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TRILL: The ESADI Protocol
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Abstract

The IETF TRILL (TRansparent Interconnection of Lots of Links) protocol provides least cost pair-wise data forwarding without configuration in multi-hop networks with arbitrary topologies and link technologies. TRILL supports the multi-pathing of both unicast and multicast traffic. Devices that implement the TRILL protocol are called RBridges (Routing Bridges) or TRILL Switches.

The ESADI (End System Address Distribution Information) protocol is a VLAN (Virtual Local Area Network) scoped way that TRILL switches can communicate end station addresses to each other. An RBridge announcing VLAN-x connectivity (normally a VLAN-x forwarder) and running the TRILL ESADI protocol can receive remote address information and/or transmit local address information for VLAN-x to other such RBridges. This document updates [RFC 6325](#), specifically the documentation of the ESADI protocol.

Status of This Memo

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1. Introduction

The IETF TRILL (TRansparent Interconnection of Lots of Links) protocol [[RFC6325](#)] provides least cost pair-wise data forwarding without configuration in multi-hop networks with arbitrary topologies and link technologies, safe forwarding even during periods of temporary loops, and support for multi-pathing of both unicast and multicast traffic. TRILL accomplishes this by using the IS-IS (Intermediate System to Intermediate System) [[IS-IS](#)] [[RFC1195](#)] [[RFC6326](#)] link state routing protocol and encapsulating traffic using a header that includes a hop count. The design supports VLANs (Virtual Local Area Networks) and optimization of the distribution of multi-destination frames based on VLANs and IP multicast groups. Devices that implement TRILL are called RBridges (Routing Bridges) or TRILL switches.

There are five ways an RBridge can learn end station addresses as described in [Section 4.8 of \[RFC6325\]](#). The ESADI (End Station Address Distribution Information) protocol is an optional VLAN scoped way RBridges can communicate end station addresses with each other. An RBridge that is announcing connectivity to VLAN-x (normally a VLAN-x appointed forwarder) MAY use the (ESADI) protocol to announce the end station address of some or all of its attached VLAN-x end nodes to other RBridges that are running ESADI for VLAN-x.

By default, RBridges with connected end stations learn addresses from the data plane when ingressing and egressing native frames. The ESADI protocol's potential advantages over data plane learning include the following:

1. Security advantages: The ESADI protocol can be used to announce end stations with an authenticated enrollment (for example enrollment authenticated by cryptographically based EAP (Extensible Authentication Protocol [[RFC3748](#)]) methods via [[802.1X](#)]). In addition, the ESADI protocol supports cryptographic authentication of its message payloads for more secure transmission.
2. Fast update advantages: ESADI protocol provides a fast update of end nodes MAC (Media Access Control) addresses. If an end station is unplugged from one RBridge and plugged into another, frames addressed to that older RBridge can be black holed. They can be sent just to the older RBridge that the end station was connected to until cached address information at some remote RBridge times out, possibly for tens of seconds [[RFC6325](#)].

MAC address reachability information and some ESADI parameters are carried in ESADI frames rather than in the TRILL IS-IS protocol. As

described below, ESADI is, for each VLAN, a virtual logical topology overlay in the TRILL topology. An advantage of using ESADI is that

the end station attachment information is not flooded to all RBridges through TRILL IS-IS but only to participating RBridges advertising ESADI support for the VLAN in which those end stations occur.

1.1 Content and Precedence

This document updates the description of the ESADI protocol in the TRILL basic specification.

[Section 2](#) is the ESADI protocol overview. [Section 3](#) specifies ESADI DRB state. [Section 4](#) discusses the processing of ESADI PDUs. [Section 5](#) describes the ESADI-LSP contents.

This document updates [[RFC6325](#)] and prevails over [[RFC6325](#)] in the case of conflicts.

1.2 Terminology

This document uses the acronyms defined in [[RFC6325](#)] and the following phrase:

LSP number zero - A Link State PDU with fragment number equal to zero.

