TRILL Working Group   Lucy Yong
INTERNET-DRAFT   Donald Eastlake
Intended status: Proposed Standard   Sam Aldrin
                                                   Huawei Technologies
                                                          Jon Hudson
                                                             Brocade
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Transport of TRILL Using Pseudowires
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Abstract

   This document specifies how to interconnect a pair of TRILL
   (Transparent Interconnection of Lots of Links) switch ports using
   pseudowires under existing TRILL and PWE3 (Pseudowire Emulation End-
   to-End) standards.

Status of This Memo

Table of Contents

1. Introduction

The TRILL (Transparent Interconnection of Lots of Links) protocol
[RFC6325] provides optimal pair-wise data frame routing without
configuration in multi-hop networks with arbitrary topology. TRILL
supports multipathing of both unicast and multicast traffic. Devices
that implement TRILL are called TRILL Switches or RBridges (Routing
Bridges).

Links between TRILL Switches can be based on arbitrary link
protocols, for example PPP [RFC6361], as well as Ethernet [RFC6325].
A set of connected TRILL Switches together form a TRILL campus which
is bounded by end stations and layer 3 routers.

This document specifies how to interconnect a pair of TRILL Switch
ports using a pseudowire under existing TRILL and PWE3 (Pseudowire
Emulation End-to-End) standards.

1.1 Conventions used in this document

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
[RFC2119].

Acronyms used in this document include the following:

   IS-IS - Intermediate System to Intermediate System [IS-IS]

   MPLS - Multi-Protocol Label Switching

   PPP - Point-to-Point Protocol [RFC1661]

   PW - Pseudowire [RFC3985]

   PWE3 - PW Emulation End-to-End

   RBridge - Routing Bridge, an alternative name for a TRILL Switch

   TRILL - Transparent Interconnection of Lots of Links [RFC6325]

   TRILL Switch - A device implementing the TRILL protocol

2. PWE3 Interconnection of TRILL Switches

When a pseudowire is used to interconnect a pair of TRILL Switch
ports, a PPP [RFC4618] pseudowire is used as described below. The
pseudowire between such ports can be auto-configured [RFC4447] or
manually configured. In this context, the TRILL Switch ports at the
ends of the pseudowire are acting as native service processing
elements (NSP [RFC3985]) and, assuming the pseudowires are over MPLS
or IP [RFC4023] networks, as label switched or IP routers at the
TRILL Switch ports.

Pseudowires provide transparent transport and the two TRILL Switch
ports appear directly interconnected with a transparent link. With
such an interconnection the TRILL adjacency over the link is
automatically discovered and established through TRILL IS-IS control
messages [RFC6327bis].

A pseudowire is carried over a packet switched network tunnel
[RFC3985]. For example, an MPLS or MPLS-TP label switched path
tunnel in MPLS networks. Either a signaling protocol or manual
configuration can be used to configure a label switched path tunnel
between two TRILL Switch ports. This application needs no additions
to the existing pseudowire standards.

2.1 PWE3 Type Independent Details

The sending pseudowire TRILL Switch port MUST copy the priority of
the TRILL Data packets being sent to the 3-bit Traffic Class field of
the pseudowire label [RFC5462] so the priority will be visible to
pseudowire transit devices and they can take the priority into
account. TRILL IS-IS PDUs critical to establishing and maintaining
adjacency (Hello and MTU PDUs) SHOULD be send with Traffic Class 7
(maximum priority) while other TRILL IS-IS PDUs SHOULD be sent with
Traffic Class 6. This minimizes the probability of other traffic
interfering with these important control PDUs and causing false loss
of adjacency or other control problems.

If a pseudowire supports fragmentation and re-assembly, there is no
reason to do TRILL MTU testing on it and the pseudowire will not be a
constraint on the TRILL campus wide Sz (see Section 4.3.1 [RFC6325]).
If the pseudowire does not support fragmentation, then the available
TRILL IS-IS packet payload size over the pseudowire (taking into
account MPLS encapsulation with a control word) or some lower value,
MUST be used in helping to determine Sz (see Section 5
[ClearCorrect]).

