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To: X3T11 and X3T10 Technical Committee

From: Bob Snively

Subject: Tutorial for SCSI use of IEEE registered company_id

The enclosed document is a draft of the tutorial for the use of the IEEE company_id as the basis for world wide unique identifiers in SCSI. This document will be provided to IEEE and, when approved, placed on the IEEE web site to show how to use the company_id in SCSI environments. Revision 1 represents the suggestions of IEEE reviewers.

The IEEE company_id is a registered and guaranteed unique 24-bit number provided for a reasonable fee to all companies that require a value to distinguish their components from all other components in the world. The registration is a public document except for a few early Ethernet implementors that have a grand-fathered privacy privilege.

Annex B: IEEE Tutorial for SCSI use of IEEE company_id

Use of the IEEE Registration Authority assigned "company_id"
with the SCSI-3 Primary Commands, SCSI Enclosure Services commands, and all SCSI extensions.

Bob Snively   December 24,.1996

Caution:

The IEEE administers the assignments of 24-bit company_id values. The assignments of these values are public, allowing a user of an SCSI defined identifier can identify the manufacturer that provided the value. The IEEE/RAC has no control over the assignments of the vendor-specified fields and assumes no liability for assignments of duplicate identifiers.

A company shall use the same IEEE company_id for all its IEEE Registration Authority based identifiers until the identifier spaces using that company_id are substantially exhausted.

1   Introduction

The IEEE Registration Authority for a fee provides a registered number that is guaranteed to be unique. The unique number may be provided in either of two formats, depending on the requirements of the manufacturer. The number is provided as a 6 hexadecimal number value as the IEEE company_id. The number is provided as three hexadecimal-digit pairs representing the 3 octlets of the 24-bit number as the IEEE Organizationally Unique Identifier (OUI). The same number is used by a manufacturer for all its products that use an IEEE registration. A manufacturer shall base all its identifiers on the same number, even if the identifiers have different formats. A manufacturer shall not purchase a new company_id until at least one of the identifier spaces using the company_id is substantially exhausted. Other identifier spaces shall continue using the original company_id until they are also exhausted.

The IEEE Registration Authority assigned "company_id" is the registration basis for object identifiers that may be obtained through two separate SCSI commands.

In the SCSI-3 Primary Commands (SPC) standard, X3T10 Project 995D, Revision 10, the INQUIRY command allows a host device to determine the world wide identifier of a logical unit or other SCSI object. Two of the options defined for this identification are based on the IEEE company_id.

In the SCSI-3 Enclosure Services (SES) standard, X3T10 Project 1212D, Revision 8.0, the RECEIVE DIAGNOSTIC RESULTS configuration diagnostic page allows a host device to determine the world wide identifier of an enclosure.

References for the required documents are contained in clause 4 of this tutorial.

The following paragraphs define how those identifiers are used.

1.1   Glossary

Identified Company: The company that has purchased and is identified by a particular value of the IEEE company_id.

■

2   SCSI access to identifiers

2.1   SPC use of INQUIRY command

By setting the EVPD (enable vital product data) bit in the INQUIRY command (see 7.5 of SPC), access to special information pages can be performed. The Page Code field of the INQUIRY command indicates which of the information pages are to be accessed. A Page Code field of 83h requests the device identification page from the device. The device identification page (see 8.4.3 of SPC) contains a list of one or more identification descriptors that identify the peripheral device and objects within the peripheral device. The device identification page indicates in the code set field for each identifier whether it is expressed in ASCII text or in binary code values. The association field specifies for each identifier which type of object is identified, the device server or a port to the device server. The identifier type field indicates for each identifier which of the following formats is used as shown in figure 1.

Figure 1 - SCSI INQUIRY command identifier types

```
     Identifier type      Description of identifier type
                                    field value
   |_____|_____|
   |                   |                                         |
   |        0          |    No assignment authority is used.     |
   |                   |    The value may not be globally        |
   |                   |    unique.                              |
   |_____|_____|
   |                   |                                         |
   |        1          |    The identifier field is based on     |
   |                   |    the Vendor ID (see SPC, annex C)     |
   |_____|_____|
   |                   |                                         |
   |        2          |    The identifier field contains an     |
   |                   |    IEEE Extended Unique Identifier       |
   |                   |    (EUI-64)                             |
   |_____|_____|
   |                   |                                         |
   |        3          |    The identifier field contains an     |
   |                   |    FC-PH Name_Identifier. Any FC-PH     |
   |                   |    identifier may be used, including     |
   |                   |    one of the four based on the IEEE    |
   |                   |    company_id.                          |
   |_____|_____|
```

The identifier formats using the IEEE company_id as a registration value are described in clause 3 of this tutorial.

