            IANA Considerations and IETF Protocol and Documentation Usage
                        for IEEE 802 Parameters

Abstract

   Some IETF protocols make use of Ethernet frame formats and IEEE 802
   parameters. This document discusses several uses of such parameters
   in IETF protocols, specifies IANA considerations for assignment of
   points under the IANA OUI (Organizationally Unique Identifier), and
   provides some values for use in documentation. This document
   obsoletes RFC 5342.

Status of This Memo

   This memo documents an Internet Best Current Practice.

   This document is a product of the Internet Engineering Task Force
   (IETF). It represents the consensus of the IETF community. It has
   received public review and has been approved for publication by the
   Internet Engineering Steering Group (IESG). Further information on
   BCPs is available in Section 2 of RFC 5741.

   Information about the current status of this document, any errata,
   and how to provide feedback on it may be obtained at
   http://www.rfc-editor.org/info/rfc7042.

Copyright Notice

Table of Contents

1. Introduction

   Some IETF protocols use Ethernet or other IEEE 802-related
   communication frame formats and parameters [IEEE802]. These include
   MAC (Media Access Control) identifiers and protocol identifiers.

   This document specifies IANA considerations for the assignment of
   code points under the IANA OUI. It also discusses several other uses
   by the IETF of IEEE 802 code points and provides some values for use
   in documentation. As noted in [RFC2606] and [RFC5737], the use of
   designated code values reserved for documentation and examples
   reduces the likelihood of conflicts and confusion arising from their
   duplication of code points assigned for some deployed use.

   [RFC5226] is incorporated herein except where there are contrary
   provisions in this document. In this document, "IESG Ratification"
   is used in some cases, and it is specified in Section 5.1. This is
   not the same as "IESG Approval" in [RFC5226].

1.1. Notations Used in This Document

   This document uses hexadecimal notation. Each octet (that is, 8-bit
   byte) is represented by two hexadecimal digits giving the value of
   the octet as an unsigned integer. Successive octets are separated by
   a hyphen. This document consistently uses IETF bit ordering although
   the physical order of bit transmission within an octet on an IEEE
   [802.3] link is from the lowest order bit to the highest order bit
   (i.e., the reverse of the IETF's ordering).

   In this document:

   "AFN"   stands for Address Family Number [RFC4760].

   "EUI"   stands for Extended Unique Identifier.

   "IAB"   stands for Individual Address Block, not for Internet
             Architecture Board.

   "MAC"   stands for Media Access Control, not for Message
             Authentication Code.

   "OUI"   stands for Organizationally Unique Identifier.

   "RRTYPE" stands for a DNS Resource Record type [RFC6895].

   "**"   indicates exponentiation. For example, 2**24 is two to the
             twenty-fourth power.

1.2. Changes from RFC 5342

   o Added MAC addresses and IANA OUI-based protocol and other values
      for use in documentation, and added relevant Security
      Considerations language.

   o Eliminated any requirements for parallel unicast and multicast
      assignment unless requested. Such requirements had been included
      in [RFC5342] on the theory they would make bookkeeping easier for
      IANA but they have proved to be problematic in practice.

   o Re-casted informational material about relevant IEEE assignment
      policies to take into account [RAC-OUI].

   o Added AFNs and RRTYPEs for 48-bit and 64-bit MACs.

1.3. The IEEE Registration Authority

   Originally the responsibility of Xerox Corporation, the registration
   authority for Ethernet parameters is now the IEEE Registration
   Authority, available on the web at:

      http://standards.ieee.org/regauth/

   Anyone may apply to that Authority for parameters. They may impose
   fees or other requirements but commonly waive fees for applications
   from standards development organizations.

   A list of some assignments and their holders is downloadable from the
   IEEE Registration Authority site.

1.4. The IANA OUI

   The OUI 00-00-5E has been assigned to IANA.

   There is no OUI value reserved at this time for documentation, but
   there are documentation code points under the IANA OUI specified
   below.

2. Ethernet Identifier Parameters

   Section 2.1 discusses EUI-48 (Extended Unique Identifier 48) MAC
   identifiers, their relationship to OUIs and other prefixes, and
   assignments under the IANA OUI. Section 2.2 extends this to EUI-64
   identifiers. Section 2.3 discusses other IETF MAC identifier use not
   under the IANA OUI.

   [RAC-OUI] indicates that the IEEE Registration Authority Committee is
   exploring the feasibility of defining a new "EUI-128" identifier.

2.1. 48-Bit MAC Identifiers, OUIs, and Other Prefixes

   48-bit MAC "addresses" are the most commonly used Ethernet interface
   identifiers. Those that are globally unique are also called EUI-48
   identifiers. An EUI-48 is structured into an initial 3-octet OUI
   (Organizationally Unique Identifier) and an additional 3 octets
   assigned by the OUI holder or into a larger initial prefix assigned
   to an organization and a shorter sequence of additional bits so as to
   add up to 48 bits in total. For example, the IEEE has assigned IABs
   (Individual Address Blocks), where the first 4 1/2 octets (36 bits)
   are assigned, giving the holder of the IAB 1 1/2 octets (12 bits)
   they can control; however, IABs will become historic, and a wider
   range of prefix lengths will be made available [RAC-OUI].

   The IEEE describes its assignment procedures and policies for IEEE
   802-related identifiers in [802_O&A], which is being revised.

