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Transparent Interconnection of Lots of Links (TRILL): Header Extension

Abstract

The IETF Transparent Interconnection of Lots of Links (TRILL) base protocol (RFC 6325) specifies minimal hooks to safely support TRILL Header extensions. This document specifies an initial extension providing additional flag bits and specifies some of those bits. It updates RFC 6325.

Status of This Memo

This is an Internet Standards Track document.

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1. Introduction

The base IETF Transparent Interconnection of Lots of Links (TRILL) protocol [RFC6325] provides a TRILL Header extension feature and describes minimal hooks to safely support header extensions. (This feature is called "options" in Section 3.8 of [RFC6325].) But, except for the first two bits, the TRILL base protocol document does not specify the structure of extensions to the TRILL Header nor the details of any particular extension.

This document is consistent with [RFC6325] and provides further details. It specifies an initial extension word providing additional flag bits and specifies some of those bits. Additional extensions, including TLV-encoded options, may be specified in later documents, for example, [Options] and [Options2].

Section 2 below describes some general principles of TRILL Header extensions and an initial extension. Section 3 specifies a pair of flags in this initial extension.

1.1. Conventions Used in This Document

The terminology and acronyms defined in [RFC6325] are used herein with the same meaning. Devices implementing the TRILL protocol are referred to as RBridges (Routing Bridges) or TRILL Switches.

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].

2. TRILL Header Extensions

The base TRILL protocol includes a feature for extension of the TRILL Header (see [RFC6325], Sections 3.5 and 3.8). The 5-bit Op-Length header field gives the length of the extensions to the TRILL Header in units of 4 octets, which allows up to 124 octets of header extension. If Op-Length is zero, there are no header extensions present; else, the extension area follows immediately after the Ingress RBridge Nickname field of the TRILL Header. The first 32-bit word of the optional extensions area consists of an extended flags area and critical summary bits as specified in this document.

As described below, provision is made for

- o hop-by-hop flags, which might affect any RBridge that receives a TRILL Data frame with such a flag set,
- o ingress-to-egress flags, which would only necessarily affect the RBridge(s) where a TRILL frame is decapsulated,
- o flags affecting an as-yet-unspecified class of RBridges, for example, border RBridges in a TRILL campus extended to support multi-level IS-IS (Intermediate System to Intermediate System) [MultiLevel], and
- o both "critical" and "non-critical" flags.

Any RBridge receiving a frame with a critical hop-by-hop extension that it does not implement MUST discard the frame because it is unsafe to process the frame without understanding such a critical extension.

Any egress RBridge receiving a frame with a critical ingress-to-egress extension it does not implement MUST drop the frame if it is a unicast frame (TRILL Header M bit = 0); if it is a multi-destination TRILL Data frame (M=1), then it MUST NOT be egressed at that RBridge, but the egress RBridge still forwards such a frame on the distribution tree.

Non-critical extensions can be safely ignored.

Any extended flag indicating a significant change in the structure or interpretation of later parts of the frame that, if the extended flag were ignored, could cause a failure of service or violation of security policy MUST be a critical extension. If such an extended flag affects any fields that transit RBridges will examine, it MUST be a hop-by-hop critical extended flag.

Note: Most RBridge implementations are expected to be optimized for simple and common cases of frame forwarding and processing. Although the hard limit on the header extensions area length, the 32-bit alignment of the extension area, and the presence of critical extension summary bits, as described below, are intended to assist in the efficient hardware processing of frames with a TRILL Header extensions area, nevertheless the inclusion of extensions may cause frame processing using a "slow path" with inferior performance to "fast path" processing. Limited slow path throughput of such frames could cause some of them to be discarded.

2.1. RBridge Extended Flag Handling Requirements

All RBridges MUST check whether there are any critical flags set that are necessarily applicable to their processing of the frame. To assist in this task, critical summary bits are provided that cover not only the extended flags specified herein but will cover any further extensions that may be specified in future documents, for example, [Options] and [Options2]. If an RBridge does not implement all critical flags in a TRILL Data frame, it MUST treat the frame as having an unimplemented critical extension as described in Section 2. A transit or egress RBridge may assume that the critical summary bits are correct.

In addition, a transit RBridge:

- MAY set or clear hop-by-hop flags as specified for such flags;
- MUST adjust the length of the extensions area, including changing Op-Length in the TRILL Header, as appropriate if it adds or removes the extended header flags word;
- MUST, if it adds the word of extended header flags or changes any critical flags, correctly set the critical summary bits in the extended header flags word;
- MUST NOT remove the extended header flags word unless it is all zero (either on arrival or after permitted modifications); and
- MUST NOT set or clear ingress-to-egress or reserved extended header flags except as specifically permitted in the specification of such flags.

