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

Some IETF protocols make use of Ethernet frame formats and IEEE 802 parameters. This document discusses some use 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

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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 some other IETF use 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](#)

Add MAC addresses and IANA OUI-based protocol and other values for use in documentation and add relevant Security Considerations language.

Eliminate 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 have proved to be problematic in practice.

Re-cast informational material about relevant IEEE assignment policies to take into account [[RAC-OUIdraft](#)].

Add 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-OUIdraft] 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-OUIdraft](#)].

The IEEE describes its assignment procedures and policies for IEEE 802 related identifiers in [802_0&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 constructed by leaving the Group bit zero.

For globally unique EUI-48 identifiers assigned by an OUI or longer prefix owner, the Local bit is zero. 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 those 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 (VRRP IPv6) [[RFC5798](#)].

00-00-5E-00-52-00 through 00-00-5E-00-52-FF: being 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 Number 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 block of a power-of-two 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.

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 proven 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-OUIdraft](#)] 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 bit 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-EF-10-00-00-00-00 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-00-00-00-00-00 to 02-00-5E-FE-FF-FF-FF-FF assigned to IPv4 address holders as described above

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

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

02-00-5E-FF-FF-00-00-00-00-00 to 02-00-5E-FF-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 block of a power-of-two 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.

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 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 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 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-00-00-00-00-00-00 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 <http://www.iana.org> under both Ethernet Parameters and PPP Parameters.)

2.3.2.1 Changes to RFC 2153

The IANA Considerations in [RFC2153] are updated as follows (no technical changes are made): Use of these identifiers based on IANA assignment is deprecated. IANA is directed 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 protocol indicator for the "main" body of the frame, as described below. Traditionally in the [802_0&A] world, tags are 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 (Link-Layer Subnet Access Points) 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 Etherypes nor LSAPs are assigned by IANA; they are assigned by the IEEE Registration Authority (see [Section 1.3](#) above and the Ethertype Annex below). However, both LSAPs and Etherypes 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 LLC format (SNAP) [802_0&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 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_0&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 updating this BCP and specifying 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 should be replaced by references to this document. In addition, any references in the registries to [draft-jabley-eui48-eui64-doc-addr](#), which has been combined into this document, should be replaced with references to this document.

This document does not create any new IANA registries.

This document assigns MAC address values for documentation but those values are already in the appropriate IANA tables due to [draft-jabley-eui48-eui64-doc-addr](#). The only other assignment made by this document is a protocol number for documentation in [Section 5.6](#).

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 [Section 4.1 of \[RFC5226\]](#).

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 the

Template Annex below and sends it to IANA <iana@iana.org>.

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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 case, 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 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	[This document]
64-bit MAC	16390	0x4006	[This documnet]

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

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

5.3 Informational IANA Web Page Material

IANA also 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 information registry is "IEEE 802 Numbers". IANA will merge in the Ethertypes listed in [Appendix B](#) that are not already included and 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 have been 90% or more exhausted, IANA should request an additional OUI from the IEEE Registration Authority for further IANA assignment use. The appointed Expert(s) should monitor for this condition and notify IANA.

The preceding paragraph should be included in the IANA Registry as a Note.

5.5 IANA OUI MAC Address Table

No changes are required in the "IANA Unicast 48-bit MAC Addresses" and "IANA Multicast 48-bit MAC Addresses" tables except for the updates to references specified in the first part of [Section 5](#).

The Note preceeding the "IANA 64-bit MAC Addresses" table should be as follows:

"These values are prefixed with 00-00-5E to form unicast MAC addresses, with 01-00-5E to form multicast MAC addresses, with 02-00-5E to form unicast modified EUI-64 addresses, and with 03-00-5E to form multicast modified EUI-64 addresses. See [this document] for more details."

[5.6](#) SNAP Protocol Number Table and Assignment

The "SNAP PROTOCOL IDs" table is renamed the "SNAP Protocol Numbers" table. The Note for that table and column headers are changed by replacing "PID" with "protocol number".

IANA will assign 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 [[EUIRRTYPE](#)] for security considerations in storing MAC addresses in the DNS.