An intervening MPLS label switched router or similar packet switched

network device has no awareness of TRILL. Such devices will not

change the TRILL Header hop count.

2.2 PPP PWE3 Transport of TRILL

For a PPP pseudowire (PW type = 0x0007), the two TRILL Switch ports
being connected are configured to form a pseudowire with PPP
encapsulation [RFC4618]. After the pseudowire is established and
TRILL use is negotiated within PPP, the two TRILL Switch ports appear
directly connected with a PPP link [RFC1661] [RFC6361].

If pseudowire interconnection of two TRILL Switch ports is auto-
configured [RFC4447], the initiating TRILL Switch port MUST attempt
the connection set-up with pseudowire type PPP (0x0007).

Behavior for TRILL with a PPP pseudowire continues to follow that of
TRILL over PPP as specified in Section 3 of [RFC6361].

The following figures show what a TRILL Data and TRILL IS-IS packet
look like over such a pseudowire in the MPLS case assuming no TRILL
Header extensions:

```
+-------------------------------+
|   Server MPLS Tunnel Label(s) |  n*4 octets (4 octets per label)
+-------------------------------+
|            PW Label           |  4 octets
+-------------------------------+
|          Control Word         |  4 octets
+-------------------------------+
|       PPP Header 0x005d        |  2 octets
+-------------------------------+
|          TRILL Header         |  4 octets
+-------------------------------+
|    Destination MAC Address    |  6 octets
+-------------------------------+
|       Source MAC Address      |  6 octets
+-------------------------------+
|           Data Label          |  4 or 8 octets
+-------------------------------+
|          Payload Body         |  variable
+-------------------------------+
```
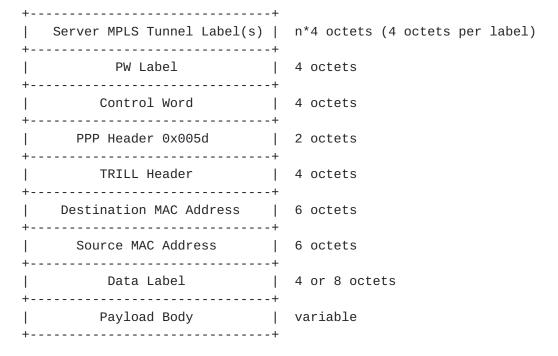
Figure 1. TRILL Data Packet in Pseudowire

"Data Label" is the VLAN Label or Fine Grained Label [FGL] of the
payload.

```
+-------------------------------+
|   Server MPLS Tunnel Label(s) |  n*4 octets (4 octets per label)
+-------------------------------+
|           PW Label            |  4 octets
+-------------------------------+
|          Control Word         |  4 octets
+-------------------------------+
|        PPP Header 0x405d      |  2 octets
+-------------------------------+
|       Common IS-IS Header     |  8 octets
+-------------------------------+
| IS-IS PDU Type Specifc Header |  variable
+-------------------------------+
|           IS-IS TLVs          |  variable
+-------------------------------+
```
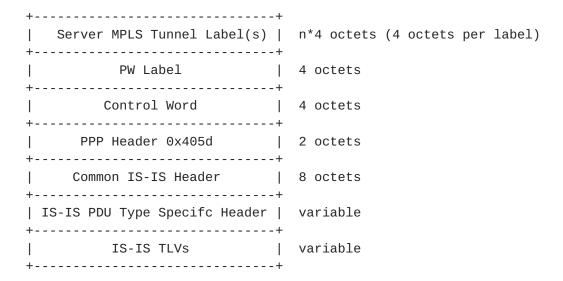
Figure 2. TRILL IS-IS Packet in Pseudowire

The PPP Header fields (0x005d and 0x405d respectively) for TRILL Data
and IS-IS packets shown above are specified in [RFC6361].

[3](). IANA Considerations

   No IANA actions are required by this document. RFC Editor: Please
   remove this section before publication.