The identifier length field specifies the number of bytes contained in the selected identifier.

If the identifier for an object is accessed by more than one mechanism, the same identifier format and identifier value should be provided through both mechanisms. If more than one identifier format or value is used for the same object, all applicable formats and values shall be presented by the SCSI-3 INQUIRY command. Specific cases are considered below.

The SCSI command set may be transported across a number of interfaces. When the Fibre Channel interface is used to transport SCSI commands, the Fibre Channel login process normally provides an identification of the device server and port using one of the IEEE Fibre Channel formats. When the IEEE 1394 interface is used to transport SCSI commands, the IEEE 1394 node identifier normally uses the EUI-64 format to identify the device server. While more than one device identifier may be defined

for a device and while more than one object may be identified within the device, at least one of the identifiers shall be the same value and format that is used by the transport medium. For devices attached using parallel SCSI, which has no identification mechanism at the transport level, it is recommended that the FC-PH IEEE Registered Name be used.

For logical units that are actual physical devices, it is recommended that the FC-PH IEEE Registered Name be used. For logical units that are virtual devices (e.g. RAID virtual volumes), it is recommended that the FC-PH IEEE Registered Extended name be used. In this case, the IEEE company_id and the 36-bit vendor specified identifier (VSID) may be the same for the RAID controller and for the virtual devices managed by the controller. The RAID controller may independently assign unique values to the vendor specified identifier extension to identify the individual logical units created under its management.

To guarantee uniqueness, the identifier type and length should be considered part of the identifier by SCSI application clients.

2.2   SES use of RECEIVE DIAGNOSTIC RESULTS command.

The SCSI-3 Enclosure Services document uses the RECEIVE DIAGNOSTIC RESULTS command to obtain configuration and status information related to various elements in an enclosure, including fans, devices, power supplies, and other elements. There are also a limited set of control functions that can be performed on the various elements using the SEND DIAGNOSTIC command. The RECEIVE DIAGNOSTIC RESULTS command obtains the description of the primary sub-enclosure and any attached sub-enclosures using the diagnostic page code of 01h, configuration page (see SES, 6.1.1). The enclosure logical identifier field is an 8-byte field that contains one of the FC-PH unique world-wide identifier formats to uniquely identify the sub-enclosure. One of the three 8-byte FC-PH formats based on the IEEE company_id should be used in this field to avoid any possibility of accidental duplication of the unique identifier.

The enclosure should be designed in such a manner that the enclosure world-wide name does not change if the enclosure services processor must be replaced.

The identifier formats that may be used are described in clause 3 of this tutorial.

3   Identifier formats for use in SCSI devices

The generation of those FC-PH world-wide identifiers based on the IEEE company_id are also described in the Fibre Channel tutorial. They are duplicated here for convenience.

The generation of the EUI-64 world-wide identifier is defined in the 64-bit global identifier format tutorial.

All FC-PH and EUI-64 identifiers shall use the binary value code set when presented in the INQUIRY command Device Identification page. All FC-PH identifiers shall use the binary value in the SES enclosure logical identifier field.

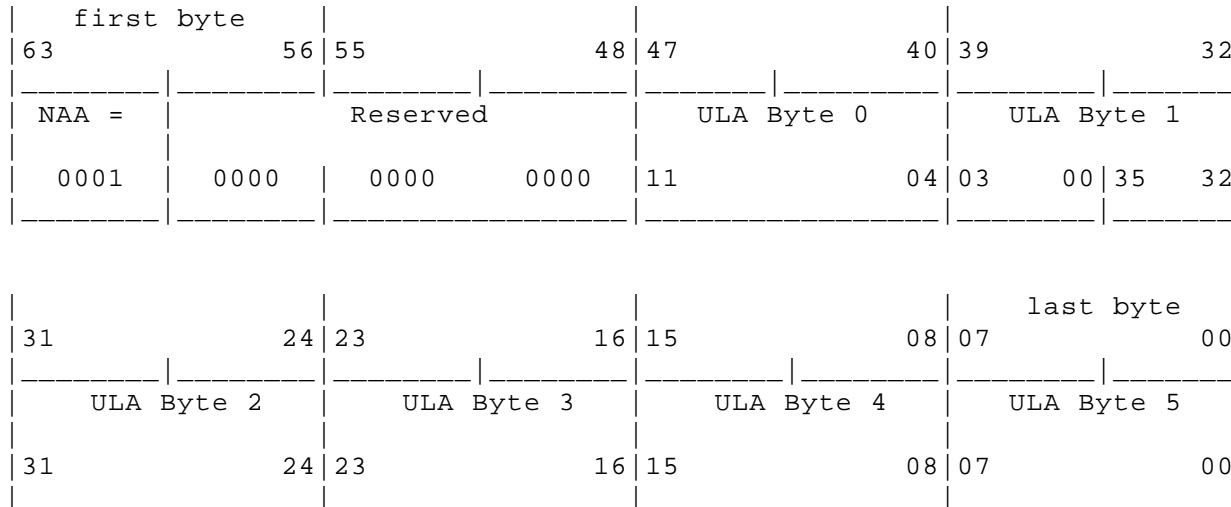## 3.1   FC-PH IEEE 48-bit identifier format