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. ESADI Protocol Overview

ESADI is a VLAN scoped way that RBridges can announce and learn end station addresses rapidly and securely. An RBridge that is announcing itself as connected to one or more VLANs (usually because it is an Appointed Forwarder) and participates in the ESADI protocol is called an ESADI RBridge.

ESADI is a separate protocol from the TRILL IS-IS implemented by all RBridges in a campus. There is a separate ESADI instance for each VLAN. In essence, for each VLAN, there is a modified instance of the IS-IS reliable flooding mechanism in which ESADI RBridges may choose to participate. (These are not the instances being specified in [\[MultiInstance\]](#).) It is an implementation decision how independent the implementations of multiple ESADI instances at an RBridge are. For example, the ESADI link state could be in a single database with a field in each record indicating the VLAN to which it applies or could be a separate database per VLAN. But the update processes operate separately for each ESADI instance.

After the TRILL header, ESADI frames have an inner Ethernet header with the Inner.MacDA of "All-Egress-RBridges" (formerly called "All-ESADI-RBridges"), an Inner.VLAN tag specifying the VLAN of interest, and the "L2-IS-IS" Ethertype followed by the ESADI payload as shown in Figure 1. For more detail see [Section 4.2.5](#) in the TRILL base protocol specification [\[RFC6325\]](#).

TRILL ESADI frame Structure

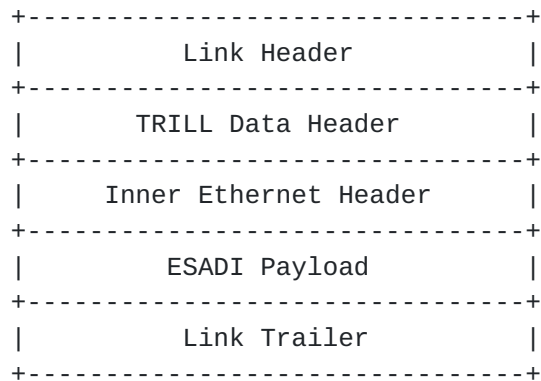


Figure 1

All transit RBridges forward ESADI frames as if they were ordinary multicast TRILL Data frames. Because of this forwarding, it appears to an instance of the ESADI protocol at an RBridge that it is directly connected by a multi-access virtual link to all other RBridges in the campus running ESADI for that VLAN. Thus no "routing"

computation or routing decisions ever have to be performed by ESADI.
An ESADI RBridge merely transmits the ESADI frames it originates on

this virtual link as described for any multicast frame in [\[RFC6325\]](#) using any distribution tree that it might use for a normal TRILL Data frame. RBridges that do not implement the ESADI protocol, do not have it enabled, or are not participating for the Inner.VLAN of an ESADI frame do not decapsulate or locally process any TRILL ESADI frames they receive. Thus the ESADI frames are transparently tunneled through transit RBridges.

TRILL ESADI frame payloads are structured like IS-IS PDUs, except as indicated below, but are always TRILL encapsulated on the wire as if they were TRILL Data frames.

The ESADI instance for VLAN-x at an RBridge RB1 determines who its ESADI potential neighbors are by logically examining the TRILL IS-IS link state database for RBridges that are data and IS-IS reachable from RB1 (see Section 2 of [\[ClearCorrect\]](#)) and are announcing their participation in VLAN-x ESADI. When an RBridge RB2 becomes IS-IS or data unreachable from RB1 or any of the relevant entries for RB2 are purged from the core IS-IS link state database, it is lost as a potential neighbor and also dropped from any ESADI instances. And when RB2 is no longer announcing participation in VLAN-x ESADI, it ceases to be a potential neighbor for the VLAN-x ESADI instance. RB2 becomes an actual ESADI adjacency for RB1 when it is a potential neighbor and RB1 holds an ESADI-LSP zero for RB2, all these considerations being VLAN scoped. Because of these mechanisms, there are no "Hellos" sent in ESADI.

