INTERNET-DRAFT
Intended status: Proposed Standard

Donald Eastlake
Yizhou Li
Huawei
Radia Perlman
Intel

Expires: December 1, 2014
June 2, 2014

TRILL: Interface Addresses APPsub-TLV
<draft-ietf-trill-ia-appsubtlv-01.txt>

Abstract

This document specifies a TRILL (Transparent Interconnection of Lots of Links) IS-IS application sub-TLV that enables the reporting by a TRILL switch of sets of addresses such that all of the addresses in each set designate the same interface (port) and the reporting for such a set of the TRILL switch by which it is reachable. For example, a 48-bit MAC (Media Access Control) address, IPv4 address, and IPv6 address can be reported as all corresponding to the same interface reachable by a particular TRILL switch. Such information could be used in some cases to synthesize responses to or by-pass the need for the Address Resolution Protocol (ARP), the IPv6 Neighbor Discovery (ND) protocol, or the flooding of unknown MAC addresses.

Status of This Memo

Table of Contents

1. Introduction

This document specifies a TRILL (Transparent Interconnection of Lots of Links) [RFC6325] IS-IS application sub-TLV (APPsub-TLV [RFC6823]) that enables the convenient representation of sets of addresses such that all of the addresses in each set designate the same interface (port). For example, a 48-bit MAC (Media Access Control [RFC7042]) address, IPv4 address, and IPv6 address can be reported as all three designating the same interface. In addition, a Data Label (VLAN or Fine Grained Label (FGL [RFC7172])) is specified for the interface along with the TRILL switch and, optional the TRILL switch port, from which the interface is reachable. Such information could be used in some cases to synthesize responses to or by-pass the need for the Address Resolution Protocol (ARP [RFC826]), the IPv6 Neighbor Discovery (ND [RFC4861]) protocol, the Reverse Address Resolution Protocol (RARP [RFC903]), or the flooding of unknown destination MAC addresses [RFC7042]. If the information report is complete, it can also be used to detect and discard packets with forged source addresses.

This APPsub-TLV appears inside the TRILL GENINFO TLV specified in ESADI [RFCesadi] but may also occur in other application contexts. Directory Assisted TRILL Edge services [DirectoryScheme] are expected to make use of this APPsub-TLV.

Although, in some IETF protocols, address field types are represented by Ethertype [RFC7042] or Hardware Type [RFC5494], only Address Family Number (AFN) is used in this APPsub-TLV to represent address field type.

1.1 Conventions Used in This Document

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]. Capitalized IANA Considertions terms such as "Expert Review" are to be interpreted as described in [RFC5226].

The terminology and acronyms of [RFC6325] are used herein along with the following additional acronyms and terms:

AFN: Address Family Number

APPsub-TLV: Application sub-TLV [RFC6823]

Data Label: VLAN or FGL

FGL: Fine Grained Label [RFC7172]

IA: Interface Addresses

RBridge: An alternative name for a TRILL switch

TRILL switch: A device that implements the TRILL protocol

2. Format of the Interface Addresses APPsub-TLV

The Interface Addresses (IA) APPsub-TLV is used to advertise that a set of addresses indicate the same interface (port) within a Data Label (VLAN or FGL) and to associate that interface with the TRILL switch, and optionally the TRILL switch port, by which the interface is reachable. These addresses can be in different address families. For example, it can be used to declare that a particular interface with specified IPv4, IPv6, and 48-bit MAC addresses in some particular Data Label is reachable from a particular TRILL switch.

The Template field in a particular Interface Addresses APPsub-TLV indicates the format of each Address Set it carries. Certain well-known sets of addresses are represented by special values. Other sets of addresses are specified by a list of AFNs. The Template format that uses a list of AFNs provides an explicit pattern for the type and order of addresses in each Address Set in an IA APPsub-TLV.