This format is defined by ANSI X3.230-1994. The name represents a historical artifact from the FC document and does not imply that the 48-bit identifier is actually generated by IEEE. This format is identified by the Name Address Authority (NAA) code value of 0001b.

This format may be used with either the SPC INQUIRY command or the SES RECEIVE DIAGNOSTIC RESULTS command, but is not recommended.

The FC-PH IEEE 48-bit world-wide identifier uses the 48-bit IEEE 802.1 universal LAN MAC address (ULA), which in turn is constructed from the IEEE company_id. This value is typically used to uniquely identify a Fibre Channel node.

The format for the FC-PH IEEE 48-bit identifier is shown in figure 2.

Figure 2 - FC-PH IEEE 48-bit identifier

```
|   first byte     |           |                 |           |           |
|63            56|55        48|47          40|39          32|
|_____|_____|_____|_____|_____|_____|_____|_____|
| NAA =  |        |     Reserved     | ULA Byte 0 |  ULA Byte 1     |
|        |        |                 |           |           |
| 0001   | 0000   | 0000    0000 |11          04|03    00|35    32|
|_____|_____|_____|_____|_____|_____|


|                  |           |                 |     last byte    |
|31            24|23        16|15          08|07          00|
|_____|_____|_____|_____|_____|_____|_____|_____|
|   ULA Byte 2     |   ULA Byte 3     |   ULA Byte 4     |   ULA Byte 5     |
|                  |           |                 |           |
|31            24|23        16|15          08|07          00|
|_____|_____|_____|_____|
```

ULA Bytes 0, 1, and 2 are generated using the IEEE company_id. ULA Bytes 3, 4, and 5 represent a unique value provided by the identified company.
With this mapping, the portion of the world-wide name that correspond to the special Ethernet address bits (if the ULA was to be used in that context) are as follows:

Bit 40 is the Individual/Group ID bit. The bit shall be zero when used with the FC-PH IEEE 48-bit address.

Bit 41 is the Universally Administered / Locally Administered Address bit. The bit shall be zero when used with the FC-PH IEEE 48-bit address.

3.1.1   Example of IEEE 48-bit identifier format

In this example, the IEEE company_id value used is:

                    AC DE 48 (hexadecimal)

which has a binary representation of:

        1010 1100 1101 1110 0100 1000

this value is combined with a value generated by the identified company of 00 00 80 to create a ULA of:

            AC DE 48 00 00 80 (hexadecimal)

The bit order is not changed for the Fibre Channel identifier as it would be if transmitting a LAN address on an Ethernet LAN link.

Using this ULA, the following 64-bit Fibre Channel IEEE 48-bit identifier format is created.

```
        10 00 AC DE   48 00 00 80 (hexadecimal)
```

