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OUI Registry Restructuring
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Abstract

The IEEE Registration Authority Committee, which has oversight for the OUI based registries, is seeking IETF community input as it finalizes restructuring the OUI registries. This document provides background on the RAC as well as explaining the proposed restructuring and the rationale.

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1. Introduction

The IEEE Registration Authority (RA) operates under the direction of the IEEE-SA Board of Governors. IEEE is recognized by ISO/IEC as the authorized Registration Authority to provide this service world-wide. The IEEE Registration Authority Committee (RAC) provides technical oversight for the IEEE Registration Authority Activities.

The IEEE RA administers the assignment of 24-bit identifiers, formally known as an "Organizationally Unique Identifier" (OUI). It can be used alone as an identifier, or used to create MAC Addresses, Bluetooth Device Addresses or Ethernet Addresses.

Given the possibility of consuming all the MAC addresses, the IEEE RAC places restrictions on their use. While the number space is large, it is not inexhaustible, and the IEEE-RAC reviews trends to determine if a new strategy is required to prevent exhaustion. Current usage trends and new applications have convinced the RAC that measures are needed to more efficiently use the MAC address space. This document presents the background as well as the proposed changes to the OUI registries.

1.1. History of the IEEE RA and RAC

The IEEE Registration Authority (RA) was formed by the IEEE Standards Board in 1986 at the initiative of the IEEE P802 (LAN/MAN) standards group in order to register Organizationally Unique Identifiers (OUI). Since that time, the activities of the Registration Authority have continued to expand.

The IEEE Registration Authority Committee (IEEE RAC) was formed in 1991 as a volunteer oversight of the IEEE staff operated RA. In 1998, the IEEE RAC became a committee of the IEEE Standards Association Board of Governors, (IEEE SA BoG).

In 1997, the IEEE Registration Authority assumed responsibility for the registration of EtherType Fields, as defined in the current edition of IEEE Std 802.3, and in 1998 began administering Individual Address Block assignments in an effort to preserve the OUI assignments and offer the option of obtaining a smaller amount of addresses.

In 2003, it assumed responsibility for administering, allocating and managing the Logical Link Control (LLC) and Standard Group MAC addresses. IEEE has become the single point of contact with respect to all information associated with LAN addresses.

In 2004, IEEE established three registration authorities associated with IEEE 1451.4-2004. They are:

- Unique Registration Numbers (URNS)
- IEEE Templates and TDL Items
- Manufacturer_ID

On 27 April 2007, three additional registries were launched. Unlike the registries launched in 2004, each registry represents a different IEEE standard.

- OUI-36
- IEEE 802.16 Operator ID
- Provider Service Identifier (PSID)

The IEEE Registration Authority formerly had administrative responsibility for the IEEE POSIX Certification.

1.2. Mission Statement of the IEEE RAC

The IEEE Registration Authority Committee (IEEE RAC) is the oversight committee for the IEEE Registration Authority.

The IEEE RAC is international in scope, assisting standard developing organizations in their establishment of unambiguous, sustainable registration authorities.

The IEEE RAC considers the long-term interests of the ultimate users of these standards, while pragmatically addressing the needs of the affected organizations, industries, and the IEEE.

2. Existing OUI based registries

The OUI ("Organizationally Unique Identifier") is defined in IEEE Std 802-2001 [1] and its structure is shown in Figure 1 below

with an example for use as a protocol identifier shown in Figure 2.