A device or application making use of IA APPsub-TLV data is not required to make use of all IA data. For example, a device or application that was only interested in MAC and IPv6 addresses could ignore any IPv4 or other types of address information that was present.

The figure below shows an IA APPsub-TLV as it would appear in an IS-IS PDU using an extended flooding scope [FSLSP] TLV, for example in ESADI [RFCesadi]. Within an IS-IS PDU using traditional [ISO-10589] TLVs, the Type and Length would be one byte unsigned integers equal to or less than 255.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Type = TBD                    |  (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Length                        |  (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Addr Sets End                 |  (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Nickname                      |  (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Flags         |                  (1 byte)
+-+-+-+-+-+-+-+-+
| Confidence    |                  (1 byte)
+-+-+-+-+-+-+-+-+-
| Template ...                     (variable)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-...-+
| Address Set 1    (size determined by Template)    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-...-+
| Address Set 2    (size determined by Template)    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-...-+
|   ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-...-+
| Address Set N    (size determined by Template)    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-...-+
| optional sub-sub-TLVs ...
+-+-+-+-+-+-+-+-+-+-+-+-...
```

Figure 1. The Interface Addresses APPsub-TLV

- o Type: Interface Addresses TRILL APPsub-TLV type, set to TBD[#2 suggested] (IA-SUBTLV).

- o Length: Variable, minimum 7. If length is 6 or less or if the APPsub-TLV extends beyond the size of an encompassing TRILL GENINFO TLV or other context, the APPsub-TLV MUST be ignored.

- o Addr Sets End: The unsigned integer offset of the byte, within the IA APPsub-TLV value part, of the last byte of the last Address Set. This will be the byte just before the first sub-sub-TLV if any sub-sub-TLVs are present (see Section 3). If this is equal to Length, there are no sub-sub-TLVs. If this is greater than Length or points to before the end of the Template, the IA APPsub-TLV is corrupt and MUST be discarded. This field is always two bytes in size.

- o Nickname: The nickname of the TRILL switch by which the address sets are reachable. If zero, the address sets are reachable from the TRILL switch originating the message containing the APPsub-TLV (for example, an ESADI [RFCesadi] message).

o Flags: A byte of flags as follows:

```
 0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
|D|L|N|  RESV   |
+-+-+-+-+-+-+-+-+
```

D: Directory flag: If D is one, the APPsub-TLV contains Directory information [RFC7067].

L: Local flag: If L is one, the APPsub-TLV contains information learned locally by observing ingressed frames [RFC6325]. (Both D and L can one in the same IA APPsub-TLV if a TRILL switch that had learned an address locally also advertised it as a directory.)

N: Notify flag: When a TRILL switch receives a new IA APPsub-TLV (one in a ESADI-LSP fragment with a higher sequence number or a new message of some other type) and the N bit is one, the TRILL switch then checks the contents of the APPsub-TLV for address sets including both an IP address and a MAC address. For each such address set it finds, a gratuitous ARP [RFC826] or spontaneous Neighbor Advertisement [RFC4861] is sent depending on whether the IP address is IPv4 or IPv6 respectively. In both cases, these are sent out all the ports of the TRILL switch that offer end station service and are in the VLAN or FGL of the address set information.

RESV: Additional reserved flag bits that MUST be sent as zero and ignored on receipt.

- Confidence: This 8-bit unsigned quantity in the range 0 to 254 indicates the confidence level in the addresses being transported [RFC6325]. A value of 255 is treated as if it was 254.

- Template: The initial byte of this field is the unsigned integer K. If K has a value from 1 to 31, it indicates that this initial byte is followed by a list of K AFNs (Address Family Numbers) that specify the exact structure and order of each Address Set occurring later in the APPsub-TLV. K can be 1, which is the minimum valid value. If K is zero, the IA APPsub-TLV is ignored. If K is 32 to 254, the length of the Template field is one byte and its value is intended to correspond to a particular ordered set of AFNs some of which are specified below. If K is 255, the length of the Template filed is three bytes and the values of the second and third byte, considered as an unsigned integer in network byte order, are reserved to correspond to future specified ordered sets of AFNs.

If the Template uses explicit AFNs, it looks like the following.

