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Transparent Interconnection of Lots of Links (TRILL) Single Area Border RBridge Nickname for Multilevel draft-ietf-trill-multilevel-single-nickname-07.txt

Abstract

A major issue in multilevel TRILL is how to manage RBridge nicknames. In this document, the area border RBridge uses a single nickname in both Level 1 and Level 2. RBridges in Level 2 must obtain unique nicknames but RBridges in different Level 1 areas may have the same nicknames.

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1. Introduction

TRILL multilevel techniques are designed to improve TRILL scalability issues. As described in [RFC8243], there have been two proposed approaches. One approach, which is referred as the "unique nickname" approach, gives unique nicknames to all the TRILL switches in the multilevel campus, either by having the Level-1/Level-2 border TRILL switches advertise which nicknames are not available for assignment in the area, or by partitioning the 16-bit nickname into an "area" field and a "nickname inside the area" field. The other approach, which is referred as the "aggregated nickname" approach, involves assigning nicknames to the areas, and allowing nicknames to be reused

in different areas, by having the border TRILL switches rewrite the nickname fields when entering or leaving an area.

The approach specified in this document is different from both "unique nickname" and "aggregated nickname" approach. In this document, the nickname of an area border RBridge is used in both Level 1 (L1) and Level 2 (L2). No additional nicknames are assigned to the L1 areas. Each L1 area is denoted by the group of all nicknames of those border RBridges of the area. For this approach, nicknames in L2 MUST be unique but nicknames inside different L1 areas MAY be reused. The use of the approach specified in this document in one L1 area does not prohibit the use of other approaches in other L1 areas in the same TRILL campus.

2. Acronyms and Terminology

Data Label: VLAN or FGL Fine-Grained Label (FGL)

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

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 RFC 2119 [RFC2119].

Familiarity with [RFC6325] is assumed in this document.

3. Nickname Handling on Border RBridges

This section provides an illustrative example and description of the border learning border RBridge nicknames.

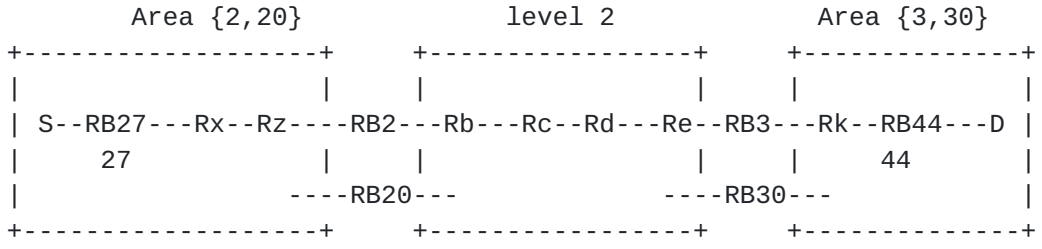


Figure 1: An Example Topology for TRILL Multilevel

In Figure 1, RB2, RB20, RB3 and RB30 are area border TRILL switches (RBridges). Their nicknames are 2, 20, 3 and 30 respectively. Area border RBridges use the set of border nicknames to denote the L1 area that they are attached to. For example, RB2 and RB20 use nicknames {2,20} to denote the L1 area on the left.

A source S is attached to RB27 and a destination D is attached to

RB44. RB27 has a nickname, say 27, and RB44 has a nickname, say 44 (and in fact, they could even have the same nickname, since the TRILL switch nickname will not be visible outside these Level 1 areas).

3.1. Actions on Unicast Packets

Let's say that S transmits a frame to destination D and let's say that D's location is learned by the relevant TRILL switches already. These relevant switches have learned the following:

1) RB27 has learned that D is connected to nickname 3.
2) RB3 has learned that D is attached to nickname 44.

The following sequence of events will occur:

- S transmits an Ethernet frame with source MAC = S and destination MAC = D.

- RB27 encapsulates with a TRILL header with ingress RBridge = 27, and egress RBridge = 3 producing a TRILL Data packet.

- RB2 and RB20 have announced in the Level 1 IS-IS instance in area {2,20}, that they are attached to all those area nicknames, including {3,30}. Therefore, IS-IS routes the packet to RB2 (or RB20, if RB20 on the least-cost route from RB27 to RB3).