2.2. No Critical Surprises

RBridges advertise the extended header flags they support in IS-IS PDUs (Protocol Data Units) [RFC7176]. Unless an RBridge advertises support for a critical extended header flag, it will not normally receive frames with that flag set. An RBridge is not required to support any extensions.

An RBridge SHOULD NOT set a critical extended flag in a frame unless,

- for a critical hop-by-hop extended header flag, it has determined that the next hop RBridge or RBridges that will accept the frame support that flag,

- o for a critical ingress-to-egress extended header flag, it has determined that the RBridge or RBridges that will egress the frame support that flag, or

- o for a critical reserved extended header flag, it may set such a flag only if it understands which RBridges it is applicable to and has determined that those RBridges that will accept the frame support that flag.

"SHOULD NOT" is specified above since there may be cases where it is acceptable for those frames, particularly for the multi-destination case, to be discarded or not egressed by any RBridges that do not implement the extended flag.

2.3. Extended Header Flags

If any extensions are present in a TRILL Header, as indicated by a non-zero Op-Length field, the first 32 bits of the extensions area consist of extended header flags, as described below. The remainder of the extensions area, if any, after the initial 32 bits may be specified in later documents, for example, [Options] and [Options2].

Any RBridge adding an extensions area to a TRILL Header must set the first 32 bits to zero except when permitted or required to set one or more of those bits as specified. For TRILL Data frames with extensions present, any transit RBridge that does not discard the frame MUST transparently copy the extended flags word, except for modifications permitted by an extension implemented by that RBridge.

The extended header flags word is illustrated below and the meanings of these bits is further described in the list following the figure.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Crit.|  CHbH   |   NCHbH   |CRSV | NCRSV |   CItE    |  NCItE  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| ... additional optional 32-bit aligned words of extension     |
|     possibly including TLV extensions ...
```

(The first two critical summary bits are as specified in [RFC6325]. In this document, an "S", for Summary, has been added at the end of their acronyms. A third critical summary bit is also specified herein and its acronym also ends with an "S" for consistency.)

```
Bits    Description
--------------------

0-2     Crit.: Critical summary bits.
        0 CHbHS: Critical Hop-by-Hop extension(s) are present.
        1 CItES: Critical Ingress-to-Egress extension(s) are present.
        2 CRSVS: Critical Reserved extension(s) are present.

3-7     CHbH: Critical Hop-by-Hop extended flag bits.
8-13    NCHbH: Non-critical Hop-by-Hop extended flag bits.

14-16   CRSV: Critical Reserved extended flag bits.
17-20   NCRSV: Non-critical Reserved extended flag bits.