which would have a binary representation of:

```
     first byte      second byte    ULA byte 0      ULA byte 1
      0001 0000        0000 0000      1010 1100       1101 1110


     ULA byte 2       ULA byte 3     ULA byte 4      ULA byte 5
      0100 1000        0000 0000      0000 0000       1000 0000
```
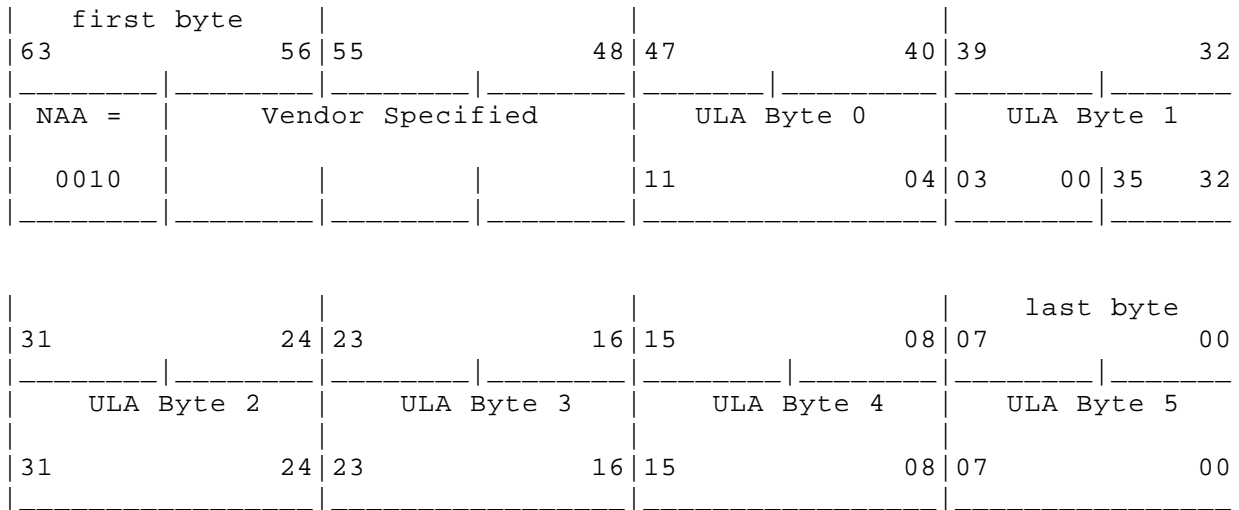
3.2   IEEE Extended identifier format

This format is identified by the Name Address Authority (NAA) code value of 0010b, as specified in X3.230-1994.

This format may be used with either the SPC INQUIRY command or the SES RECEIVE DIAGNOSTIC RESULTS command, but is not recommended.

The IEEE extended format allows the high order 12 bits that are unused in the IEEE 48-bit format to be used as a vendor specified field that extends the vendor specified field contained in the ULA. The identified company shall ensure that the combination of the 12-bit vendor specified field and the 3-byte vendor specified portion of the ULA are unique company-wide. Together with the NAA and IEEE company_id portion of the ULA, this guarantees that the overall FC-PH IEEE extended identifier shall be unique world wide.

The format is shown figure 3

Figure 3 - FC-PH IEEE Extended identifier format

```
|   first byte    |              |               |               |
|63            56|55          48|47           40|39           32|
|_____|_____|_____|_____|_____|_____|_____|_____|
| NAA =  |   Vendor Specified   |   ULA Byte 0   |   ULA Byte 1  |
|        |        |       |      |       |      |       |      |
|  0010  |        |       |      |11          04|03    00|35  32|
|_____|_____|_____|_____|_____|_____|_____|


|               |              |               |    last byte   |
|31           24|23          16|15           08|07           00|
|_____|_____|_____|_____|_____|_____|_____|_____|
|   ULA Byte 2   |   ULA Byte 3  |   ULA Byte 4  |   ULA Byte 5  |
|        |        |       |      |       |      |       |      |
|31           24|23          16|15           08|07           00|
|_____|_____|_____|_____|
```

ULA Bytes 0, 1, and 2 are generated using the IEEE company_id. ULA Bytes 3, 4, and 5 represent a unique value provided by the identified company.

With this mapping, the portion of the world-wide name that correspond to the special Ethernet address bits (if the ULA was to be used in that context) are as follows:

Bit 40 is the Individual/Group ID bit. The bit shall be zero when used with the FC-PH IEEE 48-bit address.

Bit 41 is the Universally Administered / Locally Administered Address bit. The bit shall be zero when used with the FC-PH IEEE 48-bit address.

3.2.1   Example of IEEE extended identifier format

In this example, the IEEE company_id value used is:

```
AC DE 48 (hexadecimal)
```

which has a binary representation of

```
1010 1100 1101 1110 0100 1000
```

this value is combined with a value generated by the identified company of 00 00 80 to create a ULA of:

```
AC DE 48 00 00 80 (hexadecimal)
```

The bit order is not changed for the Fibre Channel identifier as it would be in transmitting a LAN address on a LAN link.

