INTERNET-DRAFT
Updates: 7178
Intended status: Proposed Standard

Expires: September 1, 2016

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March 18, 2016

TRILL: RBridge Channel Tunnel Protocol
<draft-ietf-trill-channel-tunnel-08.txt>

Abstract

The IETF TRILL (Transparent Interconnection of Lots of Links) protocol includes an optional mechanism (specified in RFC 7178), called RBridge Channel, for the transmission of typed messages between TRILL switches in the same campus and the transmission of such messages between TRILL switches and end stations on the same link. This document specifies two optional extensions to the RBridge Channel protocol: (1) a standard method to tunnel a variety of payload types by encapsulating them in an RBridge Channel message; and (2) a method to support security facilities for RBridge Channel messages. This document updates RFC 7178.

Status of This Memo

This Internet-Draft is submitted to IETF in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

The IETF TRILL base protocol [RFC6325] [RFC7780] has been extended with the RBridge Channel [RFC7178] facility to support transmission of typed messages (for example BFD (Bidirectional Forwarding Detection) [RFC7175]) between two TRILL switches (RBridges) in the same campus and the transmission of such messages between RBridges and end stations on the same link. When sent between RBridges in the same campus, a TRILL Data packet with a TRILL Header is used and the destination RBridge is indicated by nickname. When sent between a RBridge and an end station on the same link in either direction a native RBridge Channel messages [RFC7178] is used with no TRILL Header and with the destination port or ports are indicated by a MAC address. (There is no mechanism to stop end stations on the same link, from sending native RBridge Channel messages to each other; however, such use is outside the scope of this document.)

This document updates [RFC7178] and specifies extensions to RBridge Channel that provide two additional facilities as follows:

(1) A standard method to tunnel a variety of payload types by encapsulating them in an RBridge Channel message.

(2) A method to provide security facilities for RBridge Channel messages.

Use of each of these facilities is optional, except that if Channel Tunnel is implemented there are two payload types that MUST be implemented. Both of the above facilities can be used in the same packet. In case of conflict between this document and [RFC7178], this document takes precedence.

1.1 Terminology and Acronyms

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].

This document uses terminology and acronyms defined in [RFC6325] and [RFC7178]. Some of these are repeated below for convenience along with additional new terms and acronyms.

Data Label - VLAN or FGL.

DTLS - Datagram Transport Level Security [RFC6347].

FCS - Frame Check Sequence.

FGL - Fine Grained Label [RFC7172].

HKDF - Hash based Key Derivation Function [RFC5869].

IS-IS - Intermediate System to Intermediate Systems [IS-IS].

PDU - Protocol Data Unit.

RBridge - An alternative term for a TRILL switch.

SHA - Secure Hash Algorithm [RFC6234].

Sz - Campus wide minimum link MTU [RFC6325] [RFC7780].

TRILL - Transparent Interconnection of Lots of Links or Tunneled Routing in the Link Layer.

TRILL switch - A device that implements the TRILL protocol [RFC6325], sometimes referred to as an RBridge.

2. Channel Tunnel Packet Format

The general structure of an RBridge Channel message between two TRILL switches (RBridges) in the same campus is shown in Figure 2.1 below. The structure of a native RBridge Channel message sent between an RBridge and an end station on the same link, in either direction, is shown in Figure 2.2 and, compared with the first case, omits the TRILL Header, inner Ethernet addresses, and Data Label. A Protocol field in the RBridge Channel Header gives the type of RBridge Channel message and indicates how to interpret the Channel Protocol Specific Payload [RFC7178].

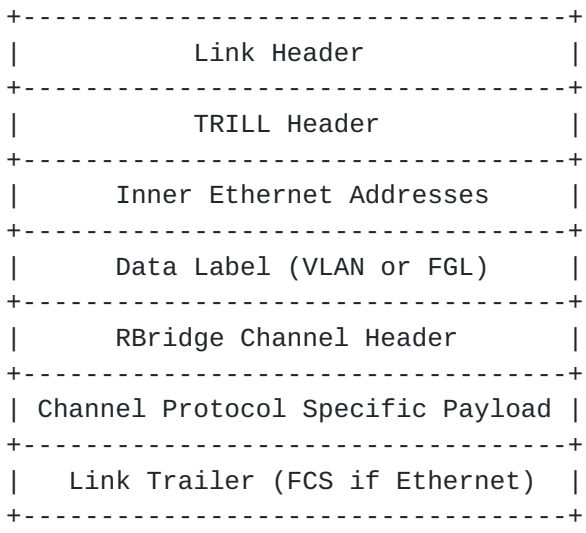

Figure 2.1 RBridge Channel Packet Structure

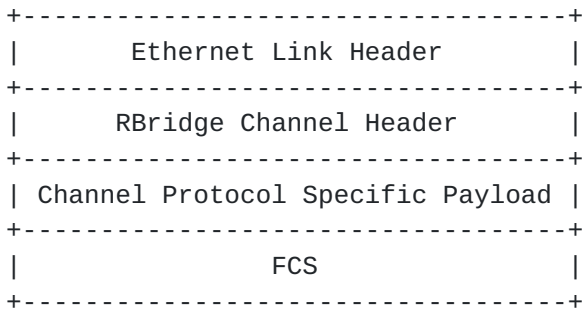

Figure 2.2 Native RBridge Channel Frame

The RBridge Channel Header looks like this:

