Network Working Group
Internet-Draft
Intended Status: Standards Track
Expires: January 4, 2014

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July 4, 2014

Energy Object Context MIB
draft-ietf-eman-energy-aware-mib-16

Status of this Memo

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Abstract

This document defines a subset of a Management Information Base (MIB) for energy management of devices. The module addresses device identification, context information, and the energy relationships between devices.

Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

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1. Introduction

The EMAN standards provide a specification for Energy Management. This document defines a subset of a Management Information Base (MIB) for use with network management protocols for Energy monitoring of network devices and devices attached to the network and possibly extending to devices in the industrial automation setting with a network interface.

The focus of the MIB module specified in this document is on the identification of Energy Objects and reporting the context and relationships of Energy Objects as defined in [EMAN-FMWK]. The module addresses Energy Object identification, Energy Object context, and Energy Object relationships.

1.1. Energy Management Document Overview

This document specifies the Energy Object Context (ENERGY-OBJECT-CONTEXT-MIB) and IANA Energy Relationship (IANA-ENERGY-RELATION-MIB) modules. The Energy Object Context MIB module specifies MIB objects for identification of Energy Objects, and reporting context and relationship of an Energy Object. The IANA Energy Relationship MIB module specifies the first version of the IANA-maintained definitions of relationships between Energy Objects.

Firstly, to illustrate the importance of energy monitoring in networks and secondly to list some of the important areas to be addressed by the Energy Management Framework, several use cases and network scenarios are presented in the EMAN applicability statement document [EMAN-AS]. In addition, for each scenario, the target devices for energy management, and how those devices powered and metered are also presented. To address the network scenarios, requirements for power and energy monitoring for networking devices are specified in [RFC6988]. Based on the requirements [RFC6988], the [EMAN-FMWK] presents a solution approach.

Accordingly, the scope of the MIB modules in this document is in accordance to the requirements specified in [RFC6988] and the concepts from [EMAN-FMWK].

This document is based on the Energy Management Framework [EMAN-FMWK] and meets the requirements on identification of Energy Objects and their context and relationships as specified in the Energy Management requirements [RFC6988].

A second MIB module meeting the EMAN requirements [RFC6988] the Power and Energy Monitoring MIB [EMAN-MON-MIB], monitors the Energy Objects for Power States, for the Power and Energy consumption. Power State monitoring includes: retrieving Power States, Power State properties, current Power State, Power State transitions, and Power State statistics. In addition, this MIB module provides the Power Characteristics properties of the Power and Energy, along with optional characteristics.

The applicability statement document [EMAN-AS] provides the list of use cases, and describes the common aspects of between existing Energy standards and the EMAN standard, and shows how the EMAN framework relates to other frameworks.

2. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of RFC 3410 [RFC3410].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies MIB modules that are compliant with SMIv2, which is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].

3. Terminology

Please refer to [EMAN-FMWK] for the definitions of the following terminology used in this draft.

        Energy Management
        Energy Management System (EnMS)
        Energy Monitoring

Energy Control
electrical equipment
non-electrical equipment (mechanical equipment)
device
component
power inlet
power outlet
energy
power
demand
provide energy
receive energy
meter (energy meter)
battery
Power Interface
Nameplate Power
Power Attributes
Power Quality
Power State
Power State Set

4. Architecture Concepts Applied to the MIB Module

This section describes the basic concepts specified in the Energy Management Architecture [EMAN-FMWK], with specific information related to the MIB modules specified in this document.

The Energy Object Context (ENERGY-OBJECT-CONTEXT-MIB) MIB module in this document specifies MIB objects for identification of Energy Objects, and reporting context and relationship of an Energy Object. The managed objects are contained in two tables eoTable and eoRelationTable.

The first table eoTable focuses on the link to the other MIB modules, on identification and context of the Energy Object. The second table eoRelationTable specifies the relationships between Energy Objects. This is a simplified representation of relationship between Energy Objects.

A "smidump-style" tree presentation of the MIB modules contained in the draft is presented. The meaning of the three symbols in is a compressed representation of the object's MAX-ACCESS clause which may have the following values:

```
"not-accessible"->"---"
"accessible-for-notify"->"--n"
```

```
       "read-only"->"r-n"
       "read-write"->"rwn"


   +- eoTable(1)
      |
      +- eoEntry(1) [entPhysicalIndex]
         |
         +-- r-n PethPsePortIndexOrZero       eoEthPortIndex(1)
         +-- r-n PethPsePortGroupIndexOrZero  eoEthPortGrpIndex(2)
         +-- r-n LldpPortNumberOrZero         eoLldpPortNumber(3)
         +-- rwn MacAddress                   eoMgmtMacAddress(4)
         +-- r-n InetAddressType              eoMgmtAddressType(5)
         +-- r-n InetAddress                  eoMgmtAddress(6)
         +-- r-n OCTET STRING                 eoMgmtDNSName(7)
         +-- rwn SnmpAdminString              eoDomainName(8)
         +-- rwn SnmpAdminString              eoRoleDescription(9)
         +-- rwn EnergyObjectKeywordList      eoKeywords(10)
         +-- rwn Integer32                    eoImportance(11)
         +-- r-n INTEGER                    eoPowerCategory(12)
         +-- rwn SnmpAdminString              eoAlternateKey(13)
         +-- r-n INTEGER                eoPowerInterfaceType(14)

   +- eoRelationTable(2)
      |
      +- eoRelationEntry(1) [entPhysicalIndex, eoRelationIndex]
         |
         +-- --n Integer32                   eoRelationIndex(1)
         +-- rwn UUIDorZero                  eoRelationID(2)
         +-- rwn IANAEnergyRelationship      eoRelationship(3)
         +-- rwn RowStatus                   eoRelationStatus(4)
         +-- rwn StorageType            eoRelationStorageType(5)
```

