trillOamMtvrEntry 2 }

   trillOamMepMtvrFlag OBJECT-TYPE
       SYNTAX          Unsigned32 (0..15)
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "FCOI (TRILL OAM Message TLV) field value for a
            returned MTVR."
       REFERENCE       "RFC 7455, Section 8.4.2"
       ::= { trillOamMtvrEntry 3 }

   trillOamMepMtvrErrorCode OBJECT-TYPE
       SYNTAX          Unsigned32 (0..65535)
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Return Code and Return Sub-code value for a returned MTVR."
       REFERENCE       "RFC 7455, Section 8.4.2"
       ::= { trillOamMtvrEntry 4 }

   trillOamMepMtvrLastEgressId OBJECT-TYPE
       SYNTAX          Unsigned32 (0..65535)
       MAX-ACCESS      read-only
       STATUS          current
```

```
        DESCRIPTION
            "An Integer field holding the Last Egress Identifier returned
            in the MTVR Upstream RBridge Nickname TLV of the MTVR.  The
            Last Egress Identifier identifies the Upstream Nickname."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamMtvrEntry 5 }

    trillOamMepMtvrIngress OBJECT-TYPE
        SYNTAX          Dot1agCfmIngressActionFieldValue
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "The value returned in the Ingress Action field of
            the MTVR.  The value ingNoTlv(0) indicates that no
            Reply Ingress TLV was returned in the MTVM."
        REFERENCE       "RFC 7455, Section 11.2.3"
        ::= { trillOamMtvrEntry 6 }

    trillOamMepMtvrIngressMac OBJECT-TYPE
        SYNTAX          MacAddress
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "MAC address returned in the ingress MAC address field."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamMtvrEntry 7 }

    trillOamMepMtvrIngressPortIdSubtype OBJECT-TYPE
        SYNTAX          LldpPortIdSubtype
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "Ingress Port ID.  The format of this object is
            determined by the value of the
            trillOamMepMtvrIngressPortIdSubtype object."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamMtvrEntry 8 }

    trillOamMepMtvrIngressPortId OBJECT-TYPE
        SYNTAX          LldpPortId
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "Ingress Port ID.  The format of this object is determined by
            the value of the trillOamMepMtvrIngressPortId object."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamMtvrEntry 9 }
```

```
   trillOamMepMtvrEgress OBJECT-TYPE
       SYNTAX          Dot1agCfmEgressActionFieldValue
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "The value returned in the Egress Action field of the MTVR.
           The value ingNoTlv(0) indicates that no Reply Egress TLV was
           returned in the MTVR."
       REFERENCE       "RFC 7455, Section 8.4.1"
       ::= { trillOamMtvrEntry 10 }

   trillOamMepMtvrEgressMac OBJECT-TYPE
       SYNTAX          MacAddress
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "MAC address returned in the egress MAC address field."
       REFERENCE       "RFC 7455, Section 8.4.1"
       ::= { trillOamMtvrEntry 11 }

   trillOamMepMtvrEgressPortIdSubtype OBJECT-TYPE
       SYNTAX          LldpPortIdSubtype
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Egress Port ID.  The format of this object is determined by
           the value of the trillOamMepMtvrEgressPortIdSubtype object."
       REFERENCE       "RFC 7455, Section 8.4.1"
       ::= { trillOamMtvrEntry 12 }

   trillOamMepMtvrEgressPortId OBJECT-TYPE
       SYNTAX          LldpPortId
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Egress Port ID.  The format of this object is determined by
           the value of the trillOamMepMtvrEgressPortId object."
       REFERENCE       "RFC 7455, Section 8.4.1"
       ::= { trillOamMtvrEntry 13 }

   trillOamMepMtvrChassisIdSubtype OBJECT-TYPE
       SYNTAX          LldpChassisIdSubtype
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "This object specifies the format of the Chassis ID returned
           in the Sender ID TLV of the MTVR, if any.  This value is
           meaningless if the trillOamMepMtvrChassisId has a
```