   Two bits within the initial octet of an EUI-48 have special
   significance in MAC addresses: the Group bit (01) and the Local bit
   (02). OUIs and longer MAC prefixes are assigned with the Local bit
   zero and the Group bit unspecified. Multicast identifiers may be
   constructed by turning on the Group bit, and unicast identifiers may
   be constructed by leaving the Group bit zero.

   The Local bit is zero for globally unique EUI-48 identifiers assigned
   by the owner of an OUI or owner of a longer prefix. If the Local bit
   is a one, the identifier has been considered by IEEE 802 to be a
   local identifier under the control of the local network
   administrator; however, there may be emerging recommendations from
   the IEEE Registration Authority on management of the local address
   space. If the Local bit is on, the holder of an OUI has no special
   authority over MAC identifiers whose first 3 octets correspond to
   their OUI.

   An AFN and a DNS RRTYPE have been assigned for 48-bit MAC addresses
   (see Section 5.2).

2.1.1. EUI-48 Assignments under the IANA OUI

   The OUI 00-00-5E has been assigned to IANA as stated in Section 1.4
   above. This includes 2**24 EUI-48 multicast identifiers from
   01-00-5E-00-00-00 to 01-00-5E-FF-FF-FF and 2**24 EUI-48 unicast
   identifiers from 00-00-5E-00-00-00 to 00-00-5E-FF-FF-FF.

Of these EUI-48 identifiers, the sub-blocks reserved or thus far
assigned by IANA for purposes of documentation are as follows:

Unicast, all blocks of 2**8 addresses thus far:

   00-00-5E-00-00-00 through 00-00-5E-00-00-FF: reserved and require
      IESG Ratification for assignment (see Section 5.1).

   00-00-5E-00-01-00 through 00-00-5E-00-01-FF: assigned for the
      Virtual Router Redundancy Protocol (VRRP) [RFC5798].

   00-00-5E-00-02-00 through 00-00-5E-00-02-FF: assigned for the IPv6
      Virtual Router Redundancy Protocol (IPv6 VRRP) [RFC5798].

   00-00-5E-00-52-00 through 00-00-5E-00-52-FF: used for very small
      assignments. Currently, 3 out of these 256 values have been
      assigned.

   00-00-5E-00-53-00 through 00-00-5E-00-53-FF: assigned for use in
      documentation.

Multicast:

   01-00-5E-00-00-00 through 01-00-5E-7F-FF-FF: 2**23 addresses
      assigned for IPv4 multicast [RFC1112].

   01-00-5E-80-00-00 through 01-00-5E-8F-FF-FF: 2**20 addresses
      assigned for MPLS multicast [RFC5332].

   01-00-5E-90-00-00 through 01-00-5E-90-00-FF: 2**8 addresses being
      used for very small assignments. Currently, 4 out of these 256
      values have been assigned.

   01-00-5E-90-10-00 through 01-00-5E-90-10-FF: 2**8 addresses for
      use in documentation.

   For more detailed and up-to-date information, see the "Ethernet
   Numbers" registry at http://www.iana.org.

2.1.2. EUI-48 Documentation Values

   The following values have been assigned for use in documentation:

      00-00-5E-00-53-00 through 00-00-5E-00-53-FF for unicast and

      01-00-5E-90-10-00 through 01-00-5E-90-10-FF for multicast.

2.1.3. EUI-48 IANA Assignment Considerations

   EUI-48 assignments under the current or a future IANA OUI (see
   Section 5.4) must meet the following requirements:

      o must be for standards purposes (either for an IETF Standard or
         other standard related to IETF work),

      o must be for a power-of-two size block of identifiers starting
         at a boundary that is an equal or greater power of two,
         including the assignment of one (2**0) identifier,

      o must not be used to evade the requirement for vendors to obtain
         their own block of identifiers from the IEEE, and

      o must be documented in an Internet-Draft or RFC.

   In addition, approval must be obtained as follows (see the procedure
   in Section 5.1):

      Small to medium assignments of a block of 1, 2, 4, ..., 32768,
         65536 (2**0, 2**1, 2**2, ..., 2**15, 2**16) EUI-48 identifiers
         require Expert Review (see Section 5.1).

      Large assignments of 131072 (2**17) or more EUI-48 identifiers
         require IESG Ratification (see Section 5.1).

   ([RFC5342] had a requirement for parallel unicast and multicast
   assignments under some circumstances even when one of the types was
   not included in the application. That requirement has proved
   impractical and is eliminated in this document.)

2.2. 64-Bit MAC Identifiers

   IEEE also defines a system of 64-bit MAC identifiers including
   EUI-64s. EUI-64 identifiers are currently used as follows:

      o In a modified form to construct some IPv6 interface identifiers
         as described in Section 2.2.1

      o In IEEE Std 1394 (also known as FireWire and i.Link)

      o In IEEE Std 802.15.4 (also known as ZigBee)

      o In [InfiniBand]

Adding a 5-octet (40-bit) extension to a 3-octet (24-bit) OUI, or a
shorter extension to longer assigned prefixes [RAC-OUI] so as to
total 64 bits, produces an EUI-64 identifier under that OUI or longer
prefix. As with EUI-48 identifiers, the first octet has the same
Group and Local bits.

An AFN and a DNS RRTYPE have been assigned for 64-bit MAC addresses
(see Section 5.2).

The discussion below is almost entirely in terms of the "Modified"
form of EUI-64 identifiers; however, anyone assigned such an
identifier can also use the unmodified form as a MAC identifier on
any link that uses such 64-bit identifiers for interfaces.