- RB2, when transitioning the packet from Level 1 to Level 2, replaces the ingress TRILL switch nickname with its own nickname, so replaces 27 with 2. Within Level 2, the ingress RBridge field in the TRILL header will therefore be 2, and the egress RBridge field will be 3. (The egress nickname MAY be replaced with an area nickname selected from {3,30}. See Section 4 for the detail of the selection method. Here, suppose nickname 3 is used.) Also RB2 learns that S is attached to nickname 27 in area {2,20} to accommodate return traffic. RB2 SHOULD synchronize with RB20 using ESADI protocol [RFC7357] that MAC = S is attached to nickname 27.

- The packet is forwarded through Level 2, to RB3, which has advertised, in Level 2, its L2 nickname as 3.

- RB3, when forwarding into area {3,30}, replaces the egress nickname in the TRILL header with RB44's nickname (44). (The ingress nickname MAY be replaced with an area nickname selected from {2,20}. See Section 4 for the detail of the selection method. Here, suppose nickname 2 is selected.) So, within the destination area, the ingress nickname will be 2 and the egress nickname will be 44.

- RB44, when decapsulating, learns that S is attached to nickname 2, which is one of the area nicknames of the ingress.

3.2. Actions on Multi-Destination Packets

Distribution trees for flooding of multi-destination packets are calculated separately within each L1 area and in L2. When a multi-destination packet arrives at the border, it needs to be transitioned either from L1 to L2, or from L2 to L1. All border RBridges are eligible for Level transition. However, for each multi-destination packet, only one of them acts as the Designated Border RBridge (DBRB) to do the transition while other non-DBRBs MUST drop the received copies. All border RBridges of an area SHOULD agree on a pseudorandom algorithm and locally determine the DBRB as they do in the "Per-flow Load Balancing" section. It's also possible to implement a certain election protocol to elect the DBRB. However, such kind of implementations are out the scope of this document.

As per [RFC6325], multi-destination packets can be classified into three types: unicast packet with unknown destination MAC address (unknown-unicast packet), multicast packet and broadcast packet. Now suppose that D's location has not been learned by RB27 or the frame received by RB27 is recognized as broadcast or multicast. What will happen, as it would in TRILL today, is that RB27 will forward the packet as multi-destination, setting its M bit to 1 and choosing an L1 tree, flooding the packet on the distribution tree, subject to possible pruning.

When the copies of the multi-destination packet arrive at area border RBridges, non-DBRBs MUST drop the packet while the DBRB, say RB2, needs to do the Level transition for the multi-destination packet. For a unknown-unicast packet, if the DBRB has learnt the destination MAC address, it SHOULD convert the packet to unicast and set its M bit to 0. Otherwise, the multi-destination packet will continue to be flooded as multicast packet on the distribution tree. The DBRB chooses the new distribution tree by replacing the egress nickname with the new root RBridge nickname. The following sequence of events will occur:

- RB2, when transitioning the packet from Level 1 to Level 2, replaces the ingress TRILL switch nickname with its own nickname, so replaces 27 with 2. RB2 also needs to replace the egress RBridge nickname with the L2 tree root RBridge nickname, say 2. In order to accommodate return traffic, RB2 records that S is attached to nickname 27 and SHOULD use ESADI protocol to synchronize this attachment information with other border RBridges (say RB20) in the area.

- RB20, will receive the packet flooded on the L2 tree by RB2. It is important that RB20 does not transition this packet back to L1 as it does for a multicast packet normally received from another remote L1 area. RB20 should examine the ingress nickname of this packet. If this nickname is found to be a border RBridge nickname of the area {2,20}, RB2 must not forwarded the packet into this area.

- The packet is flooded on the Level 2 tree to reach both RB3 and RB30. Suppose RB3 is the selected DBRB. The non-DBRB RB30 will drop the packet.