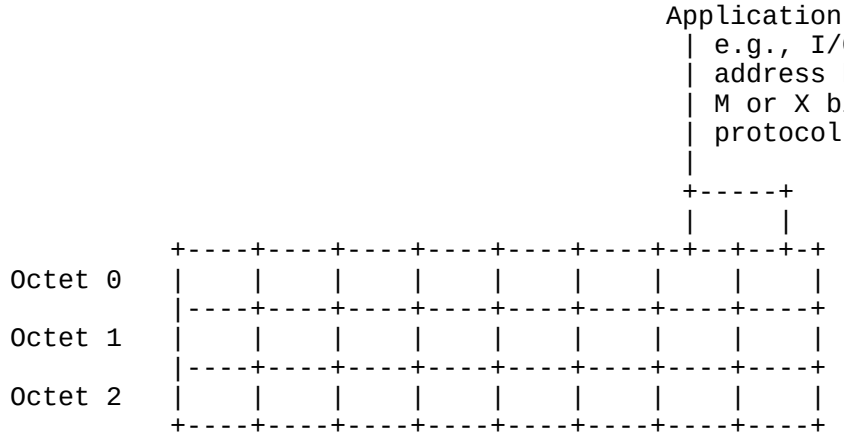

Figure 1 - Structure of an OUI

Of note is that only 22 bits are actually assigned as there are specific uses for the first two bits transmitted (the two least significant bits of octet 0). As a MAC address, the first bit transmitted indicates either an individual or group address (I/G), and the second bit transmitted indicates universal or local administration of the address (U/L). When used as a protocol identifier (Figure 2), these bits are the M and X bits. As a result of these uses, all previous OUI assignments have set these two bits to 0.

Hexadecimal representation: AC-DE-48

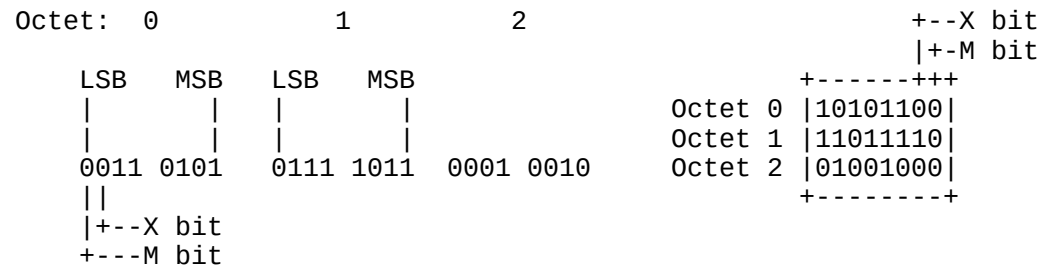

Figure 2 - Format of an OUI used as protocol identifier

While the majority of customers purchase the OUI, there are currently three OUI based registries:

1. OUI

2. OUI-36

3. IAB

The latter two use an IEEE reserved OUI from the first registry as their root.

These registries support the standards of IEEE 802 as well as ISO/IEC 8802 and other standards that use unique LAN addresses. IEEE has been authorized by the ISO Council to act as the exclusive registration authority for the implementation of International Standards in the ISO/IEC 8802 series.

2.1. OUI

An OUI or 'company_id' is a 24-bit globally unique assigned number referenced by various standards. The OUI is usually concatenated with 24 or 40 bits by an Organization to create a 48-bit or 64-bit number that is unique to a particular piece of hardware. It can be used to create MAC Addresses, Bluetooth Device Addresses or Ethernet Addresses.

There are other uses of the OUI as well, such as its use as a company identifier in the SNAP protocol.

The OUI or 'company_id' can be used in conjunction with a number of standards. It does not limit your right to use your assignment for both OUI and 'company_id' purposes.

Additional information can be found on the IEEE RA website: http://standards.ieee.org/develop/regauth/oui/index.html

2.2. OUI-36

OUI-36 is a 36-bit identifier that can be used as an Individual Address Block (IAB) or as an extended OUI. The OUI-36 may be appended with four organization-supplied bits to form a 40-bit Context Dependent Identifier (CDI-40), with twelve organization-supplied bits to form an EUI-48, or with organization-supplied 28 bits to form an EUI-64. Applications making use of an OUI-36 should make no assumptions about the bit pattern that will be present in the (24-bit most-significant) OUI portion of the assigned OUI-36.

Additional information can be found on the IEEE RA website: http://standards.ieee.org/develop/regauth/oui36/index.html

2.3. IAB

An IAB is for organizations that need less than 4097 unique 48-bit numbers (EUI-48) and thus find it hard to justify buying their own OUI. It is a particular OUI concatenated with 12 additional IEEE-provided bits, leaving only 12 bits for the owners to assign to their (up to 4096) individual devices.