The following UML diagram illustrates the relationship of the MIB objects in the eoTable, eoRelationTable and ENTITY-MIB. The MIB objects describe the identity, context and relationship of an Energy Object. The UML diagram furthermore contains objects from the ENTITY-MIB [RFC6933].

```
         +--------------------------+
         |  EO Context Information  |
         | ------------------------ |
         |  eoRoleDescription       |
         |  eoKeywords              |
         |  eoImportance            |
         |  eoPowerCategory         |
```

```
         |  eoPowerInterfaceType    |
         |  eoDomainName            |
         +--------------------------+
                ^
                |
                |
             +-----------------------------+
       |---  |  EO Identification          |
       |     | --------------------------- |
       |     | entPhysicalIndex (*)        |
       |     | entPhysicalName (*)         |
       |     | entPhysicalUUID (*)         |
       |     | entPhysicalClass (*)        |
       |      -----------------------------
       |
       |     +-----------------------------+
       |---> | Link to other identifiers   |
       |     |-----------------------------|
       |     | eoEthPortIndex (**)         |
       |     | eoEthPortGrpIndex (**)      |
       |     | eoLldpPortNumber (***)      |
       |     |                             |
       |     | eoMgmtMacAddress (optional) |
       |     | eoMgmtAddressType (optional)|
       |     | eoMgmtAddress (optional)    |
       |     | eoMgmtDNSName (optional)    |
       |     | eoAlternateKey              |
       |     +-----------------------------+
       |
       |     +-----------------------------+
       |---> |  EO Relationship            |
             | --------------------------- |
             |  eoRelationIndex            |
             |  eoRelationID               |
             |  eoRelationship             |
             |  eoRelationStatus           |
             |  eoRelationStorageType      |
             +-----------------------------+

    (*)   Compliance with entity4CRCompliance ENTITY MIB[RFC6933]
    (**)  Link with the Power over Ethernet MIB [RFC3621]
    (***) Link with LLDP MIBs [LLDP-MIB] [LLDP-MED-MIB]
```

Figure 1: MIB Objects Grouping

As displayed in figure 1, the MIB objects can be classified in different logical grouping of MIB objects.

1) The Energy Object Identification. See Section 5.1 "Energy Object Identification". Devices and their sub-components are characterized by the power-related attributes of a physical entity present in the ENTITY MIB [RFC6933].
2) The Context Information. See Section 5.2 "Energy Object Context"
3) The links to other MIB modules. See Section 5.3 "Links to other Identifiers"
4) The Energy Object Relationships specific information. See Section 5.4
5) The Energy Object Identity Persistence. See Section 5.5 "Energy Object Identity Persistence"

4.1 Energy Object Identification

Refer to the "Energy Object Information" section in [EMAN-FMWK] for background information about Energy Objects.

Every Energy Object MUST implement the unique index, entPhysicalIndex, entPhysicalName, entPhysicalClass, and entPhysicalUUID from the ENTITY MIB [RFC6933]. Module Compliance with respect to entity4CRCompliance of ENTITY-MIB MUST be supported which require a limited number of objects supported (entPhysicalIndex, entPhysicalName, entPhysicalClass, and entPhysicalUUID). entPhysicalIndex is used as index for the Energy Object in the ENERGY-OBJECT-CONTEXT-MIB module. Every Energy Object MUST have a printable name assigned to it. Energy Objects MUST implement the entPhysicalName object specified in the ENTITY-MIB [RFC6933], which must contain the Energy Object name.

For the ENERGY-OBJECT-CONTEXT-MIB compliance, every Energy Object instance MUST implement the entPhysicalUUID from the ENTITY MIB [RFC6933].

As displayed in [RFC4122], the following is an example of the string representation of a UUID as a URN: urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6.

For example, to understand the relationship between Energy Object Components and Energy Objects, the ENTITY-MIB physical containment tree [RFC6933] MUST be implemented.

A second example deals with one of the ENTITY-MIB extensions: if the Energy Object temperature is required, the managed objects from the ENTITY-SENSOR-MIB [RFC3433] should be supported.

Each Energy Object MUST belong to a single Energy Management Domain or in other words, an Energy Object cannot belong to more than one Energy Management Domain. Refer to the "Energy Management Domain" section in [EMAN-FMWK] for background information. The eoDomainName, which is an element of the eoTable, is a read-write MIB object. The Energy Management Domain should map 1-1 with a metered or sub-metered portion of the network. The Energy Management Domain MUST be configured on the Energy Object. The Energy Object MAY inherit the some of the domain parameters (possibly domain name, some of the context information such as role or keywords, importance) from the Energy Object or the Energy Management Domain MAY be configured directly in an Energy Object.