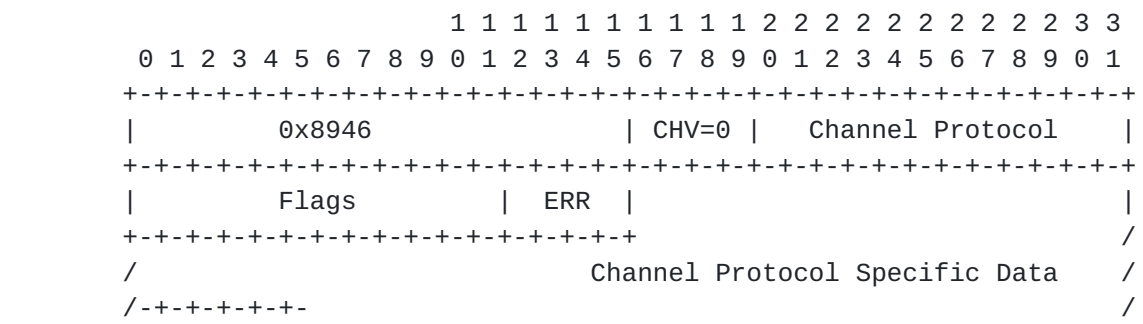

Figure 2.3 RBridge Channel Header

where 0x8946 is the RBridge Channel Ethertype and CHV is the Channel Header Version. This document is based on RBridge Channel version zero.

The extensions specified herein are in the form of an RBridge Channel protocol, the Channel Tunnel Protocol. Figure 2.4 below expands the RBridge Channel Header and Protocol Specific Payload above for the case of the Channel Tunnel Protocol.

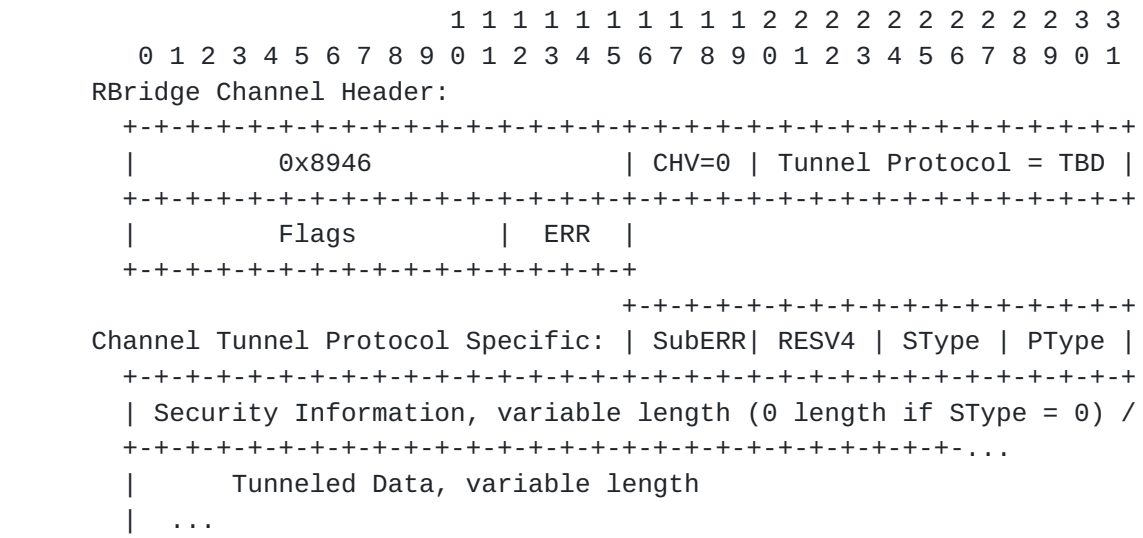

Figure 2.4 Channel Tunnel Header Structure

The RBridge Channel Header field specific to the RBridge Channel Tunnel Protocol is the Protocol field. Its contents MUST be the value allocated for this purpose (see Section 6).

The RBridge Channel Tunnel Protocol Specific Data fields are as follows:

SubERR: This field provides further details when a Channel Tunnel error is indicated in the RBridge Channel ERR field. If ERR is zero, then SubERR MUST be sent as zero and ignored on receipt.

See Section 5.

RESV4: This field MUST be sent as zero. If non-zero when received, this is an error condition (see Section 5).

SType: This field describes the type of security information and features, including keying material, being used or provided by the Channel Tunnel packet. See Section 4.

PType: Payload type. This describes the tunneled data. See Section 3 below.

Security Information: Variable length information. Length is zero if SType is zero. See Section 4.

The Channel Tunnel protocol is integrated with the RBridge Channel facility. Channel Tunnel errors are reported as if they were RBridge Channel errors, using newly allocated code points in the ERR field of the RBridge Channel Header supplemented by the SubERR field.

3. Channel Tunnel Payload Types

The Channel Tunnel Protocol can carry a variety of payloads as indicated by the PType field. Values are shown in the table below with further explanation after the table.

PType	Section	Description
0		Reserved
1	3.1	Null
2	3.2	Ethertyped Payload
3	3.3	Ethernet Frame
4-14		Unassigned
15		Reserved

Table 3.1 Payload Type Values

While implementation of the Channel Tunnel protocol is optional, if it is implemented PType 1 (Null) MUST be implemented and PType 2 (Ethertyped Payload) with the RBridge Channel Ethertype MUST be implemented. PType 2 for any Ethertypes other than the RBridge Channel Ethertype MAY be implemented. PType 3 MAY be implemented.

