

TRILL Working Group
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TRILL: Campus Label and Priority Regions
<[draft-ietf-trill-rbridge-vlan-mapping-10.txt](#)>

Abstract

Within a TRILL campus, the data label (VLAN or Fine Grained Label) and priority of TRILL encapsulated frames is preserved. However, in some cases it may be desired that data label and/or priority be mapped at the boundary between regions of such a campus. This document describes an optional TRILL switch feature to provide this function.

Status of This Memo

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1. Introduction

The IETF TRILL protocol provides transparent forwarding, with a number of additional features, by use of link state routing and encapsulation with a hop count as specified in [\[RFC6325\]](#) [\[RFC6327bis\]](#) [\[RFCclear\]](#) and [\[RFCfgl\]](#).

Devices implementing the TRILL protocol are called TRILL switches or RBridges (Routing Bridges). A TRILL campus is an area of TRILL switches and possibly bridges bounded by and interconnecting end stations and Layer 3 routers, analogous to a customer bridge LAN (which is an area of bridges interconnecting end stations, Layer 3 routers, and TRILL switches). In a TRILL campus, native frames (as defined in [\[RFC6325\]](#)), when they arrive at their first or ingress RBridge, are encapsulated, routed in encapsulated form via zero or more transit TRILL switches, and finally decapsulated and delivered by their egress TRILL switch or switches.

TRILL switch ports have some features specified in IEEE 802.1Q as described in [\[RFC6325\]](#), with TRILL being implemented above those ports. Such ports provide for the association of incoming frames with a particular frame priority and customer VLAN (see [Appendix D of \[RFC6325\]](#)) or, in TRILL, 24-bit Fine Grained Label [\[RFCfgl\]](#).

Bridge ports can map frame priorities, a process called "priority regeneration" in IEEE 802.1. In addition, some bridge ports/products provide a feature to map the customer VLAN of incoming VLAN tagged frames, a process of the type called "VLAN ID translation" in IEEE 802.1.

Using such port features, it is possible to configure RBridge ports

to map the priority and/or VLAN of native frames being received for ingress or to map the priority and/or VLAN of the frame inside a TRILL Data packet after it has been decapsulated for egress through an output port. But priority and/or VLAN mapping of the outer priority and VLAN (Outer.VLAN) of a TRILL Data packet on Ethernet links has no effect on the Data Label (Inner.VLAN or Inner.FGL [[RFCfgl](#)]) in the encapsulated frame. In TRILL, the Data Label gives the real label and priority of the data and these are unaffected by any Ethernet port features that change only the Outer.VLAN priority or VLAN ID.

(Note: VLAN mapping is also referred to in [[RFC6325](#)]. However, that reference concerns Outer.VLAN mapping within an Ethernet link between neighbor TRILL switches, a condition that may require the TRILL switches connected to such a link to take precautions as described in [Section 4.4.5 of \[RFC6325\]](#).)

The default for TRILL is to provide connectivity between all end station and Layer 3 router ports in the same Data Label. However,

there are cases where it may be desirable to have the same Data Label in different regions of a TRILL campus mean different things. In that case, it would be necessary for end stations or Layer 3 routers in that label not to be connected if they are in different regions. It might also be desirable to have connectivity between end stations in different regions that are in different Data Labels if those different labels in their different regions actually indicate membership in the same Layer 2 community. Similar circumstances can arise for priority. This document describes how to achieve this through an optional TRILL switch feature.

An example of where this feature might be useful would be the merger of two organizations which previously had separate networks. They might desire to combine these networks into a new unified network under unified control; however, for some period of time, there might be disagreements between the previously separate networks as to Data Label and/or priority assignments requiring mapping at any points of interconnection. If these were Layer 2 networks, and particularly if they were TRILL campuses, combination into a single unified TRILL campus would be natural; but, this would probably require mapping facilities, such as those specified herein, between the regions of the new unified campus that had previously been separate networks.

Considerations related to service or S-VLANs are beyond the scope of this document but are an obvious extension.