When an Energy Object acts as a Power Aggregator, the Energy Objects for which Power should be aggregated MUST be members of the same Energy Management Domain, specified by the eoDomainName MIB Object.

4.2 Energy Object Context

Refer to the "Energy Object Context" section in [EMAN-FMWK] for background information.

An Energy Object must provide a value for eoImportance in the range of 1...100 to help differentiate the use or relative value of the device. The importance range is from 1 (least important) to 100 (most important). The default importance value is 1.

An Energy Object can provide a set of eoKeywords. These keywords are a list of tags that can be used for grouping and summary reporting within or between Energy Management Domains.

An Energy Object can have Power Interfaces and those interfaces can be classified as Power Inlet, Power Outlet or both.

An Energy Object can be classified based on the physical properties of the Energy Object. That Energy Object can be classified as consuming power or supplying power to other devices or that Energy Object can perform both of those functions and finally, an Energy Object can be a passive meter.

Additionally, an Energy Object can provide an eoRoleDescription string that indicates the purpose the Energy Object serves in the network.

4.3 Links to Other Identifiers

While the entPhysicalIndex is the primary index for all MIB objects in the ENERGY-OBJECT-CONTEXT-MIB module, the Energy Management Systems (EnMS) must be able to make the link with the identifier(s) in other supported MIB modules.

If the Energy Object is a Power over Ethernet (PoE) port, and if the Power over Ethernet MIB [RFC3621] is supported by the SNMP agent managing the Energy Object, then the Energy Object eoethPortIndex and eoethPortGrpIndex MUST contain the corresponding values of pethPsePortIndex and pethPsePortGroupIndex [RFC3621].

If the LLDP-MED MIB [LLDP-MIB] is supported by the Energy Object SNMP agent, then the Energy Object eoLldpPortNumber MUST contain the corresponding lldpLocPortNum from the LLDP MIB.

The intent behind the links to the other MIB module identifier(s) is to correlate the instances in the different MIB modules. This will allow the ENERGY-OBJECT-CONTEXT-MIB module to reference other MIB modules in cases where the Power over Ethernet and the LLDP MIB modules are supported by the SNMP agent. Some use cases may not implement any of these two MIB modules for the Energy Objects. However, in situation where any of these two MIB modules are implemented, the EnMS must be able to correlate the instances in the different MIB modules.

The eoAlternateKey object specifies an alternate key string that can be used to identify the Energy Object. Since an EnMS may need to correlate objects across management systems, this alternate key is provided to facilitate such a link. This optional value is intended as a foreign key or alternate identifier for a manufacturer or EnMS to use to correlate the unique Energy Object Id in other systems or namespaces. If an alternate key is not available or is not applicable then the value is the zero-length string.

An Energy Object can have additional MIB objects that can be used for easier identification by the EnMS. The optional objects eoMgmtMacAddress, eoMgmtAddressType eoMgmtDNSName can be used to help identify the relationship between the Energy Objects and other NMS objects. These objects can be used as an alternate

key to help link the Energy Object with other keyed information that may be stored within the EnMS(s). For the optional objects that may not be included in some vendor implementations, the expected behavior when those objects are polled is a response noSuchInstance.

4.4 Energy Object Relationships

Refer to the "Energy Object Relationships" section in [EMAN-FMWK] for the definition and background information.In order to link two Energy Objects a separate table (eoRelationTable) has been introduced in this MIB module.

Each Energy object can have one or more Energy Object relationships with other Energy Objects. The relationship between Energy Objects are specified in eoRelationTable. The relationship between the Energy Objects is specified with the entPhysicalIndex of the Energy Object and the UUID of the remote Energy Object. The UUID MUST comply to the RFC 4122 specifications. It is important to note that it is possible that an Energy Object may not have an Energy Object relationship with other Energy Objects.

The following relationships between Energy objects have been considered in the eoRelationTable.

```
Metering Relationship     -> meteredBy / metering

Power Source Relationship -> poweredBy / powering

Aggregation Relationship  -> aggregatedBy / aggregating
```

An Energy Object B has "meteredBy" relationship with Energy Object A, if the energy consumption of Energy Object B is measured by Energy Object A. Equivalently, it is possible to indicate that Energy Object A has "metering" relationship with Energy Object B.

An Energy Object B has "poweredBy" relationship with Energy Object A, if the power source of Energy Object B Energy Object A. Equivalently, it is possible to indicate that Energy Object A has "powering" relationship with Energy Object B.

An Energy Object B has "aggregatedBy" relationship with Energy Object A, if Energy Object A is an aggregation point for energy usage of Energy Object B. Equivalently, it is possible to

indicate that Energy Object A has "aggregating" relationship with Energy Object B.

The IANA Energy Relationship MIB module in Section 6 below specifies the first version of the IANA-maintained definitions of relationships. This way, for Energy Relationships, new textual conventions can be specified, without updating the primary Energy Object Context MIB module.

4.5 Energy Object Identity Persistence

In some situations, the Energy Object identity information should be persistent even after a device reload. For example, in a static setup where a switch monitors a series of connected PoE phones, there is a clear benefit for the EnMS if the Energy Object Identification and all associated information persist, as it saves a network discovery. However, in other situations, such as a wireless access point monitoring the mobile user PCs, there is not much advantage to persist the Energy Object Information. The identity information of an Energy Object should be persisted and there is value in the writable MIB objects persisted.