The processing of any particular Channel Protocol message and its payload depends on meeting local security and other policy at the destination TRILL switch or end station.

3.1 Null Payload

The Null payload type (PType = 1) is intended to be used for testing or for messages such as key negotiation or the like where only security information is present. It indicates that there is no payload. Any data after the Security Information field is ignored. If the Channel Tunnel feature is implemented, Null Payload MUST be supported in the sense that an "Unsupported PType" error is not returned (see Section 5). Any particular use of the Null Payload should specify what VLAN or priority should be used when relevant.

3.2 Ethertyped Payload

A PType of 2 indicates that the payload of the Channel Tunnel message begins with an Ethertype. A TRILL switch supporting the Channel Tunnel protocol MUST support a PType of 2 with a payload beginning with the RBridge Channel Ethertype as describe in Section 3.2.1. Other Ethertypes, including the TRILL and L2-IS-IS Ethertypes as

described in Section 3.2.2 and 3.2.3, MAY be supported.

3.2.1 Tunneled RBridge Channel Message

A PType of 2 with an initial RBridge Channel Ethertype indicates an encapsulated RBridge Channel message payload. A typical reason for sending an RBridge Channel message inside a Channel Tunnel message is to provide security services, such as authentication or encryption.

This payload type looks like the following:

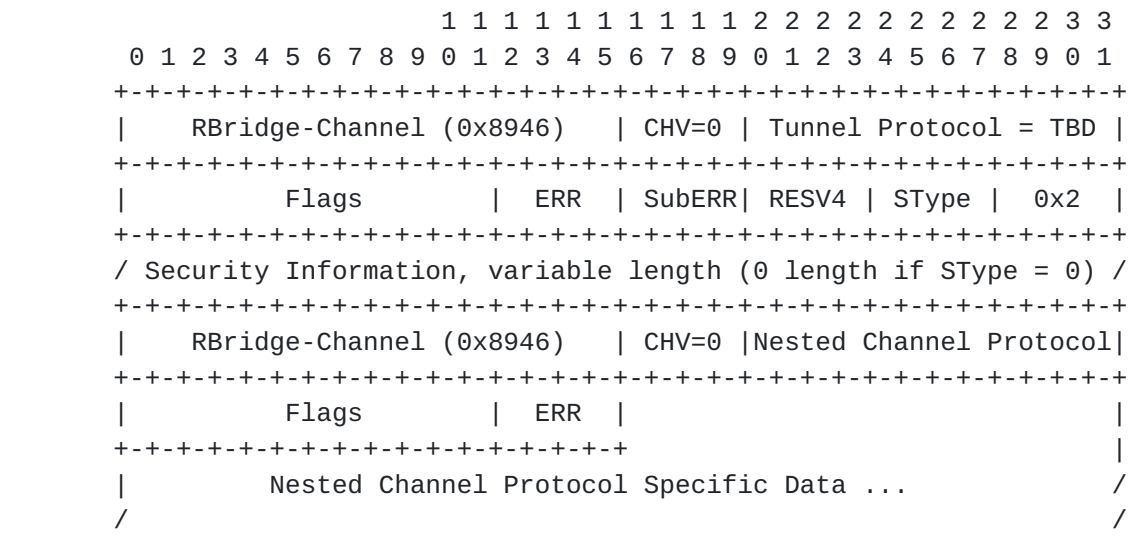

Figure 3.1 Tunneled RBridge Channel Message Structure

3.2.2 Tunneled TRILL Data Packet

A PType of 2 and an initial TRILL Ethertype indicates that the payload of the Tunnel protocol message is an encapsulated TRILL Data packet as shown in the figure below. If this Ethertype is supported for PType = 2 and the message meets local policy for acceptance, the tunneled TRILL Data packet is handled as if it had been received by the destination TRILL switch on the port where the Channel Tunnel message was received.