Unlike an OUI, which allows the assignee to assign values in various different number spaces (for example, EUI-48, EUI-64, and the various CDI number spaces), the IAB can only be used to assign EUI-48 identifiers.

The Individual Address Block (IAB) can be used in conjunction with a number of standards. It does not limit your right to use your assignment for multiple purposes.

Additional information can be found on the IEEE RA website: http://standards.ieee.org/develop/regauth/iab/index.html

3. Common identifiers

The OUI defined in IEEE Std 802-2001 [1] can be used to generate 48-bit Universal LAN MAC addresses to uniquely identify Local and Metropolitan Area Networks stations, and Protocol Identifiers to identify public and private protocols. A revision [3] of this standard is underway (expecting to complete in late 2013) that will, among other updates, also describe the 64-bit address.

3.1. EUI-48

The IEEE defined 48-bit extended unique identifier (EUI-48) is a concatenation of either a 24-bit Organizationally Unique Identifier (OUI) value administered by the IEEE Registration Authority (IEEE-RA) and a 24-bit extension identifier assigned by the organization with that OUI assignment, or the concatenation of a 36-bit Individual Address Block (IAB) identifier /or 36-bit Organizationally Unique Identifier (OUI-36)/ and a 12-bit extension identifier assigned by the organization with that IAB assignment.

Additional information can be found on the IEEE RA website: http://standards.ieee.org/develop/regauth/tut/eui48.pdf

3.2. EUI-64

The IEEE-defined 64-bit extended unique identifier (EUI-64) is a concatenation of the Organizationally Unique Identifier (OUI) value assigned by the IEEE Registration Authority (IEEE RA) and the extension identifier assigned by the organization with that OUI assignment resulting in a 64-bit unique identifier. The extension identifiers shall be 40 bits for the 24-bit OUI-24 and 28 bits for the 36-bit OUI-36. Other OUI lengths will have extension identifiers making up the difference between each assigned OUI length and the 64-bit EUI-64.

Additional information can be found on the IEEE RA website: http://standards.ieee.org/develop/regauth/tut/eui48.pdf

3.3. Company ID / Protocol identifier

IEEE Std 802 provides for the use of Protocol Identifiers in conjunction with the SNAP/SAP reserved LLC address. A Protocol Identifier is defined as a sequence of five octets. The first

three octets take the values of the three octets of the OUI in order; the following two octets are administered by the OUI assignee. The hexadecimal representation of the Protocol Identifier consists of the hexadecimal values of the five octets in order, separated by hyphens, in the order transmitted by the network application, left to right.

Additional information can be found on the IEEE RA website: http://standards.ieee.org/develop/regauth/tut/lanman.pdf

4. Preventing exhaustion

Given the possibility of consuming all the MAC addresses, the IEEE RAC places restrictions on their use. For new applications, EUI-48 identifiers are restricted to use in low volume applications, such as the identification of software interface standards or hardware model numbers.

While the number of EUI-48 identifiers is large, it is not inexhaustible, and the IEEE-RAC reviews trends to determine if a new strategy is required to prevent exhaustion. Current usage trends and new applications have convinced the RAC that measures are needed to more efficiently use the EUI-48 address space.

4.1. IEEE RAC Prime Directive

A "prime directive" of the IEEE RAC is to not run out of global EUI-48 addresses (previously called MAC or MAC-48 addresses) for 100 years. The clock started in 1980 when this space was created by Xerox (and was called Block ID at the time).

In about 30 years, less than 20,000 OUIs have been assigned. So if the growth is linear, there is more than 99% of the space left, giving the world a 4000 year supply. However, the growth trend from last few years is not linear. If that trend continues, then there is only 26 years left before exhaustion of OUIs and global address space they are used to create. The IEEE RAC is studying these trends and has considered several possible causes.

4.2. New devices

There has been an increase in new device categories in the last several years - including smart phones, tablets and various sensors - all that have more than one network interface (e.g., WiFi, Bluetooth, Ethernet) that requires a MAC address.

In addition, there are a few manufacturers that are volume users. That is, they are using more than 32 million MAC (EUI-48) addresses per month.