- RB3, when forwarding into area {3,30}, replaces the egress nickname in the TRILL header with the root RBridge nickname, say 3, of the distribution tree of L1 area {3,30}. (Here, the ingress nickname MAY be replaced with an area nickname selected from {2,20} as specified in Section 4.) Now suppose that RB27 has learned the location of D (attached to nickname 3), but RB3 does not know where D is. In that case, RB3 must turn the packet into a multi-destination packet and floods it on the distribution tree of L1 area {3,30}.

- RB30, will receive the packet flooded on the L1 tree by RB3. It is important that RB30 does not transition this packet back to L2. RB30 should also examine the ingress nickname of this packet. If this nickname is found to be an L2 border RBridge nickname, RB30 must not transition the packet back to L2.

- The multicast listener RB44, when decapsulating the received packet, learns that S is attached to nickname 2, which is one of the area nicknames of the ingress.

4. Per-flow Load Balancing

Area border RBridges perform ingress/egress nickname replacement when they transition TRILL data packets between Level 1 and Level 2. This nickname replacement enables the per-flow load balance which is specified as follows.

4.1. Ingress Nickname Replacement

When a TRILL data packet from other areas arrives at an area border RBridge, this RBridge MAY select one area nickname of the ingress to replace the ingress nickname of the packet. The selection is simply based on a pseudorandom algorithm as defined in Section 5.3 of [RFC7357]. With the random ingress nickname replacement, the border RBridge actually achieves a per-flow load balance for returning traffic.

All area border RBridges in an L1 area MUST agree on the same pseudorandom algorithm. The source MAC address, ingress area nicknames, egress area nicknames and the Data Label of the received TRILL data packet are candidate factors of the input of this pseudorandom algorithm. Note that the value of the destination MAC address SHOULD be excluded from the input of this pseudorandom algorithm, otherwise the egress RBridge will see one source MAC address flip flopping among multiple ingress RBridges.

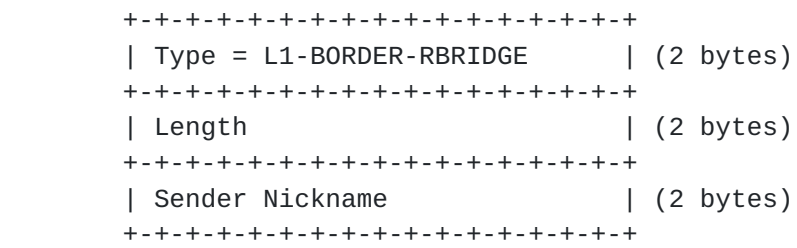
4.2. Egress Nickname Replacement

When a TRILL data packet originated from the area arrives at an area border RBridge, this RBridge MAY select one area nickname of the egress to replace the egress nickname of the packet. By default, it SHOULD choose the egress area border RBridge with the least cost route to reach. The pseudorandom algorithm as defined in Section 5.3 of [RFC7357] may be used as well. In that case, however, the ingress area border RBridge may take the non-least-cost Level 2 route to forward the TRILL data packet to the egress area border RBridge.

5. Protocol Extensions for Discovery

5.1. Discovery of Border RBridges in L1

The following Level 1 Border RBridge APPsub-TLV will be included in an E-L1FS FS-LSP fragment zero [RFC7780] as an APPsub-TLV of the TRILL GENINFO-TLV. Through listening to this Appsub-TLV, an area border RBridge discovers all other area border RBridges in this area.

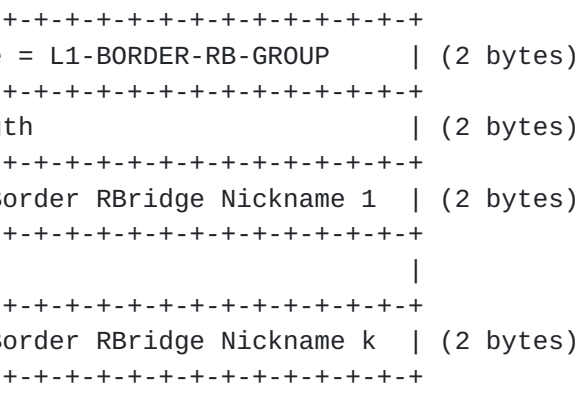


- Type: Level 1 Border RBridge (TRILL APPsub-TLV type tbd1)
- Length: 2
- Sender Nickname: The nickname the originating IS will use as the L1 Border RBridge nickname. This field is useful because the originating IS might own multiple nicknames.