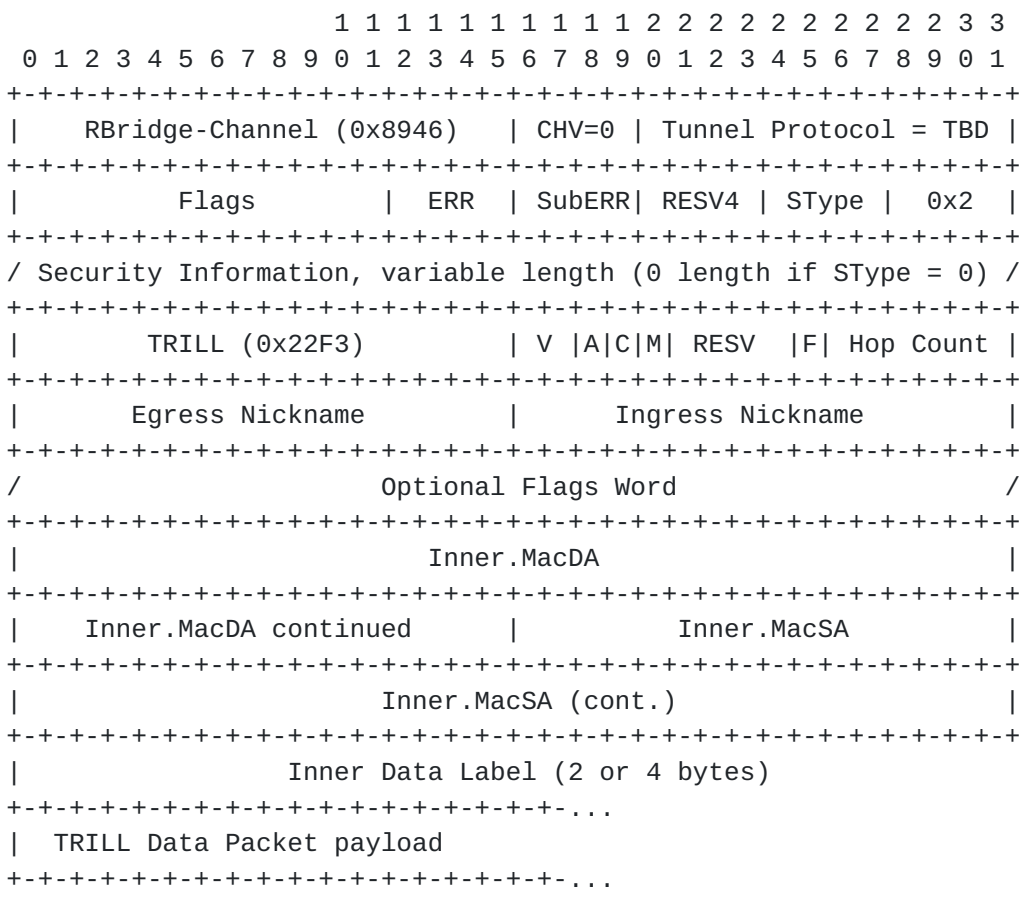

Figure 3.2 Nested TRILL Data Packet Channel Tunnel Structure

The optional flags word is only present if the F bit in the TRILL Header is one [RFC7780].

3.2.3 Tunneled TRILL IS-IS Packet

A PType of 2 and an initial L2-IS-IS Ethertype indicates that the payload of the Tunnel protocol message is an encapsulated TRILL IS-IS PDU as shown in Figure 3.3. If this Ethertype is supported for PType = 2, the tunneled TRILL IS-IS packet is processed by the destination RBridge if it meets local policy. One possible use is to expedite the receipt of a link state PDU (LSP) by some TRILL switch or switches with an immediate requirement for the link state information. A link local IS-IS PDU (Hello, CSNP, or PSNP [IS-IS]; MTU-probe or MTU-ack [RFC7176]; or circuit scoped FS-LSP, FS-CSNP or FS-PSNP [RFC7356]) would not normally be sent via this Channel Tunnel method except possibly to encrypt it since such PDUs can just be transmitted on the link and do not normally need RBridge Channel tunneling.

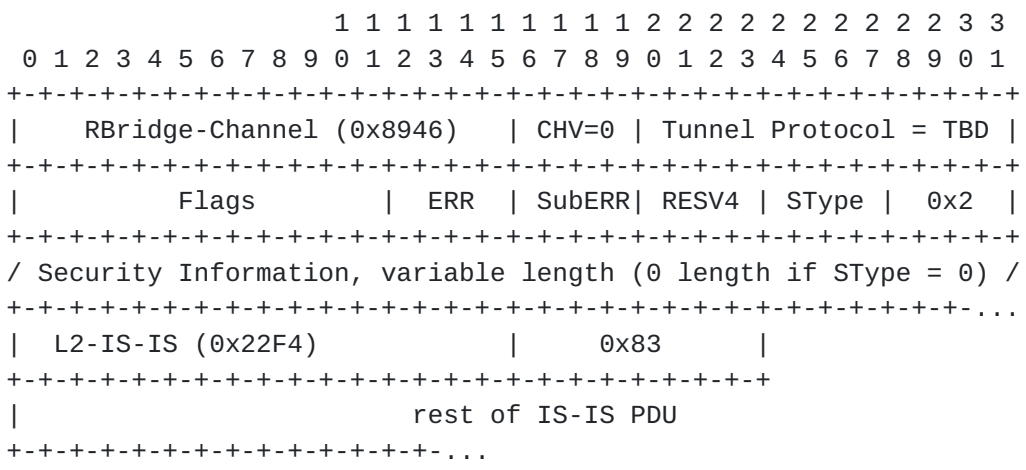

Figure 3.3 Tunneled TRILL IS-IS Packet Structure

3.3 Ethernet Frame

If PType is 3, the Tunnel Protocol payload is an Ethernet frame as might be received from or sent to an end station except that the tunneled Ethernet frame's FCS is omitted, as shown in Figure 3.4. (There is still an overall final FCS if the RBridge Channel message is being sent on an Ethernet link.) If this PType is implemented and the message meets local policy, the tunneled frame is handled as if it had been received on the port on which the Channel Tunnel message was received.

The priority of the RBridge Channel message can be copied from the Ethernet frame VLAN tag, if one is present, except that priority 7 SHOULD only be used for messages critical to establishing or maintaining adjacency and priority 6 SHOULD only be used for other important control messages.

