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LISP Canonical Address Format (LCAF)
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Abstract

This draft defines a canonical address format encoding used in LISP control messages and in the encoding of lookup keys for the LISP Mapping Database System.

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Table of Contents

1. Introduction 3
2. Definition of Terms 4
3. LISP Canonical Address Format Encodings 5
4. LISP Canonical Address Applications 7
  4.1. Segmentation using LISP 7
  4.2. Carrying AS Numbers in the Mapping Database 8
  4.3. Convey Application Specific Data 9
  4.4. Assigning Geo Coordinates to Locator Addresses 10
  4.5. Generic Database Mapping Lookups 11
  4.6. NAT Travesal Scenarios 13
  4.7. PETR Admission Control Functionality 14
  4.8. Applications for AFI List Type 15
    4.8.1. Binding IPv4 and IPv6 Addresses 15
    4.8.2. Layer-2 VPNs 16
    4.8.3. ASCII Names in the Mapping Database 16
    4.8.4. Using Recursive LISP Canonical Address Encodings . . . 17
5. Security Considerations 18
6. IANA Considerations 19
7. References 20
  7.1. Normative References 20
  7.2. Informative References 20
Appendix A. Acknowledgments 21
Authors' Addresses 22

1. Introduction

The LISP architecture and protocols [LISP] introduces two new numbering spaces, Endpoint Identifiers (EIDs) and Routing Locators (RLOCs) which are intended to replace most use of IP addresses on the Internet. To provide flexibility for current and future applications, these values can be encoded in LISP control messages using a general syntax that includes Address Family Identifier (AFI), length, and value fields.

Currently defined AFIs include IPv4 and IPv6 addresses, which are formatted according to code-points assigned in [AFI] as follows:

IPv4 Encoded Address:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            AFI = 1            |       IPv4 Address ...        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     ...  IPv4 Address         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IPv6 Encoded Address:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            AFI = 2            |       IPv6 Address ...        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     ...  IPv6 Address  ...                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     ...  IPv6 Address  ...                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     ...  IPv6 Address  ...                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     ...  IPv6 Address         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

This document describes the currently-defined AFIs the LISP protocol uses along with their encodings and introduces the LISP Canonical Address Format (LCAF) that can be used to define the LISP-specific encodings for arbitrary AFI values.

2. Definition of Terms

Address Family Identifier (AFI): a term used to describe an address encoding in a packet. An address family currently defined for IPv4 or IPv6 addresses. See [AFI] and [RFC1700] for details. The reserved AFI value of 0 is used in this specification to indicate an unspecified encoded address where the the length of the address is 0 bytes following the 16-bit AFI value of 0.

Unspecified Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            AFI = 0            |    <nothing follows AFI=0>    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Endpoint ID (EID): a 32-bit (for IPv4) or 128-bit (for IPv6) value used in the source and destination address fields of the first (most inner) LISP header of a packet. The host obtains a destination EID the same way it obtains a destination address today, for example through a DNS lookup or SIP exchange. The source EID is obtained via existing mechanisms used to set a host's "local" IP address. An EID is allocated to a host from an EID-prefix block associated with the site where the host is located. An EID can be used by a host to refer to other hosts.

Routing Locator (RLOC): the IPv4 or IPv6 address of an egress tunnel router (ETR). It is the output of a EID-to-RLOC mapping lookup. An EID maps to one or more RLOCs. Typically, RLOCs are numbered from topologically-aggregatable blocks that are assigned to a site at each point to which it attaches to the global Internet; where the topology is defined by the connectivity of provider networks, RLOCs can be thought of as PA addresses. Multiple RLOCs can be assigned to the same ETR device or to multiple ETR devices at a site.

3. LISP Canonical Address Format Encodings

IANA has assigned AFI value 16387 (0x4003) to the LISP architecture and protocols. This specification defines the encoding format of the LISP Canonical Address (LCA).

The first 4 bytes of an LISP Canonical Address are followed by a variable length of fields:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |     Flags     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Type       |     Rsvd2     |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Rsvd1: this 8-bit field is reserved for future use and MUST be transmitted as 0 and ignored on receipt.

Flags: this 8-bit field is for future definition and use. For now, set to zero on transmission and ignored on receipt.