5. MIB Definitions

```
-- ************************************************************
--
--
-- This MIB is used for describing the identity and the
-- context information of Energy Objects in network
--
--
-- *************************************************************


ENERGY-OBJECT-CONTEXT-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY,
    OBJECT-TYPE,
    mib-2, Integer32
        FROM SNMPv2-SMI                        -- RFC2578
    TEXTUAL-CONVENTION, MacAddress, TruthValue,
       RowStatus, StorageType
```

```
           FROM SNMPv2-TC                              -- RFC2579
       MODULE-COMPLIANCE,  OBJECT-GROUP
           FROM SNMPv2-CONF                            -- RFC2580
       SnmpAdminString
           FROM SNMP-FRAMEWORK-MIB                     -- RFC3411
       InetAddressType, InetAddress
          FROM INET-ADDRESS-MIB                        -- RFC3291
       entPhysicalIndex
          FROM ENTITY-MIB                              -- RFC6933
       UUIDorZero
          FROM UUID-TC-MIB                             -- RFC6933
       IANAEnergyRelationship
          FROM IANA-ENERGY-RELATION-MIB;



   energyObjectContextMIB MODULE-IDENTITY
       LAST-UPDATED    "201406110000Z"

       ORGANIZATION    "IETF EMAN Working Group"
       CONTACT-INFO
          "WG Charter:
           http://datatracker.ietf.org/wg/eman/charter/

          Mailing Lists:
           General Discussion: eman@ietf.org
           To Subscribe: https://www.ietf.org/mailman/listinfo/eman
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       DESCRIPTION
          "This MIB is used for describing the identity and the
          context information of Energy Objects"
       REVISION
           "201406110000Z"
       DESCRIPTION
          "Initial version, published as RFC YYYY."


      ::= { mib-2 xxx1 }

        -- RFC Editor, please replace xxx1 with the IANA allocation
        -- for this MIB module and YYYY with the number of the
        -- approved RFC

   energyObjectContextMIBNotifs OBJECT IDENTIFIER
       ::= { energyObjectContextMIB 0 }

   energyObjectContextMIBObjects OBJECT IDENTIFIER
       ::= { energyObjectContextMIB 1 }

   energyObjectContextMIBConform  OBJECT IDENTIFIER
       ::= { energyObjectContextMIB 2 }


   -- Textual Conventions


   PethPsePortIndexOrZero ::= TEXTUAL-CONVENTION
   DISPLAY-HINT "d"
      STATUS            current
      DESCRIPTION
          "This textual convention is an extension of the
          pethPsePortIndex convention, which defines a greater than
          zero value used to identify a power Ethernet PSE port.
```

```
          This extension permits the additional value of zero.  The
          semantics of the value zero are object-specific and must,
          therefore, be defined as part of the description of any
          object that uses this syntax.  Examples of the usage of
          this extension are situations where none or all physical
          entities need to be referenced."
      SYNTAX Integer32 (0..2147483647)

  PethPsePortGroupIndexOrZero ::= TEXTUAL-CONVENTION
   DISPLAY-HINT "d"
      STATUS           current
      DESCRIPTION
          "This textual convention is an extension of the
          pethPsePortGroupIndex convention from the Power Over
          Ethernet MIB RFC 3621, which defines a greater than zero
          value used to identify group containing the port to which
          a power Ethernet PSE is connected.  This extension
          permits the additional value of zero.  The semantics of
          the value zero are object-specific and must, therefore,
          be defined as part of the description of any object that
          uses this syntax.  Examples of the usage of this
          extension are situations where none or all physical
          entities need to be referenced."
      SYNTAX Integer32 (0..2147483647)


 LldpPortNumberOrZero ::= TEXTUAL-CONVENTION
      DISPLAY-HINT "d"
      STATUS     current
      DESCRIPTION
          "This textual convention is an extension of the
          LldpPortNumber convention specified in the LLDP MIB,
          which defines a greater than zero value used to uniquely
          identify each port contained in the chassis (that is
          known to the LLDP agent) by a port number.  This
          extension permits the additional value of zero. The
          semantics of the value zero are object-specific and must,
          therefore, be defined as part of the description of any
          object that uses this syntax.  Examples of the usage of
          this extension are situations where none or all physical
          entities need to be referenced."
     SYNTAX Integer32(0..4096)
```

```
  EnergyObjectKeywordList ::= TEXTUAL-CONVENTION
      STATUS          current
      DESCRIPTION
          "A list of keywords that can be used to group Energy
          Objects for reporting or searching. If multiple keywords
          are present, then this string will contain all the
          keywords separated by the ',' character. All alphanumeric
          characters and symbols (other than a comma), such as #,
          (, $, !, and &, are allowed. White spaces before and
          after the commas are ignored, as well as within a keyword
          itself.

          For example, if an Energy Object were to be tagged with
          the keyword values 'hospitality' and 'guest', then the
          keyword list will be 'hospitality,guest'."
      SYNTAX OCTET STRING (SIZE (0..2048))

   -- Objects

   eoTable OBJECT-TYPE
       SYNTAX          SEQUENCE OF EoEntry
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
          "This table lists Energy Objects."
       ::= { energyObjectContextMIBObjects 1 }

   eoEntry OBJECT-TYPE
       SYNTAX          EoEntry
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
          "An entry describes the attributes of an Energy Object.
          Whenever a new Energy Object is added or an existing
          Energy Object is deleted, a row in the eoTable is added
          or deleted."

        INDEX      {entPhysicalIndex }
       ::= { eoTable 1 }

   EoEntry ::= SEQUENCE {
           eoEthPortIndex              PethPsePortIndexOrZero,
           eoEthPortGrpIndex           PethPsePortGroupIndexOrZero,
           eoLldpPortNumber            LldpPortNumberOrZero,
```

```
           eoMgmtMacAddress            MacAddress,
           eoMgmtAddressType           InetAddressType,
           eoMgmtAddress               InetAddress,
           eoMgmtDNSName               OCTET STRING,
           eoDomainName                SnmpAdminString,
           eoRoleDescription           SnmpAdminString,
           eoKeywords                  EnergyObjectKeywordList,
           eoImportance                Integer32,
           eoPowerCategory             INTEGER,
           eoAlternateKey              SnmpAdminString,