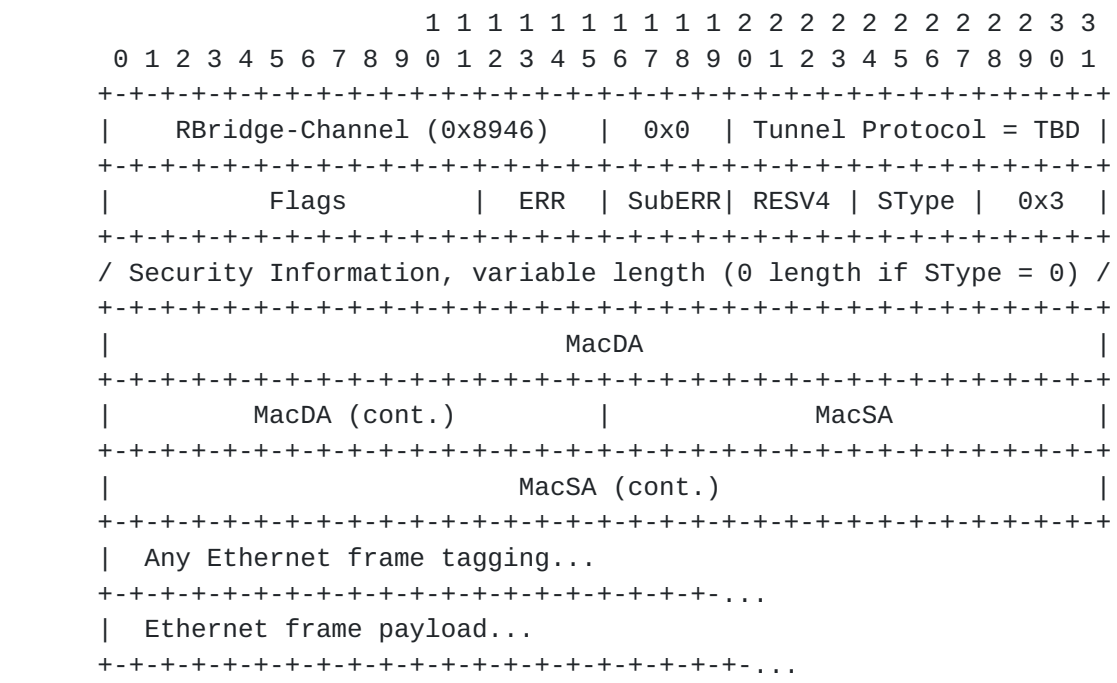

Figure 3.4 Ethernet Frame Channel Tunnel Structure

In the case of a non-Ethernet link, such as a PPP (Point-to-Point Protocol) link [RFC6361], the ports on the link are considered to have link local synthetic 48-bit MAC addresses constructed as described below. These constructed addresses MAY be used as a MacSA. If the RBridge Channel message is link local, the source TRILL switch will have the information to construct such a MAC address for the destination TRILL switch port and that MAC address MAY be used as the MacDA. By the use of such a MacSA and either such a unicast MacDA or a group addressed MacDA, an Ethernet frame can be sent between two TRILL switch ports connected by a non-Ethernet link.

These synthetic TRILL switch port MAC addresses for non-Ethernet ports are constructed as follows: 0xFEFF, the nickname of the TRILL switch used in TRILL Hellos sent on that port, and the Port ID that the TRILL switch has assigned to that port, as shown in Figure 3.5. (Both the Port ID of the port on which a TRILL Hello is sent and the nickname of the sending TRILL switch appear in the Special VLANs and Flags sub-TLV [RFC7176] in TRILL IS-IS Hellos.) The resulting MAC address has the Local bit on and the Group bit off [RFC7042]. However, since there will be no Ethernet end stations on a non-Ethernet link in a TRILL campus, such synthetic MAC addresses cannot conflict on the link with a real Ethernet port address.

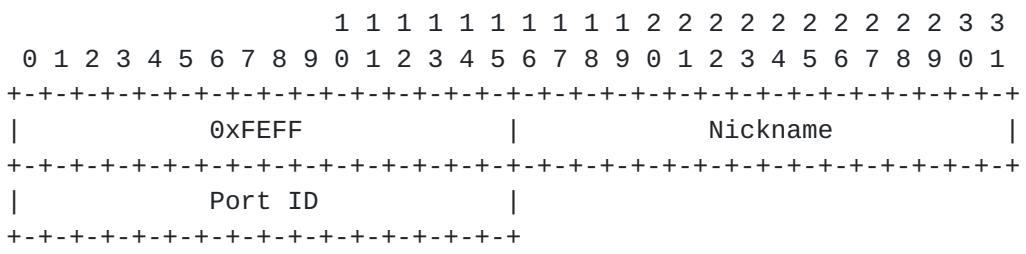

Figure 3.5 Synthetic MAC Address

4. Security, Keying, and Algorithms

Table 4.1 below gives the assigned values of the SType field and their meaning. Use of DTLS Pairwise Security (SType = 2) is RECOMMENDED. While [RFC5310] based authentication applies to both pairwise and multi-destination traffic, it provides only authentication and is generally considered not to met current security standards, as it does not provide for key negotiation; thus, its use is NOT RECOMMENDED.

Channel Tunnel DTLS based security specified in Section 4.6 below is intended for pairwise (known unicast) use in which case the M bit in the TRILL Header would be zero and in the native RBridge Channel case (Figure 2.2) the Outer.MacDA would be individually addressed.

Multi-destination Channel Tunnel packets would be those with the M bit in the TRILL Header set to one or, in the native RBridge Channel case, the Outer.MacDA would be group addressed. However, the DTLS Pairwise Security SType can be used in the multi-destination case by serially unicasting the messages to all data accessible RBridges (or end stations in the native RBridge Channel case) in the recipient group. For TRILL Data packets, that group is specified by the Data Label; for native frames, the group is specified by the groupcast destination MAC address. It is intended to specify a true group keyed SType to secure multi-destination packets in a separate document [GroupKey].