Type: this 8-bit field is specific to the LISP Canonical Address formatted encodings, values are:

Type 0: Null Body Type

Type 1: AFI List Type

Type 2: Instance ID Type

Type 3: AS Number Type

Type 4: Application Data Type

Type 5: Geo Coordinates Type

Type 6: Opaque Key Type

Type 7: NAT-Traversal Type

Type 8: Nonce Locator Type

Rsvd2: this 8-bit field is reserved for future use and MUST be transmitted as 0 and ignored on receipt.

Length: this 16-bit field is in units of bytes and covers all of the LISP Canonical Address payload, starting and including the byte after the Length field. So any LCAF encoded address will have a minimum length of 8 bytes when the Length field is 0. The 8 bytes include the AFI, Flags, Type, Reserved, and Length fields. When the AFI is not next to encoded address in a control message, then the encoded address will have a minimum length of 6 bytes when the Length field is 0. The 6 bytes include the Flags, Type, Reserved, and Length fields.

4. LISP Canonical Address Applications

4.1. Segmentation using LISP

When multiple organizations inside of a LISP site are using private addresses [RFC1918] as EID-prefixes, their address spaces must remain segregated due to possible address duplication. An Instance ID in the address encoding can aid in making the entire AFI based address unique.

Another use for the Instance ID LISP Canonical Address Format is when creating multiple segmented VPNs inside of a LISP site where keeping EID-prefix based subnets is desirable.

Instance ID LISP Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |    Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 2    |     Rsvd2     |             4 + n             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Instance ID                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              AFI = x          |         Address  ...          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length value n: length in bytes of the AFI address that follows the Instance ID field including the AFI field itself.

Instance ID: the low-order 24-bits that can go into a LISP data header when the I-bit is set. See [LISP] for details.

AFI = x: x can be any AFI value from [AFI].

This LISP Canonical Address Type can be used to encode either EID or RLOC addresses.

4.2. Carrying AS Numbers in the Mapping Database

When an AS number is stored in the LISP Mapping Database System for either policy or documentation reasons, it can be encoded in a LISP Canonical Address.

AS Number LISP Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |    Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 3    |     Rsvd2     |             4 + n             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           AS Number                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              AFI = x          |         Address  ...          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length value n: length in bytes of the AFI address that follows the AS Number field including the AFI field itself.

AS Number: the 32-bit AS number of the autonomous system that has been assigned either the EID or RLOC that follows.

AFI = x: x can be any AFI value from [AFI].

The AS Number Canonical Address Type can be used to encode either EID or RLOC addresses. The former is used to describe the LISP-ALT AS number the EID-prefix for the site is being carried for. The latter is used to describe the AS that is carrying RLOC based prefixes in the underlying routing system.

4.3. Convey Application Specific Data

When a locator-set needs to be conveyed based on the type of application or the Per-Hop Behavior (PHB) of a packet, the Application Data Type can be used.

Application Data LISP Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |    Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 4    |     Rsvd2     |             8 + n             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       IP TOS, IPv6 TC, or Flow Label          |    Protocol   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Local Port          |         Remote Port           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              AFI = x          |         Address  ...          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length value n: length in bytes of the AFI address that follows the 8-byte Application Data fields including the AFI field itself.

IP TOS, IPv6 TC, or Flow Label: this field stores the 8-bit IPv4 TOS field used in an IPv4 header, the 8-bit IPv6 Traffic Class or Flow Label used in an IPv6 header.

Local Port/Remote Port: these fields are from the TCP, UDP, or SCTP transport header.

AFI = x: x can be any AFI value from [AFI].

The Application Data Canonical Address Type is used for an EID encoding when an ITR wants a locator-set for a specific application. When used for an RLOC encoding, the ETR is supplying a locator-set for each specific application is has been configured to advertise.

4.4. Assigning Geo Coordinates to Locator Addresses

If an ETR desires to send a Map-Reply describing the Geo Coordinates for each locator in its locator-set, it can use the Geo Coordinate Type to convey physical location information.

Geo Coordinate LISP Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |    Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 5    |     Rsvd2     |             8 + n             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|N|     Latitude Degrees        |    Minutes    |    Seconds    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|E|     Longitude Degrees       |    Minutes    |    Seconds    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              AFI = x          |         Address  ...          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length value n: length in bytes of the AFI address that follows the 8-byte Longitude and Latitude fields including the AFI field itself.