The information distributed by the ESADI protocol is a list of local end station MAC addresses connected to the originating RBridge and, for each such address, a one octet unsigned "confidence" rating in the range 0-254 (see [Section 5.2](#)). It is entirely up to the originating RBridge which locally connected MAC addresses it wishes to advertise via ESADI and with what confidence. It MAY advertise all, some, or none of such addresses it has. Future uses of ESADI may distribute additional types of information.

TRILL ESADI-LSPs MUST NOT contain a VLAN ID in their payload. The VLAN ID to which the ESADI data applies is the Inner.VLAN of the TRILL Data frame enclosing the ESADI payload. If a VLAN ID could occur within the payload, it might conflict with the Inner.VLAN and could conflict with any future VLAN mapping scheme that may be adopted [\[VLANmapping\]](#). If a VLAN ID field in an ESADI-LSP PDU does include a VLAN ID, its contents is ignored.

(In the future, TRILL may be extended to provide more fine-grained labeling of data and ports. If so, it is expected that ESADI will be extended by allowing such fine-grained labeling of ESADI frames, as an alternative to the currently allowed Inner.VLAN labeling. As with

the current ESADI specification, it would generally be prohibited for such fine-grained labeling information to appear inside such extended

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ESADI frames.)

3. ESADI DRB State

Generally speaking, the DRB state on an ESADI link operate similarly to a TRILL IS-IS broadcast link with the following exception:

In the ESADI-DRB election at RB1 on an ESADI link, comparing with [\[RFC6327\]](#), the candidates are the local ESADI instance for VLAN-x and all remote ESADI instances at RBridges that (1) are data and IS-IS reachable from RB1 [\[ClearCorrect\]](#), (2) are announcing in their TRILL IS-IS LSP that they are participating in ESADI for VLAN-x, and (3) for which RB1 is holding an ESADI-LSP zero with an ESADI Parameters APPsub-TLV. The winner is the instance with the highest ESADI Parameter 7-bit priority field with ties broken by System ID, comparing fields as unsigned integers with the larger magnitude considered higher priority. In particular "SNPA/MAC address" is not considered and there is no "Port ID".

Because ESADI does no routing, the ESADI-DRB does not create a pseudo-node.

4. ESADI PDU processing

VLAN-x ESADI neighbors are usually not connected directly by a physical link, but are always logically connected by a virtual link. There could be hundreds of ESADI RBridges on the virtual link. There are only EASDI-LSP, EASDI-CSNP and EASDI-PSNP PDUs used in ESADI. In particular, there are no Hello or MTU PDUs because ESADI does not build a topology and does not do any routing.

In IS-IS, multicasting is normally on a local link and no effort is made to optimize to unicast because under the original conditions when IS-IS was designed (commonly a piece of multi-access Ethernet cable), any frame made the entire link busy for that frame time. But in ESADI what appears to be a simple multi-access link is actually a multi-hop distribution tree that may or may not be pruned. Thus, transmitting a multicast frame on such a tree imposes a greater load than transmitting a unicast frame. This load may be justified if there are likely to be multiple listeners but may not be justified if there is only one recipient of interest. For this reason, under some circumstances and if the target indicates that it has the capability to receive unicast ESADI, ESADI PDUs MAY be TRILL unicast.

[Section 4.1](#) describes the sending of ESADI PDUs. [Section 4.2](#) covers the receipt of ESADI PDUs.

4.1 Sending of ESADI PDUs

The MTU available to instances of ESADI is 24 bytes less than that available to TRILL IS-IS because of the additional fields required ($2(\text{TRILL Ethertype}) + 6(\text{TRILL Header}) + 6(\text{Inner.MacDA}) + 6(\text{Inner.MacSA}) + 4(\text{Inner.VLAN})$). Thus the inner ESADI payload, starting with the Intradomain Routing Protocol Discriminator, MUST NOT exceed Sz minus 24; however, if a larger payload is received, it is processed normally.