2.2.1. IPv6 Use of Modified EUI-64 Identifiers

MAC-64 identifiers are used to form the lower 64 bits of some IPv6
addresses (Section 2.5.1 and Appendix A of [RFC4291] and Appendix A
of [RFC5214]). When so used, the MAC-64 is modified by inverting the
Local/Global bit to form an IETF "Modified EUI-64 identifier". Below
is an illustration of a Modified EUI-64 unicast identifier under the
IANA OUI, where aa-bb-cc-dd-ee is the extension.

    02-00-5E-aa-bb-cc-dd-ee

The first octet is shown as 02 rather than 00 because, in Modified
EUI-64 identifiers, the sense of the Local/Global bit is inverted
compared with EUI-48 identifiers. It is the globally unique values
(universal scope) that have the 02 bit on in the first octet, while
those with this bit off are locally assigned and out of scope for
global assignment.

The Local/Global bit was inverted to make it easier for network
operators to type in local-scope identifiers. Thus, such Modified
EUI-64 identifiers as 1, 2, etc. (ignoring leading zeros) are local.
Without the modification, they would have to be
02-00-00-00-00-00-00-01, 02-00-00-00-00-00-00-02, etc. to be local.

As with MAC-48 identifiers, the 01 bit on in the first octet
indicates a group identifier.

When the first two octets of the extension of a Modified EUI-64
identifier are FF-FE, the remainder of the extension is a 24-bit
value as assigned by the OUI owner for an EUI-48. For example:

    02-00-5E-FF-FE-yy-yy-yy
or
    03-00-5E-FF-FE-yy-yy-yy

where yy-yy-yy is the portion (of an EUI-48 global unicast or
multicast identifier) that is assigned by the OUI owner (IANA in this
case). Thus, any holder of one or more EUI-48 identifiers under the
IANA OUI also has an equal number of Modified EUI-64 identifiers that
can be formed by inserting FF-FE in the middle of their EUI-48
identifiers and inverting the Local/Global bit.

   (Note: [EUI-64] defines FF-FF as the bits to be inserted to create
   an IEEE EUI-64 identifier from a MAC-48 identifier. That document
   says the FF-FE value is used when starting with an EUI-48
   identifier. The IETF uses only FF-FE to create Modified EUI-64
   identifiers from 48-bit Ethernet station identifiers regardless of
   whether they are EUI-48 or MAC-48 local identifiers. EUI-48 and
   local MAC-48 identifiers are syntactically equivalent, and this
   doesn't cause any problems in practice.)

In addition, certain Modified EUI-64 identifiers under the IANA OUI
are reserved for holders of IPv4 addresses as follows:

   02-00-5E-FE-xx-xx-xx-xx

where xx-xx-xx-xx is a 32-bit IPv4 address. The owner of an IPv4
address has both the unicast- and multicast-derived EUI-64 address.
Modified EUI-64 identifiers from

   02-00-5E-FE-F0-00-00-00 to 02-00-5E-FE-FF-FF-FF-FF

are effectively reserved pending the specification of IPv4 Class E
addresses. However, for Modified EUI-64 identifiers based on an IPv4
address, the Local/Global bit should be set to correspond to whether
the IPv4 address is local or global. (Keep in mind that the sense of
the Modified EUI-64 identifier Local/Global bit is reversed from that
in (unmodified) MAC-64 identifiers.)

2.2.2. EUI-64 IANA Assignment Considerations

The following table shows which Modified EUI-64 identifiers under the
IANA OUI are reserved, assigned, or available as indicated. As noted
above, the corresponding MAC addresses can be determined by
complementing the 02 bit in the first octet. In all cases, the
corresponding multicast 64-bit MAC addresses formed by complementing
the 01 bit in the first octet have the same status as the modified
64-bit unicast address blocks listed below.

   02-00-5E-00-00-00-00-00 to 02-00-5E-0F-FF-FF-FF-FF reserved

   02-00-5E-10-00-00-00-00 to 02-00-5E-10-00-00-00-FF assigned for
      documentation use

02-00-5E-10-00-00-01-00 to 02-00-5E-EF-FF-FF-FF-FF, which is
    available for assignment

02-00-5E-F0-00-00-00-00 to 02-00-5E-FD-FF-FF-FF-FF reserved

02-00-5E-FE-00-00-00-00 to 02-00-5E-FE-FF-FF-FF-FF assigned to
    IPv4 address holders as described above

02-00-5E-FF-00-00-00-00 to 02-00-5E-FF-FD-FF-FF-FF reserved

02-00-5E-FF-FE-00-00-00 to 02-00-5E-FF-FE-FF-FF-FF assigned for
    holders of EUI-48 identifiers under the IANA OUI as described
    above

02-00-5E-FF-FF-00-00-00 to 02-00-5E-FF-FF-FF-FF-FF reserved

The reserved identifiers above require IESG Ratification (see
Section 5.1) for assignment. IANA EUI-64 identifier assignments
under the IANA OUI must meet the following requirements:

   o must be for standards purposes (either for an IETF Standard or
      other standard related to IETF work),

   o must be for a power-of-two size block of identifiers starting
      at a boundary that is an equal or greater power of two,
      including the assignment of one (2**0) identifier,

   o must not be used to evade the requirement for vendors to obtain
      their own block of identifiers from the IEEE, and

   o must be documented in an Internet-Draft or RFC.

In addition, approval must be obtained as follows (see the procedure
in Section 5.1):

   Small to medium assignments of a block of 1, 2, 4, ..., 134217728,
      268435456 (2**0, 2**1, 2**2, ..., 2**27, 2**28) EUI-64
      identifiers require Expert Review (see Section 5.1).