4.3. Assignment efficiencies

Most manufacturers, however, use far less MAC (EUI-48) addresses per month. They either have a smaller production volume or are just starting. And actually, most OUI customers have only bought one OUI. If they need only MAC addresses, then they could benefit from options that would offer them fewer.

This would reduce the many "lost" or "unused" MAC addresses from OUIs that were assigned but the manufacturer did not use the full 16 million.

4.3.1. MAC (EUI48) Addressing

˜260 billion EUI-48 (of ˜70 trillion possible) addresses have been assigned. While the RAC knows these have not all be used in devices, there is no way to confirm this. The RAC does however, require that repeat customers confirm that they have used 95% of the addresses before they are assigned another OUI block.

The RAC requires that only one (or at most a few) global EUI-48 addresses be assigned to a single hardware device. This is to avoid stockpiling of addresses in devices. However, this may be problematic for some applications like virtualization

4.3.2. Company ID

In order to get a Protocol identifier or company ID, an OUI must be assigned. If the manufacturer does not intend to use it for addressing, then those addresses are lost.

4.4. Virtualization

Virtualization from the IEEE RAC perspective is essentially the usage of global MAC (EUI-48) addresses by software - instead of

by a hardware device (i.e., "burned in") as was originally intended.

Traditionally the RAC limited manufacturers to only a few addresses per hardware device to prevent stockpiling addresses in devices. This would invalidate virtualization solutions. As a result, the RAC is now allowing assignment of an OUI (16M EUI-48 addresses) for virtualization use until a further policy is clarified.

One requirement for virtual machines is that they are mobile and can be moved around on a rack, within a data center or even across data centers. Such movement in a multi-vendor environment requires a globally unique MAC (EUI48) address to be scalable.

4.4.1. Reusing addresses

However, another inherent nature of virtualization is the creation and destruction of the virtual machine. Hundreds, thousands or millions can be created or destroyed per second in a data center. If kept in a closed environment, this requires a local or reusable MAC (EUI48) address. If a global address is used, then they could be used at an alarming rate as they are not defined as reusable.

Unfortunately, there appears to be violation of the IEEE RAC policy in the virtualization sector. That is, some are using global MAC (EUI-48) addresses per rack / cluster / data center and then reusing them in an adjacent rack / cluster / data center.

Clearly this is not permitted and the RAC has been studying what guidance should be given to virtualization vendors such that the global MAC address space is not tainted.

It has been suggested that a DHCP-like mechanism or a standard allocation should be developed for reusable MAC addresses such that there is some order to assignment in an environment where addresses are created and destroyed.

4.4.2. EUI-128 addresses

Given the potential for using a large number of addresses, the RAC is also exploring the feasibility of defining a new "EUI-128" identifier (i.e., 128 bits) specifically for future virtualization applications.

5. Proposed new OUI-based registries

The IEEE RAC has been studying options to restructure the OUI-based registries and products for over a year and is now reviewing a final proposal. This proposal provides a refinement of the OUI-based registries improves efficiency of assignment allocations and attempts to address virtualization issues.

While there was some desire for the OUI registries to fully separate the semantic of protocol identifier (e.g., the 24 bits assigned) and addresses (e.g., a 48-bit address created based on the 24 bits assigned), the concern raised was that this was not enforceable by definition.

The IEEE RAC conducted a survey of its customers and it quickly became clear that there were first-time customers (and in most cases they never made another purchase) and repeat customers (many of who were volume users). It was also very clear that the dominant use was to create global MAC (EUI48) addresses. As a result, the assignment decisions could be separated as proposed in Figure 3 below.