5.2. Discovery of Border RBridge Sets in L2

The following APPsub-TLV will be included in an E-L2FS FS-LSP

fragment zero [RFC7780] as an APPsub-TLV of the TRILL GENINFO-TLV. Through listening to this APPsub-TLV in L2, an area border RBridge discovers all groups of L1 border RBridges and each such group identifies an area.



- Type: Level 1 Border RBridge Group (TRILL APPsub-TLV type tbd2)

- Length: 2 * k. If length is not a multiple of 2, the APPsub-TLV is corrupt and MUST be ignored.

- L1 Border RBridge Nickname: The nickname that an area border RBridge uses as the L1 Border RBridge nickname. The L1-BORDER-RB-GROUP TLV generated by an area border RBridge MUST include all L1 Border RBridge nicknames of the area. It's RECOMMENDED that these k nicknames are ordered in ascending order according to the 2-octet nickname considered as an unsigned integer.

When an L1 area is partitioned [RFC8243], border RBridges will re-discover each other in both L1 and L2 through exchanging LSPs. In L2, the set of border RBridge nicknames for this splitting area will change. Border RBridges that detect such a change MUST flush the reach-ability information associated to any RBridge nickname from this changing set.

6. One Border RBridge Connects Multiple Areas

It's possible that one border RBridge (say RB1) connects multiple L1 areas. RB1 SHOULD use a single area nickname for all these areas.

Nicknames used within one of these areas can be reused within other areas. It's important that packets destined to those duplicated nicknames are sent to the right area. Since these areas are connected to form a layer 2 network, duplicated {MAC, Data Label} across these areas ought not occur. Now suppose a TRILL data packet arrives at the area border nickname of RB1. For a unicast packet, RB1 can lookup the {MAC, Data Label} entry in its MAC table to identify the right

destination area (i.e., the outgoing interface) and the egress RBridge's nickname. For a multicast packet: suppose RB1 is not the DBRB, RB1 will not transition the packet; otherwise, RB1 is the DBRB,

- if this packet is originated from an area out of the connected areas, RB1 should replicate this packet and flood it on the proper Level 1 trees of all the areas in which it acts as the DBRB.

- if the packet is originated from one of the connected areas, RB1 should replicate the packet it receives from the Level 1 tree and flood it on other proper Level 1 trees of all the areas in which it acts as the DBRB except the originating area (i.e., the area connected to the incoming interface). RB1 may also receive the replication of the packet from the Level 2 tree. This replication must be dropped by RB1.

7. E-L1FS/E-L2FS Backwards Compatibility

All Level 2 RBridges MUST support E-L2FS [RFC7356] [RFC7780]. The Extended TLVs defined in Section 5 are to be used in Extended Level 1/2 Flooding Scope (E-L1FS/E-L2FS) PDUs. Area border RBridges MUST support both E-L1FS and E-L2FS. RBridges that do not support either E-L1FS or E-L2FS cannot serve as area border RBridges but they can well appear in an L1 area acting as non-area-border RBridges.

8. Security Considerations

For general TRILL Security Considerations, see [RFC6325].

The newly defined TRILL APPsub-TLVs in Section 5 are transported in IS-IS PDUs whose authenticity can be enforced using regular IS-IS security mechanism [IS-IS] [RFC5310]. This document raises no new security issues for IS-IS.

Using aggregated nicknames, and the resulting possible duplication of nicknames between areas, increases the possibility of a TRILL Data packet being delivered to the wrong egress RBridge if areas are suddenly merged. However, in many cases the data would be discarded at that egress because it would not match a known end station data label/MAC address.

9. IANA Considerations

9.1. TRILL APPsub-TLVs

IANA is requested to allocate two new types under the TRILL GENINFO TLV [RFC7357] from the range allocated by standards action for the TRILL APPsub-TLVs defined in Section 5. The following entries are

added to the "TRILL APPsub-TLV Types under IS-IS TLV 251 Application Identifier 1" Registry on the TRILL Parameters IANA web page.