Once an ESADI instance is operationally up, it multicasts its self-originated LSP number zero on the virtual link to announce its ESADI parameters. When the other ESADI instances receive the LSP number zero and find a new neighbor, their self-originated LSP fragments are scheduled to be sent and MAY be unicast to that neighbor. If all the other ESADI instances send their self-originated LSPs immediately, there may be a surge of traffic to that new neighbor. So the other ESADI instances should wait an interval time before sending the LSP to a new neighbor. The interval time value is up to the device implementation. One suggestion is that the interval time can be assigned a random value with a range based on the ESADI priority when

implementation.

If the ESADI instance is DRB, it multicasts an ESADI-CSNP periodically to keep the Link State Database synchronized among its neighbors on the virtual link. After receiving an ESADI-PSNP PDU, the DRB will transmit the LSPs requested by the PSNP on the virtual link.

For robustness, if an ESADI instance has two or more ESADI neighbors and is not DRB and it receives no ESADI-CSNP PDUs for at least the CSNP Time (see [Section 5.1](#)) of the DRB, it MAY transmit an ESADI-CSNP.

In the case of receiving an ESADI-LSP with a smaller sequence number than the copy stored in local ESADI Link State Database, the local ESADI instance will also schedule to transmit the stored copy and MAY unicast it to the sender.

The format of a unicast ESADI frame is the format of TRILL ESADI frame, in [section 4.2 in \[RFC6325\]](#), except that, in the TRILL header, the M bit is set to zero and the Egress Nickname is the nickname of the destination RBridge.

[4.2](#) Receipt of ESADI PDUs

Because ESADI adjacency is in terms of System ID, all PDU acceptance tests that check that the PDU is from an adjacent system check that the System ID is that of an ESADI neighbor and do not check the source SNPA/MAC.

Because all ESADI instance for VLAN-x are adjacent, when RB1 receives an ESADI-CSNP from RB2 and detects that it has ESADI-LSPs that RB1 is missing, it sets the transmission flag only for its own ESADI-LSPs that RB1 is missing. Missing ESADI-LSPs originated by other ESADI instances will be detected by those other instances.

When receiving an ESADI-PSNP PDU, if the local ESADI instance is DRB, ESADI-LSP PDU requested by the ESADI-PSNP will be multicast on the virtual link.

5. ESADI-LSP Contents

The only PDUs used in ESADI are the Level 1 ESADI-LSP, ESADI-CSNP, and ESADI-PSNP PDUs. The content of an ESADI-LSP consists of zero or more MAC Reachability TLVs, optionally an Authentication TLV, and exactly one ESADI parameter APPsub-TLV in ESADI-LSP zero. This section specifies the format for ESADI parameter data APPsub-TLV and gives the reference for the ESADI MAC Reachability TLV. In the future, there may be other TLVs or sub-TLVs carried in EASDAI-LSPs.

ESADI-LSP number zero MUST NOT exceed 1470 minus 24 bytes in length (1446 bytes) but if received longer, it is still processed normally.

5.1 ESADI Parameter Data

The figure below presents the format of the ESADI parameter data. This APPsub-TLV MUST be included in a TRILL GENAPP TLV in ESADI-LSP number zero. If it is missing, priority is assumed to be zero and CSNP time 40. If there is more than one occurrence, the first occurrence will be used.

```

+-+--+--+--+--+
| Type          |           (1 byte)
+-+--+--+--+--+
| Length        |           (1 byte)
+-+--+--+--+--+
|R| Priority     |           (1 byte)
+-+--+--+--+--+
| CSNP Time     |           (1 byte)
+-+--+--+--+--+
| Reserved for expansion (variable)
+-+--+--+...

```

Type: set to TRILL APPsub-TLV type 1.

Length: Set to 2 to 255.

R: A reserved bit that MUST be sent as zero and ignored on receipt.

Priority: The Priority field gives the ESADI instance's priority for being DRB on the TRILL ESADI virtual link for the VLAN in which the PDU containing the parameter data was sent. It is an unsigned seven-bit integer with larger magnitude indication higher priority. It defaults to 0x40.