Using this ULA, the following 64-bit Fibre Channel IEEE extended identifier can be created. In this example, the vendor specified value selected by the identified company is B17 hexadecimal, which has a binary representation of 1011 0001 0111. The resulting Fibre Channel IEEE extended identifier is:

```
2B 17 AC DE  48 00 00 80 (hexadecimal)
```

which would have a binary representation of:

```
    first byte      second byte    ULA byte 0      ULA byte 1
     0010 1011        0001 0111      1010 1100       1101 1110


    ULA byte 2      ULA byte 3     ULA byte 4      ULA byte 5
     0100 1000        0000 0000      0000 0000       1000 0000
```

3.3   IEEE Registered format

This format is identified by the Name Address Authority (NAA) code value of 0101b, as specified in X3T11/96-467.
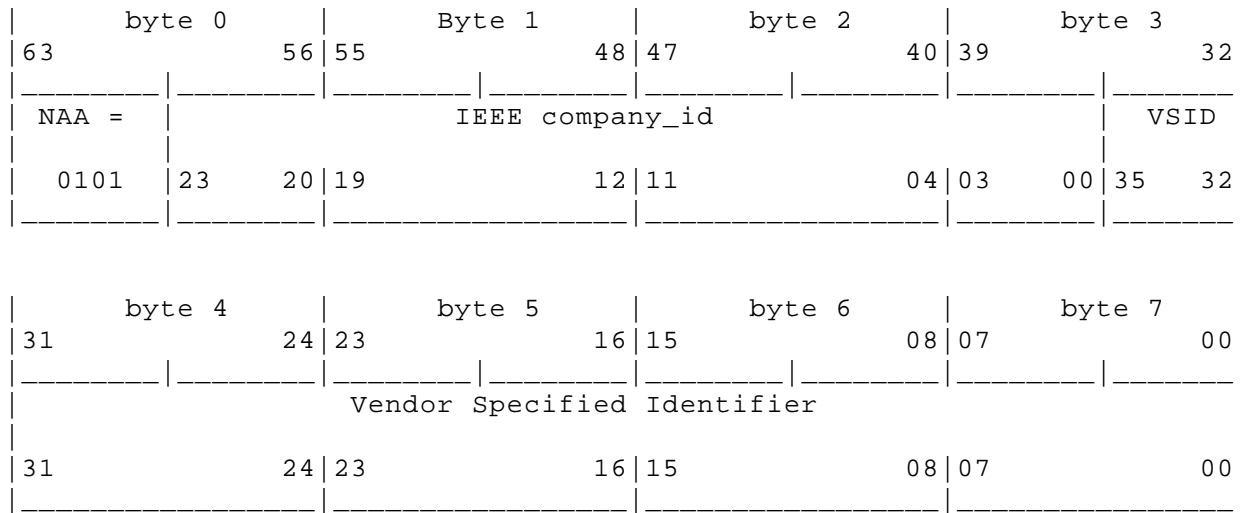
This format is recommended for use with both the SPC INQUIRY command and the SES RECEIVE DIAGNOSTIC RESULTS command.

The IEEE Registered format is based directly on the IEEE company_id, avoiding the requirement for the manufacturer to maintain a 48-bit ULA registry. Instead, the manufacturer shall maintain a registry of vendor specified identifier values that guarantees that all identifiers are unique world wide. The registry mechanism should guarantee that the identified company uses substantially all of the identifiers that can be created with a single IEEE company_id before a new IEEE company_id is purchased and used.

When NAA indicates that the format is IEEE registered, the identifier shall contain the 24-bit IEEE company_id followed by a 36-bit vendor specified identifier (VSID) which uniquely indicates a Node, an N_Port, an F_Port, a Fabric, or other object.

The format for the IEEE registered identifier is shown in figure 4.

Figure 4 - FC-PH IEEE Registered identifier format

```
|       byte 0      |       Byte 1      |       byte 2      |       byte 3      |
|63             56|55             48|47             40|39             32|
|_____|_____|_____|_____|_____|_____|_____|_____|
|  NAA = |                 IEEE company_id                 |  VSID  |
|        |        |                 |                 |        |        |
|  0101  |23    20|19           12|11           04|03    00|35    32|
|_____|_____|_____|_____|_____|_____|


|       byte 4      |       byte 5      |       byte 6      |       byte 7      |
|31             24|23             16|15             08|07             00|
|_____|_____|_____|_____|_____|_____|_____|_____|
|                Vendor  Specified  Identifier                |
|                                                             |
|31             24|23             16|15             08|07             00|
|_____|_____|_____|_____|
```

3.3.1 Example of IEEE registered format

In this example, the IEEE company_id value used is:

          AC DE 48 (hexadecimal)

which has a binary representation of

       1010 1100 1101 1110 0100 1000

In this example, the vendor specified value selected by the vendor is:

        B 17 34 F6 2D (hexadecimal)

which has a binary representation of

       1011 0001 0111 0011 0100 1111 0110 0010 1101

The resulting IEEE registered format is:

```
        5A CD E4 8B 17 34 F6 2D (hexadecimal)
```

which would have a binary representation of:

```
     byte 0       byte 1       byte 2       byte 3
   0101 1010    1100 1101    1110 0100    1000 1011

     byte 4       byte 5       byte 6       byte 7
   0001 0111    0011 0100    1111 0110    0010 1101
```

3.4   IEEE registered extended identifier format

This format is identified by the Name Address Authority (NAA) code value of 0110b, as specified in X3T11/96-467.