   Assignments of any size, including 536870912 (2**29) or more
      EUI-64 identifiers, may be made with IESG Ratification (see
      Section 5.1).

2.2.3. EUI-64 Documentation Values

   The following blocks of unmodified 64-bit MAC addresses are for
   documentation use. The IPv4-derived addresses are based on the IPv4
   documentation addresses [RFC5737], and the MAC-derived addresses are
   based on the EUI-48 documentation addresses above.

   Unicast:

      00-00-5E-EF-10-00-00-00 to 00-00-5E-EF-10-00-00-FF general

      00-00-5E-FE-C0-00-02-00 to 00-00-5E-FE-C0-00-02-FF and
      00-00-5E-FE-C6-33-64-00 to 00-00-5E-FE-C6-33-64-FF and
      00-00-5E-FE-CB-00-71-00 to 00-00-5E-FE-CB-00-71-FF IPv4 derived

      00-00-5E-FF-FE-00-53-00 to 00-00-5E-FF-FE-00-53-FF EUI-48 derived

      00-00-5E-FE-EA-C0-00-02 and
      00-00-5E-FE-EA-C6-33-64 and
      00-00-5E-FE-EA-CB-00-71 IPv4 multicast derived from IPv4 unicast
         [RFC6034]

   Multicast:

      01-00-5E-EF-10-00-00-00 to 01-00-5E-EF-10-00-00-FF general

      01-00-5E-FE-C0-00-02-00 to 01-00-5E-FE-C0-00-02-FF and
      01-00-5E-FE-C6-33-64-00 to 01-00-5E-FE-C6-33-64-FF and
      01-00-5E-FE-CB-00-71-00 to 01-00-5E-FE-CB-00-71-FF IPv4 derived

      01-00-5E-FE-EA-C0-00-02 and
      01-00-5E-FE-EA-C6-33-64 and
      01-00-5E-FE-EA-CB-00-71 IPv4 multicast derived from IPv4 unicast
         [RFC6034]

      01-00-5E-FF-FE-90-10-00 to 01-00-5E-FF-FE-90-10-FF EUI-48 derived

2.3. Other MAC-48 Identifiers Used by the IETF

   There are two other blocks of MAC-48 identifiers that are used by the
   IETF as described below.

2.3.1. Identifiers Prefixed "33-33"

   All MAC-48 multicast identifiers prefixed "33-33" (that is, the 2**32
   multicast MAC identifiers in the range from 33-33-00-00-00-00 to
   33-33-FF-FF-FF-FF) are used as specified in [RFC2464] for IPv6
   multicast. In all of these identifiers, the Group bit (the bottom

bit of the first octet) is on, as is required to work properly with
existing hardware as a multicast identifier. They also have the
Local bit on and are used for this purpose in IPv6 networks.

   (Historical note: It was the custom during IPv6 design to use "3"
   for unknown or example values, and 3333 Coyote Hill Road, Palo
   Alto, California, is the address of PARC (Palo Alto Research
   Center, formerly "Xerox PARC"). Ethernet was originally specified
   by the Digital Equipment Corporation, Intel Corporation, and Xerox
   Corporation. The pre-IEEE [802.3] Ethernet protocol has sometimes
   been known as "DIX" Ethernet from the first letters of the names
   of these companies.)

2.3.2. The 'CF Series'

The Informational [RFC2153] declared the 3-octet values from CF-00-00
through CF-FF-FF to be OUIs available for assignment by IANA to
software vendors for use in PPP [RFC1661] or for other uses where
vendors do not otherwise need an IEEE-assigned OUI. It should be
noted that, when used as MAC-48 prefixes, these values have the Local
and Group bits on, while all IEEE-assigned OUIs thus far have those
bits off. The Group bit is meaningless in PPP. To quote [RFC2153]:
"The 'CF0000' series was arbitrarily chosen to match the PPP NLPID
'CF', as a matter of mnemonic convenience."

   CF-00-00 is reserved, and IANA lists multicast identifier
   CF-00-00-00-00-00 as used for Ethernet loopback tests.

In over a decade of availability, only a handful of values in the
'CF Series' have been assigned. (See "Ethernet Numbers"
<http://www.iana.org/assignments/ethernet-numbers> and "PPP Numbers"
<http://www.iana.org/assignments/ppp-numbers>).

2.3.2.1. Changes to RFC 2153

The IANA Considerations in [RFC2153] were updated as follows by the
approval of [RFC5342] (no technical changes were made at that time):

   o Use of these identifiers based on IANA assignment was
      deprecated.

   o IANA was instructed not to assign any further values in the
      'CF Series'.

3. Ethernet Protocol Parameters

   Ethernet protocol parameters provide a means of indicating the
   contents of a frame -- for example, that its contents are IPv4 or
   IPv6.

   The concept has been extended to labeling by "tags". A tag in this
   sense is a prefix whose type is identified by an Ethertype that is
   then followed by either another tag, an Ethertype, or an LSAP (Link-
   Layer Service Access Point) protocol indicator for the "main" body of
   the frame, as described below. Traditionally, in the [802_O&A]
   world, tags are a fixed length and do not include any encoding of
   their own length. Any device that is processing a frame cannot, in
   general, safely process anything in the frame past an Ethertype it
   does not understand. An example is the C-Tag (formerly the Q-Tag)
   [802.1Q]. It provides customer VLAN and priority information for a
   frame.

