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RBridges: OAM Channel Support in TRILL
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Abstract

This document specifies a general channel for sending OAM (Operations, Administration, and Maintenance) messages in an RBridge campus through an extension to the TRILL (TRansparent Interconnection of Lots of Links) protocol.

Status of This Memo

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1. Introduction

RBridge campuses provide Layer 2 data networking using the TRILL protocol. However, the TRILL base protocol specification [RFCtrill] does not specifically provide for OAM (Operations, Administration, and Maintenance) messages. This document specifies a facility for the transmission of OAM messages within an RBridge campus.

Familiarity with [RFCtrill] is assumed in this document.

1.1 TRILL Channel Requirements

It is anticipated that various OAM protocols operating at the TRILL level will be desired in RBridge campuses. For example, there is a need for rapid response continuity checking with a protocol such as BFD [RFC5880] [RFC5882] and for a variety of optional reporting, in the spirit of some ICMP [RFC792] messages, such as reporting Hop Count exhaustion, unknown egress nickname in the TRILL header, and the like, including ping and trace route functions.

To avoid having to design and specify a way to carry each new OAM protocol in TRILL, this document specifies a general channel for sending OAM messages between RBridges in a campus at the TRILL level using extensions to the TRILL protocol. To accommodate a wide variety of OAM protocols, the OAM Channel facility accommodates all the regular modes of TRILL Data transmission including single and multiple hop unicast as well as VLAN scoped multi-destination distribution. To minimize any unnecessary burden on transit RBridges and to provide a more realistic test of network continuity and the like, TRILL OAM Channel messages are designed to look like TRILL Data frames and, in the case of multi-hop messages, can normally be handled by transit RBridges as if they were TRILL data frames; however, to enable processing of an OAM message at transit RBridges when required, an optional Alert non-critical hop-by-hop extended header flag is specified to cause transit RBridge to examine a frame with that flag set.

This document also provides a format for sending OAM messages between end stations and RBridges, in either direction, when appropriate for the OAM protocol involved.

Each particular OAM protocol will likely use only a subset of the facilities specified herein.

The TRILL OAM Channel is similar to the MPLS Generic Channel specified in [RFC5586]. Instead of using a special MPLS label to indicate a special channel message, a TRILL OAM Channel message is

indicated by a special Inner.MacDA.

1.2 Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

The terminology and acronyms of [RFCtrill] are used in this document with the additions listed below.

BFD - Bidirectional Forwarding Detection

ICMP - Internet Control Message Protocol

MH - Multi-Hop

OAM - Operations, Administration, and Maintenance

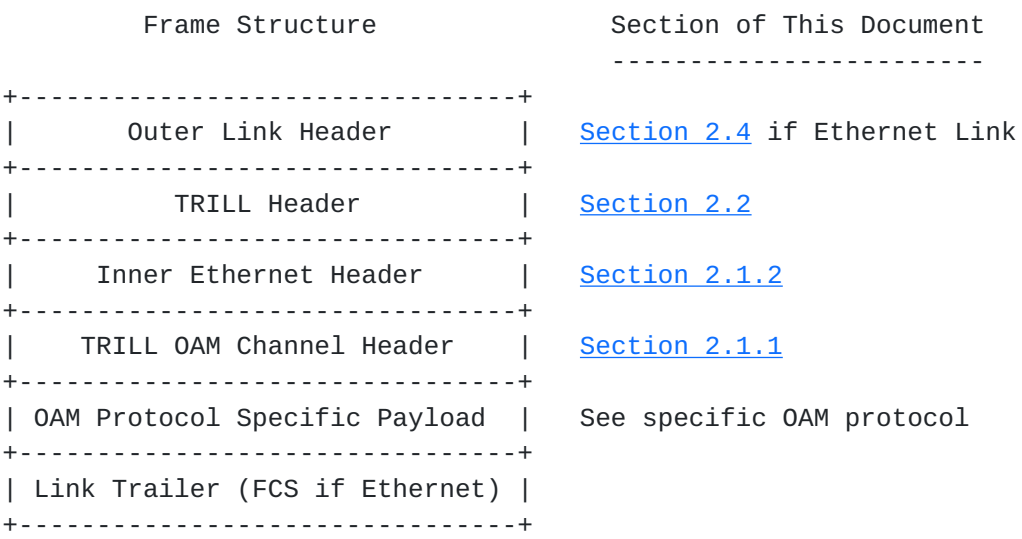
OV - OAM (Message Channel) Version

SL - Silent

2. The TRILL OAM Channel Messages

TRILL OAM messages are transmitted as TRILL Data frames. They are identified as OAM messages by their Inner.MacDA. The encapsulated frame has, after the Inner Ethernet Header, the TRILL-OAM Ethertype that is part of an OAM Channel Header. That Header indicates the OAM protocol of the following OAM protocol specific data.