SType	Section	Meaning
0	4.4	None
1	4.5	[RFC5310] Based Authentication
2	4.6	DTLS Pairwise Security
3-14		Available for assignment by IETF Review
15		Reserved

Table 4.1 SType Values

4.1 Basic Security Information Format

When SType is zero, there is no Security Information after the Channel Tunnel header and before the payload. For all SType values except zero, the Security Information starts with four reserved flag bits and twelve bits of remaining length as follows:

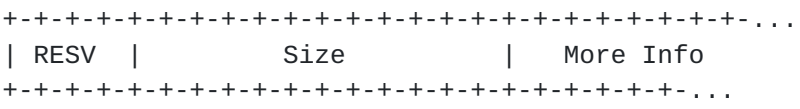

Figure 4.1 Security Information Format

The fields are as follows:

RESV: Four reserved bits that MUST be sent as zero and ignored on receipt. In the future, meanings may be assigned to these bits and those meanings may differ for different STypes.

Size: The number of bytes, as an unsigned integer, of More Info in the Security Information after the Size byte itself. Thus the maximum possible length of Security Information is 4,097 bytes for a Size of 4,095 plus 2 for the RESV and Size fields.

More Info: Additional Security Information of length Size. Contents depends on the SType.

4.2 Authentication and Encryption Coverage

As show in Figure 4.2, the area covered by Channel Tunnel authentication starts with the byte immediately after the TRILL Header optional Flag Word if it is present. Otherwise, it starts after the TRILL Header Ingress Nickname. In either case, it extends to just before the TRILL Data packet link trailer. For example, for an Ethernet packet it would extend to just before the FCS.

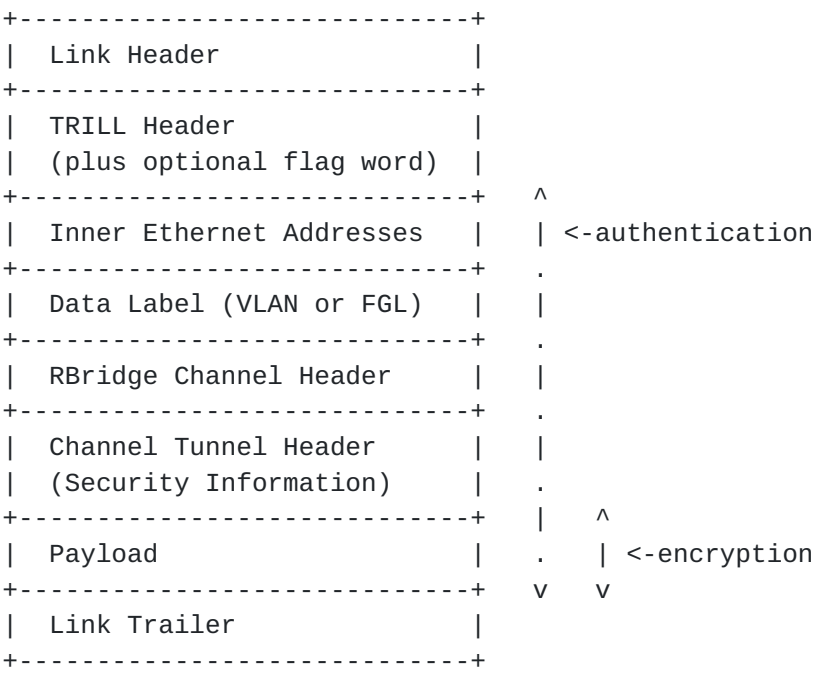

Figure 4.2. Channel Tunnel Security Coverage

Channel Tunnel authentication in the native RBridge Channel case (see Figure 4.3), is as specified in the above paragraph except that it starts with the RBridge Channel Ethertype, since there is no TRILL Header, inner Ethernet addresses, or inner Data Label.

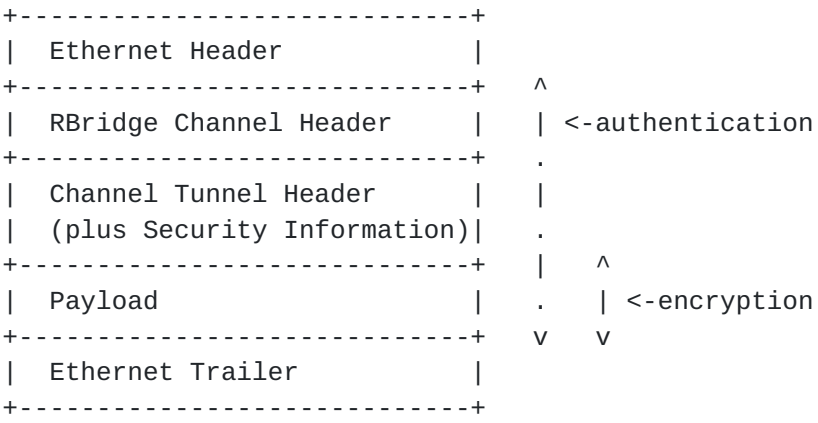

Figure 4.3. Native Channel Tunnel Security Coverage

If an authentication value is included in the More Info field shown in Section 4.1, it is treated as zero when authentication is calculated. If an authentication value is included in a payload after the security information, it is calculated as provided by the SType and security algorithms in use.

If encryption is provided, it covers the payload from right after the Channel Tunnel header Security Information through to just before the

TRILL Data packet link trailer (see Figures 4.2 and 4.3).