```
            length of 0."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamMtvrEntry 14 }

    trillOamMepMtvrChassisId OBJECT-TYPE
        SYNTAX          LldpChassisId
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "The Chassis ID returned in the Sender ID TLV of the MTVR, if
            any.  The format of this object is determined by the
            value of the trillOamMepMtvrChassisIdSubtype object."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamMtvrEntry 15 }

    trillOamMepMtvrOrganizationSpecificTlv OBJECT-TYPE
        SYNTAX          OCTET STRING (SIZE  (0 | 4..1500))
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "All organization-specific TLVs returned in the MTVR, if
            any.  Includes all octets including and following the TLV
            Length field of each TLV, concatenated together."
        REFERENCE       "RFC 7455, Section 8.4.1"
        ::= { trillOamMtvrEntry 16 }

    trillOamMepMtvrNextHopNicknames OBJECT-TYPE
        SYNTAX          OCTET STRING (SIZE  (0 | 4..1500))
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "Next hop RBridge List TLV returned in the PTR, if
            any.  Includes all octets including and following the TLV
            Length field of each TLV, concatenated together."
        REFERENCE       "RFC 7455, Section 8.4.3"
        ::= { trillOamMtvrEntry 17 }

    trillOamMepMtvrReceiverAvailability OBJECT-TYPE
        SYNTAX          TruthValue
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
            "A value of true indicates that the MTVR response contained
            Multicast receiver availability TLV."
        REFERENCE       "RFC 7455, Section 8.4.10"
        ::= { trillOamMtvrEntry 18 }
```

```
   trillOamMepMtvrReceiverCount OBJECT-TYPE
       SYNTAX          TruthValue
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
           "Indicates the number of multicast receivers available on
           the responding RBridge on the VLAN specified by the
           diagnostic VLAN."
       REFERENCE       "RFC 7455, Section 8.4.10"
       ::= { trillOamMtvrEntry 19 }

   -- ****************************************************************
   -- TRILL OAM MEP Database Table
   -- ****************************************************************

   trillOamMepDbTable OBJECT-TYPE
       SYNTAX      SEQUENCE OF TrillOamMepDbEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "This table is an extension of the dot1agCfmMepDbTable
           and rows are automatically added to or deleted from
           this table based upon row creation and destruction of the
           dot1agCfmMepDbTable."
       REFERENCE
          "RFC 7455"
       ::= { trillOamMep 5 }

   trillOamMepDbEntry OBJECT-TYPE
       SYNTAX      TrillOamMepDbEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "The conceptual row of trillOamMepDbTable."
       AUGMENTS {
                dot1agCfmMepDbEntry
                }
       ::= { trillOamMepDbTable 1 }

   TrillOamMepDbEntry ::= SEQUENCE {
         trillOamMepDbFlowIndex         Unsigned32,
         trillOamMepDbFlowEntropy       OCTET STRING,
         trillOamMepDbFlowState         Dot1agCfmRemoteMepState,
         trillOamMepDbFlowFailedOkTime  TimeStamp,
         trillOamMepDbRBridgeName       Unsigned32,
         trillOamMepDbLastGoodSeqNum    Counter32
       }
```

```
   trillOamMepDbFlowIndex OBJECT-TYPE
       SYNTAX        Unsigned32 (1..65535)
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
         "This object identifies the flow.  If the Flow Identifier TLV
          is received, then the index received can also be used."
       REFERENCE "RFC 7455"
       ::= {trillOamMepDbEntry 1 }

   trillOamMepDbFlowEntropy OBJECT-TYPE
       SYNTAX        OCTET STRING (SIZE  (96))
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
         "96 byte Flow Entropy."
       REFERENCE "RFC 7455, Section 3"
       ::= {trillOamMepDbEntry 2 }

   trillOamMepDbFlowState OBJECT-TYPE
       SYNTAX       Dot1agCfmRemoteMepState
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
           "The operational state of the remote MEP (flow-based)
            IFF State machines.  State Machine is running now per
            flow."
       REFERENCE "RFC 7455"
       ::= {trillOamMepDbEntry 3 }

    trillOamMepDbFlowFailedOkTime OBJECT-TYPE
       SYNTAX        TimeStamp
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
           "The Time (sysUpTime) at which the Remote MEP flow state
            machine last entered either the RMEP_FAILED or RMEP_OK
            state."
       REFERENCE "RFC 7455"
       ::= {trillOamMepDbEntry 4 }

   trillOamMepDbRBridgeName OBJECT-TYPE
       SYNTAX        Unsigned32(0..65471)
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
            "Remote MEP RBridge Nickname."
       REFERENCE "RFC 7455 and RFC 6325, Section 3"
```