CSNP Time: An unsigned byte that give the amount of time in seconds

during the originating RBridge, if it is DRB on the ESADI link,

will send at least 3 EASDI-CSNP PDUs. It defaults to 30 seconds.

Reserved for future expansion: Future versions of the ESADI Parameters APPsub-TLV may have additional information. A receiving ESADI RBridge ignores any additional data here unless it implements such future expansion(s).

5.2 MAC Reachability TLV

The information in TRILL ESADI-LSP PDUs consists of one or more MAC Reachability (MAC-RI) TLVs as specified in [[RFC6165](#)]. These TLVs contain one or more unicast MAC addresses of end stations that are both on a port and in a VLAN for which the originating RBridge is appointed forwarder, along with the one octet unsigned Confidence in this information with a value in the range 0-254. If such a TLV is received with a confidence of 255, it is treated as if the confidence was 254.

To avoid conflict with the Inner.VLAN ID, the TLVs in TRILL ESADI PDUs, including the MAC-RI TLV, MUST NOT contain the VLAN ID. If a VLAN-ID is present in the MAC-RI TLV, it is ignored. The VLAN to which the ESADI-LSP applies is indicated only by the Inner.VLAN tag in the encapsulated TRILL ESADI frame.

6. IANA Considerations

IANA allocation considerations are given below.

6.1 ESADI Participation Flag

IANA is requested to allocate an "ESADI Participation" bit in the Interested VLANs and Spanning Tree Roots sub-TLV [[RFC6326](#)]. (bit 2 in the Interested VLANs field recommended) If this bit is a one, it indicates that the originating RBridge is participating in ESADI for the indicated VLAN or VLANs.

6.2 TRILL GENAPP TLV

IANA is requested to allocate an IS-IS Application Identifier under the Generic Information TLV (#251) for TRILL [[RFCgenapp](#)] and to create a subregistry in the TRILL Parameters Registry for "TRILL APPsub-TLVs under IS-IS TLV #251 Application Identifier #TBD". The initial contents of this subregistry are as follows:

| Type | Name | Reference |
|-------|------------------|------------|
| ----- | ----- | ----- |
| 0 | Reserved | <this RFC> |
| 1 | ESADI Parameters | <this RFC> |
| 2-254 | Available | <this RFC> |
| 255 | Reserved | <this RFC> |

TRILL APPsub-TLV Types 2 through 254 are available for allocation by Standard Action, as modified by [[RFC4020](#)]. For example, such APPsub-TLVs might be used in connection with OAM [[OAMdraft](#)]. The standards track RFC causing such an allocation will also include a discussion of security issues and of the rate of change of the information being advertised. TRILL APPsub-TLVs MUST NOT alter basic TRILL IS-IS protocol operation including the establishment of adjacencies, the update process, and the decision process for TRILL IS-IS [[IS-IS](#)] [[RFC1195](#)] [[RFC6327](#)]. The TRILL Generic Information TLV MUST NOT be used in IS-IS instance zero.

The V, I, D, and S flags in the initial flags byte of a TRILL Generic Information TLV have the meanings specified in [[RFCgenapp](#)] but are not currently used as TRILL operates as a Level 1 IS-IS area and no semantics is hereby assigned to the inclusion of an IPv4 and/or IPv6 address via the I and V flags. Thus these flags MUST be zero;

however, use of multi-level IS-IS is an obvious extension for TRILL

[MultiLevel] and future IETF Standards Actions may update or obsolete this specification to provide for the use of any or all of these flags in the TRILL GENAPP TLV.

The ESADI Parameters information, for which APPsub-TLV 1 is hereby assigned, is compact and slow changing (see [Section 5.1](#)).

For Security Considerations related to ESADI and the ESADI parameters APPsub-TLV, see [Section 7](#).

7. Security Considerations

For general TRILL Security Considerations, see [[RFC6325](#)].

More TBD

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Normative and informative references for this document are below.

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