1.1 TRILL Campus Regions

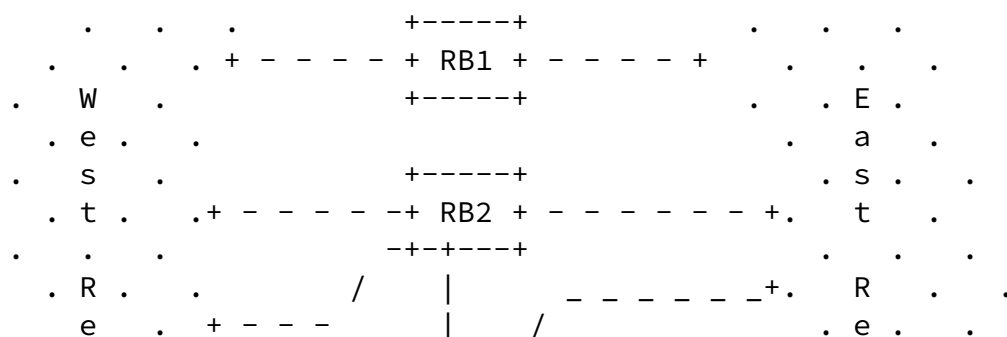
The set of TRILL switches interconnecting different regions of a TRILL campus are known as the "cut set", meaning that if that set of switches is removed, the regions are disconnected from each other.

TRILL switches in the cut set can be optionally configured to translate some set of Data Labels in one region to different Data Labels when forwarding from that region to another region and/or to block TRILL data packets with certain labels. They can be similarly configured for priority.

This feature is accomplished solely by configuring TRILL switches in the cut set. No other TRILL switches need even be aware that the feature is in use. In particular, use of this feature has no effect on the path (sequence of RBridges) followed by TRILL Data packets (except that for multi-destination packets, tree pruning may be affected). The TRILL features of optimum routing and of optional multi-pathing of both unicast and multi-destination frames are unaffected.

This document explains how to implement this feature in TRILL

switches (RBridges). We will usually assume there are two regions, "East" and "West", and RBridges RB1, RB2, and RB3 that interconnect the two regions and constitute the cut set as shown in Figure 1. Extension to more than two regions is straightforward and will also be briefly described.



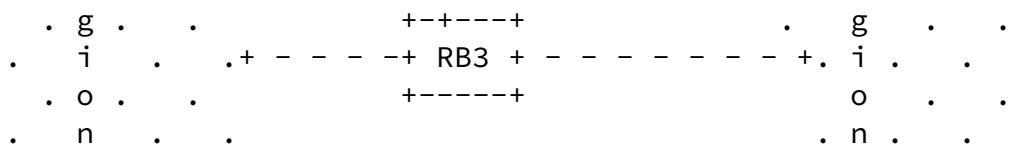


Figure 1.

General familiarity with the TRILL base protocol standard [[RFC6325](#)] and with Fine Grained Labels [[RFCfgl](#)] is assumed in this document.

[1.2](#) Terminology

The same terminology and acronyms are used in this document as in [[RFC6325](#)] and [[RFCfgl](#)] with the following additions.

"Cut set" is defined in [Section 1.1](#).

"Data Label" means VLAN or FGL.

"FGL" means Fine Grained Label [[RFCfgl](#)].

"Internal RBridges" are TRILL switches other than the "cut set".

"label" means "Data Label" unless the context requires some other meaning.

RBridge - an alternative name for a TRILL Switch.

TRILL Switch - a device which implements the TRILL protocol.

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](#). Internal and Cut Set Configuration and Mappings

Internal RBridges will not be aware that label and priority mapping is going on and require no configuration. They will behave exactly as they would without mapping. The only evidence they might have of label or priority mapping is the existence of an optional informational sub-TLV that a cut set RBridge, RB1, MAY include in its

LSP, listing the mappings that RB1 is configured to be performing. Internal RBridges will ignore this information field. It is there for detection of misconfiguration.