```
        ::= {trillOamMepDbEntry 5 }

    trillOamMepDbLastGoodSeqNum OBJECT-TYPE
        SYNTAX        Counter32
        MAX-ACCESS    read-only
        STATUS        current
        DESCRIPTION
             "Last Sequence Number received."
        REFERENCE "RFC 7455, Section 13.1"
        ::= {trillOamMepDbEntry 6}

    -- ****************************************************************
    -- TRILL OAM MIB NOTIFICATIONS (TRAPS)
    -- This notification is sent to management entity whenever a
    -- MEP loses/restores
    -- contact with its peer flow MEPs
    -- ****************************************************************
    trillOamFaultAlarm NOTIFICATION-TYPE
        OBJECTS         { trillOamMepDbFlowState }
        STATUS          current
        DESCRIPTION
            "A MEP flow has a persistent defect condition.
             A notification (fault alarm) is sent to the management
             entity with the OID of the flow that has detected the fault.

            The management entity receiving the notification can identify
            the system from the network source address of the
            notification and can identify the flow reporting the defect
            by the indices in the OID of the trillOamMepFlowIndex and
            trillOamFlowDefect variable in the notification:

               dot1agCfmMdIndex - Also the index of the MEP's
                                  Maintenance Domain table entry
                                  (dot1agCfmMdTable).
               dot1agCfmMaIndex - Also an index (with the MD table index)
                                  of the MEP's Maintenance Association
                                  network table entry
                                  (dot1agCfmMaNetTable) and (with the MD
                                  table index and component ID) of the
                                  MEP's MA component table entry
                                  (dot1agCfmMaCompTable).
               dot1agCfmMepIdentifier - MEP Identifier and final index
                                  into the MEP table (dot1agCfmMepTable).
               trillOamMepFlowCfgIndex - Index identifies
                                  indicates the specific flow for
                                  the MEP"
        REFERENCE       "RFC 7455"
       ::= { trillOamNotifications 1 }
```

```
   -- ********************************************************************
   -- TRILL OAM MIB Module - Conformance Information
   -- ********************************************************************

   trillOamMibCompliances  OBJECT IDENTIFIER
       ::= { trillOamMibConformance 1 }

   trillOamMibGroups  OBJECT IDENTIFIER
       ::= { trillOamMibConformance 2 }

   -- ********************************************************************
   -- TRILL OAM MIB Units of Conformance
   -- ********************************************************************

   trillOamMepMandatoryGroup OBJECT-GROUP
       OBJECTS         {
                           trillOamMepRName,
                           trillOamMepNextPtmTId,
                           trillOamMepNextMtvmTId,
                           trillOamMepPtrIn,
                           trillOamMepPtrInOutofOrder,
                           trillOamMepPtrOut,
                           trillOamMepMtvrIn,
                           trillOamMepMtvrInOutofOrder,
                           trillOamMepMtvrOut,
                           trillOamMepTxLbmDestRName,
                           trillOamMepTxLbmHC,
                           trillOamMepTxLbmReplyModeOob,
                           trillOamMepTransmitLbmReplyIp,
                           trillOamMepTxLbmFlowEntropy,
                           trillOamMepTxPtmDestRName,
                           trillOamMepTxPtmHC,
                           trillOamMepTxPtmReplyModeOob,
                           trillOamMepTransmitPtmReplyIp,
                           trillOamMepTxPtmFlowEntropy,
                           trillOamMepTxPtmStatus,
                           trillOamMepTxPtmResultOK,
                           trillOamMepTxPtmMessages,
                           trillOamMepTxPtmSeqNumber,
                           trillOamMepTxMtvmTree,
                           trillOamMepTxMtvmHC,
                           trillOamMepTxMtvmReplyModeOob,
                           trillOamMepTransmitMtvmReplyIp,
                           trillOamMepTxMtvmFlowEntropy,
                           trillOamMepTxMtvmStatus,
                           trillOamMepTxMtvmResultOK,
                           trillOamMepTxMtvmMessages,
                           trillOamMepTxMtvmSeqNumber,
```