This format is recommended for use with the SPC INQUIRY command. The value typically uses the same value as the IEEE registered format for a controller, then allows the controller to assign the vendor specified identifier extension field in a manner designed to guarantee uniqueness for any logical units that are created by the controller. The vendor specified identifier extension field may have many unused values. An example of a device created by a controller is a RAID virtual volume generated under control of a RAID controller. The format shall not be used for the SES RECEIVE DIAGNOSTIC RESULTS command, since only 64 bits are available for the identifier in that command.
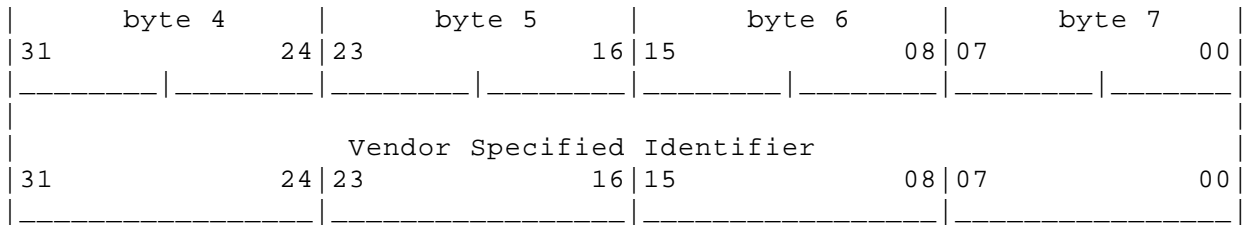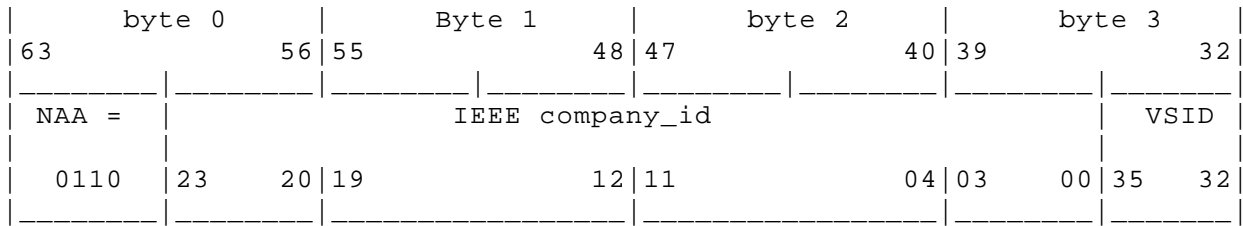
The IEEE Registered Extended format provides a world-wide unique identifier typically used to identify any Fibre Channel objects that require identifiers that are generated by the Fibre Channel node. This value is based directly on the IEEE company_id, avoiding the requirement for the manufacturer to maintain a 48-bit ULA registry. Instead, the manufacturer shall maintain a registry of vendor specified identifier values that guarantees that all identifiers are unique world wide.

When NAA indicates that the format is IEEE registered extended, the identifier shall contain the 24-bit IEEE company_id, a 36-bit vendor specified identifier (VSID), and a 64-bit vendor specified identifier extension which uniquely identifies the specified object. The identified company should use substantially all of the identifiers that can be created with a single IEEE company_id and the VSID before a new IEEE company_id is purchased and used. The vendor specified identifier extension may be used sparsely or assigned by the identified object as long as uniqueness of the full 128-bit IEEE registered extended identifier is guaranteed.

The location of the vendor specified identifier extension is defined for each type of object. At present, the only usage defined for this format is with the SPC INQUIRY command.

The format for the IEEE registered extended identifier is shown in figure 5.

Figure 5 - FC-PH IEEE registered extended identifier format

```
|        byte 0      |        Byte 1      |        byte 2      |        byte 3      |
|63              56|55              48|47              40|39              32|
|_____|_____|_____|_____|_____|_____|_____|_____|
| NAA =  |                IEEE company_id                |        | VSID  |
|        |        |                                        |        |       |
|  0110  |23    20|19              12|11              04|03    00|35    32|
|_____|_____|_____|_____|_____|_____|_____|
```

```
|        byte 4      |        byte 5      |        byte 6      |        byte 7      |
|31              24|23              16|15              08|07              00|
|_____|_____|_____|_____|_____|_____|_____|_____|
|                                                                            |
|                      Vendor Specified Identifier                           |
|31              24|23              16|15              08|07              00|
|_____|_____|_____|_____|
```