Cut set RBridges are configured as follows:

If label A in region "East" is to be translated into label B in region "West", each cut set RBridge MUST be configured, for every port, as to whether that port is in East or West, and configured with label mappings, such as:

"East/Label A -----> West/Label B"

That mapping means that a TRILL Data frame with an Data Label of A received by RB1 on a port configured to be in East and forwarded to a port configured to be in West is forwarded with the Data Label changed to B. It is possible to configure asymmetric mappings; however, such asymmetric mappings have negative consequences as described below. For the above mapping to be symmetrically configured, it would be necessary to also configure the cut set RBridge in question so that frames arriving from West in Data Label B would also be mapped to label A if they are destined for East, that is

"West/Label B <-----> East/Label A"

Figure 2.

Data Labels A and B may be both VLAN IDs, both FGLs, or one a VLAN ID and one an FGL.

Mappings of the inner priority of TRILL Data packets are configured in the same way.

The requirement that every port of a cut set RBridge MUST be configured as to which region it is in applies even to ports for a link between cut set RBridges such as the link between RB2 and RB3 in Figure 1. The TRILL Data packets on that link have a normal Data Label and priority. In a campus with multiple regions, a label and priority are, in general, meaningless unless you know the region in which they occurs. So some specific region must be chosen for such a link.

All cut set RBridges between a pair of regions SHOULD be configured similarly if, as is normally the case, it is desired that the mapping of a TRILL Data packet going between those regions will be independent of which cut set RBridge the packet traverses.

The default Data Label and priority mapping is the mapping that leaves labels and priorities unchanged. If a mapping has been specified for both the label and priority of a frame, both mappings are applied.

2.1 Multiple Crossings

Under some circumstances, a TRILL Data packet could pass through cut set RBridges between a pair of regions more than once and thus have its Data Label and priority mapped more than one. This is true of both known unicast and multi-destination packets. For example, in Figure 3, if the link between RBwest1 and RBwest2 fails, then the shortest path from RBwest1 to RBwest2 may be through RBcut1, RBeast1, and RBcut2. In addition, multi-destination packets are sent via a distribution tree which might constrain such packets going between RBwest1 and RBwest2 to be routed through RBeast1.

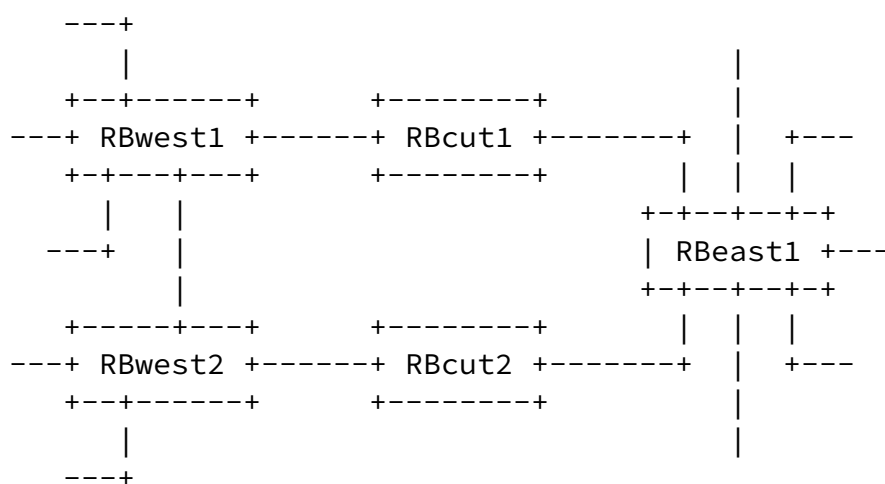


Figure 3.

If all of the mappings at RBcut1 and RBcut2 are symmetric then the label and/or priority of such packets going from west to west via east might get mapped twice but the second mapping would restore them to their original value. Symmetric means, for example, that if RB1 is translating from "label A" to "label B" when forwarding from East to West, it will translate "label B" to "label A" when forwarding from West to East (see Figure 2).

However, assume that RBcut1 and RBcut2 are configured with asymmetric mappings. Then multiple cut set transit may cause problems. For

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example, if label A in west is mapped to label B in east and label B in east is mapped to label C in west, then the above scenario could lead to frames in label A from west to west being unexpectedly mapped to label C causing connectivity between labels A and C in west and failure to deliver the frame as intended. Similar considerations apply to priority mappings. The probability of such situations can be minimized by providing rich interconnectivity within each region and increasing the cost of links to cut set RBridges, so that packets internal to a regions will be routed internally to that region except in cases of low probability multiple failures. It is generally safest to configure symmetric mappings.