```
+-+-+-+-+-+-+-+-+
|  K            |                  (1 byte)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  AFN 1                        |  (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  AFN 2                        |  (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  AFN K                        |  (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

For K in the 32 to 103 range, values indicate combinations of a specific number of MAC addresses, IPv4 addresses, IPv6 addresses, and TRILL switch port IDs appearing in that order. The value of K is

$$K = 32 + M + 3*v4 + 9*v6 + 36*P$$

where M is 0, 1, or 2 (0 if no MAC address is present, 1 if a 48-bit MAC is present, 2 if a MAC/24 (see Section 5.1) is present), v4 is the number of IPv4 addresses (limited to 0, 1, or 2) and v6 is the number of IPv6 addresses (limited to 0 through 3 inclusive), and P is the number of TRILL switch port IDs (limited to 0 or 1). That equation specifies values of K from 32 through 103. Values from 104 through 254 of the byte value are available for assignment by Expert Review (see Section 5). K = 255 indicates a three-byte Template field as specified above. All values (0 through 65,545) of this two-byte value are available for assignment by Expert Review.

If an unknown Template K value in the range 104 to 254 is received or a K of 255 followed by an unknown two byte value, the IA APPsub-TLV MUST be ignored.

- AFN: A two-byte Address Family Number. The number of AFNs present is given by K but there are no AFNs if K is greater than 31. The AFN sequence specifies the structure of the Address Sets occurring later in the TLV. For example, if Template Size is 2 and the two AFNs present are the AFNs for a 48-bit MAC and an IPv4 address, in that order, then each Address set present will consist of a 6-byte MAC address followed by a 4-byte IPv4 address. If any AFNs are present that are unknown to the receiving IS and the length of the corresponding address is not provided by a sub-sub-TLV as specified below, the receiving IS will be unable to parse the Address Sets and MUST ignore the IA APPsub-TLV.

- Address Set: Each address set in the APPsub-TLV consists of

exactly the same sequence of addresses of the types specified by the Template earlier in the APPsub-TLV. No alignment, other than

to a byte boundary, is guaranteed. The addresses in each Address Set are contiguous with no unused bytes between them and the Address Sets are contiguous with no unused bytes between successive Address Sets. The Address Sets must fit within the TLV.

- o sub-sub-TLVs: If the Address Sets indicated by Addr Sets End do not completely fill the Length of the APPsub-TLV, the remaining bytes are parsed as sub-sub-TLVs [RFC5305]. Any such sub-sub-TLVs that are not known to the receiving TRILL switch are ignored. Should this parsing not be possible, for example there is only one remaining byte or an apparent sub-sub-TLV extends beyond the end of the TLV, the containing IA APPsub-TLV is considered corrupt and is ignored. (Several sub-sub-TLV types are specified in Section 3.)

Different IA APPsub-TLVs within the same or different LSPs or other data structures may have different Templates. The same AFN may occur more than once in a Template and the same address may occur in different address sets. For example, a 48-bit MAC address interface might have three different IPv6 addresses. This could be represented by an IA APPsub-TLV whose Template specifically provided for one EUI-48 address and three IPv6 addresses, which might be an efficient format if there were multiple interfaces with that pattern. Alternatively, a Template with one 48-bit MAC and one IPv6 address could be used in an IA APPsub-TLV with three address sets each having the same MAC address but different IPv6 addresses, which might be the most efficient format if only one interface had multiple IPv6 addresses and other interfaces had only one IPv6 address.