Type	Name	Reference
tbd1[256]	L1-BORDER-RBRIDGE	[This document]
tbd2[257]	L1-BORDER-RB-GROUP	[This document]

10. References

10.1. Normative References

[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>.

[RFC6325] Perlman, R., Eastlake 3rd, D., Dutt, D., Gai, S., and A. Ghanwani, "Routing Bridges (RBridges): Base Protocol Specification", RFC 6325, DOI 10.17487/RFC6325, July 2011, <http://www.rfc-editor.org/info/rfc6325>.

[RFC7356] Ginsberg, L., Previdi, S., and Y. Yang, "IS-IS Flooding Scope Link State PDUs (LSPs)", RFC 7356, DOI 10.17487/RFC7356, September 2014, <http://www.rfc-editor.org/info/rfc7356>.

[RFC7357] Zhai, H., Hu, F., Perlman, R., Eastlake 3rd, D., and O. Stokes, "Transparent Interconnection of Lots of Links (TRILL): End Station Address Distribution Information (ESADI) Protocol", RFC 7357, DOI 10.17487/RFC7357, September 2014, <http://www.rfc-editor.org/info/rfc7357>.

[RFC7780] Eastlake 3rd, D., Zhang, M., Perlman, R., Banerjee, A., Ghanwani, A., and S. Gupta, "Transparent Interconnection of Lots of Links (TRILL): Clarifications, Corrections, and Updates", RFC 7780, DOI 10.17487/RFC7780, February 2016, <https://www.rfc-editor.org/info/rfc7780>.

10.2. Informative References

[IS-IS] International Organization for Standardization, ISO/IEC 10589:2002, "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, Second Edition, November 2002.

[RFC5310] Bhatia, M., Manral, V., Li, T., Atkinson, R., White, R., and M. Fanto, "IS-IS Generic Cryptographic Authentication", RFC 5310, DOI 10.17487/RFC5310, February 2009, <http://www.rfc-editor.org/info/rfc5310>.

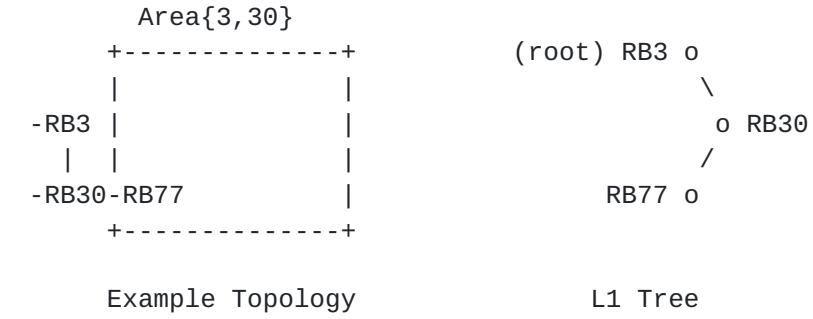
[RFC8243] Perlman, R., Eastlake 3rd, D., Zhang, M., Ghanwani, A., and H. Zhai, "Alternatives for Multilevel Transparent Interconnection of Lots of Links (TRILL)", RFC 8243, DOI 10.17487/RFC8243, September 2017, <https://www.rfc-editor.org/info/rfc8243>.

Appendix A. Clarifications

A.1. Level Transition

It's possible that an L1 RBridge is only reachable from a non-DBRB RBridge. If this non-DBRB RBridge refrains from Level transition, the question is, how can a multicast packet reach this L1 RBridge? The answer is, it will be reached after the DBRB performs the Level transition and floods the packet using an L1 distribution tree.

Take the following figure as an example. RB77 is reachable from the border RBridge RB30 while RB3 is the DBRB. RB3 transitions the multicast packet into L1 and floods the packet on the distribution tree rooted from RB3. This packet will finally flooded to RB77 via RB30.



In the above example, the multicast packet is forwarded along a non-optimal path. A possible improvement is to have RB3 configured not to belong to this area. In this way, RB30 will surely act as the DBRB to do the Level transition.

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