The diagram below shows the overall structure of a TRILL OAM Message Channel frame on a link between two RBridges:



Some OAM messages may require examination of the frame, to determine if the transit RBridge needs to take any action, by transit RBridges that support the OAM Channel feature. To indicate this, a non-critical hop-by-hop extended TRILL header flag is allocated as the Alert bit, as further described in Section 4 below.

In addition, a TRILL Header extended flag is provided that may optionally be used to guarantee that frames sent over the TRILL OAM Message Channel cannot be accidentally forwarded to end stations, even by minimally conformant RBridges that are ignorant of the TRILL OAM Message Channel feature.

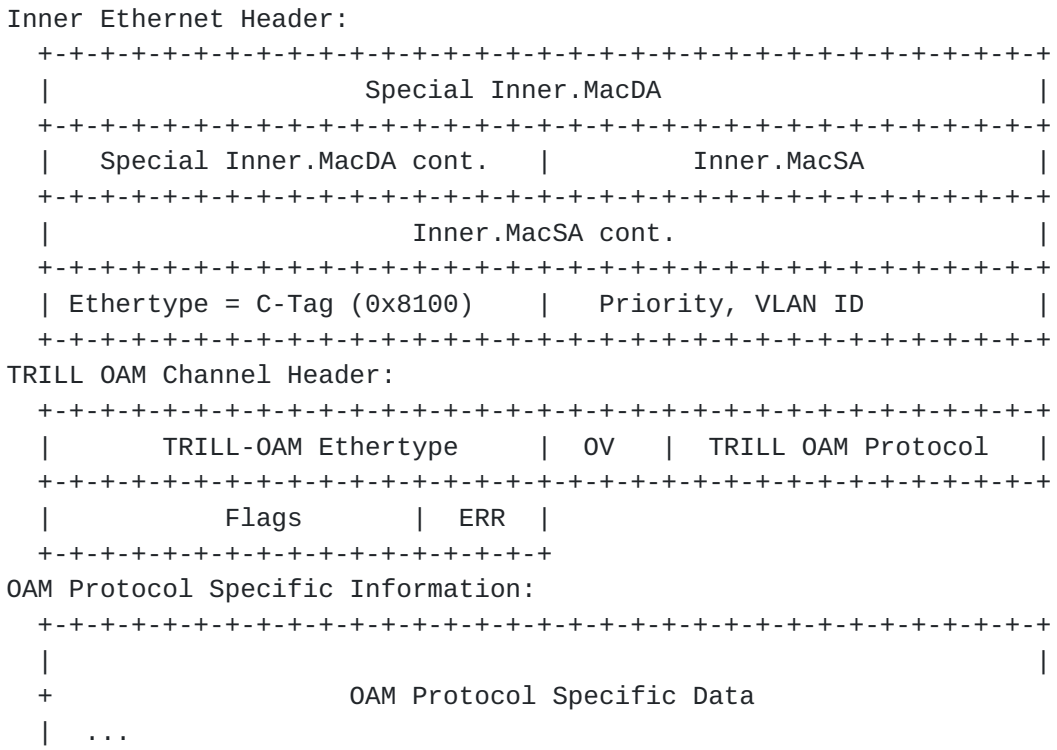
The Sections 2.1 and 2.2 below describe the Inner frame and the TRILL Header for frames sent in the TRILL OAM Message Channel. As always, the Outer link header is whatever is needed to get a TRILL Data frame to the next hop RBridge, depends on link technology, and can change with each hop for multi-hop OAM messages. Section 2.4 describes the Outer link header for Ethernet. And Section 2.5 discusses some special considerations for the first hop transmission of OAM Channel messages.

Section 3 describes the OAM-Channel extended flag. Section 4 describes some details of TRILL OAM Message processing. And Section 5

specifies an optional format for native OAM frames.

2.1 The OAM Message Inner Frame

The encapsulated Inner frame within a TRILL OAM Message Channel frame is as shown below.



The OAM protocol specific data contains the information related to the specific protocol type used in the OAM channel message. Details of that data are outside the scope of the document, except in the case of the OAM Channel error protocol specified below.