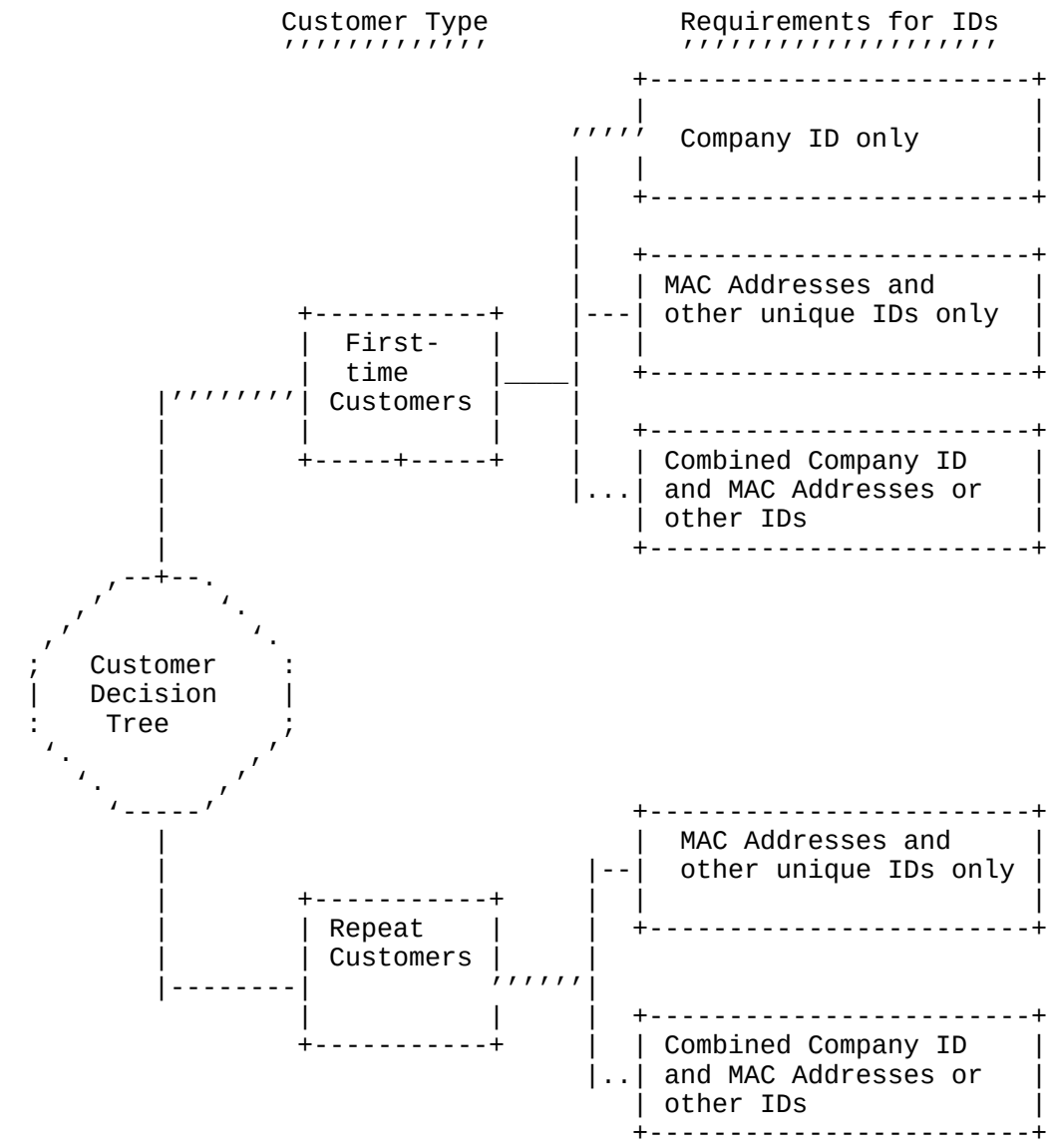

Figure 3: Decision Tree for assignment of Unique IDs/MAC addresses

The proposal that the IEEE RAC is considering is to add an additional size option for creating MAC (EUI48) addresses -- 1 million -- as well as creating a new CompanyID registry. This is

shown in Table 1 below and described in the following sub-sections.

Table 1: New Proposed OUI-based Product Registries

Manufacturer field	Product	EUI48(MAC)addresses
24-bit identifier	OUI-24/MA-L	16777216
-	OUI-28/MA-M	1048576
36-bit identifier	OUI-36/MA-S	4096
24-bit identifier	CompanyID	-

5.1. OUI-24: MAC Addresses - Large

The OUI-24 is a 24-bit globally unique assigned number.

This is the base OUI registry. It is simply a renaming of the existing OUI registry.

