                 Transmission of IPv6 Packets over FDDI 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 FDDI 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 FDDI network.

   This document replaces RFC 2019, "Transmission of IPv6 Packets Over
   FDDI", 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

   FDDI permits a frame length of 4500 octets (9000 symbols), including
   at least 22 octets (44 symbols) of Data Link encapsulation when
   long-format addresses are used. Subtracting 8 octets of LLC/SNAP
   header, this would, in principle, allow the IPv6 [IPV6] packet in the
   Information field to be up to 4470 octets. However, it is desirable
   to allow for the variable sizes and possible future extensions of the
   MAC header and frame status fields. The default MTU size for IPv6
   packets on an FDDI network is therefore 4352 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 FDDI interface has an
MTU option specifying an MTU larger than 4352, 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 FDDI includes CDDI.

3. Frame Format

FDDI provides both synchronous and asynchronous transmission, with
the latter class further subdivided by the use of restricted and
unrestricted tokens. Only asynchronous transmission with
unrestricted tokens is required for FDDI interoperability.
Accordingly, IPv6 packets shall be sent in asynchronous frames using
unrestricted tokens. The robustness principle dictates that nodes
should be able to receive synchronous frames and asynchronous frames
sent using restricted tokens.

IPv6 packets are transmitted in LLC/SNAP frames, using long-format
(48 bit) addresses. The data field contains the IPv6 header and
payload and is followed by the FDDI Frame Check Sequence, Ending
Delimiter, and Frame Status symbols.

```
                    0                       1
                    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
                                    +-+-+-+-+-+-+-+-+
                                    |      FC       |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |          Destination          |
                    +-                             -+
                    |            FDDI               |
                    +-                             -+
                    |           Address             |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |            Source             |
                    +-                             -+
                    |            FDDI               |
                    +-                             -+
                    |           Address             |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |    DSAP       |    SSAP        |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |    CTL        |    OUI ...     |
                    +-+-+-+-+-+-+-+-+               +
                    |         ... OUI               |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |           Ethertype           |
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                    |            IPv6               |
                    +-                             -+
                    |           header              |
                    +-                             -+
                    |            and                |
                    +-                             -+
                    /          payload ...          /
                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

            (Each tic mark represents one bit.)

    FDDI Header Fields:

    FC   The Frame Code must be in the range 50 to 57
                hexadecimal, inclusive, with the three low order bits
                indicating the frame priority.

    DSAP, SSAP Both the DSAP and SSAP fields shall contain the value AA
                hexadecimal, indicating SNAP encapsulation.

    CTL   The Control field shall be set to 03 hexadecimal,
                indicating Unnumbered Information.

OUI   The Organizationally Unique Identifier shall be set to
            000000 hexadecimal.

Ethertype   The Ethernet protocol type ("ethertype") shall be set to
            the value 86DD hexadecimal.

4. Interaction with Bridges

   802.1d MAC bridges which connect different media, for example
   Ethernet and FDDI, have become very widespread. Some of them do IPv4
   packet fragmentation and/or support IPv4 Path MTU discovery [RFC
   1981], many others do not, or do so incorrectly. Use of IPv6 in a
   bridged mixed-media environment must not depend on support from MAC
   bridges, unless those bridges are known to correctly implement IPv6
   Path MTU Discovery [RFC 1981, ICMPV6].

   For correct operation when mixed media are bridged together by
   bridges which do not support IPv6 Path MTU Discovery, the smallest
   MTU of all the media must be advertised by routers in an MTU option.
   If there are no routers present, this MTU must be manually configured
   in each node which is connected to a medium with a default MTU larger
   than the smallest MTU.

5. Stateless Autoconfiguration

   The Interface Identifier [AARCH] for an FDDI 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. See [CANON] for a
   caution on bit-order effects in LAN interfaces.)

   The OUI of the FDDI MAC 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 FDDI MAC 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. For further
   discussion on this point, see [ETHER] and [AARCH].

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

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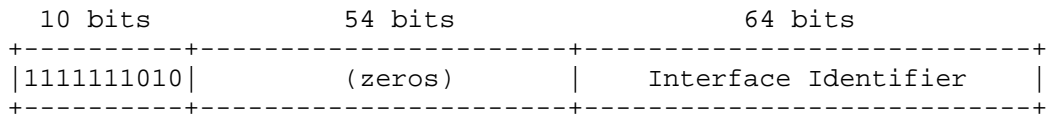
would be

                          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]
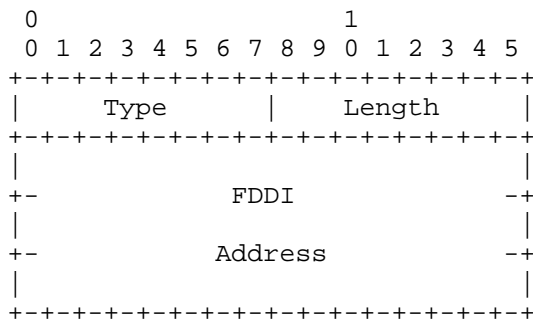of an FDDI interface must have a length of 64 bits.

6. Link-Local Addresses

The IPv6 link-local address [AARCH] for an FDDI 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    |
  +----------+-----------------------+---------------------------+
```

7. Address Mapping -- Unicast

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

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

Option fields:

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

Length   1 (in units of 8 octets).

FDDI Address
              The 48 bit FDDI 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.

8. 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
   FDDI 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]     |
                 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

9. Differences From RFC 2019

   The following are the functional differences between this
   specification and RFC 2019.

        "FDDI adjacency detection" has been removed, due to recent work
        in IEEE 802.1p.

        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.

10. 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.

11. 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.

   [CANON] Narten, T. and C. Burton, "A Caution On The Canonical
            Ordering Of Link-Layer Addresses", RFC 2469, December 1998.

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

   [ETHER] Crawford, M., "Transmission of IPv6 Packets over Ethernet
            Networks", RFC 2464, December 1998.

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

   [ICMPV6] Conta, A. and S. Deering, "Internet Control Message
             Protocol (ICMPv6) for the Internet Protocol Version 6
             (IPv6) Specification", RFC 2463, December 1998.

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

   [RFC 1981] McCann, J., Deering, S. and J. Mogul, "Path MTU Discovery
               for IP version 6", RFC 1981, August 1996.

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

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