[2.2](#) Native Frame Considerations

If the processing model described in [\[RFC6325\]](#) is followed, then no special handling is necessary for the case where a cut set RBridge receives or transmits a native data frame, that is, where the cut set RBridge is also an ingress or egress RBridge. In particular, the processing model used in [\[RFC6325\]](#) provides that an ingressed native frame is always encapsulated, even if it is to be immediately decapsulated and delivered out a different port of the same RBridge in native form. (Of course, implementers are free to handle this in other ways provided the external behavior is the same.) Thus, following this processing model, no changes are needed in an implementation model of Data Label and priority mapping described entirely in terms of the manipulation of the Data Label and priority of TRILL data packets.

On the other hand, if there are no internal RBridges in a region, say region West in Figure 1, then all frames will arrive from that region at the cut set RBridges as native frames and all native frames sent into that region will be unencapsulated. Under these limited circumstances, traditional bridge port VLAN and priority mapping could work to assist in performing the inter-regional mappings described in this document.

[2.3](#) More than Two Regions

A TRILL campus may have more than two regions. An RBridge is in the cut set between any pair of such regions if and only if it has at least one port in each of the regions. There may be pairs of regions that, because of other intervening regions, have no cut set RBridges connected to them both.

Every RBridge that is in any cut set MUST have every port configured as to which region that port is in. Every RBridge port on a link

between two or more cut set RBridges, such as that shown between RB2 and RB3 in Figure 1, SHOULD be configured to be in the same region. The mappings performed on TRILL Data packets transiting a cut set RBridge that has ports in three or more regions depend only on the region of that packet's input and output ports and are unaffected by what region any other ports of that RBridge might be connected to.

It is RECOMMENDED that not only should any mappings be symmetric at every cut set RBridge in a campus that implements the label and priority mapping feature but that all cut set RBridges in the campus should be configured so as to be transitively symmetric and similar. That is, the mapping of the label and priority in a packet going from region A to region Z should be independent of the path that frame follows in the campus and symmetric with the mapping to which any packet going from region Z to region A would be subjected.

[2.4](#) Mapping Implementation

If RB1 is configured to believe port X is in "East" and port Y is in "West", and RB1 is configured such that "East/Label A ----> West/Label B", then when RB1 forwards data packets from port X to port Y, if the received packet from port X has Data Label A, then RB1 changes that from label A to label B before it forwards out port Y. Similarly, if priority mapping has been configured, the inner priority field is mapped. In the case of FGL, the first priority, the priority which affects the packets propagation through the campus, is mapped. The second priority field, which is restored on egress, is unaffected.

This mapping is performed whether RB1 is the appointed forwarder on port X for VLAN A and the frame arrives unencapsulated, or whether the traffic has arrived already in TRILL Data packet form. Likewise,

RB1 performs the same label and priority mapping, depending on input and output port, whether the packet is to a known unicast address or is multi-destination.

RBridges may implement campus region label and priority mapping in any way desired so long as the externally visible behavior matches this specification. Two example models of processing, forwarding-oriented and port-oriented, are described below.

In the forwarding-oriented model, label and priority mappings occur once as part of the inter-port forwarding process within a TRILL switch and depend on the ordered pair { input-port-region, output-port-region }.

In the port-oriented model, label and priority mappings occur once or twice associated with input and/or output port. For example,

for Data Labels, each input port of a cut set RBridge could (after encapsulation in the case of a native frame) map the Data Label to a value in an RBridge specific generic label space, with the mapping dependent only on the region to which that input port was assigned. Then, the output port through which the packet was sent would map from that generic label space to a specific Data Label with the mapping depending only on the region to which the output port was assigned. Either mapping could be the mapping that did not change the label. A similar model could be used for priority mapping with similar considerations.

These two processing models are logically interchangeable.

[3.](#) End Node Address Learning Between Regions

TRILL switches by default learn end node MAC addresses and labels from the observation of ingress native frames and the decapsulation of native frames at egress, as described in [\[RFC6325\]](#) and [\[RFC6811\]](#). This process requires no modification at internal RBridges to accommodate Data Label mapping as described herein as the label will be appropriate for the region where it is observed.