4.3 Derived Keying Material

In some cases, it is possible to use material derived from [RFC5310] IS-IS keying material as an element of Channel Tunnel security. In such cases, the More Info field shown in Figure 4.1 includes the two byte IS-IS Key ID to identify the keying material. It is assumed that the IS-IS keying material is of high quality. The material actually used in Channel Tunnel security is derived from the IS-IS keying material as follows:

```
Derived Material =
   HKDF-Expand-SHA256 ( IS-IS-key, "Channel Tunnel" | 0x0S, L )
```

where "|" indicates concatenation, HKDF is as in [RFC5869], SHA256 is as in [RFC6234], IS-IS-key is the input IS-IS keying material, "Channel Tunnel" is the 14-character ASCII [RFC20] string indicated without any leading length byte or trailing zero byte, 0x0S is a single byte where S is the SType for which this key derivation is being used and the upper nibble is zero, and L is the length of output-derived material needed.

Whenever IS-IS keying material is being used as above, the underlying [RFC5310] keying material might expire or become invalidated. At the time of or before such expiration or invalidation, the use Derived Material from the IS-IS keying material MUST cease. Continued security may depend on using new derived material from currently valid [RFC5310] keying material.

4.4 SType None

No security services are being invoked. The length of the Security Information field (see Figure 2.4) is zero.

4.5 RFC 5310 Based Authentication

The Security Information (see Figure 2.4) is the RESV and Size fields specified in Section 4.1 with the value of the [RFC5310] Key ID and Authentication Data, as shown in Figure 4.4.

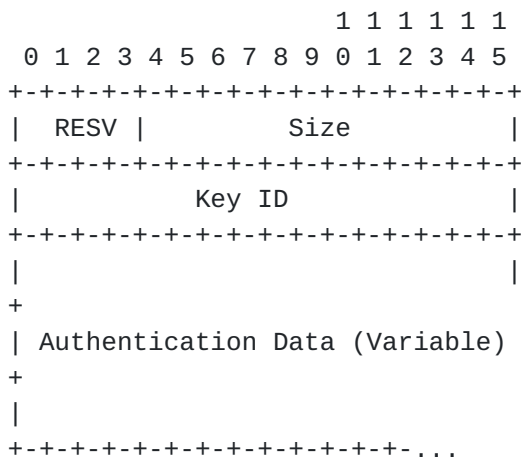

Figure 4.4 SType 1 Security Information

- RESV: Four bits that MUST be sent as zero and ignored or receipt.
- Size: Set to 2 + the size of Authentication Data in bytes.
- Key ID: specifies the keying value and authentication algorithm that the Key ID specifies for TRILL IS-IS LSP [RFC5310] Authentication TLVs. The keying material actually used is derived as shown in Section 4.3.
- Authentication Data: The authentication data produced by the derived key and algorithm associated with the Key ID acting on the packet as specified in Section 4.2. Length of the authentication data depends on the algorithm.

While RBridges, which are IS-IS routers, can reasonable be expected to hold [RFC5310] keying, so that this SType can be used for RBridge Channel messages, how end stations might come to hold [rfc5310] keying is beyond the scope of this document. Thus this SType might not be applicable to native RBridge Channel messages.

4.6 DTLS Pairwise Security

DTLS supports key negotiation and provides both encryption and authentication. The Channel Tunnel DTLS [RFC6347] SType uses a negotiated DTLS version that MUST NOT be less than 1.2.

When DTLS pairwise security is used, the entire payload of the Channel Tunnel packet, starting just after the Security Information and ending just before the link trailer, is one or more DTLS records [RFC6347]. As specified in [RFC6347], DTLS records MUST be limited by the path MTU, in this case so each record fits entirely within a

single Channel Tunnel message. A minimum path MTU can be determined

from the TRILL campus wide minimum MTU Sz, which will not be less than 1470 bytes, by allowing for the TRILL Data packet, Channel Tunnel, and DTLS framing overhead. With this SType, the security information provided before the DTLS record(s) is 0, as shown in Figure 4.5, because all the security information is in the payload area.

The DTLS Pairwise keying is set up between a pair of RBridges independent of Data Label using messages of a priority configurable at the RBridge level which defaults to priority 6. DTLS messages other than application_data can be encapsulated in the Channel Tunnel protocol with a TRILL Header using any Data Label. Actual application_data sent with Channel Tunnel using this SType should use the Data Label and priority as specified for that application_data. The PType indicates the nature of the application_data.

TRILL switches that support the Channel Tunnel DTLS SType MUST support the use of pre-shared keys for DTLS. If the psk_identity (see [RFC4279]) is two bytes, it represents, as a pre-shared key to be used in the DTLS negotiation, the value derived as shown in Section 4.3 from the key associated with that psk_identity as a [RFC5310] Key ID. A psk_identity with a length other than two bytes MAY be used to indicate other implementation dependent pre-shared keys.

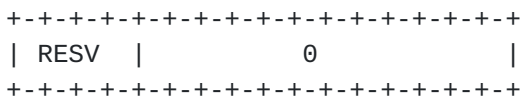

Figure 4.5 DTLS Channel Tunnel Security Info

TRILL switches that implement the Channel Tunnel DTLS SType MAY support the use of certificates for DTLS but certificate size may be limited by the DTLS requirement that each record fit within a single message.