2.1.1 TRILL OAM Channel Header

As shown in the diagram above, the TRILL OAM header starts with the TRILL OAM Ethertype (see Section 6.2). Following that is a four-byte quantity with four sub-fields as follows:

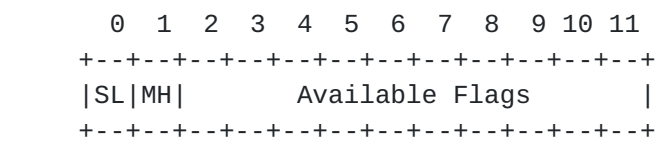
OV gives the OAM Header version and MUST be zero.

A 12-bit field that specifies the particular TRILL OAM protocol to which the message applies.

Flags provides 12 bits of flags described below.

ERR is a four-bit field used in connection with error reporting at the OAM Channel level as described in Section 4.

The flag bits are numbered from 0 to 11 as shown below.



Bit 0, which is the high order bit in network order, is defined as the SL or Silent bit. If it is a one, it suppresses OAM Channel Error messages (see Section 4).

Bit 1 is the MH or Multi-Hop bit. It is used to inform the destination OAM protocol that the message was intended to be multi-hop (MH=1) or one-hop (MH=0).

The TRILL OAM Protocol field specifies the OAM protocol that the OAM Channel message relates to. The initial defined value is listed below. See Section 5 for IANA Considerations.

Protocol	Name - Section of this Document
0x0001	OAM Channel Error - Section 4

2.1.2 Inner Ethernet Header

The special Inner.MacDA is All-OAM-RBridges to signal that the frame is a TRILL OAM Chanel message (see Section 6.1).

The RBridge originating the OAM message selects the Inner.MacSA. Because OAM Channel messages are handled very much like ordinary TRILL Data frames, if the Inner.MacSA is a unicast MAC address, on decapsulation it will be learned as being attached to the ingress RBridge. If that learning is not desired, the Inner.MacSA MAY be set to All-OAM-RBridges or the like. MAC address learning on does not occur if the MAC address has the group bit on.

2.1.3 Inner.VLAN

As with all TRILL encapsulated frames, a VLAN tag MUST be present. Use of a VLAN tag Ethertype other than 0x8100 or stacked VLAN tags is beyond the scope of this document.

Multi-destination TRILL OAM messages are, like all multi-destination TRILL Data messages, VLAN scoped so the Inner.VLAN ID MUST be set to the VLAN of interest. To the extent that distribution tree pruning is in effect, such OAM messages will only reach RBridges advertising that they have appointed forwarder connectivity to that VLAN.

For known unicast OAM messages, if the message is one-hop it is RECOMMENDED that the Inner.VLAN ID be the Designated VLAN on that hop. For multi-hop unicast OAM messages, it is RECOMMENDED that the Inner.VLAN ID be the default VLAN 1.

The Inner.VLAN will specify a three-bit frame priority for which the following recommendations apply:

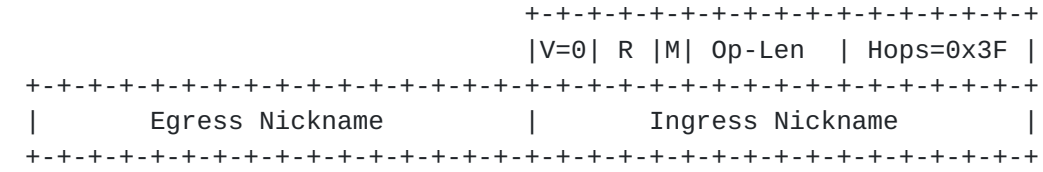
- For one-hop OAM messages critical to network connectivity, such as one-hop BFD for rapid link failure detection in support of TRILL IS-IS, the RECOMMENDED priority is 7.

- For single and multi-hop known unicast OAM messages important to network operation but not critical for connectivity, the RECOMMENDED priority is 6.

- For other known unicast OAM messages and all multi-destination OAM messages, it is RECOMMENDED that the default priority zero be used and, in any case priorities higher than 5 SHOULD NOT be used.

2.3 The TRILL Header for OAM Messages

After the Outer link header (which, for Ethernet, ends with the TRILL Ethertype) and before the encapsulated frame, the OAM message's TRILL Header appears as follows:



The TRILL Header version V MUST be zero, the R bit are reserved, the M bit is set appropriately as the OAM message is known unicast (M=0) or multi-destination (M=1), and Op-Len is set appropriately for the length of the options area, if any, all as specified in [RFCtrill].