An assignment from this registry includes the ability to create:

- 24-bit company ID / protocol identifiers
- 48-bit EUI48 addresses
- 64-bit EUI64 addresses

5.2. OUI-28: MAC Addresses - Medium

The OUI-28 is a 28-bit globally unique assigned number.

This new OUI-28 is created by the IEEE RA by assigning an additional 4 bits from an OUI-24 (that would be listed as IEEE reserved).

An assignment from this registry includes the ability to create:

- 48-bit EUI48 addresses

- 64-bit EUI64 addresses

Note that the IEEE RAC does not intend to define the usage of a 28-bit company ID / protocol identifier at this time.

5.3. OUI-36: MAC Addresses - Small

The OUI-36 is a 36-bit globally unique assigned number.

The OUI-36 is created by the IEEE RA by assigning an additional 12 bits from an OUI-24 (that is listed as IEEE reserved).

This is the existing OUI-36 registry, and it is proposed to merge the IAB registry with this as well.

An assignment from this registry includes the ability to create:

- 36-bit company ID / protocol identifiers
- 48-bit EUI48 addresses
- 64-bit EUI64 addresses

5.4. CompanyID

The CompanyID is a 24-bit globally unique assigned number. However, any MAC addresses created with this Company ID would only be locally significant (i.e., the U/L bit is set to 1)

This new CompanyID is created by the IEEE RA assigning an OUI with the X bit set to 1 (this bit becomes the U/L bit when used to create a MAC address). Traditionally, this use has been reserved to separate the local and global address spaces but no use had been defined for protocol identifiers. It is proposed that only a segment (e.g., the bottom half) of the potential 22-bit space be made available for allocation.

An assignment from this registry includes the ability to create:

- 24-bit company ID / protocol identifiers

NOTE: This requires that legacy uses of the OUI in protocols do not try to define the M and X bits for other uses. The RAC is not aware of any standard uses of the M and X bits that would prevent defining this new registry.

5.4.1. Application Note

It is further proposed that virtualization manufacturers apply for assignments of these CompanyIDs. These could then be used to create MAC (EUI48) addresses in the local space that could be reused. Additionally, it would also provide some order and allow for multi-vendor usage of a subset of the local space for the virtualization application (or any application that could benefit from reusable addresses).

6. Protocol Considerations

There may be unintended consequences of these additions to the OUI-based registries for existing protocols. A study and review of many protocols was conducted and there were no apparent issues identified.

IETF community input is requested, especially as it relates to the embedded use or carriage of addresses or protocol identifiers in other protocols. For protocol identifiers, the IEEE RAC would be interested if any protocol defines the M and X bits for other uses.

7. Security Considerations

There may be unintended consequences of these additions to the OUI-based registries, though none are apparent.

IETF community input is requested.

8. IANA Considerations

There may be some affect on the existing IANA registries based on the restructuring of the OUI based registries.

However, this has not yet been studied.

IETF community input is requested.

9. Conclusions

While the background presented in this document is representative of the current situation, the proposals in this document have not yet been implemented, and therefore may change.

The IEEE-SA Board of Governors has made a decision, based on the recommendation of the IEEE RAC, on the implementation of the OUI registry restructuring. A summary has been provided in this document, but full details are under development by the IEEE RAC. It is expected that implementation will start in 2014.

IETF community input is requested to identify any issues with the restructuring proposal, especially as it affects IETF protocols. Please provide your comments to the RAC public list with "IETF community comment" as the start of the subject field:

STDS-RAC-PUBLIC@LISTSERV.IEEE.ORG

10. References

10.1. Normative References

[1] IEEE Std 802-2001, "IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture" https://standards.ieee.org/about/get/802/802.html

10.2. Informative References

[2] IEEE Registration Authority website http://standards.ieee.org/develop/regauth/

[3] IEEE P802 - Overview & Architecture revision project http://www.ieee802.org/1/pages/802-rev.html

11. Acknowledgments

The IEEE RAC appreciates the cooperation of IETF in publicizing these proposals to the IETF community including at its meetings.

Some of the background material in this document is based on information previously available on the IEEE RA website [2].

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