           eoPowerInterfaceType        INTEGER
          }

   eoEthPortIndex   OBJECT-TYPE
       SYNTAX       PethPsePortIndexOrZero
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION
          "This variable uniquely identifies the power Ethernet
          port to which a Power over Enternet device is connected .
          If the Power over Ethernet MIB RFC 3621 is supported by
          the SNMP agent managing the Energy Object, then the
          Energy Object eoethPortIndex MUST contain the
          corresponding value of pethPsePortIndex. f such a power
          Ethernet port cannot be specified or is not known then
          the object is zero."
          REFERENCE "RFC 3621 "
          DEFVAL { 0 }


       ::= { eoEntry 1 }

   eoEthPortGrpIndex   OBJECT-TYPE
       SYNTAX       PethPsePortGroupIndexOrZero
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION
          "This variable uniquely identifies the group containing
          the port to which a power over Ethernet device PSE is
          connected [RFC3621]. If the Power over Ethernet MIB RFC
          3621 is supported by the SNMP agent managing the Energy
          Object, then the Energy Object eoEthPortGrpIndex MUST
          contain the corresponding value of eoethPortGrpIndex. If
          such a power Ethernet port cannot be specified or is not
          known then the object is zero."
          REFERENCE "RFC 3621"
          DEFVAL { 0 }
```

```
       ::= { eoEntry 2 }

   eoLldpPortNumber   OBJECT-TYPE
       SYNTAX       LldpPortNumberOrZero
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION
         "This variable uniquely identifies the port component
         (contained in the local chassis with the LLDP agent) as
         defined by the lldpLocPortNum in the [LLDP-MIB] and
         [LLDP-MED-MIB]. If the [LLDP-MIB] is supported by the
         SNMP agent managing the Energy Object, then the Energy
         Object eoLldpPortNumber MUST contain the corresponding
         value of lldpLocPortNum from the [LLDP-MIB]. If such a
         port number cannot be specified or is not known then the
         object is zero."
          REFERENCE "LLDP MIB, IEEE 802.1AB-2005,
          LLDP-MED-MIB, ANSI/TIA-1057"
          DEFVAL { 0 }

      ::= { eoEntry 3 }

   eoMgmtMacAddress OBJECT-TYPE
       SYNTAX          MacAddress
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
          "This object specifies a MAC address of the Energy
          Object."
       ::= { eoEntry 4  }

   eoMgmtAddressType OBJECT-TYPE
       SYNTAX          InetAddressType
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
         "This object specifies the eoMgmtAddress type, i.e. an
         IPv4 address or an IPv6 address. This object MUST be
         populated when eoMgmtAddress is populated."
       ::= { eoEntry 5  }

   eoMgmtAddress OBJECT-TYPE
       SYNTAX          InetAddress
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
         "This object specifies the management address as an IPv4
         address or IPv6 address of Energy Object. The IP address
```

```
          type, i.e. IPv4 or IPv6, is determined by the
          eoMgmtAddressType value. This object can be used as an
          alternate key to help link the Energy Object with other
          keyed information that may be stored within the EnMS(s)."
        ::= { eoEntry 6  }

    eoMgmtDNSName OBJECT-TYPE
        SYNTAX          OCTET STRING
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
           "This object specifies a DNS name of the eoMgmtAddress.
           This object can be used as an alternate key to help link
           the Energy Object with other keyed information that may
           be stored within the EnMS(s). A DNS Name must always be a
           fully qualified name. This MIB uses the same encoding as
           the DNS protocol."
         REFERENCE
              "RFC-1034 section 3.1."
        ::= { eoEntry 7  }

    eoDomainName OBJECT-TYPE
        SYNTAX          SnmpAdminString
        MAX-ACCESS      read-write
        STATUS          current
        DESCRIPTION
           "This object specifies the name of an Energy Management
           Domain for the Energy Object. By default, this object
           should be an empty string. The value of eoDomainName must
           remain constant at least from one re-initialization of
           the entity local management system to the next re-
           initialization."
        ::= { eoEntry 8   }

    eoRoleDescription OBJECT-TYPE
        SYNTAX          SnmpAdminString
        MAX-ACCESS      read-write
        STATUS          current
        DESCRIPTION
           "This object specifies an administratively assigned name
           to indicate the purpose an Energy Object serves in the
           network.

           For example, we can have a phone deployed to a lobby with
           eoRoleDescription as 'Lobby phone'.
```

```
          This object specifies that the value is the zero-length
          string value if no role description is configured.
          The value of eoRoleDescription must remain constant at
          least from one re-initialization of the entity local
          management system to the next re-initialization. "
       ::= { eoEntry 9   }

   eoKeywords OBJECT-TYPE
       SYNTAX          EnergyObjectKeywordList
       MAX-ACCESS      read-write
       STATUS          current
       DESCRIPTION
          "This object specifies a list of keywords that can be
          used to group Energy Objects for reporting or searching.
          The value is the zero-length string if no keywords have
          been configured. If multiple keywords are present, then
          this string will contain all the keywords separated by
          the ',' character. For example, if an Energy Object were
          to be tagged with the keyword values 'hospitality' and
          'guest', then the keyword list will be
          'hospitality,guest'.

          If write access is implemented and a value is written
          into the instance, the agent must retain the supplied
          value in the eoKeywords instance associated with
          the same physical entity for as long as that entity
          remains instantiated.  This includes instantiations
          across all re-initializations/reboots of the local
          management agent. "
       ::= { eoEntry 10    }

   eoImportance OBJECT-TYPE
       SYNTAX          Integer32 (1..100)
       MAX-ACCESS      read-write
       STATUS          current
       DESCRIPTION
          "This object specifies a ranking of how important the
          Energy Object is (on a scale of 1 to 100) compared with
          other Energy Objects in the same Energy Management
          Domain. The ranking should provide a business or
          operational context for the Energy Object as compared to
