                 Transmission of IPv6 Packets over Ethernet Networks

Status of this Memo

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1. Introduction

   This document specifies the frame format for transmission of IPv6
   packets and the method of forming IPv6 link-local addresses and
   statelessly autoconfigured addresses on Ethernet networks. It also
   specifies the content of the Source/Target Link-layer Address option
   used in Router Solicitation, Router Advertisement, Neighbor
   Solicitation, Neighbor Advertisement and Redirect messages when those
   messages are transmitted on an Ethernet.

   This document replaces RFC 1972, "A Method for the Transmission of
   IPv6 Packets over Ethernet Networks", which will become historic.

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in [RFC 2119].

2. Maximum Transmission Unit

   The default MTU size for IPv6 [IPV6] packets on an Ethernet is 1500
   octets. This size may be reduced by a Router Advertisement [DISC]
   containing an MTU option which specifies a smaller MTU, or by manual
   configuration of each node. If a Router Advertisement received on an
   Ethernet interface has an MTU option specifying an MTU larger than
   1500, or larger than a manually configured value, that MTU option may
   be logged to system management but must be otherwise ignored.

   For purposes of this document, information received from DHCP is
   considered "manually configured" and the term Ethernet includes
   CSMA/CD and full-duplex subnetworks based on ISO/IEC 8802-3, with
   various data rates.

3. Frame Format

   IPv6 packets are transmitted in standard Ethernet frames. The
   Ethernet header contains the Destination and Source Ethernet
   addresses and the Ethernet type code, which must contain the value
   86DD hexadecimal. The data field contains the IPv6 header followed
   immediately by the payload, and possibly padding octets to meet the
   minimum frame size for the Ethernet link.

```
                     0                   1
                     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |           Destination         |
                    +-                             -+
                    |            Ethernet           |
                    +-                             -+
                    |            Address            |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |             Source            |
                    +-                             -+
                    |            Ethernet           |
                    +-                             -+
                    |            Address            |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |1 0 0 0 0 1 1 0 1 1 0 1 1 1 0 1|
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |             IPv6              |
                    +-                             -+
                    |            header             |
                    +-                             -+
                    |             and               |
                    +-                             -+
                    /           payload ...         /
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
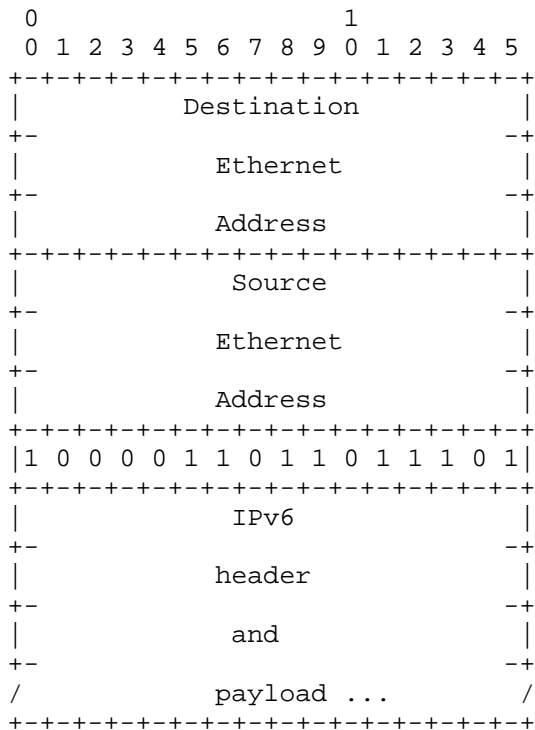
   (Each tic mark represents one bit.)

4. Stateless Autoconfiguration

   The Interface Identifier [AARCH] for an Ethernet interface is based
   on the EUI-64 identifier [EUI64] derived from the interface's built-
   in 48-bit IEEE 802 address. The EUI-64 is formed as follows.
   (Canonical bit order is assumed throughout.)

   The OUI of the Ethernet address (the first three octets) becomes the
   company_id of the EUI-64 (the first three octets). The fourth and
   fifth octets of the EUI are set to the fixed value FFFE hexadecimal.
   The last three octets of the Ethernet address become the last three
   octets of the EUI-64.

   The Interface Identifier is then formed from the EUI-64 by
   complementing the "Universal/Local" (U/L) bit, which is the next-to-
   lowest order bit of the first octet of the EUI-64. Complementing
   this bit will generally change a 0 value to a 1, since an interface's
   built-in address is expected to be from a universally administered
   address space and hence have a globally unique value. A universally
   administered IEEE 802 address or an EUI-64 is signified by a 0 in the
   U/L bit position, while a globally unique IPv6 Interface Identifier
   is signified by a 1 in the corresponding position. For further
   discussion on this point, see [AARCH].

   For example, the Interface Identifier for an Ethernet interface whose
   built-in address is, in hexadecimal,

                        34-56-78-9A-BC-DE

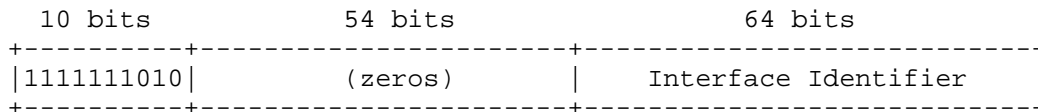   would be

                        36-56-78-FF-FE-9A-BC-DE.

   A different MAC address set manually or by software should not be
   used to derive the Interface Identifier. If such a MAC address must
   be used, its global uniqueness property should be reflected in the
   value of the U/L bit.

   An IPv6 address prefix used for stateless autoconfiguration [ACONF]
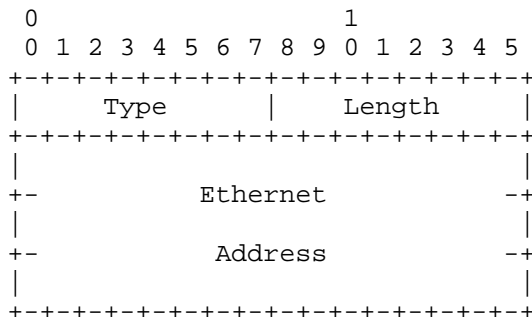   of an Ethernet interface must have a length of 64 bits.

5. Link-Local Addresses

   The IPv6 link-local address [AARCH] for an Ethernet interface is
   formed by appending the Interface Identifier, as defined above, to
   the prefix FE80::/64.