Vendor Specified Identifier Extension field

```
|        byte 8      |        byte 9      |        byte 10     |        byte 11     |
|63              56|55              48|47              40|39              32|
|_____|_____|_____|_____|_____|_____|_____|_____|
|                      Vendor Specified Identifier  Extension                |
|                                                                            |
|63              56|55              48|47              40|39              32|
|_____|_____|_____|_____|
```

```
|        byte 12     |        byte 13     |        byte 14     |        byte 15     |
|31              24|23              16|15              08|07              00|
|_____|_____|_____|_____|_____|_____|_____|_____|
|                                                                            |
|                      Vendor Specified Identifier  Extension                |
|31              24|23              16|15              08|07              00|
|_____|_____|_____|_____|
```
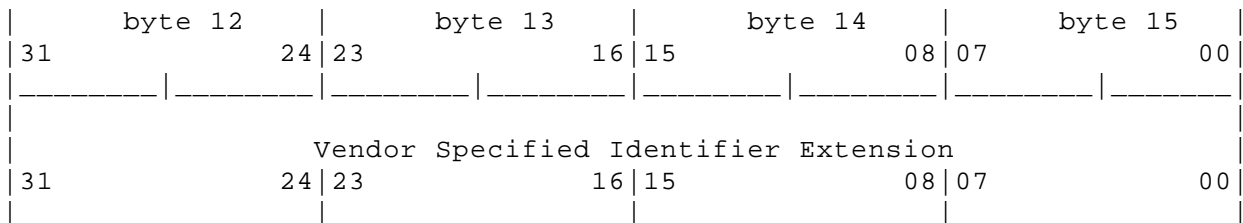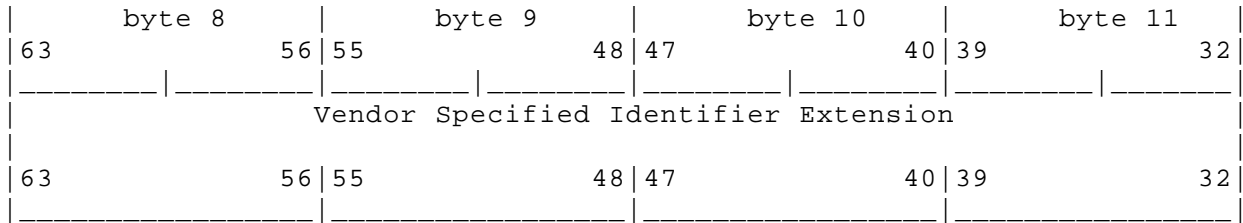
3.4.1   Example of IEEE registered extended format

In this example, the IEEE company_id value used is:

AC DE 48 (hexadecimal)

which has a binary representation of

1010 1100 1101 1110 0100 1000

■

In this example, the vendor specified value selected by the vendor is:

```
B 17 34 F6 2D (hexadecimal)
```

which has a binary representation of

```
1011  0001 0111  0011 0100  1111 0110  0010 1101
```

The vendor specified identifier extension, which may be selected by the vendor or assigned uniquely by the object itself, has the following value in this example:

```
12 34 56 78 9A BC DE 31 (hexadecimal)
```

The resulting IEEE extended registered format (in hexadecimal) is:

```
6A CD E4 8B 17 34 F6 2D
12 34 56 78 9A BC DE 31
```