   There are two types of protocol identifier parameters that can occur
   in Ethernet frames after the initial MAC-48 destination and source
   identifiers:

      Ethertypes: These are 16-bit identifiers appearing as the initial
         two octets after the MAC destination and source (or after a
         tag), which, when considered as an unsigned integer, are equal
         to or larger than 0x0600.

      LSAPs: These are 8-bit protocol identifiers that occur in pairs
         immediately after an initial 16-bit (two-octet) remaining frame
         length, which is in turn after the MAC destination and source
         (or after a tag). Such a length must, when considered as an
         unsigned integer, be less than 0x5DC, or it could be mistaken
         as an Ethertype. LSAPs occur in pairs where one is intended to
         indicate the source protocol handler and one the destination
         protocol handler; however, use cases where the two are
         different have been relatively rare.

   Neither Ethertypes nor LSAPs are assigned by IANA; they are assigned
   by the IEEE Registration Authority (see Section 1.3 above and
   Appendix B). However, both LSAPs and Ethertypes have extension
   mechanisms so that they can be used with five-octet Ethernet protocol
   identifiers under an OUI, including those assigned by IANA under the
   IANA OUI.

When using the IEEE 802 Logical Link Control (LLC) format (Subnetwork
Access Protocol (SNAP)) [802_O&A] for a frame, an OUI-based protocol
identifier can be expressed as follows:

    xx-xx-AA-AA-03-yy-yy-yy-zz-zz

where xx-xx is the frame length and, as above, must be small enough
not to be confused with an Ethertype; "AA" is the LSAP that indicates
this use and is sometimes referred to as the SNAP Service Access
Point (SAP); "03" is the LLC control octet indicating datagram
service; yy-yy-yy is an OUI; and zz-zz is a protocol number, under
that OUI, assigned by the OUI owner. The odd five-octet length for
such OUI-based protocol identifiers was chosen so that, with the LLC
control octet ("03"), the result is 16-bit aligned.

When using an Ethertype to indicate the main type for a frame body,
the special "OUI Extended Ethertype" 88-B7 is available. Using this
Ethertype, a frame body can begin with

    88-B7-yy-yy-yy-zz-zz

where yy-yy-yy and zz-zz have the same meaning as in the SNAP format
described above.

It is also possible, within the SNAP format, to use an arbitrary
Ethertype. Putting the Ethertype as the zz-zz field after an all-
zeros OUI (00-00-00) does this. It looks like

    xx-xx-AA-AA-03-00-00-00-zz-zz

where zz-zz is the Ethertype.

    (Note that, at this point, the 802 protocol syntax facilities are
    sufficiently powerful that they could be chained indefinitely.
    Whether support for such chaining is generally required is not
    clear, but [802_O&A] requires support for

        xx-xx-AA-AA-03-00-00-00-88-B7-yy-yy-yy-zz-zz

    although this could be more efficiently expressed by simply
    pinching out the "00-00-00-88-B7" in the middle.)

As well as labeling frame contents, 802 protocol types appear within
NBMA (Non-Broadcast Multi-Access) Next Hop Resolution Protocol
[RFC2332] messages. Such messages have provisions for both two-octet
Ethertypes and OUI-based protocol types.

3.1. Ethernet Protocol Assignment under the IANA OUI

   Two-octet protocol numbers under the IANA OUI are available, as in

      xx-xx-AA-AA-03-00-00-5E-qq-qq

   where qq-qq is the protocol number.

   A number of such assignments have been made out of the 2**16 protocol
   numbers available from 00-00-5E-00-00 to 00-00-5E-FF-FF (see [IANA]).
   The extreme values of this range, 00-00-5E-00-00 and 00-00-5E-FF-FF,
   are reserved and require IESG Ratification for assignment (see
   Section 5.1). New assignments of SNAP SAP protocol (qq-qq) numbers
   under the IANA OUI must meet the following requirements:

      o the assignment must be for standards use (either for an IETF
         Standard or other standard related to IETF work),

      o it must be documented in an Internet-Draft or RFC, and

      o such protocol numbers are not to be assigned for any protocol
         that has an Ethertype (because that can be expressed by putting
         an all-zeros "OUI" before the Ethertype as described above).

   In addition, the Expert Review (or IESG Ratification for the two
   reserved values) must be obtained using the procedure specified in
   Section 5.1.

3.2. Documentation Protocol Number

   0x0042 is a protocol number under the IANA OUI (that is,
   00-00-5E-00-42) to be used for documentation purposes.

4. Other OUI-Based Parameters

   Some IEEE 802 and other protocols provide for parameters based on an
   OUI beyond those discussed above. Such parameters most commonly
   consist of an OUI plus one octet of additional value. They are
   usually called "vendor specific" parameters, although "organization
   specific" might be more accurate. They would look like

      yy-yy-yy-zz

   where yy-yy-yy is the OUI and zz is the additional specifier. An
   example is the Cipher Suite Selector in IEEE [802.11].

   Values may be assigned under the IANA OUI for such other OUI-based
   parameter usage by Expert Review except that, for each use, the

additional specifier values consisting of all zero bits and all one
bits (0x00 (00-00-5E-00) and 0xFF (00-00-5E-FF) for a one-octet
specifier) are reserved and require IESG Ratification (see
Section 5.1) for assignment; also, the additional specifier value
0x42 (00-00-5E-42) is assigned for use in documentation.

Assignments of such other IANA OUI-based parameters must be for
standards use (either for an IETF Standard or other standard related
to IETF work) and be documented in an Internet-Draft or RFC. The
first time a value is assigned for a particular parameter of this
type, an IANA registry will be created to contain that assignment and
any subsequent assignments of values for that parameter under the
IANA OUI. The Expert will specify the name of the registry.