When a TRILL OAM message is originated, the hop count field MUST be set to the maximum value, 0x3F. For messages sent a known number of hops, particularly one-hop messages or two-hop neighbor echo messages, checking the Hops (Hop Count) field provides an additional

validity check as discussed in [RFC5082].

The RBridge originating a TRILL OAM message places a nickname that it holds into the ingress nickname field.

There are several cases for the egress nickname field. If the OAM message is multi-destination, then the egress nickname designates the distribution tree to use. If the OAM message is a multi-hop unicast message, then the egress nickname is a nickname of the target RBridge; this includes the special case of an "echo" OAM message where the originator places one of its own nicknames in both the ingress and egress nickname fields. If the OAM message is a one-hop unicast message, there are two possibilities for the egress nickname.

- The egress nickname can bet set to a nickname of the target neighbor RBridge.

- The special nickname Any-RBridge may be used. RBridges supporting the TRILL OAM Channel facility MUST recognize the Any-RBridge special nickname and accept TRILL Data frames having that value in the egress nickname field as being sent to them as the egress. Thus, for such RBridges, using this egress nickname guarantees processing by an immediate neighbor regardless of the state of nicknames.

2.4 OAM Message Ethernet Link Header

If the link on which a TRILL OAM frame is transmitted between neighbor RBridges is Ethernet, the link header follows the usual rules for a TRILL Data frame over Ethernet [RFCtrill]. In particular, the Outer.MacSA is the MAC address of the port from which the frame is sent. The Outer.MacDA is the MAC address of the next-hop RBridge port for unicast TRILL OAM messages or the All-RBridges multicast address for multi-destination TRILL OAM messages. The Outer.VLAN tag specifies the Designated VLAN for that hop and the priority must be the same as in the Inner.VLAN tag; however, the output port may have been configured to strip VLAN tags, in which case no Outer.VLAN tag appears on the wire.

2.5 Special Transmission and Rate Considerations

If a multi-hop OAM Channel message is received by an RBridge, the criteria and method of forwarding it is the same as for any TRILL Data frame. If it is so forwarded, it will be on a link that was included in the routing topology because it was in Report state as specified in [RFCadj].

However, special considerations apply to the first hop because it may

be desirable to use some OAM messages on links that are not yet fully up. In particular, it is permissible, if specified by the particular OAM protocol, for the source RBridge that has created an OAM Channel message to transmit it to a next hop RBridge when the link is in the Detect and Two-Way states, as specified in [RFCadj], as well as when it is in the Report state.

OAM messages may represent a burden on the RBridges in a campus and should be rate limited, especially if they are multi-destination, multi-hop, and/or have the Alert extended flag set.

3. The TRILL OAM-Channel Extended Flag

If an OAM Channel ignorant RBridge were to receive an OAM Channel frame, it would generally flood the encapsulated frame out all ports where it was the appointed forwarder for the frame's VLAN as specified by the Inner.VLAN ID. It may be desirable to stop such flooding in case, due to transient conditions, an OAM Channel frame is misdelivered to an OAM Channel ignorant RBridge. It is also desirable for an RBridge to be able to indicate that it supports the OAM Channel facility.

To provide these facilities, a critical ingress-to-egress TRILL Header extended flag, OAM-Channel, is specified for the TRILL OAM Channel facility [TRILLopt]. This flag is not required to be set in the TRILL Header in TRILL OAM message frames. It serves the two functions described above, as follows:

- An RBridge indicates that it supports the TRILL OAM Channel facility by advertising, in the link state database, its support for this extended flag.

- If this extended flag is set in a TRILL OAM message frame, it guarantees that, if the inner frame is processed for egress by an RBridge that does not implement the TRILL OAM Channel, the decapsulated frame will be discarded because egress RBridges are required by the base standard to discard frames indicating a critical ingress-to-egress extended flag they do not support. If it is certain that all RBridges in the campus implement the TRILL OAM Channel or if the possible local flooding of the inner frame as described above is acceptable, there is no requirement to include an options area nor to set this particular extended flag in the TRILL Header even if an options area is included.

As with any other critical ingress-to-egress extended flag, if this extended flag is set, then the summary CItE bit MUST be set at the top of the options area.