          other similar Energy Objects. This ranking could be used
          as input for policy-based network management.


          Although network managers must establish their own
          ranking, the following is a broad recommendation:
```

```
          90 to 100 Emergency response
          80 to 90 Executive or business critical
          70 to 79 General or Average
          60 to  69 Staff or support
          40 to  59 Public or guest
          1  to 39 Decorative or hospitality

          The value of eoImportance must remain constant at least
          from one re-initialization of the Energy Object local
          management system to the next re-initialization. "
       DEFVAL          { 1 }
       ::= { eoEntry 11   }

   eoPowerCategory OBJECT-TYPE
       SYNTAX          INTEGER {
                           consumer(0),
                           producer(1),
                           meter(2),
                           distributor(3),
                           store(4)
                       }
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
          "This object describes the Energy Object category, which
          indicates the expected behavior or physical property of
          the Energy Object, based on its design. An Energy Object
          can be a consumer(0), producer(1), meter(2),
          distributor(3) or store(4).

          In some cases, a meter is required to measure the power
          consumption. In such a case, this meter Energy Object
          category is meter(2). If a device is distributing
          electric Energy, the category of the Energy Object is
          distributor (3). If a device is storing electric Energy,
          the category of the device can be store (4). "
       ::= { eoEntry 12    }

   eoAlternateKey OBJECT-TYPE
       SYNTAX          SnmpAdminString
       MAX-ACCESS      read-write
       STATUS          current
       DESCRIPTION
          "The eoAlternateKey object specifies an alternate key
          string that can be used to identify the Energy Object.
          Since Energy Management Systems (EnMS) and Network
          Management Systems (NMS) may need to correlate objects
          across management systems, this alternate key is provided
```

```
          to provide such a link. This optional value is intended
          as a foreign key or alternate identifier for a
          manufacturer or EnMS/NMS to use to correlate the unique
          Energy Object Id in other systems or namespaces. If an
          alternate key is not available or is not applicable then
          the value is the zero-length string.
          The value of eoAlternateKey must remain constant at
          least from one re-initialization of the  entity local
          management system to the next re-initialization. "
       ::= { eoEntry 13 }

   eoPowerInterfaceType            OBJECT-TYPE
       SYNTAX          INTEGER {
                           inlet(0),
                           outlet(1),
                           both(2)
                       }
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
         "This object describes the Power Interface for an Energy
         Object. A Power Interface is an interface at which a
         Energy Object is connected to a power transmission
         medium, at which it can in turn receive power, provide
         power, or both. A Power Interface type can be an inlet(0)
         or outlet(1) or both(2), respectively."
       ::= { eoEntry 14 }

   eoRelationTable OBJECT-TYPE
       SYNTAX          SEQUENCE OF EoRelationEntry
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
         "This table describes the relationships between Energy
         Objects."
       ::= { energyObjectContextMIBObjects 2 }


   eoRelationEntry OBJECT-TYPE
       SYNTAX          EoRelationEntry
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
         "An entry in this table specifies the Energy relationship
         between Energy objects. Energy relations between two
         Energy objects are defined in the EMAN-FMWK."
       REFERENCE
          "EMAN-FMWK,  Energy Management Framework, RFC abcs,
```

```
          Jan 2014"
       INDEX        { entPhysicalIndex, eoRelationIndex }
       ::= { eoRelationTable 1 }


   EoRelationEntry ::= SEQUENCE {
                  eoRelationIndex        Integer32,
                  eoRelationID           UUIDorZero,
                  eoRelationship         IANAEnergyRelationship,
                  eoRelationStatus       RowStatus,
                  eoRelationStorageType  StorageType
                 }

   eoRelationIndex     OBJECT-TYPE
       SYNTAX          Integer32 (0..2147483647)
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
         "This object is an arbitrary index to identify the Energy
         Object related to another Energy Object"
       ::= { eoRelationEntry 1 }

   eoRelationID        OBJECT-TYPE
       SYNTAX          UUIDorZero
       MAX-ACCESS      read-create
       STATUS          current
       DESCRIPTION
         "This object specifies the Universally Unique Identifier
         (UUID) of the peer (other) Energy Object. The UUID must
         comply the specifications of UUID in UUID-TC-MIB.

         If UUID of the energy object is unknown or non-existent,
         the eoRelationID will be set to a zero-length string
         instead. It is preferable that the value of
         entPhysicalUUID from ENTITY-MIB is used for values for
         this object."

   REFERENCE
          "RFC 6933, Entity MIB - version 4,  May 2013 "
       ::= { eoRelationEntry 2 }

   eoRelationship      OBJECT-TYPE
       SYNTAX          IANAEnergyRelationship
       MAX-ACCESS      read-create
       STATUS          current
       DESCRIPTION
```

```
         "This object describes the relations between Energy
         objects. For each Energy object, the relations between
         the other Energy objects are specified using the bitmap."
       ::= { eoRelationEntry 3 }



   eoRelationStatus OBJECT-TYPE
       SYNTAX          RowStatus
       MAX-ACCESS      read-create
       STATUS          current
       DESCRIPTION
        "The status controls and reflects the creation and
         activation status of a row in this table to specify energy
         relationship between Energy objects.

        An entry status may not be active(1) unless all objects in
        the entry have the appropriate values.
        No attempt to modify a row columnar object instance value
        in the eoRelationTable should be issued while the value of
        eoRelationStatus is active(1). The data can be destroyed by
        setting up the eoRelationStatus to destroy(2)."

   ::= { eoRelationEntry 4 }

    eoRelationStorageType OBJECT-TYPE
      SYNTAX          StorageType
      MAX-ACCESS      read-create