which would have a binary representation of:

```
  byte 0       byte 1       byte 2       byte 3
0101 1010    1100 1101    1110 0100    1000 1011

  byte 4       byte 5       byte 6       byte 7
0001 0111    0011 0100    1111 0110    0010 1101

  byte 8       byte 9       byte 10      byte 11
0001 0010    0011 0100    0101 0110    0111 1000

  byte 12      byte 13      byte 14      byte 15
1001 1010    1011 1100    1101 1110    0011 0001
```
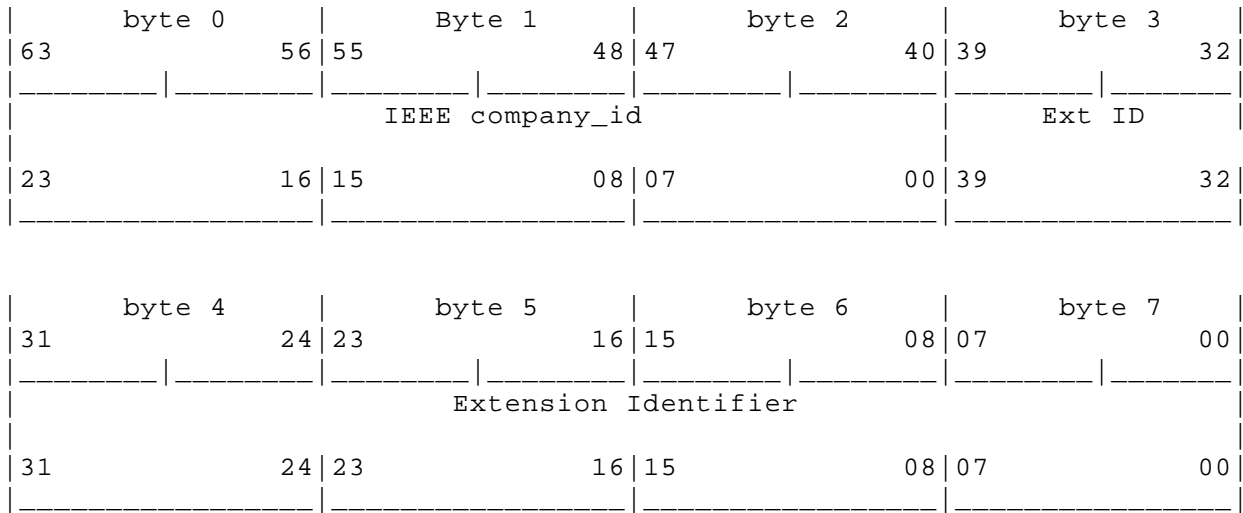
3.5   EUI-64 format

This format is specified by the 64-bit Global Identifier Tutorial. The 64-bit identifier is a concatenation of the 24-bit IEEE company_id value and a 40-bit extension identifier (Ext Id) assigned by the organization with that company_id assignment.

This format is recommended for use with the SPC INQUIRY command when access to the SCSI command set is made through an IEEE 1394-1995 interface. It is not recommended for use with enclosure services devices.

The EUI-64 format is shown in figure 6.

Figure 6 - EUI-64 identifier format

```
|       byte 0       |       Byte 1       |       byte 2       |       byte 3       |
|63              56|55              48|47              40|39              32|
|_____|_____|_____|_____|_____|_____|_____|_____|
|                     IEEE company_id                    |       Ext ID       |
|                                                        |                    |
|23              16|15              08|07              00|39              32|
|_____|_____|_____|_____|


|       byte 4       |       byte 5       |       byte 6       |       byte 7       |
|31              24|23              16|15              08|07              00|
|_____|_____|_____|_____|_____|_____|_____|_____|
|                          Extension Identifier                                 |
|                                                                               |
|31              24|23              16|15              08|07              00|
|_____|_____|_____|_____|
```

3.5.1   Example EUI-64 format

In this example, the IEEE company_id value used is:

AC DE 48 (hexadecimal)

which has a binary representation of

1010 1100 1101 1110 0100 1000

In this example, the vendor specified value selected by the vendor is:

23 45 67 AB CDh (hexadecimal)

which has a binary representation of

0010 0011 0100 0101 0110 0111 1010 1011 1100 1101

The resulting IEEE registered format is:

AC DE 48 23 45 67 AB CDh (hexadecimal)

which would have a binary representation of:

```
    byte 0        byte 1        byte 2        byte 3
  1010 1100     1101 1110     0100 1000     0010 0011

    byte 4        byte 5        byte 6        byte 7
  0100 0101     0110 0111     1010 1011     1100 1101
```

■

4   Availability of references

Copies of the following documents can be obtained from ANSI: Approved ANSI standards, approved and draft international and regional standards (ISO, IEC, CEN/CENELEC, ITUT), and approved and draft foreign standards (including BSI, JIS, and DIN). For further information, contact ANSI Customer Service Department at 212-642-4900 (phone), 212-302-1286 (fax) or via the World Wide Web at http://www.ansi.org.

ANSI X3.230-1995, Fibre Channel Physical and Signaling Interface (FC-PH)

Copies of these X3T10 draft documents are available for purchase from Global Engineering Documents. For further information, contact Global Engineering Documents at 800-854-7179 (phone) or 303-792-2181 (phone) or by mail at 15 Inverness Way East, Englewood, CO 80122-5704

ANSI X3.301-199X, SCSI-3 Primary Commands (SPC)

X3T10/Project 1212-D/Revision 8, SCSI-3 Enclosure Services Commands (SES)

New identifier formats based on IEEE registration, Bob Snively, Dec 12, 1996, X3T11/96-467.

Copies of the following document will be available from the IEEE web site as final approval by the IEEE-RAC takes place.

64-bit Global Identifier Format Tutorial