```
                        trillOamMepTxMtvmScopeList,
                        trillOamMepDiscontinuityTime
                    }
        STATUS          current
        DESCRIPTION
            "Mandatory objects for the TRILL OAM MEP group."
        ::= { trillOamMibGroups 1 }

    trillOamMepFlowCfgTableGroup OBJECT-GROUP
        OBJECTS         {
                        trillOamMepFlowCfgFlowEntropy,
                        trillOamMepFlowCfgDestRName,
                        trillOamMepFlowCfgFlowHC,
                        trillOamMepFlowCfgRowStatus
                    }
        STATUS          current
        DESCRIPTION
            "TRILL OAM MEP Flow Configuration objects group."
        ::= { trillOamMibGroups 2 }

    trillOamPtrTableGroup OBJECT-GROUP
        OBJECTS         {
                        trillOamMepPtrHC,
                        trillOamMepPtrFlag,
                        trillOamMepPtrErrorCode,
                        trillOamMepPtrTerminalMep,
                        trillOamMepPtrLastEgressId,
                        trillOamMepPtrIngress,
                        trillOamMepPtrIngressMac,
                        trillOamMepPtrIngressPortIdSubtype,
                        trillOamMepPtrIngressPortId,
                        trillOamMepPtrEgress,
                        trillOamMepPtrEgressMac,
                        trillOamMepPtrEgressPortIdSubtype,
                        trillOamMepPtrEgressPortId,
                        trillOamMepPtrChassisIdSubtype,
                        trillOamMepPtrChassisId,
                        trillOamMepPtrOrganizationSpecificTlv,
                        trillOamMepPtrNextHopNicknames
                    }
        STATUS          current
        DESCRIPTION
            "TRILL OAM MEP PTR objects group."
        ::= { trillOamMibGroups 3 }
```

```
   trillOamMtvrTableGroup OBJECT-GROUP
       OBJECTS         {
                           trillOamMepMtvrFlag,
                           trillOamMepMtvrErrorCode,
                           trillOamMepMtvrLastEgressId,
                           trillOamMepMtvrIngress,
                           trillOamMepMtvrIngressMac,
                           trillOamMepMtvrIngressPortIdSubtype,
                           trillOamMepMtvrIngressPortId,
                           trillOamMepMtvrEgress,
                           trillOamMepMtvrEgressMac,
                           trillOamMepMtvrEgressPortIdSubtype,
                           trillOamMepMtvrEgressPortId,
                           trillOamMepMtvrChassisIdSubtype,
                           trillOamMepMtvrChassisId,
                           trillOamMepMtvrOrganizationSpecificTlv,
                           trillOamMepMtvrNextHopNicknames,
                           trillOamMepMtvrReceiverAvailability,
                           trillOamMepMtvrReceiverCount
                       }
       STATUS          current
       DESCRIPTION
           "TRILL OAM MEP MTVR objects group."
       ::= { trillOamMibGroups 4 }

   trillOamMepDbGroup  OBJECT-GROUP
       OBJECTS   {
         trillOamMepDbFlowIndex,
         trillOamMepDbFlowEntropy,
         trillOamMepDbFlowState,
         trillOamMepDbFlowFailedOkTime,
         trillOamMepDbRBridgeName,
         trillOamMepDbLastGoodSeqNum
       }

       STATUS      current
       DESCRIPTION
          "TRILL OAM MEP DB objects group."
       ::= { trillOamMibGroups 5 }

   trillOamNotificationGroup NOTIFICATION-GROUP
       NOTIFICATIONS  { trillOamFaultAlarm }
       STATUS current
       DESCRIPTION
           "A collection of objects describing notifications(traps)."
       ::= { trillOamMibGroups 6 }
```

```
-- ********************************************************************
-- TRILL OAM MIB Module Compliance Statements
-- ********************************************************************

trillOamMibCompliance MODULE-COMPLIANCE
    STATUS          current
    DESCRIPTION
        "The compliance statement for the TRILL OAM MIB."
    MODULE          -- this module
    MANDATORY-GROUPS {
                        trillOamMepMandatoryGroup,
                        trillOamMepFlowCfgTableGroup,
                        trillOamPtrTableGroup,
                        trillOamMtvrTableGroup,
                        trillOamMepDbGroup,
                        trillOamNotificationGroup
                     }
    ::= { trillOamMibCompliances 1 }