In order to be able to parse the Address Sets, a receiving TRILL switch must know at least the size of the address for each AFN or address type the Template specifies; however, the presence of the Addr Set End field means that the sub-sub-TLVs, if any, can always be located by a receiver. A TRILL switch can be assumed to know the size of the AFNs mentioned in Section 5. Should a TRILL switch wish to include an AFN that some receiving TRILL switch in the campus may not know, it SHOULD include an AFN-Size sub-sub-TLV as described in Section 3.1. If an IA APPsub-TLV is received with one or more AFNs in its template for which the receiving TRILL switch does not know the length and for which an AFN-Size sub-sub-TLV is not present, that IA APPsub-TLV MUST be ignored.

3. IA APPsub-TLV sub-sub-TLVs

IA APPsub-TLVs can have trailing sub-sub-TLVs [RFC5305] as specified below. These sub-sub-TLVs occur after the Address Sets and the amount of space available for sub-sub-TLVs is determined from the overall IA APPsub-TLV length and the value of the Addr Set End byte.

There is no ordering restriction on sub-sub-TLVs. Unless otherwise specified each sub-sub-TLV type can occur zero, one, or many times in an IA APPsub-TLV. Any sub-sub-TLVs for which the Type is unknown are ignored.

The sub-sub-TLVs data structures shown below, with two byte Types and Lengths, assume that the enclosing IA-APPsubTLV is in an extended LSP TLV [FSLSP] or some non-LSP context. If they were used in a IA-APPsubTLV in a traditional LSP [ISO-10589], the only one byte Types and Lengths could be used. As a result, any sub-sub-TLV types greater than 255 could not be used and Length would be limited to 255.

3.1 AFN Size sub-sub-TLV

Using this sub-sub-TLV, the originating TRILL switch can specify the size of an address type. This is useful under two circumstances as follows:

1. One or more AFNs that are unknown to the receiving TRILL switch appears in the template. If an AFN Size sub-sub-TLV is present for each such AFN, then at least the IA APPsub-TLV can be parsed and possibly other addresses in each address set can still be used.

2. If an AFN occurs in the Template that represents a variable length address, this sub-sub-TLV gives its size for all occurrences in that IA APPsub-TLV.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Type = AFNsz                  |  (2 byte)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Length                        |  (2 byte)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| AFN Size Record 1                             |  (3 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| AFN Size Record 2                             |  (3 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| AFN Size Record N                             |  (3 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Where each AFN Size Record is structured as follows:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  AFN                          |  (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  AdrSize      |                  (1 byte)
+-+-+-+-+-+-+-+-+
```

o Type: AFN-Size sub-sub-TLV type, set to 1 (AFNsz).

o Length: 3*n where n is the number of AFN Size Records present. If Length is not a multiple of 3, the sub-sub-TLV MUST be ignored.

o AFN Size Record(s): Zero or more 3-byte records, each giving the size of an address type identified by an AFN,

o AFN: The AFN whose length is being specified by the AFN Size Record.

o AdrSize: The length in bytes of addresses specified by the AFN field as an unsigned integer.

An AFN Size sub-sub-TLV for any AFN known to the receiving TRILL switch is compared with the size known to the TRILL switch. If they differ the IA APPsub-TLV is assumed to be corrupt and MUST be ignored.

3.2 Fixed Address sub-sub-TLV

There may be cases where, in an Interface Addresses APP-subTLV, the same address would appear in every address set across the APP-subTLV. To avoid wasted space, this sub-sub-TLV can be used to indicate such a fixed address. The address or addresses incorporated into the sets by this sub-sub-TLV are NOT mentioned in the IA APPsub-TLV Template.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Type=FIXEDADR                 | (2 byte)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Length                        | (2 byte)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| AFN                           | (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Fixed Address                   (variable)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-...
```

o Type: Data Label sub-sub-TLV type, set to 2 (FIXEDADR).

o Length: variable, minimum 3. If Length is 2 or less, the sub-sub-

TLV MUST be ignored.

- o AFN: Address Family Number of the Fixed Address.