4. Processing TRILL OAM Chanel Messages

TRILL OAM messages are designed to look like and, to the extent practical, be processed as regular TRILL Data frames. On receiving a TRILL OAM frame, the initial tests on the Outer.MacDA, Outer Ethertype, TRILL Header V and Hop Count fields and the Reverse Path Forwarding Check if the frame is multi-destination, are all performed as usual. The forwarding and/or decapsulation decisions are the same as for a regular TRILL Data frame with following exceptions for RBridges implementing the TRILL OAM Channel:

1. An RBridge implementing the TRILL OAM Channel MUST recognize the Any-RBridge egress nickname in unicast TRILL Data frames, decapsulating and not forwarding such frames if they meet other checks.

2. If the Alert extended flag is set, then the RBridge needs to process the OAM Channel message as described below even if it is not egressing the frame. If it is egressing the frame, then no additional processing beyond egress processing is needed even if the Alert flag is set.

3. On decapsulation, the special Inner.MacDA value of All-OAM-RBridges MUST be recognized to trigger processing as a TRILL OAM Channel message.

If the OAM-Channel extended flag is present and set and an egressing RBridge does not implement the TRILL OAM Channel feature, the frame is discarded. If other extended flags or options are present, they may affect processing or cause the frame to be discarded.

4.1 Processing the TRILL OAM Channel Header

Knowing that it has a TRILL OAM Channel message, the egress RBridge, and any transit RBridge if the Alert bit is set in the TRILL Header, looks at the OV (OAM Message Header version) and OAM Protocol fields; however, if the frame is so short that the Ethertype or the OAM Channel Header does not fit or the Ethertype is other than TRILL-OAM, the frame is discarded.

If any of the following conditions occur at an egress RBridge, the frame is not processed and an error may be generated as specified in Section 4.2; however, if these conditions are detected at a transit RBridge examining the message because the Alert flag is set, no error is generated and the frame is still forwarded normally.

1. The OV field is non-zero.

2. The OAM Protocol field is a reserved value or a value unknown to the processing RBridge.

3. The ERR field is non-zero and OAM protocol is a value other than 0x001.

If the OV field is zero and the processing RBridge recognizes the OAM Protocol value, it processes the message in accordance with that OAM protocol. The processing model is as if the received frame starting with and including the TRILL Header is delivered to the OAM protocol along with a flag indicating whether this is (a) transit RBridge processing due to the Alert flag being set or (b) egress processing.

Errors within a recognized OAM Protocol are handled by that OAM protocol itself and do not produce OAM Message Channel Error frames.

4.2 OAM Channel Errors

A variety of problems at the OAM Channel level cause the return of an OAM Channel Error frame unless the "SL" (Silent) flag is a one in the OAM message for which the problem was detected or the frame in error appears, itself, to be an OAM Channel error frame or the error is suppressed due to rate limiting.

An OAM Channel Error frame is a multi-hop unicast TRILL OAM Channel message with the ingress nickname set to the nickname of the RBridge detecting the error, and the egress nickname set to the value of the ingress nickname in the OAM message for which the error was detected. The SL and MH flags SHOULD be set to one and the ERR field MUST be non-zero as described below. In case more than one error applies, the lower numbered ERR value is used. For the protocol specific data area, an OAM Channel Message Error frame has at least the first 256 bytes (or less if less are available) of the erroneous decapsulated OAM message starting with the TRILL Header.

The following values for ERR are specified:

ERR	Meaning
0	- Not an OAM Channel error frame.
1	Unimplemented value of OV
2	Reserved or unimplemented value of Protocol
3	ERR field is non-zero but Protocol field does not equal 0x001
4-15	- Available for allocation, see Section 6.1.

All RBridges implementing the TRILL OAM Message Channel feature MUST recognize the OAM Message Channel Error protocol value (0x001). They

MUST NOT generate an OAM Message Channel Error message in response to

a TRILL OAM Channel Error message, that is an OAM message with a protocol value of 0x001.

5. Native TRILL-OAM Frames

If provided for by the OAM protocol involved, native TRILL OAM messages may be sent between end-stations and RBridges in either direction. Such native frames have the TRILL-OAM Ethertype and look like the encapsulated frame within a TRILL OAM Channel message with the following exceptions:

1. TRILL does not require the presence of VLAN tagging on such native TRILL OAM frames. However, port configuration, link characteristics, or the OAM protocol involved may require such tagging.