If different policies from those above are required for such a
parameter, a BCP or Standards Track RFC must be adopted to update
this BCP and specify the new policy and parameter.

5. IANA Considerations

The entirety of this document concerns IANA considerations for the
assignment of Ethernet parameters in connection with the IANA OUI and
related matters.

As this document replaces [RFC5342], references to [RFC5342] in IANA
registries have been replaced by references to this document. In
addition, any references in the registries to [DOC-ADDR], which has
been combined into this document, have been replaced by references to
this document.

This document does not create any new IANA registries.

This document assigns MAC address values for documentation. These
values had been previously assigned by [DOC-ADDR]; as noted above,
any references in the registries to [DOC-ADDR] have been replaced by
references to this document.

The only other assignment that has been made by this document is a
protocol number for documentation. See Section 5.6 for details.

No existing assignment is changed by this document.

5.1. Expert Review and IESG Ratification

This section specifies the procedure for Expert Review and IESG
Ratification of MAC, protocol, and other IANA OUI-based identifiers.
The Expert(s) referred to in this document shall consist of one or
more persons appointed by and serving at the pleasure of the IESG.

The procedure described for Expert Review assignments in this
document is fully consistent with the IANA Expert Review policy
described in [RFC5226].

While finite, the universe of code points from which Expert-judged
assignments will be made is felt to be large enough that the
requirements given in this document and the Experts' good judgment
are sufficient guidance. The idea is for the Expert to provide a
light sanity check for small assignments of EUI identifiers, with
increased scrutiny by the Expert for medium-sized assignments of EUI
identifiers and assignments of protocol identifiers and other IANA
OUI-based parameters. However, it can make sense to assign very
large portions of the MAC identifier code point space. (Note that
existing assignments include one for 1/2 of the entire multicast IANA
EUI-48 code point space and one for 1/16 of that multicast code point
space.) In those cases, and in cases of the assignment of "reserved"
values, IESG Ratification of an Expert Review approval recommendation
is required as described below. The procedure is as follows:

     The applicant always completes the appropriate template from
        Appendix A below and sends it to IANA <iana@iana.org>.

     IANA always sends the template to an appointed Expert. If the
        Expert recuses themselves or is non-responsive, IANA may choose
        an alternative appointed Expert or, if none is available, will
        contact the IESG.

     In all cases, if IANA receives a disapproval from an Expert
        selected to review an application template, the application
        will be denied.

     If the assignment is based on Expert Review:

          If IANA receives approval and code points are available,
          IANA will make the requested assignment.

     If the assignment is based on IESG Ratification:

          The procedure starts with the first steps above for Expert
          Review. If the Expert disapproves the application, they
          simply inform IANA; however, if the Expert believes the
          application should be approved, or is uncertain and believes
          that the circumstances warrant the attention of the IESG,
          the Expert will inform IANA about their advice, and IANA
          will forward the application, together with the reasons for
          approval or uncertainty, to the IESG. The IESG must decide
          whether the assignment will be granted. This can be
          accomplished by a management item in an IESG telechat as is

done for other types of requests. If the IESG decides not
to ratify a favorable opinion by the Expert or decides
against an application where the Expert is uncertain, the
application is denied; otherwise, it is granted. The IESG
will communicate its decision to the Expert and to IANA.

5.2. MAC Address AFNs and RRTYPEs

   IANA has assigned Address Family Numbers (AFNs) for MAC addresses as
   follows:

         AFN   Decimal   Hex   Reference
        ----------   -------   ------   ---------
      48-bit MAC   16389   0x4005   [RFC7042]
      64-bit MAC   16390   0x4006   [RFC7042]

   IANA has assigned DNS RRTYPEs [RFC6895] for MAC addresses as follows:

                              RRTYPE Code
         Data   Mnemonic Decimal   Hex   Reference
        ----------   -------- ------- ------   -----------
      48-bit MAC   EUI48   108   0x006C   [RFC7043]
      64-bit MAC   EUI64   109   0x006D   [RFC7043]

5.3. Informational IANA Web Page Material

   IANA maintains an informational listing on its web site concerning
   Ethertypes, OUIs, and multicast addresses assigned under OUIs other
   than the IANA OUI. The title of this informational registry is "IEEE
   802 Numbers". IANA has merged in those Ethertypes listed in Appendix
   B that were not already included. IANA will update that
   informational registry when changes are provided by the Expert.

5.4. OUI Exhaustion

   When the available space for either multicast or unicast EUI-48
   identifiers under OUI 00-00-5E has been 90% or more exhausted, IANA
   should request an additional OUI from the IEEE Registration Authority
   for further IANA assignment. The appointed Expert(s) should monitor
   for this condition and notify IANA.

5.5. IANA OUI MAC Address Table

   No changes have been made in the "IANA Unicast 48-bit MAC Addresses"
   and "IANA Multicast 48-bit MAC Addresses" tables except for the
   updates to references as specified in the first part of Section 5.

5.6. SNAP Protocol Number Table and Assignment

   The "SNAP PROTOCOL IDs" table has been renamed the "SNAP Protocol
   Numbers" table. "PID" has been replaced by "Protocol Number".

   IANA has assigned 0x0042 as the SNAP protocol number under the IANA
   OUI to be used for documentation purposes.

6. Security Considerations

   This document is concerned with assignment of parameters under the
   IANA OUI and closely related matters. It is not directly concerned
   with security except as follows.