21-26   CItE: Critical Ingress-to-Egress extended flag bits.
27-31   NCItE: Non-critical Ingress-to-Egress extended flag bits.
```

2.3.1. Critical Summary Bits

The top three bits of the extended header flags area, bits 0, 1, and 2 above, are called the critical summary bits. They summarize the presence of critical extensions as follows:

CHbHS: If the CHbHS (Critical Hop-by-Hop Summary) bit is one, one or more critical hop-by-hop extensions are present. These might be critical hop-by-hop extended header flags or critical hop-by-hop extensions after the first word in the extensions area. Transit RBridges that do not support all of the critical hop-by-hop extensions present, for example, an RBridge that supported no critical hop-by-hop extensions, MUST drop the frame. If the CHbHS bit is zero, the frame is safe, from the point of view of extensions processing, for a transit RBridge to forward, regardless of what extensions that RBridge does or does not support.

CItES: If the CItES (Critical Ingress-to-Egress Summary) bit is a one, one or more critical ingress-to-egress extensions are present. These might be critical ingress-to-egress extended header flags or critical ingress-to-egress extensions after the first word in the extensions area. If the CItES bit is zero, no such extensions are present. If either CHbHS or CItES is non-zero, egress RBridges that do not support all critical extensions present, for example, an RBridge that supports no critical extensions, MUST drop the frame. If both CHbHS and CItES are zero, the frame is safe, from the point of view of extensions, for an egress RBridge to process, regardless of what extensions that RBridge does or does not support.

CRSVS: If the CRSVS (Critical Reserved Summary) bit is a one, one or more critical extensions are present that are reserved to apply to a class of RBridges to be specified in the future, for example, border RBridges in a TRILL campus extended to support multi-level IS-IS. This class will be a subset of transit RBridges. RBridges in this class MUST drop frames with the CRSVS bit set unless they implement all critical hop-by-hop and all critical reserved extensions present in the frame.

The critical summary bits enable simple and efficient processing of TRILL Data frames by egress RBridges that support no critical extensions, by transit RBridges that support no critical hop-by-hop extensions, and by RBridges in the reserved class that support no critical hop-by-hop or reserved extensions. Such RBridges need only check whether Op-Length is non-zero and, if it is, check the top one, two, or three bits just after the fixed portion of the TRILL Header. Based on those three bits, such RBridges can decide whether to discard or forward/process the frame.

2.4. Conflict of Extensions

Defining TRILL extensions including extended header flags that conflict with each other would be undesirable. Should conflicting extensions appear in the same packet, the results would be unpredictable if different implementations processed them in different orders. While rules could be defined to specify how to predictably process conflicting extensions, such rules would also limit implementation flexibility and could impose substantial processing burdens.

Conflicting extensions SHOULD NOT be defined, but if they are, careful thought should be given as to whether and how to specify the handling of conflicting extensions.

3. Specific Extended Header Flags

The table below shows the state of TRILL Header extended flag assignments. See Section 5 for IANA Considerations.

Bits	Purpose	Section
0-2	Critical Summary Bits	2.3.1
3-6	available critical hop-by-hop flags	
7	Critical Channel Alert flag	3.1
8	Non-critical Channel Alert flag	3.1
9-13	available non-critical hop-by-hop flags	
14-16	available critical reserved flags	
17-20	available non-critical reserved flags	
21-26	available critical ingress-to-egress flags	
27-31	available non-critical ingress-to-egress flags	

Table 1: Extended Header Flags Area

3.1. RBridge Channel Alert Extended Flags

The RBridge Channel Alert extended header flags indicate that the frame is an RBridge Channel frame [RFC7178] that requests processing at each hop.

If the Critical Channel Alert flag (bit 7) is a one and the RBridge does not implement the RBridge Channel feature or the particular RBridge Channel protocol involved [RFC7178] or the frame does not actually appear to be an RBridge Channel message, then the frame is discarded. This permits implementation, for example, of a channel message requiring strict source routing or the like, with assurance that it will be discarded rather than deviate from the directed path.

If the frame is not discarded as described above, then the presence of either the Critical or Non-critical Channel Alert flag alerts transit RBridges to the presence of an RBridge Channel message [RFC7178] that may require special handling. The non-critical alert flag supports, for example, an RBridge Channel protocol message including a "record route" function where not recording transit RBridges that do not support this function is acceptable.

4. Additions to IS-IS

RBridges use IS-IS Link State PDUs (LSPs) to inform other RBridges which extended header flags they support. The IS-IS PDU(s), TLV(s), or sub-TLV(s) used to encode and advertise this information are specified in a separate document [RFC7176].

5. IANA Considerations

IANA has created a "TRILL Extended Header Flags" subregistry within the TRILL Parameters registry. The "TRILL Extended Header Flags" subregistry is initially populated as specified in Table 1 in Section 3. References in that table to sections of this document have been replaced in the IANA subregistry by references to this document as an RFC.

New TRILL extended header flags are allocated by IETF Review [RFC5226].

To indicate support of extended header flags, IANA has assigned the following bits in the TRILL-VER and PORT-TRILL-VER Sub-TLV Capability Flag registries created by [RFC7176]:

- o Bits 3-13 of the PORT-TRILL-VER Sub-TLV Capability Flags have been assigned to indicate support of TRILL hop-by-hop extended header flags 3-13.

- o Bits 14-31 of the TRILL-VER Sub-TLV Capability Flags have been assigned to indicate support of TRILL extended header flags 14-31.

6. Security Considerations

For general TRILL protocol security considerations, see [RFC6325].

For security considerations related to extended header flags, see the document where the flag is specified.

It is important that the critical summary bits in the extended header flags word be set properly. If set when critical extensions of the appropriate category are not present, frames may be unnecessarily discarded. If not set when critical extensions are present, frames may be mishandled or corrupted, and intended security policies may be violated.

The RBridge Channel Alert extended header flags have the following security considerations. Implementations should keep in mind that they might be erroneously set in a frame. If either RBridge Channel Alert flag is found set in a frame that is not an RBridge Channel message [RFC7178], the flag MAY be cleared and should have no effect except, possibly, delaying processing of the frame. If either RBridge Channel Alert flag is erroneously omitted from a frame, desired per-hop processing for the frame may not occur.

7. Acknowledgements

The following, listed in alphabetic order, are thanked for their valuable contributions: Ben Campbell, Adrian Farrel, Barry Leiba, and Thomas Narten.

8. References

8.1. Normative References

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8.2. Informative References

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