- o Fixed Address: The address of the type indicated by the preceding AFN field that is considered to be part of every Address Set in the IA APPsub-TLV.

The Length field implies a size for the Fixed Address. If that size differs from the size of the address type for the given AFN as known by the receiving TRILL switch, the Fixed Address sub-sub-TLV is considered corrupt and MUST be ignored.

3.3 Data Label sub-sub-TLV

This sub-sub-TLV indicates the Data Label within which the interfaces listed in the IA APPsub-TLV are reachable. It is useful if the IA APPsub-TLV occurs outside of the context of an ESADI [RFCesadi] or other type of message specifying the Data Label or if it is desired and permitted to override that specification. Multiple occurrences of this sub-sub-TLV indicate that the interfaces are reachable in all of the Data Labels given.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Type=DATALEN                   | (2 byte)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Length                        | (2 byte)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Data Label                      (variable)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-...
```

- o Type: Data Label sub-TLV type, set to 3 (LABEL).

- o Length: 2 or 3. If Length is some other value, the sub-sub-TLV MUST be ignored.

- o Data Label: If length is 2, the bottom 12 bits of the Data Label are a VLAN ID and the top 4 bits are reserved (MUST be sent as zero and ignored on receipt). If the length is 3, the three Data Label bytes contain an FGL [RFC7172].

3.4 Topology sub-sub-TLV

The presence of this sub-sub-TLV indicates that the interfaces given in the IA APPsub-TLV are reachable in the topology give. It is useful

if the IA APPsub-TLV occurs outside of the context of an ESADI

[RFCesadi] or other type of message indicating the topology or if it is desired and permitted to override that specification. If it occurs multiple times, then the Address Sets are in all of the topologies given.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Type=DATALEN                   |  (2 byte)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Length                        |  (2 byte)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| RESV  |        Topology       |  (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

o Type: Topology sub-TLV type, set to 4 (TOPOLOGY).

o Length: 2. If Length is some other values, the sub-sub-TLV MUST be ignored.

RESV: Four reserved bits. MUST be sent as zero and ignored on receipt.

o Topology: The 12-bit topology number [RFC5120].

4. Security Considerations

The integrity of address mapping and reachability information and the correctness of Data Labels (VLANs or FGLs [RFC7172]) are very important. Forged, altered, or incorrect address mapping or Data Labeling can lead to delivery of packets to the incorrect party, violating security policy. However, this document merely describes a data format and does not provide any explicit mechanisms for securing that information, other than a few trivial consistency checks that might detect some corrupted data. Security on the wire, or in storage, for this data is to be providing by the transport or storage used. For example, when transported with ESADI [RFCesadi] or RBridge Channel [RFC7178], ESADI security or Channel Tunnel [ChannelTunnel] security mechanisms can be used, respectively.

The address mapping and reachability information, if known to be complete and correct, can be used to detect some cases of forged packet source addresses [RFC7067]. In particular, if native traffic from an end station is received by a TRILL switch that would otherwise accept it but authoritative data indicates the source address should not be reachable from the receiving TRILL switch, that traffic should be discarded. The data format specified in this document may optionally include TRILL switch Port ID number so that this forged address filtering can be optionally applied with port granularity.

See [RFC6325] for general TRILL Security Considerations.

5. IANA Considerations

As specified below, IANA has allocated AFN numbers and IANA is requested to create the TRILL IS-APPsub-TLV sub-sub-TLV subregistries under the TRILL Parameters Registry.

5.1 Additional AFN Number Allocation

IANA has assigned AFN numbers as follows:

Hex	Decimal	Description	References
4007	16391	OUI	This document.
4008	16392	MAC/24	This document.
4009	16393	MAC/40	This document.
400A	16394	IPv6/64	This document.
400B	16395	RBridge Port ID	This document.

The OUI AFN is provided so that MAC addresses can be abbreviated if they have the same upper 24 bits. A MAC/24 is a 24-bit suffix intended to be pre-fixed by an OUI to create a 48-bit MAC address [RFC7042]; in the absence of an OUI, a MAC/24 entry cannot be used. A MAC/40 is a suffix intended to be pre-fixed by an OUI to create a 64-bit MAC address [RFC7042]; in the absence of an OUI, a MAC/40 entry cannot be used.

Typically, an OUI would be provided as a Fixed Address sub-sub-TLV (see Section 3.2).

After Fixed Address sub-sub-TLV processing above, each address set is processed by combining each OUI in the address set with each MAC/24 and each MAC/40 address in the address set. Depending on how many of each of these address types is present, zero or more 48-bit and/or 64-bit MAC addresses may be produced that are considered to be part of the address set. If there are no MAC/48 or MAC/40 addresses present, any OUI's are ignored. If there are no OUIs, any MAC/24 and/or MAC/40s are ignored.

IPv6/64 is an 8-byte quantity that is the first 64 bits of an IPv6 address. IPv6/64s are ignored unless, after the processing above in this sub-section, there are one or more 48-bit and/or 64-bit MAC addresses in the address set to provide the lower 64 bits of the IPv6 address. For this purpose, an 48-bit MAC address is expanded to 64 bits as described in [RFC7042].

The following already allocated AFN values may be particularly useful

for IA APPsub-TLVs:

Hex	Decimal	Description	References
0001	1	IPv4	
0002	2	IPv6	
4005	16,389	48-bit MAC	[RFC7042]
4006	16,390	64-bit MAC	[RFC7042]

Other AFNs can be found at http://www.iana.org/assignments/address-family-numbers

5.2 IA APPsub-TLV Sub-Sub-TLVs SubRegistry

IANA is requested to establish a new subregistry of the TRILL Parameter Registry for sub-sub-TLVs of the Interface Addresses APPsub-TLV with initial contents as shown below.

Name: Interface Addresses APPsub-TLV Sub-Sub-TLVs

Procedure: Expert Review

Note: Types greater than 255 are not usable in some contexts.

Reference: This document

Type	Description	Reference
0	Reserved	
1	AFN Size	This document
2	Fixed Address	This document
3	Data Label	This document
4	Topology	This document
5-254	Available	
255	Reserved	
256-65534	Available	
65535	Reserved	

Acknowledgments

The authors gratefully acknowledge the contributions and review by the following:

Linda Dunbar

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

Appendix A: Examples

Below are example IA APPsub-TLVs.

A.1 Simple Example

Below is an annotated IA APPsub-TLV carrying two simple pairs of EUI-48 MAC addresses and IPv4 addresses from a Push Directory [RFC7042]. No sub-sub-TLVs are included.