[4](). Security Considerations

   TRILL level secuirty mechanisms, such as the ability use
   authentication with TRILL IS-IS PDUs [[RFC6325]()], are not affected by
   link technology, such as the use of pseudowire links as specified in
   this document.

   Link security may be useful in improving TRILL campus security.
   TRILL is transported over pseudowires as TRILL over PPP over
   pseudowires, pseudowires are over MPLS or IP, and MPLS and IP are
   over some lower level link technology. Thus link security below the
   TRILL level for a pseudowire link could be provided by PPP security,
   pseudowire security, MPLS or IP security, or security of the link
   technolgy supporting MPLS or IP.

   PPP TRILL security considerations are discussed in [[RFC6361]()]. For
   security considerations introduced by carrying PPP TRILL links over
   pseudowires, see [[RFC3985]()], which discusses the risks introduced by
   sending protocols that previously assumed a point-to-point link on a
   pseudo wire built on a packet switched network (PSN). However, the
   PPP layer in TRILL transport by pseudowire is somewhat vestigial and
   intended primarily as a convenient way to use existing PPP code
   points to identify TRILL data packets and TRILL IS-IS packets.
   Furthermore, existing PPP security standards are arguably
   questionable in terms of current security criterion. For these
   reasons, it is NOT RECOMMENDED to use PPP security in the transport
   of TRILL by pseudowires as sepecified in this document.

   It is RECOMMENDED that link security be provided at the layers
   supporting pseudowires transporting TRILL, that is, at the MPLS or IP
   layer or the link layer transporting MPLS or IP.

   For applications involving sensitive data, end-to-end security should
   always be considered, in addition to link security, to provide
   security in depth. In this context, such end-to-end security should
   be between the end stations involved so as to protect the entire path
   to, through, and from the TRILL campus.

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

Appendix A: Use of Other Pseudowire Types

   This informational Appendix briefly discusses use of pseudowire types
   other than PPP for the transport of TRILL.

   The use of Ethernet pseudowires [RFC4448] was examined by the authors
   and would be possible; however, they would require an additional 12
   or 16 bytes per packet as shown in the following figures for a TRILL
   Data and TRILL IS-IS packet over such an Ethernet pseudowire in the
   MPLS case assuming no TRILL Header extensions (compare with Figures 1
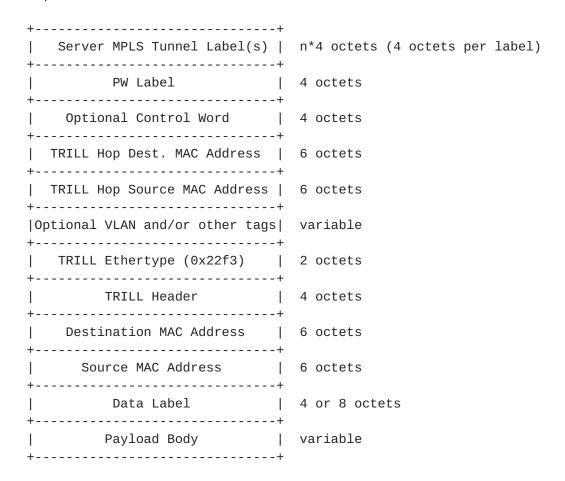   and 2):

```
    +-------------------------------+
    |   Server MPLS Tunnel Label(s) |  n*4 octets (4 octets per label)
    +-------------------------------+
    |           PW Label            |  4 octets
    +-------------------------------+
    |     Optional Control Word     |  4 octets
    +-------------------------------+
    |  TRILL Hop Dest. MAC Address  |  6 octets
    +-------------------------------+
    |  TRILL Hop Source MAC Address |  6 octets
    +-------------------------------+
    |Optional VLAN and/or other tags|  variable
    +-------------------------------+
    |    TRILL Ethertype (0x22f3)   |  2 octets
    +-------------------------------+
    |          TRILL Header         |  4 octets
    +-------------------------------+
    |     Destination MAC Address   |  6 octets
    +-------------------------------+
    |       Source MAC Address      |  6 octets
    +-------------------------------+
    |           Data Label          |  4 or 8 octets
    +-------------------------------+
    |          Payload Body         |  variable
    +-------------------------------+
```