Acknowledgements

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This document:

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[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, Mark Townsley, and Geoff Thompson.

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

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.

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 Information technology / Telecommunications and information exchange between systems / Local and metropolitan area networks / Specific requirements / Part 3: Carrier sense multiple access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications", IEEE Std 802.3-2008, 26 December 2008.

[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.

[EUI-64] - IEEE, "Guidelines for 64-bit Global Identifier (EUI-64) Registration Authority", <<http://standards.ieee.org/regauth/oui/tutorials/EUI64.html>>, March 1997.

[EUIRRTYPE] - J. Abley, "Resource Records for EUI-48 and EUI-64 Addresses in the DNS", [draft-jabley-dnsext-eui48-eui64-rrtypes](#), work in progress.

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

[IEEE] - Institute of Electrical and Electronics Engineers,

<<http://www.ieee.org>>.

- [IEEE802] - IEEE 802 LAN/MAN (Local Area Network / Metropolitan Area Network) Standards Committee, <<http://www.ieee802.org>>.
- [InfiniBand] - InfiniBand Trade Association, "InfiniBand Architecture Specification Volume 1", November 2007.
- [RAC-OUIDraft] - G. Parsons, "OUI Registry Restructing", [draft-ieee-rac-oui-restructuring](#), work in progress.
- [RFC1112] - Deering, S., "Host Extensions for IP Multicasting", STD 5, [RFC 1112](#), Stanford University, August 1989.
- [RFC1661] - Simpson, W., "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.

Appendix A. Templates

This annex provides the specific templates for IANA assignments of parameters. Explanatory words in parenthesis 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 annex 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](http://iana.org)]. 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
0x880B	Point-to-Point Tunneling Protocol (PPTP)
0x880C	General Switch Management Protocol (GSMP)
0x8035	Reverse Address Resolution Protocol (RARP)
0x86DD	Internet Protocol Version 6 (IPv6)
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)
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)

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 for assignment of a IANA OUI based protocol number value 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

Appendix Z: Change History

RFC Editor Note: Please delete this section before publication.

From -00 to -01

The -00 version was accidentally labeled with intended status "Proposed Standard". This has been corrected to "Best Current Practice".

Update author information.

Add acknowledgement.

Add Change History Appendix.

Fix various typos.

From -01 to -02

Move "Changes from [RFC 5342](#)" up from former [Section 7](#) to be a part of [Section 1](#).

Add AFN numbers for 48-bit and 64-bit MAC addresses.

Add Security Considerations language for documentation purpose MAC addresses.

Fix various typos.

From -02 to -03

Add assignment of 00-42 as the protocol number for documentation use to new sub[section 5.6](#) and make editorial changes to the protocol number subregistry.

Add assigned AFN and RRTYPE values for 48 and 64 bit MAC addresses in decimal and hex.

Add note to [Section 1](#) that "IESG Ratification" as specified in [Section 5.1](#) is not the same as "IESG Approval" as specified in [RFC 5226](#).

Add note to 1.4 that there is no documentation OUI but that

documentation code points under the IANA OUI are specified herein.

Replace references to [[RFC5342](#)] and [draft-jabley-eui48-eui64-doc-addr](#) in IANA registries with references to this document.

Update note for "IANA 64-bit MAC Addresses" table.

Update "PID" (Protocol ID) in connection with SNAP protocols IANA table to "protocol number" for consistency.

Update [Appendix B](#).

Minor editorial fixes.

From -03 to -04

Fix typos in IANA OUI in [Section 3.2](#) and 5.5.

Expand "AFN" on first use in [Section 5.2](#).

Direct IANA to merge in any values in [Appendix B](#) that are not yet in the IANA "IEEE 802 Numbers" informational web page.

Minor editorial changes.

From -04 to -05

Re-cast informational material about relevant IEEE assignment policies to take into account the planned changes by the IEEE Registration Authority as per [[RAC-OUIDraft](#)].

Add a sentence foreshadowing the future possibility of EUI-128 MAC addresses.

Add InfiniBand as example of EUI-64 use.

Minor editorial changes.

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