```
0x0002(TBD)   Type: Interface Addresses
0x001B        Length: 27 (=0x1B)
0x001B        Address Sets End: 27 (=0x1B)
0x1234        RBridge Nickname from which reachable
0b10000000    Flags: Push Directory data
0xE3          Confidence = 227
35            Template: 35 (0x23) = 32 + 1(MAC48) + 3*1(IPv4)

      Address Set One
0x00005E0053A9   48-bitMAC address
198.51.100.23    IPv4 address

      Address Set Two
0x00005E00536B   48-bit MAC address
203.0.113.201    IPv4 address
```

Size includes 7 for the fixed fields though and including the one byte template, plus 2 times the Address Set size. Each Address Set is 10 bytes, 6 for the 48-bit MAC address plus 4 for the IPv4 address. So total size is 7 + 2*10 = 27.

See Section 2 for more information on Template.

A.2 Complex Example

Below is an annotated IA APPsub-TLV carrying three sets of addresses, each consisting of an EUI-48 MAC address, an IPv4 addresses, an IPv6 address, and an RBridge Port ID, all from a Push Directory [RFC7042]. The IPv6 address for each address set is synthesized from the MAC address given in that set and the IPv6/64 64-bit prefix provided through a Fixed Address sub-sub-TLV. In addition, a sub-sub-TLV is included that provides an FGL which overrides whatever Data Label may be provided by the envelope (for example ESADI [RFCesadi]) within which this IA APPsub-TLV occurs.