-- Compliance requirement for read-only implementation.

trillOamMibReadOnlyCompliance MODULE-COMPLIANCE
    STATUS current
    DESCRIPTION
        "Compliance requirement for implementations that only
         provide read-only support for TRILL-OAM-MIB.
         Such devices can be monitored but cannot be configured
         using this MIB module."
    MODULE -- this module
    MANDATORY-GROUPS {
                        trillOamMepMandatoryGroup,
                        trillOamMepFlowCfgTableGroup,
                        trillOamPtrTableGroup,
                        trillOamMtvrTableGroup,
                        trillOamMepDbGroup,
                        trillOamNotificationGroup
                      }
    -- trillOamMepTable

    OBJECT trillOamMepTxLbmDestRName
    MIN-ACCESS  read-only
         DESCRIPTION
             "Write access is not required."

    OBJECT trillOamMepTxLbmHC
    MIN-ACCESS  read-only
         DESCRIPTION
             "Write access is not required."
```

```
        OBJECT trillOamMepTxLbmReplyModeOob
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTransmitLbmReplyIp
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxLbmFlowEntropy
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxPtmDestRName
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxPtmHC
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxPtmReplyModeOob
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTransmitPtmReplyIp
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxPtmFlowEntropy
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxPtmStatus
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."
```

```
        OBJECT trillOamMepTxPtmResultOK
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxPtmMessages
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxPtmSeqNumber
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxMtvmTree
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxMtvmHC
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxMtvmReplyModeOob
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTransmitMtvmReplyIp
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxMtvmFlowEntropy
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxMtvmStatus
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."
```

```
        OBJECT trillOamMepTxMtvmResultOK
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxMtvmMessages
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxMtvmSeqNumber
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepTxMtvmScopeList
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

    -- trillOamMepFlowCfgTable

        OBJECT trillOamMepFlowCfgFlowEntropy
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepFlowCfgDestRName
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepFlowCfgFlowHC
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        OBJECT trillOamMepFlowCfgRowStatus
        MIN-ACCESS  read-only
             DESCRIPTION
                 "Write access is not required."