   Confusion and conflict can be caused by the use of MAC addresses or
   other OUI-derived protocol parameters as examples in documentation.
   Examples used "only" in documentation can end up being coded and
   released or cause conflicts due to later real use and the possible
   acquisition of intellectual property rights in such addresses or
   parameters. The reservation herein of MAC addresses and parameters
   for documentation purposes will minimize such confusion and conflict.

   See [RFC7043] for security considerations in storing MAC addresses in
   the DNS.

7. Acknowledgements

   The comments and suggestions of the following people, listed in
   alphabetic order, are gratefully acknowledged:

   This document:
      David Black, Adrian Farrel, Bob Grow, Joel Jaeggli, Pearl Liang,
      Glenn Parsons, Pete Resnick, and Dan Romascanu.

   RFC 5342:
      Bernard Aboba, Scott O. Bradner, Ian Calder, Michelle Cotton, Lars
      Eggert, Eric Gray, Alfred Hoenes, Russ Housley, Charlie Kaufman,
      Erik Nordmark, Dan Romascanu, Geoff Thompson, and Mark Townsley.

8. References

8.1. Normative References

   [802_O&A]   "IEEE Standard for Local and Metropolitan Area Networks:
               Overview and Architecture", IEEE Std 802-2001, 8 March
               2002.

               "IEEE Standard for Local and Metropolitan Area Networks:
               Overview and Architecture / Amendment 1: Ethertypes for
               Prototype and Vendor-Specific Protocol Development", IEEE
               Std 802a-2003, 18 September 2003.

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

8.2. Informative References

   [802.1Q]   "IEEE Standard for Local and metropolitan area networks /
               Media Access Control (MAC) Bridges and Virtual Bridge
               Local Area Networks", IEEE Std 802.1Q-2011, 31 August
               2011.

   [802.3]   "IEEE Standard for Ethernet", IEEE Std 802.3-2012, 28
               December 2012.

   [802.11]   "IEEE Standard for Information technology /
               Telecommunications and information exchange between
               systems / Local and metropolitan area networks / Specific
               requirements / Part 11: Wireless LAN Medium Access Control
               (MAC) and Physical Layer (PHY) Specifications", IEEE Std
               802.11-2012, 29 March 2012.

   [DOC-ADDR] Abley, J., "EUI-48 and EUI-64 Address Assignments for use
               in Documentation", Work in Progress, March 2013.

   [EUI-64]   IEEE Registration Authority, "Guidelines for 64-bit Global
               Identifier (EUI-64(TM))", <http://standards.ieee.org/
               regauth/oui/tutorials/EUI64.html>, November 2012.

   [IANA]   Internet Assigned Numbers Authority,
               <http://www.iana.org>.

   [IEEE802]   IEEE 802 LAN/MAN Standards Committee,
               <http://www.ieee802.org>.

   [InfiniBand]
             InfiniBand Trade Association, "InfiniBand Architecture
             Specification Volume 1", November 2007.

   [RAC-OUI] Parsons, G., "OUI Registry Restructuring", Work in
             Progress, September 2013.

   [RFC1112] Deering, S., "Host extensions for IP multicasting", STD 5,
             RFC 1112, August 1989.

   [RFC1661] Simpson, W., Ed., "The Point-to-Point Protocol (PPP)", STD
             51, RFC 1661, July 1994.

   [RFC2153] Simpson, W., "PPP Vendor Extensions", RFC 2153, May 1997.

   [RFC2332] Luciani, J., Katz, D., Piscitello, D., Cole, B., and N.
             Doraswamy, "NBMA Next Hop Resolution Protocol (NHRP)", RFC
             2332, April 1998.

   [RFC2464] Crawford, M., "Transmission of IPv6 Packets over Ethernet
             Networks", RFC 2464, December 1998.

   [RFC2606] Eastlake 3rd, D. and A. Panitz, "Reserved Top Level DNS
             Names", BCP 32, RFC 2606, June 1999.

   [RFC3092] Eastlake 3rd, D., Manros, C., and E. Raymond, "Etymology
             of "Foo"", RFC 3092, April 1 2001.

   [RFC4291] Hinden, R. and S. Deering, "IP Version 6 Addressing
             Architecture", RFC 4291, February 2006.

   [RFC4760] Bates, T., Chandra, R., Katz, D., and Y. Rekhter,
             "Multiprotocol Extensions for BGP-4", RFC 4760, January
             2007.

   [RFC5214] Templin, F., Gleeson, T., and D. Thaler, "Intra-Site
             Automatic Tunnel Addressing Protocol (ISATAP)", RFC 5214,
             March 2008.

   [RFC5332] Eckert, T., Rosen, E., Ed., Aggarwal, R., and Y. Rekhter,
             "MPLS Multicast Encapsulations", RFC 5332, August 2008.

   [RFC5342] Eastlake 3rd, D., "IANA Considerations and IETF Protocol
             Usage for IEEE 802 Parameters", BCP 141, RFC 5342,
             September 2008.

   [RFC5737] Arkko, J., Cotton, M., and L. Vegoda, "IPv4 Address Blocks
             Reserved for Documentation", RFC 5737, January 2010.

   [RFC5798]   Nadas, S., Ed., "Virtual Router Redundancy Protocol (VRRP)
               Version 3 for IPv4 and IPv6", RFC 5798, March 2010.

   [RFC6034]   Thaler, D., "Unicast-Prefix-Based IPv4 Multicast
               Addresses", RFC 6034, October 2010.

   [RFC6895]   Eastlake 3rd, D., "Domain Name System (DNS) IANA
               Considerations", BCP 42, RFC 6895, April 2013.