N: When set to 1 means North, otherwise South.

Latitude Degrees: Valid values range from 0 to 90. degrees above or below the equator (northern or southern hemisphere, respectively).

Latitude Minutes: Valid values range from 0 to 59.

Latitude Seconds: Valid values range from 0 to 59.

E: When set to 1 means East, otherwise West.

Longitude Degrees: Value values are from 0 to 90 degrees right or left of the Prime Meridian.

Longitude Minutes: Valid values range from 0 to 59.

Longitude Seconds: Valid values range from 0 to 59.

AFI = x: x can be any AFI value from [AFI].

The Geo Coordinates Canonical Address Type can be used to encode either EID or RLOC addresses. When used for EID encodings, you can

determine the physical location of an EID along with the topological location by observing the locator-set.

4.5. Generic Database Mapping Lookups

When the LISP Mapping Database system holds information accessed by a generic formatted key (where the key is not the usual IPv4 or IPv6 address), an opaque key may be desirable.

Opaque Key LISP Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |    Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 6    |     Rsvd2     |               n               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Key Field Num |      Key Wildcard Fields      |   Key . . .   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       . . . Key                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length value n: length in bytes of the type's payload. The value n is the number of bytes that follow this Length field.

Key Field Num: the number of fields (minus 1) the key can be broken up into. The width of the fields are fixed length. So for a key size of 8 bytes, with a Key Field Num of 4 allows 4 fields of 2 bytes in length. Valid values for this field range from 0 to 15 supporting a maximum of 16 field separations.

Key Wildcard Fields: describes which fields in the key are not used as part of the key lookup. This wildcard encoding is a bitfield. Each bit is a don't-care bit for a corresponding field in the key. Bit 0 (the low-order bit) in this bitfield corresponds the first field, right-justified in the key, bit 1 the second field, and so on. When a bit is set in the bitfield it is a don't-care bit and should not be considered as part of the database lookup. When the entire 16-bits is set to 0, then all bits of the key are used for the database lookup.

Key: the variable length key used to do a LISP Database Mapping lookup. The length of the key is the value n (shown above) minus 3.

4.6. NAT Travesal Scenarios

When a LISP system is conveying global address and mapped port information when traversing through a NAT device, the NAT-Traversal LCAF Type is used.

NAT-Traversal Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |    Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 7    |     Rsvd2     |             4 + n             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Reserved            |         UDP Port Number       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              AFI = x          |    Global RLOC Address  ...   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              AFI = x          |   Private RLOC Address  ...   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              AFI = x          |      NTR RLOC Address  ...    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length value n: length in bytes of the AFI addresses that follows the UDP Port Number field including the AFI fields themselves.

Reserved: must be set to zero and ignore on receipt.

UDP Port Number this is the port number returned to a LISP system which was copied from the source port from a packet that has flowed through a NAT device.

AFI = x: x can be any AFI value from [AFI].

Global RLOC Address: this is an address known to be globally unique built by NAT-traversal functionality in a LISP router.

Private RLOC Address: this is an address known to be a private address inserted in this LCAF format by a LISP router that resides on the private side of a NAT device.

NTR RLOC Address: this is an encapsulation address used by an ITR or PITR which resides behind a NAT device. This address is known to have state in a NAT device so packets can flow from it to the LISP ETR behind the NAT.

4.7. PETR Admission Control Functionality

When a public PETR device wants to verify who is encapsulating to it, it can check for a specific nonce value in the LISP encapsulated packet. To convey the nonce to admitted ITRs or PITRs, this LCAF format is used in a Map-Register or Map-Reply locator-record.

Nonce Locator Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |    Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 8    |     Rsvd2     |             4 + n             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Reserved    |                  Nonce                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              AFI = x          |         Address  ...          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length value n: length in bytes of the AFI address that follows the Nonce field including the AFI field itself.

Reserved: must be set to zero and ignore on receipt.

Nonce: this is a nonce value returned by an ETR in a Map-Reply locator-record to be used by an ITR or PITR when encapsulating to the locator address encoded in the AFI field of this LCAF type.

AFI = x: x can be any AFI value from [AFI].