      STATUS          current
      DESCRIPTION
       "This variable indicates the storage type for this row."
          DEFVAL { nonVolatile }
    ::= {eoRelationEntry 5 }



   -- Conformance

   energyObjectContextMIBCompliances  OBJECT IDENTIFIER
       ::= { energyObjectContextMIBConform 1   }

   energyObjectContextMIBGroups  OBJECT IDENTIFIER
       ::= { energyObjectContextMIBConform 2   }

   energyObjectContextMIBFullCompliance MODULE-COMPLIANCE
       STATUS          current
       DESCRIPTION
           "When this MIB is implemented with support for
```

```
           read-write, then such an implementation can
           claim full compliance. Such devices can then
           be both monitored and configured with this MIB.
           Module Compliance of ENTITY-MIB with respect to
           entity4CRCompliance MUST be supported."

       MODULE          -- this module
       MANDATORY-GROUPS {
                   energyObjectContextMIBTableGroup,
                  energyObjectRelationTableGroup
                        }

      GROUP     energyObjectOptionalMIBTableGroup
                DESCRIPTION
                "A compliant implementation does not have to
                implement. "
       ::= { energyObjectContextMIBCompliances 1 }


   energyObjectContextMIBReadOnlyCompliance MODULE-COMPLIANCE
       STATUS          current
       DESCRIPTION
           "When this MIB is implemented without support for
           read-write (i.e. in read-only mode), then such an
           implementation can claim read-only compliance.
           Such a device can then be monitored but cannot be
           Configured with this MIB.
           Module Compliance of ENTITY-MIB with respect to
           entity4CRCompliance MUST be supported."
       MODULE          -- this module

       MANDATORY-GROUPS {
                    energyObjectContextMIBTableGroup,
                   energyObjectRelationTableGroup
                        }

      GROUP energyObjectOptionalMIBTableGroup
         DESCRIPTION
         "A compliant implementation does not have to implement
         the managed objects in this GROUP. "

      ::= { energyObjectContextMIBCompliances 2 }

   -- Units of Conformance

   energyObjectContextMIBTableGroup OBJECT-GROUP
       OBJECTS         {
                           eoDomainName,
```

```
                           eoRoleDescription,
                           eoAlternateKey,
                           eoKeywords,
                           eoImportance,
                           eoPowerCategory,
                           eoPowerInterfaceType
                       }
       STATUS          current
       DESCRIPTION
           "This group contains the collection of all the objects
           related to the EnergyObject. "

       ::= { energyObjectContextMIBGroups 1 }

    energyObjectOptionalMIBTableGroup OBJECT-GROUP
           OBJECTS         {
                           eoEthPortIndex,
                           eoEthPortGrpIndex,
                           eoLldpPortNumber,
                           eoMgmtMacAddress,
                           eoMgmtAddressType,
                           eoMgmtAddress,
                           eoMgmtDNSName
                          }
       STATUS          current
       DESCRIPTION
           "This group contains the collection of all the objects
           related to the Energy Object."
       ::= { energyObjectContextMIBGroups 2 }

    energyObjectRelationTableGroup OBJECT-GROUP
         OBJECTS         {


                       eoRelationID,
                       eoRelationship,
                       eoRelationStatus,
                       eoRelationStorageType
                        }
         STATUS          current
       DESCRIPTION
           "This group contains the collection of all objects
           specifying the relationship between Energy Objects."
       ::= { energyObjectContextMIBGroups 3 }

    END
```

```
   IANA-ENERGY-RELATION-MIB DEFINITIONS ::= BEGIN
        IMPORTS
          MODULE-IDENTITY, mib-2
              FROM SNMPv2-SMI
          TEXTUAL-CONVENTION
              FROM SNMPv2-TC;

        ianaEnergyRelationMIB MODULE-IDENTITY
          LAST-UPDATED "201406110000Z"  -- June 11, 2014
          ORGANIZATION "IANA"
          CONTACT-INFO "
                        Internet Assigned Numbers Authority
                        Postal: ICANN
                        12025 Waterfront Drive Suite 300
                        Los Angeles, CA 90094
                        Tel: +1-310-301 5800
                        EMail: iana&iana.org"


          DESCRIPTION
           "This MIB module defines a TEXTUAL-CONVENTION that
            describes the relationships between Energy Objects.

            Copyright (C) The IETF Trust (2013).

            The initial version of this MIB module was published in
            RFC YYYY; for full legal notices see the RFC itself.
            Supplementary information may be available at
            http://www.ietf.org/copyrights/ianamib.html"


          REVISION     "201406110000Z"  -- June 11, 2014
          DESCRIPTION  "Initial version of this MIB as published in
                        RFC YYYY."
          ::= { mib-2 xxx2 }

        -- RFC Editor, please replace xxx2 with the IANA allocation
        -- for this MIB module and YYYY with the number of the
        -- approved RFC

        -- Textual Conventions

   IANAEnergyRelationship ::= TEXTUAL-CONVENTION
       STATUS            current
       DESCRIPTION
              "An enumerated value specifying the type of
               relationship between an Energy Object A, on
               which the relationship is specified, with the
```

```
               Energy Object B, identified by the UUID.

               The enumeration 'poweredBy' is applicable if the
               Energy Object A is poweredBy Energy Object B.

               The enumeration 'powering' is applicable if the
               Energy Object A is powering Energy Object B.

               The enumeration 'meteredBy' is applicable if the
               Energy Object A is meteredBy Energy Object B.

               The enumeration 'metering' is applicable if the
               Energy Object A is metering Energy Object B.


               The enumeration 'aggregatedBy' is applicable if the
               Energy Object A is aggregatedBy Energy Object B.

               The enumeration 'aggregating' is applicable if the
               Energy Object A is aggregating Energy Object B."

       SYNTAX      INTEGER  {
                    poweredBy(1),    --  power relationship
                    powering(2),
                    meteredBy(3),    --  meter relationship
                    metering(4),
                    aggregatedBy(5), -- aggregation relationship
                    aggregating(6)
                    }

   END
```