5. Channel Tunnel Errors

RBridge Channel Tunnel Protocol errors are reported like RBridge Channel level errors. The ERR field is set to one of the following error codes:

ERR	Meaning
6	Unknown or unsupported field value
7	Authentication failure
8	Error in nested RBridge Channel message

Table 5.1 Additional ERR Values

5.1 SubERRs under ERR 6

If the ERR field is 6, the SubERR field indicates the problematic field or value as show in the table below.

SubERR	Meaning (for ERR = 6)
0	Reserved
1	Non-zero RESV4 nibble
2	Unsupported SType
3	Unsupported PType
4	Unknown Key ID
5	Unknown Ethertype with PType = 2

Table 5.2 SubERR values under ERR 6

5.2 Secure Nested RBridge Channel Errors

If
   a Channel Tunnel message is sent with security and with a payload type (PType) indicating a nested RBridge Channel message
and
   there is an error in the processing of that nested message that results in a return RBridge Channel message with a non-zero ERR field,
then that returned message SHOULD also be nested in an Channel Tunnel message using the same type of security. In this case, the ERR field in the Channel Tunnel envelope is set to 8 indicating that there is a nested error in the message being tunneled back.

6. IANA Considerations

This section lists IANA Considerations.

6.1 Channel Tunnel RBridge Channel Protocol Number

IANA is requested to assign TBD as the RBridge Channel protocol number for the "Channel Tunnel" protocol from the range assigned by Standards Action.

The added RBridge Channel protocols registry entry on the TRILL Parameters web page is as follows:

Protocol	Description	Reference
TBD	Channel Tunnel	[this document]

6.2 RBridge Channel Error Codes Subregistry

IANA is requested to create a "RBridge Channel Error Codes" subregistry under the "RBridge Channel Protocols" registry. The header information is as follows:

Registration Procedures: IETF Review References: [RFC7178] [this document]

The subregistry is to have columns and entries as follows:

Code	Meaning	Reference
[populate rows for codes 0 through 5 from Section xxx of [RFC7178] with reference [RFC7178]]		
[populate rows for codes 6 through 8 from Table 5.1 of this document with reference [this document]]		
9-15	Unassigned	
16	Reserved	

7. Security Considerations

The RBridge Channel Tunnel facility has potentially positive and negative effects on security.

On the positive side, it provides optional security that can be used to authenticate and/or encrypt RBridge Channel messages. Some RBridge Channel message payloads, such as BFD [RFC7175], provide their own security but where this is not true, consideration should be given, when specifying an RBridge Channel protocol, to recommending or requiring use of the security features of the Channel Tunnel protocol.

On the negative side, the optional ability to tunnel various payload types and to tunnel them between TRILL switches and to and from end stations can increase risk unless precautions are taken. The processing of decapsulating Tunnel Protocol payloads is not a good place to be liberal in what you accept. This is because the tunneling facility makes it easier for unexpected messages to pop up in unexpected places in a TRILL campus due to accidents or the actions of an adversary. Local policies should generally be strict and only process payload types required and then only with adequate authentication for the particular circumstances.

See the first paragraph of Section 4 for recommendations on SType usage. See [RFC7457] for Security Considerations of DTLS for security.

If IS-IS authentication is not being used, then [RFC5310] keying information would not normally be available but that presumably represents a judgment by the TRILL campus operator that no security is needed.

See [RFC7178] for general RBridge Channel Security Considerations and [RFC6325] for general TRILL Security Considerations.

Normative References

[IS-IS] - ISO/IEC 10589:2002, Second Edition, "Information technology -- Telecommunications and information exchange between systems -- Intermediate System to Intermediate System intra-domain routeing information exchange protocol for use in conjunction with the protocol for providing the connectionless-mode network service (ISO 8473)", 2002.

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Appendix Z: Change History

From -00 to -01

1. Fix references for RFCs published, etc.

2. Explicitly mention in the Abstract and Introduction that this document updates [RFC7178].

3. Add this Change History Appendix.

From -01 to -02

1. Remove section on the "Scope" feature as mentioned in http://www.ietf.org/mail-archive/web/trill/current/msg06531.html

2. Editorial changes to IANA Considerations to correspond to draft-leiba-cotton-iana-5226bis-11.txt.

3. Improvements to the Ethernet frame payload type.

4. Other Editorial changes.

From -02 to -03

1. Update TRILL Header to correspond to [RFC7780].

2. Remove a few remnants of the "Scope" feature that was removed from -01 to -02.

3. Substantial changes to and expansion of Section 4 including adding details of DTLS security.

4. Updates and additions to the References.

5. Other minor editorial changes.

From -03 to -04

1. Add SType for [RFC5310] keying based security that provides encryption as well as authentication.

2. Editorial improvements and fixes.

From -04 to -05

1. Primary change is collapsing the previous PTypes 2, 3, and 4 for RBridge Channel message, TRILL Data, and TRILL IS-IS into one by including the Ethertype. Previous PType 5 is renumbered as 3.

2. Add Channel Tunnel Crypto Suites to IANA Considerations

3. Add some material to Security Considerations,

4. Assorted Editorial changes.

From -05 to -06

Fix editorials found during WG Last Call.

From -06 to -07

Minor editorial changes resulting for Shepherd review.

From -07 to -08

Move group keyed security out of the draft. Simplify and improve remaining security provisions.

Acknowledgements

The contributions of the following are hereby gratefully acknowledged:

Susan Hares, Gayle Noble, Yaron Sheffer

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

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