2. If the frame is unicast, the destination MAC address is the unicast MAC address of the RBridge or end-station port that is its intended destination. If the frame is multicast to all the RBridges on a link that support some OAM protocol that uses this transport, the destination MAC address is All-OAM-RBridges. If the frame is multicast to all the devices that TRILL considers to be end stations on a link that support some OAM protocol that uses this transport, the destination MAC address is TRILL-End-Stations (see Section 6.1).

3. As with any native frame, the source MAC address is that of the port sending the frame.

A native frame with the TRILL-OAM Ethertype must meet the usual VLAN and destination MAC address restrictions to be accepted by an RBridge. If provided for by the OAM protocol involved, the receipt of such a native frame MAY lead to the generation and forwarding of one or more TRILL OAM Channel frames. The decapsulation and processing of a TRILL OAM Channel frame MAY, if provided for by the OAM protocol involved, result in the sending of one or more native TRILL OAM frames to one or more end stations.

6. Allocations Considerations

The following subsections give IANA and IEEE Registration Authority Considerations.

6.1 IANA Considerations

In this document, the allocation procedures "Standards Action", "IETF Review", "RFC Publication", and "Private Use" are as specified in [RFC5226].

IANA is requested to allocate a previously unassigned TRILL Nickname as follows:

Any-RBridge	TBD (0xFFCO suggested)

IANA is requested to allocate two previously unassigned TRILL Multicast address as follows:

All-OAM-RBridges	TBD (01-80-C2-00-00-43 suggested)
TRILL-End-Stations	TBD (01-80-C2-00-00-44 suggested)

IANA is requested to allocate a previously unassigned TRILL critical ingress-to-egress extended flag bit as follows:

TBD	OAM-Flag

IANA is request to allocate a previously unassigned TRILL non-critical hop-by-hop extended flag bit as follows:

TBD	Alert

IANA is requested to create an additional sub-registry in the TRILL Parameter Registry for TRILL OAM Protocols, with initial contents as follows:

Protocol	Use
0x000	Reserved
0x001	OAM Channel Error
0x002-0x0FF	Available for allocation (1)
0x100-0xFF7	Available for allocation (2)
0xFF8-0xFFE	Private Use
0xFFF	Reserved

(1) TRILL OAM protocol code points from 0x002 to 0x0FF require a

Standards Action for allocation.

(2) TRILL OAM protocol code points from 0x100 to 0xFF7 require RFC Publication to allocate a single value or IETF Review to allocate multiple values.

IANA is requested to create an additional sub-registry in the TRILL Parameter Registry for TRILL OAM Header Flags with initial contents as follows:

Flag Bit	Mnemonic	Allocation
0	SL	Silent
1	MH	Multi-hop
2-11	-	Available for allocation

Allocation of a TRILL OAM Header Flag is based on Standards Action [RFC5226].

IANA is requested to create an additional sub-registry in the TRILL Parameter Registry for TRILL OAM Channel error codes with initial contents as listed in Section 4.2 above and with available values allocated by Standards Action.

6.2 IEEE Registration Authority Considerations

The Ethertype TBD has been is assigned by the IEEE Registration Authority for TRILL-OAM.

7. Security Considerations

See [RFCtrill] for general RBridge Security Considerations.

-- More TBD --

8. References

The following sections list normative and informative references for this document.

8.1 Normative References

[RFC2119] - Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997

[RFC5226] - Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, May 2008.

[RFC5880] - D. Katz, D. Ward, "Bidirectional Forwarding Detection (BFD)", June 2010.

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[RFCtrill] - R. Perlman, D. Eastlake, D. Dutt, S. Gai, and A. Ghanwani, "RBridges: Base Protocol Specification", draft-ietf-trill-rbridge-protocol-16.txt, in RFC Editor's queue.

[RFCadj] - Eastlake, D., R. Perlman, A. Ghanwani, D. Dutt, V. Manral, "RBridges: Adjacency", draft-ietf-trill-adj, work in progress.

[TRILLopt] - D. Eastlake, A. Ghanwani, V. Manral, C. Bestler, "RBridges: TRILL Header Options", draft-ietf-trill-rbridge-options, work in progress.

8.2 Informative References

[RFC792] - Postel, J., "Internet Control Message Protocol", STD 5, RFC 792, September 1981.

[RFC5082] - Gill, V., Heasley, J., Meyer, D., Savola, P., Ed., and C. Pignataro, "The Generalized TTL Security Mechanism (GTSM)", RFC 5082, October 2007

[RFC5586] - Bocci, M., Ed., Vigoureux, M., Ed., and S. Bryant, Ed., "MPLS Generic Associated Channel", RFC 5586, June 2009.

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