   [RFC7043]   Abley, J., "Resource Records for EUI-48 and EUI-64
               Addresses in the DNS", RFC 7043, October 2013.

Appendix A. Templates

   This appendix provides the specific templates for IANA assignments of
   parameters. Explanatory words in parentheses in the templates below
   may be deleted in a completed template as submitted to IANA.

A.1. EUI-48/EUI-64 Identifier or Identifier Block Template

   Applicant Name:

   Applicant Email:

   Applicant Telephone: (starting with country code)

   Use Name: (brief name of Parameter use such as "Foo Protocol"
   [RFC3092])

   Document: (ID or RFC specifying use to which the identifier or block
   of identifiers will be put.)

   Specify whether this is an application for EUI-48 or EUI-64
   identifiers:

   Size of Block requested: (must be a power-of-two-sized block, can be
   a block of size one (2**0))

   Specify multicast, unicast, or both:

A.2. IANA OUI-Based Protocol Number Template

   Applicant Name:

   Applicant Email:

   Applicant Telephone: (starting with country code)

   Use Name: (brief name of use of code point such as "Foo Protocol")

   Document: (ID or RFC specifying use to which the protocol identifier
   will be put.)

   Note: (any additional note)

A.3. Other IANA OUI-Based Parameter Template

    Applicant Name:

    Applicant Email:

    Applicant Telephone: (starting with country code)

    Protocol where the OUI-Based Parameter for which a value is being
    requested appears: (such as: Cipher Suite selection in IEEE 802.11)

    Use Name: (brief name of use of code point to be assigned, such as
    "Foo Cipher Suite" [RFC3092])

    Document: (ID or RFC specifying use to which the other IANA OUI-based
    parameter value will be put.)

    Note: (any additional note)

Appendix B. Ethertypes

    This appendix lists some Ethertypes specified for IETF protocols or
    by IEEE 802 as known at the time of publication. A more up-to-date
    list may be available on the IANA web site, currently at [IANA]. The
    IEEE Registration Authority page of Ethertypes,
    http://standards.ieee.org/regauth/ethertype/eth.txt, may also be
    useful. See Section 3 above.

B.1. Some Ethertypes Specified by the IETF

    0x0800 Internet Protocol Version 4 (IPv4)
    0x0806 Address Resolution Protocol (ARP)
    0x0808 Frame Relay ARP
    0x22F3 TRILL
    0x22F4 L2-IS-IS
    0x8035 Reverse Address Resolution Protocol (RARP)
    0x86DD Internet Protocol Version 6 (IPv6)
    0x880B Point-to-Point Protocol (PPP)
    0x880C General Switch Management Protocol (GSMP)
    0x8847 MPLS
    0x8848 MPLS with upstream-assigned label
    0x8861 Multicast Channel Allocation Protocol (MCAP)
    0x8863 PPP over Ethernet (PPPoE) Discovery Stage
    0x8864 PPP over Ethernet (PPPoE) Session Stage
    0x893B TRILL Fine Grained Labeling (FGL)
    0x8946 TRILL RBridge Channel

B.2. Some IEEE 802 Ethertypes

```
   0x8100  IEEE Std 802.1Q   - Customer VLAN Tag Type (C-Tag, formerly
                                 called the Q-Tag) (initially Wellfleet)
   0x8808  IEEE Std 802.3    - Ethernet Passive Optical Network (EPON)
   0x888E  IEEE Std 802.1X   - Port-based network access control
   0x88A8  IEEE Std 802.1Q   - Service VLAN tag identifier (S-Tag)
   0x88B5  IEEE Std 802      - Local Experimental Ethertype
   0x88B6  IEEE Std 802      - Local Experimental Ethertype
   0x88B7  IEEE Std 802      - OUI Extended Ethertype
   0x88C7  IEEE Std 802.11   - Pre-Authentication (802.11i)
   0x88CC  IEEE Std 802.1AB  - Link Layer Discovery Protocol (LLDP)
   0x88E5  IEEE Std 802.1AE  - Media Access Control Security
   0x88F5  IEEE Std 802.1Q   - Multiple VLAN Registration Protocol
                                 (MVRP)
   0x88F6  IEEE Std 802.1Q   - Multiple Multicast Registration
                                 Protocol (MMRP)
   0x890D  IEEE Std 802.11   - Fast Roaming Remote Request (802.11r)
   0x8917  IEEE Std 802.21   - Media Independent Handover Protocol
   0x8929  IEEE Std 802.1Qbe - Multiple I-SID Registration Protocol
   0x8940  IEEE Std 802.1Qbg - ECP Protocol (also used in 802.1BR)
```

Appendix C. Documentation Protocol Number

   Below is the template based on which an IANA OUI-based protocol
   number value was assigned for document use. (See Section 3 and
   Appendix A.2.)

   Applicant Name: Donald E. Eastlake 3rd

   Applicant Email: d3e3e3@gmail.com

   Applicant Telephone: 1-508-333-2270

   Use Name: Documentation

   Document: This document.

   Note: Request value 0x0042

Authors' Addresses

   Donald E. Eastlake 3rd
   Huawei Technologies
   155 Beaver Street
   Milford, MA 01757
   USA

   Phone: +1-508-634-2066
   EMail: d3e3e3@gmail.com

   Joe Abley
   Dyn, Inc.
   470 Moore Street
   London, ON N6C 2C2
   Canada

   Phone: +1 519 670 9327
   EMail: jabley@dyn.com