For a cut set RBridge, each port is specified to be in a particular region. For such an RBridge, the Data Label portion of the addresses learned at a port providing direct end station service will be that label in the region to which the cut set RBridge has assigned the port. Care must be taken within a cut set RBridge when using such learned information. For example, if a native frame is received in label X from region Y destined for MAC address Z, then address Z can be looked up in the address information learned for other regions only after applying any mapping for label X to that region.

TRILL also allows RBridges to optionally advertise attached end nodes. This end node advertisement uses the TRILL ESADI (End System Address Distribution Information) protocol [[RFCesadi](#)]. Because TRILL ESADI packets do not include the label to which they are applicable anywhere except in their Data Label and ESADI packets are forwarded just like ordinary multi-destination TRILL Data packets, the label mapping described above works for ESADI learning. Because of this, any future ESADI extensions MUST NOT require label fields inside the ESADI packet payload.

[4.](#) Cut Set Attraction of Labels and Multicast

The above described mechanisms are all that is required for Data Label and priority mapping of frames sent to known unicast addresses. However, to correctly handle multi-destination traffic, additional steps are required. In particular, unless cut-set RBridges take additional action, multi-destination packets that they need to forward from one region to another might not reach the cut set RBridge due to the optional pruning of distribution trees by internal RBridges.

If RB1 is configured to translate Data Label A in East to label B in West, then RB1 MUST report, in its LSP, that it is interested in both label A and label B data, even if RB1 does not actually have a port for which it is ingressing to or egressing from either label A or label B. If it did not do this, a multi-destination frame in label A in East might be pruned before reaching RB1 and not mapped to label B and forwarded to West as it should.

If RB1 is configured to translate label A in East to label B in West, then RB1 MUST take steps to ensure that a multicast packet for group G in label A will not be filtered inside the East region. To solve this problem RB1 MUST report that it is connected in label A to an IPv4 and IPv6 multicast router so it will get all multi-cast traffic in label A and can forward appropriate multicast frames mapped to label B. While this increases traffic to cut set RBridges, it does so to an extent no worse than an RBridge connected to an actual Layer 3 multicast router or routers.

Because all the regions operate as a single TRILL campus with a unified IS-IS link state database, it is not possible to confine the above required announcements to a subset of the RBridges in the campus.

Cut set RBridges and the links connecting them to the rest of the network should be appropriately engineered for any additional traffic load these requirements impose.

To help detect misconfiguration, a cut set RBridge RB1 MAY advertise its label and priority mappings in its LSP. To enable this, a 16-bit unsigned ID is assigned to each of the regions by manual configuration. All cut set RBridges SHOULD be configured with the same IDs for the regions but means of accomplishing this are outside of the scope of this document. So, in our example Figure 1, if "East" is "1" and "West" is "2", and Data Label A in East is mapped to Data Label B in West, and vice versa to be symmetric, the LSP would report a set of mappings, including:

`{label: (1:A,2:B), (2:B,1:A)}`

Data Labels must include the type such as VLAN-42 or FGL-1234.

Illegal VLAN IDs (VLAN-0 or VLAN-4095 (0xFFF)) should never appear as a Data Label in an LSP advertising label mappings but if they do, the mapping where they appear are ignored for consistency checking.

Priority mappings can be similarly advertised.

The actual encoding of this information and the Type or sub-Type values for any new TLV or sub-TLV data elements are specified in a separate document

6. IANA Considerations

This document requires no IANA actions. RFC Editor: Please delete this section before publication.

7. Security Considerations

See [[RFC6325](#)] for general TRILL Security Considerations and [[RFCfgl](#)] for Fine Grained Label Security Considerations

If cut set RBridges have misconfigured Data Label mappings, labels may be inadvertently partitioned or inadvertently merged and frames may be delivered in the wrong label, which could violate security policies. However, misconfiguration of label or priority mappings cannot cause loops because mappings of labels and/or priority have no effect on unicast frame routing, shortest path calculations, distribution tree construction or selection, or the like.