```
0x0002(TBD)   Type: Interface Addresses
0x0036        Length: 54 (=0x36)
0x0021        Address Sets End: 33 (=0x21)
0x4321        RBridge Nickname from which reachable
0b10000000    Flags: Push Directory data
0xD3          Confidence = 211
72            Template: 72(0x48)=32+1(MAC48)+3*1(IPv4)+36*1(P)

      Address Set One
0x00005E0053DE   48-bitMAC address
198.51.100.105   IPv4 address
0x1DE3           RBridge Port ID

      Address Set Two
0x00005E0053E3   48-bit MAC address
203.0.113.89     IPv4 address
0x1DEE           RBridge Port ID

      Address Set Three
0x00005E0053D3   48-bit MAC address
192.0.2.139      IPv4 address
0x01DE           RBridge Port ID

      sub-sub-TLV One
0x0003           Type: Data Label
0x0003           Length: implies FGL
0xD3E3E3         Fine Grained Label

      sub-sub-TLV Two
0x0002           Type: Fixed Address
0x000A           Size: 0x0A = 10
0x400A           AFN: IPv6/64
0x20010DB800000000   IPv6 Prefix: 2001:DB8::
```

See Section 2 for more information on Template.

The Fixed Address sub-sub-TLV causes the IPv6/64 value give to be treated as if it occurred as a 4th entry inside each of the three Address Sets. When there is an IPv6/64 entry and a 48-bit MAC entry, the MAC value is expanded by inserting 0xFFFE immediately after the OUI and the resulting 64-bit value is used as the lower 64 bits of the resulting IPv6 address [RFC7042]. As a result, a receiving TRILL switch would treat the three Address Sets shown as if they had an IPv6 address in them as follows:

```
      Address Set One
0x20010DB80000000000005EFFFE0053DE  IPv6 Address

      Address Set Two
0x20010DB80000000000005EFFFE0053E3  IPv6 Address

      Address Set Three
0x20010DB80000000000005EFFFE0053D3  IPv6 Address
```

As an alternative to the compact "well know value" Template encoding used in this example above, the less compact explicit AFN encoding could have been used. In that case, the IA APPsub-TLV would have started as follows:

```
0x0002(TBD)   Type: Interface Addresses
0x003C        Length: 60 (=0x3C)
0x0027        Address Sets End: 39 (=0x27)
0x4321        RBridge Nickname from which reachable
0b10000000    Flags: Push Directory data
0xD3          Confidence = 211
0x3           Template: 3 AFNs
0x4005        AFN: 48-bit MAC
0x0001        AFN: IPv4
0x400B        AFN: RBridge Port ID
```

As a final point, since the 48-bit MAC addresses in these three Address Sets all have the same OUI (the IANA OUI [RFC7042]), it would have been possible to just have a MAC/24 value giving the lower 24 bits of the MAC in each Address Set. The OUI would them be supplied by a second Fixed Address sub-sub-TLV proving the OUI. With N Address Sets, this would have saved 3*N or 9 bytes in this case at the cost of 7 bytes (1 each for the type and length of the sub-sub-TLV, 2 for the OUI AFN number, and 3 for the OUI). So, even with just three Address Sets, there would be a small net saving of 2 bytes. The savings would grow with a larger number of Address Sets.

Appendix Z: Change History

From -00 to -01

1. Update references for RFC publications.

2. Add this Change History Appendix.

Normative References

[ISO-10589] - ISO/IEC 10589:2002, Second Edition, "Intermediate System to Intermediate System Intra-Domain Routing Exchange Protocol for use in Conjunction with the Protocol for Providing the Connectionless-mode Network Service (ISO 8473)", 2002.

[RFC826] - Plummer, D., "An Ethernet Address Resolution Protocol", RFC 826, November 1982.

[RFC903] - Finlayson, R., Mann, T., Mogul, J., and M. Theimer, "A Reverse Address Resolution Protocol", STD 38, RFC 903, June 1984.

[RFC2119] - Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997

[RFC4861] - Narten, T., Nordmark, E., Simpson, W., and H. Soliman, "Neighbor Discovery for IP version 6 (IPv6)", RFC 4861, September 2007.

[RFC5120] - Przygienda, T., Shen, N., and N. Sheth, "M-ISIS: Multi Topology (MT) Routing in Intermediate System to Intermediate Systems (IS-ISs)", RFC 5120, February 2008.

[RFC5226] - Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, May 2008.

[RFC5305] - Li, T. and H. Smit, "IS-IS Extensions for Traffic Engineering", RFC 5305, October 2008.

[RFC6325] - Perlman, R., Eastlake 3rd, D., Dutt, D., Gai, S., and A. Ghanwani, "Routing Bridges (RBridges): Base Protocol Specification", RFC 6325, July 2011.

[RFC6823] - Ginsberg, L., Previdi, S., and M. Shand, "Advertising Generic Information in IS-IS", RFC 6823, December 2012.

[RFC7042] - Eastlake 3rd, D. and J. Abley, "IANA Considerations and IETF Protocol and Documentation Usage for IEEE 802 Parameters", BCP 141, RFC 7042, October 2013.

[RFC7172] - Eastlake 3rd, D., Zhang, M., Agarwal, P., Perlman, R., and D. Dutt, "Transparent Interconnection of Lots of Links (TRILL): Fine-Grained Labeling", RFC 7172, May 2014.

[FSLSP] - Ginsberg, L., S. Previdi, Y. Yang, "IS-IS Flooding Scope LSPs", draft-ietf-isis-fs-lsp, work in progress.

Informational References

[ARP reduction] - Shah, et. al., "ARP Broadcast Reduction for Large Data Centers", Oct 2010.

[ChannelTunnel] - D. Eastlake, Y. Li, "TRILL: RBridge Channel Tunnel Protocol", draft-eastlake-trill-channel-tunnel, work in progress.

[DirectoryScheme] - Dunbar, L., D. Eastlake, R. Perlman, I. Gashinsky, Y. Li, "TRILL": Directory Assistance Mechanisms", draft-dunbar-trill-scheme-for-directory-assist, work in progress.

[RFC5494] - Arkko, J. and C. Pignataro, "IANA Allocation Guidelines for the Address Resolution Protocol (ARP)", RFC 5494, April 2009.

[RFC7067] - Dunbar, L., Eastlake 3rd, D., Perlman, R., and I. Gashinsky, "Directory Assistance Problem and High-Level Design Proposal", RFC 7067, November 2013.

[RFC7178] - Eastlake 3rd, D., Manral, V., Li, Y., Aldrin, S., and D. Ward, "Transparent Interconnection of Lots of Links (TRILL): RBridge Channel Support", RFC 7178, May 2014.

[RFCesadi] - Zhai, H., F. Hu, R. Perlman, D. Eastlake, O. Stokes, "TRILL (Transparent Interconnection of Lots of Links): The ESADI (End Station Address Distribution Information) Protocol", draft-ietf-trill-esadi, work in progress.

Authors' Addresses

Donald Eastlake
Huawei Technologies
155 Beaver Street
Milford, MA 01757 USA

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

Yizhou Li
Huawei Technologies
101 Software Avenue,
Nanjing 210012 China

Phone: +86-25-56622310
Email: liyizhou@huawei.com

Radia Perlman
Intel Labs
2200 Mission College Blvd.
Santa Clara, CA 95054-1549 USA

Phone: +1-408-765-8080
Email: Radia@alum.mit.edu