          Figure 3. TRILL Data Packet in Ethernet Pseudowire

   "Data Label" is the VLAN Label or Fine Grained Label [FGL] of the
   payload.

```
     +-------------------------------+
     |    Server MPLS Tunnel Label(s) |   n*4 octets (4 octets per label)
     +-------------------------------+
     |          PW Label             |   4 octets
     +-------------------------------+
     |     Optional Control Word     |   4 octets
     +-------------------------------+
     |   TRILL Hop Dest. MAC Address  |   6 octets
     +-------------------------------+
     |   TRILL Hop Source MAC Address |   6 octets
     +-------------------------------+
     |Optional VLAN and/or other tags|   variable
     +-------------------------------+
     |Layer 2 IS-IS Ethertype 0x22f4 |   2 octets
     +-------------------------------+
     |      Commmon IS-IS Header     |   8 octets
     +-------------------------------+
     | IS-IS PDU Type Specifc Header |   variable
     +-------------------------------+
     |           IS-IS TLVs          |   variable
     +-------------------------------+
```

        Figure 4. TRILL IS-IS Packet in Ethernet Pseudowire

   It would also be possible to specify a new pseudowire type for TRILL
   traffic but the authors feel that any efficiency gain over PPP
   pseudowires would be too small to be worth the complexity of adding
   such a specification. Furthermore using PPP pseudowire encoding means
   that any traffic dissector that understands TRILL PPP encoding
   [RFC6361] and understands PPP pseudowires [RFC4618] will
   automatically be able to recursively decode TRILL transported by
   pseudowire.

Appendix Z: Change History

    RFC Editor Note: Please remove this appendix prior to publication.

From -00 to -01

    Add information on Traffic Classes that should be used for TRILL IS-
    IS PDUs.

    Other changes to resolve WG Last Call comments:

        Change title from "TRILL Over Psuedowires".

        Change "Class of Service" to "Traffic Class".

        Expand informational paragraph about the consideration of using
        other pseudowire types for the transport of TRILL and make that
        paragraph into Appendix A.

        Add this Change History Appendix Z.

From -01 to -02

    Add packet diagrams.

    Minor editing changes.

From -02 to -03

    Editorial and minor Security Considerations changes based on the
    Shepherd review by Erik Nordmark. See
        http://www.ietf.org/mail-archive/web/trill/current/msg06029.html
    and ensuing conversation.

From -03 to -04

    Security Considerations changes based on SECDIR review.

    Minor Editorial change to the first sentence of Section 1 based on
    GENART review.

    Add final sentence to first paragraph of Section 2.1 to resolve
    COMMENT by Barry Leiba.

Acknowledgements

   Thanks for the valuable comments from the following who are listed in
   alphabetic order:

      Christer Holmberg, Barry Leiba, Erik Nordmark, Yaron Sheffer, and
      Yaakov (J) Stein

   The document was prepared in raw nroff. All macros used were defined
   within the source file.

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Authors' Addresses

     Lucy Yong
     Huawei Technologies
     5340 Legacy Drive
     Plano, TX 75025 USA

     Phone: +1-469-227-5837
     Email: lucy.yong@huawei.com

     Donald E. Eastlake, 3rd
     Huawei Technologies
     155 Beaver Street
     Milford, MA 01757 USA

     Phone: +1-508-333-2270
     Email: d3e3e3@gmail.com

     Sam Aldrin
     Huawei Technologies
     2330 Central Expressway
     Santa Clara, CA 95050 USA

     Phone: +1-408-330-4517
     Email: sam.aldrin@huawei.com

     Jon Hudson
     Brocade
     130 Holger Way
     San Jose, CA 95134 USA

     Phone: +1-408-333-4062
     jon.hudson@gmail.com