4.8. Applications for AFI List Type

4.8.1. Binding IPv4 and IPv6 Addresses

When header translation between IPv4 and IPv6 is desirable a LISP Canonical Address can use the AFI List Type to carry multiple AFIs in one LCA AFI.

Bounded Address LISP Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |     Flags     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 1    |     Rsvd2     |         2 + 4 + 2 + 16        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            AFI = 1            |       IPv4 Address ...        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     ...  IPv4 Address         |            AFI = 2            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          IPv6 Address ...                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     ...  IPv6 Address  ...                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     ...  IPv6 Address  ...                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     ...  IPv6 Address                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length: length in bytes is fixed at 24 when IPv4 and IPv6 AFI encoded addresses are used.

This type of address format can be included in a Map-Request when the address is being used as an EID, but the Mapping Database System lookup destination can use only the IPv4 address. This is so a Mapping Database Service Transport System, such as LISP-ALT [ALT], can use the Map-Request destination address to route the control message to the desired LISP site.

4.8.2. Layer-2 VPNs

When MAC addresses are stored in the LISP Mapping Database System, the AFI List Type can be used to carry AFI 6.

MAC Address LISP Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |     Flags     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 1    |     Rsvd2     |             2 + 6             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             AFI = 6           |    Layer-2 MAC Address  ...   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     ... Layer-2 MAC Address                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length: length in bytes is fixed at 8 when MAC address AFI encoded addresses are used.

This address format can be used to connect layer-2 domains together using LISP over an IPv4 or IPv6 core network to create a layer-2 VPN. In this use-case, a MAC address is being used as an EID, and the locator-set that this EID maps to can be an IPv4 or IPv6 RLOCs, or even another MAC address being used as an RLOC.

4.8.3. ASCII Names in the Mapping Database

If DNS names or URIs are stored in the LISP Mapping Database System, the AFI List Type can be used to carry an ASCII string where it is delimited by length 'n' of the LCAF Length encoding.

ASCII LISP Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |     Flags     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 1    |     Rsvd2     |             2 + n             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             AFI = 17          |      DNS Name or URI  ...     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length value n: length in bytes AFI=17 field and the null-terminated ASCII string (the last byte of 0 is included).

4.8.4. Using Recursive LISP Canonical Address Encodings

When any combination of above is desirable, the AFI List Type value can be used to carry within the LCA AFI another LCA AFI.

Recursive LISP Canonical Address Format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |    Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 1    |     Rsvd2     |         4 + 8 + 2 + 4         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           AFI = 16387         |    Rsvd1      |    Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type = 4    |     Rsvd2     |              12               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   IP TOS, IPv6 QQS or Flow Label              |    Protocol   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Local Port          |         Remote Port           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            AFI = 1            |       IPv4 Address ...        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     ...  IPv4 Address         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length: length in bytes is fixed at 18 when an AFI=1 IPv4 address is included.

This format could be used by a Mapping Database Transport System, such as LISP-ALT [ALT], where the AFI=1 IPv4 address is used as an EID and placed in the Map-Request destination address by the sending LISP system. The ALT system can deliver the Map-Request to the LISP destination site independent of the Application Data Type AFI payload values. When this AFI is processed by the destination LISP site, it can return different locator-sets based on the type of application or level of service that is being requested.

5. Security Considerations

There are no security considerations for this specification. The security considerations are documented for the protocols that use LISP Canonical Addressing. Refer to the those relevant specifications.

6. IANA Considerations

The Address Family AFI definitions from [AFI] only allocate code-points for the AFI value itself. The length of the address or entity that follows is not defined and is implied based on conventional experience. Where the LISP protocol uses LISP Canonical Addresses specifically, the address length definitions will be in this specification and take precedent over any other specification.

An IANA Registry for LCAF Type values will be created. The values that are considered for use by the main LISP specification [LISP] will be in the IANA Registry. Other Type values used for experimentation will be defined and described in this document.

7. References

7.1. Normative References

[RFC1700] Reynolds, J. and J. Postel, "Assigned Numbers", RFC 1700, October 1994.

[RFC1918] Rekhter, Y., Moskowitz, R., Karrenberg, D., Groot, G., and E. Lear, "Address Allocation for Private Internets", BCP 5, RFC 1918, February 1996.

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Appendix A. Acknowledgments

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