        ::= { trillOamMibCompliances 2 }

    END
```

8. Security Considerations

This MIB relates to a system that will provide network connectivity and packet-forwarding services. As such, improper manipulation of the objects represented by this MIB may result in denial of service to a large number of end users.

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection opens devices to attack. There are the tables and objects and their sensitivity/vulnerability:

The following table and objects in the TRILL OAM MIB can be manipulated to interfere with the operation of RBridges by causing CPU use spikes:

- trillOamMepTransmitLbmReplyIp allows the reply from a Loopback message to be transmitted to an IP address in the TLV, thus allowing replies to be sent to any system to cause denial of service.

- trillOamMepTransmitPtmReplyIp allows the reply from a Path Trace message to be transmitted to an IP address in the TLV, thus allowing replies to be sent to any system to cause denial of service.

- trillOamMepTxPtmMessages allows the generation of PTMs and can be used to generate lots of CPU-driven traffic.

- trillOamMepTransmitMtvmReplyIp allows a from reply from an MTVM to be transmitted to an IP address in the TLV, thus allowing replies to be sent to any system to cause denial of service.

- trillOamMepTxMtvmMessages allows the generation of MTVMs and can be used to generate lots of CPU-driven traffic.

The following objects in the TRILL OAM MIB are read-create and can be manipulated to interfere with the OAM operations of RBridges. If the number of OAM frames generated in the network is high, this can cause a CPU spike on destination RBridges if control-plane policing is not properly implemented or configured on destination RBridges.

- trillOamMepTxLbmHC is used to set the Maximum Hop Count for the LBM. As OAM frames don’t leak out of the TRILL network, it has no side effects.

- trillOamMepTxLbmReplyModeOob is used to indicate whether the reply is in or out of band. This object's vulnerability is covered as part of trillOamMepTransmitLbmReplyIp.

- trillOamMepTxLbmFlowEntropy is used to indicate the customer flow and find the exact path in the network. The creation of valid flows is its intended purpose. If invalid flows are created on vulnerable system, they will be dropped in forwarding.

- trillOamMepTxLbmDestRName is read-create, but it's not vulnerable as invalid-name routes won't be present and will be rejected by the OAM application as part of normal processing.

- trillOamMepTxPtmHC is used to set the Maximum Hop Count for the PTM. As OAM frames don't leak out of the TRILL network, it has no side effect.

- trillOamMepTxPtmReplyModeOob is used to indicate whether the reply is in or out of band. This object's vulnerability is covered as part of trillOamMepTransmitPtmReplyIp.

- trillOamMepTxPtmFlowEntropy is used to indicate the customer flow and find the exact path in the network. Creation of valid flows is its intended purpose. If invalid flows are created on vulnerable systems, they will be dropped in forwarding.

- trillOamMepTxPtmDestRName is read-create, but it's not vulnerable as invalid-name routes won't be present and will be rejected by the OAM application as part of normal processing.

- trillOamMepTxPtmStatus is required for normal PTM operation.

- trillOamMepTxPtmResultOK is required for normal PTM operation.

- trillOamMepTxPtmSeqNumber is required for normal PTM operation.

- trillOamMepTxPtmMessages is required for normal PTM operation.

- trillOamMepTxMtvmTree is required for normal MTVM operation.

- trillOamMepTxMtvmHC is used to set the Maximum Hop Count for the MTVM. As OAM frames don't leak out of the TRILL network, it has no side effect

- trillOamMepTxMtvmReplyModeOob is used to indicate whether the reply is in or out of band. This object's vulnerability is covered as part of trillOamMepTransmitMtmReplyIp

- trillOamMepTxMtvmFlowEntropy is used to indicate the customer flow and find the exact path in the network. Creation of valid flows is its intended purpose. If invalid flows are created on vulnerable systems, they will be dropped in forwarding.

- trillOamMepTxMtvmStatus is required for normal MTVM operation.

- trillOamMepTxMtvmResultOK, trillOamMepTxMtvmMessages, trillOamMepTxMtvmSeqNumber, and trillOamMepTxMtvmScopeList are required for normal MTVM operation.

trillOamMepTransmitLbmReplyIp, trillOamMepTransmitPtmReplyIp, and trillOamMepTransmitMtvmReplyIp allow setting of the IP address to which reports are sent; thus, it can be used for denial of service for that IP.

Some of the readable objects in this MIB module (i.e., objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP. For example, Path Trace messages expose the unicast topology of the network and Multi-destination Tree Verification Messages expose the multicast tree topology of the network. This information should not be available to all users of the network.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPsec), there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module.

Implementation should provide the security features described by the SNMPv3 framework (see [RFC3410]), and implementations claiming compliance to the SNMPv3 standard MUST include full support for authentication and privacy via the User-based Security Model (USM) [RFC3414] with the AES cipher algorithm [RFC3826]. Implementations MAY also provide support for the Transport Security Model (TSM) [RFC5591] in combination with a secure transport such as SSH [RFC5592] or TLS/DTLS [RFC6353].

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give only those

principals (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

9. IANA Considerations

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER value recorded in the SMI Numbers registry:

Descriptor	OBJECT IDENTIFIER value
trillOamMIB	{ mib-2 238 }

10. References

10.1. Normative References

[802.1Q] IEEE, "IEEE Standard for Local and metropolitan area networks -- Media Access Control (MAC) Bridges and Virtual Bridge Local Area Networks", IEEE Std 802.1Q-2011, DOI 10.1109/IEEESTD.2011.6009146.

[IEEE8021-CFM-MIB] IEEE, "Connectivity Fault Management module for managing IEEE 802.1ag", IEEE 802.1ag, October 2008, <http://www.ieee802.org/1/files/public/MIBs/IEEE8021-CFM-MIB-200810150000Z.txt>.

[LLDP-MIB] IEEE, "Management Information Base module for LLDP configuration, statistics, local system data and remote systems data components", IEEE 802.1AB, May 2005, <http://www.ieee802.org/1/files/public/MIBs/LLDP-MIB-200505060000Z.txt>.

[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>.

[RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, DOI 10.17487/RFC2578, April 1999, <http://www.rfc-editor.org/info/rfc2578>.

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