```
     10 bits            54 bits                      64 bits
   +----------+-----------------------+----------------------------+
   |1111111010|        (zeros)        |     Interface Identifier   |
   +----------+-----------------------+----------------------------+
```

6. Address Mapping -- Unicast

   The procedure for mapping IPv6 unicast addresses into Ethernet link-
   layer addresses is described in [DISC]. The Source/Target Link-layer
   Address option has the following form when the link layer is
   Ethernet.

```
                     0                   1
                     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |     Type      |    Length     |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |                               |
                    +-        Ethernet            -+
                    |                               |
                    +-        Address             -+
                    |                               |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Option fields:

   Type   1 for Source Link-layer address.
               2 for Target Link-layer address.

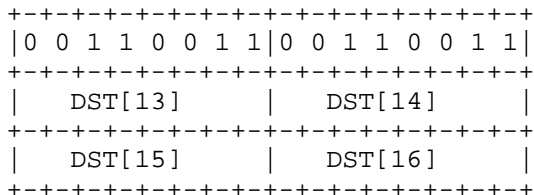   Length   1 (in units of 8 octets).

   Ethernet Address
               The 48 bit Ethernet IEEE 802 address, in canonical bit
               order. This is the address the interface currently
               responds to, and may be different from the built-in
               address used to derive the Interface Identifier.

7. Address Mapping -- Multicast

   An IPv6 packet with a multicast destination address DST, consisting
   of the sixteen octets DST[1] through DST[16], is transmitted to the
   Ethernet multicast address whose first two octets are the value 3333
   hexadecimal and whose last four octets are the last four octets of
   DST.

```
               +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
               |0 0 1 1 0 0 1 1|0 0 1 1 0 0 1 1|
               +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
               |    DST[13]     |    DST[14]    |
               +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
               |    DST[15]     |    DST[16]    |
               +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

8. Differences From RFC 1972

   The following are the functional differences between this
   specification and RFC 1972.

      The Address Token, which was a node's 48-bit MAC address, is
      replaced with the Interface Identifier, which is 64 bits in
      length and based on the EUI-64 format [EUI64]. An IEEE-defined
      mapping exists from 48-bit MAC addresses to EUI-64 form.

      A prefix used for stateless autoconfiguration must now be 64 bits
      long rather than 80. The link-local prefix is also shortened to
      64 bits.

9. Security Considerations

   The method of derivation of Interface Identifiers from MAC addresses
   is intended to preserve global uniqueness when possible. However,
   there is no protection from duplication through accident or forgery.

10. References

   [AARCH] Hinden, R. and S. Deering "IP Version 6 Addressing
           Architecture", RFC 2373, July 1998.

   [ACONF] Thomson, S. and T. Narten, "IPv6 Stateless Address
           Autoconfiguration", RFC 2462, December 1998.

   [DISC] Narten, T., Nordmark, E. and W. Simpson, "Neighbor Discovery
           for IP Version 6 (IPv6)", RFC 2461, December 1998.

   [EUI64] "Guidelines For 64-bit Global Identifier (EUI-64)",
           http://standards.ieee.org/db/oui/tutorials/EUI64.html

   [IPV6] Deering, S. and R. Hinden, "Internet Protocol, Version 6
           (IPv6) Specification", RFC 2460, December 1998.

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

11. Author's Address

   Matt Crawford
   Fermilab MS 368
   PO Box 500
   Batavia, IL 60510
   USA

   Phone: +1 630 840-3461
   EMail: crawdad@fnal.gov

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