8. Normative References

- [RFC2119] - Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- [RFC6325] - Perlman, R., Eastlake 3rd, D., Dutt, D., Gai, S., and A. Ghanwani, "Routing Bridges (RBridges): Base Protocol Specification", [RFC 6325](#), July 2011.
- [RFCfgl] - D. Eastlake, M. Zhang, P. Agarwal, R. Perlman, D. Dutt, "TRILL (Transparent Interconnection of Lots of Links): Fine-Grained Labeling", [draft-ietf-trill-fine-labeling](#), in RFC Editor's queue.

9. Informative References

- [RFC6327bis] - Eastlake, D., R. Perlman, A. Ghanwani, H. Yang, V. Manral, "Routing Bridges (RBridges): Adjacency", [draft-ietf-trill-rfc6327bis](#), work in progress.
- [RFCclear] - D. Eastlake, M. Zhang, A. Ghanwani, V. Manral, A. Banerjee, [draft-ietf-trill-clear-correct](#), in RFC Editor's queue.
- [RFCesadi] - H. Zhai, F. Hu, R. Perlman, D. Eastlake, O. Stokes, "TRILL: ESADI Protocol", [draft-ietf-trill-esadi](#), work in progress.

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Appendix Z: Change Summary

RFC Editor Note: Please delete this [Appendix Z](#) on publication.

Changes from -00 to -01

1. Because RBridges cannot tell what cloud other RBridges are in, drop the "optimized" option for advertising multicast listeners and require the advertisement of multicast router connectivity.
2. Specify that the cloud connectivity must be specified for all cut set RBridges and that cloud IDs are manually configured and are 16 bit.
3. Expand rules for VLAN ID mapping/handling at a cut set RBridge so as to drop frames that are for a VLAN ID to which another VLAN ID is being mapped. (See [Section 3](#).)
4. Add mention of "VLAN ID translation", the 802.1 name for VLAN mapping.
5. Minor editing changes.

Changes from -01 to -02

1. Remove previous confused text about VLAN mapping (point 3 in changes from -00 to -01).
2. Add text allowing mapping to zero to indicate frames should be dropped. Add text and diagram explaining that this can lead to VLAN partition.
3. Add normative reference to [draft-ietf-isis-layer2](#).

4. Minor editing changes.

Changes from -02 to -03

This was a substantial re-write of the draft but there was no fundamental conceptual change in the mapping mechanism.

1. Replace "cloud" with "region".
2. Introductory material was re-written to primarily reference

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RBridge campuses and reduce references to 802.1 bridges.

3. Mapping of priority was added to mapping of VLANs.
4. Two different models are now described for implementation of mappings, one in the forwarding mechanism as before and one associated with the RBridge ports.
5. Add the specification of the TRILL GenApp TLV. Switch to using TRILL GenApp TLV sub-TLVs to advertise VLAN and priority mappings. Add specification of those sub-TLVs. Remove reference to [draft-ietf-isis-layer2](#).
6. The IANA considerations section calls for the allocation of a GenApp TLV code for TRILL and provides for sub-TLVs under that code where the LSP advertisement of VLAN and priority mappings was moved. Set up IANA registry for TRILL GenApp sub-TLVs.
7. Numerous minor editing changes.

Changes from -03 to -04

1. Because distribution trees for multi-destination frames may cause frames to cross region boundaries multiple times even to get between RBridges within a single regions, remove facilities for dropping frames at region boundaries.
2. Due to questions about the timing of the approval of the IS-IS

GenApp draft, move VLAN/priority mapping informational advertisement code points and data structures to a separate draft.

3. Numerous minor editing changes.

Changes from -04 to -05

Increment version and update dates. Update author info. One or two minor editorial changes.

Changes from -05 to -06

Update draft reference to [[RFC6325](#)]. Increment version and update dates.

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Changes from -06 to -07

Update author information, increment version, and update dates.

Changes from -07 to -08

Minor editorial changes, update author information, increment version, and update dates.

Changes from -08 to -09

Extend to cover Fine Grained Labeling.

Update author information, increment version, and update dates.

Changes from -09 to -10

Update [RFC 6327](#) reference to [draft-ietf-trill-rfc6327bis](#).

Editorial changes, increment version, and update dates.

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