6. Implementation Status

[Note to RFC Editor: Please remove this section and the reference to [RFC6982] before publication.]

This section records the status of known implementations of the EMAN-Monitoring MIB at the time of posting of this Internet-Draft, and is based on a proposal described in [RFC6982].

The description of implementations in this section is intended to assist the IETF in its decision processes in progressing drafts to RFCs.

6.1 SNMP Research

Organization: SNMP Research, Inc.

Maturity: Prototype based upon early drafts of the MIBs.
            We anticipate updating it to more recent
            documents as development schedules allow.

Coverage: Code was generated to implement all MIB objects
            in ENTITY-MIB (Version 4),
            ENERGY-OBJECT-CONTEXT-MIB,
            ENERGY-OBJECT-MIB,
            POWER-CHARACTERISTICS-MIB,
            and BATTERY-MIB.

Implementation experience: The documents are implementable.

Comments: Technical comments about the
            ENERGY-OBJECT-CONTEXT-MIB,
            ENERGY-OBJECT-MIB, and
            BATTERY-MIB
            were submitted to the EMAN Working Group
            E-mail list.

Licensing: Proprietary, royalty licensing

Contact: Alan Luchuk, luchuk at snmp.com

URL: http://www.snmp.com/

6.2 Python

Priyanka Rao has mentioned on the mailing list (http://www.ietf.org/mail-archive/web/eman/current/msg02063.html) that she has a python implementation.

7. Security Considerations

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. These are the tables and objects and their sensitivity/vulnerability:

. Unauthorized changes to the eoDomainName, entPhysicalName, eoRoleDescription, eoKeywords, and/or eoImportance MAY disrupt power and energy collection, and therefore any predefined policies defined in the network.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPsec), there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module.

Implementations SHOULD provide the security features described by the SNMPv3 framework (see [RFC3410]), and implementations claiming compliance to the SNMPv3 standard MUST include full support for authentication and privacy via the User-based Security Model (USM) [RFC3414] with the AES cipher algorithm [RFC3826]. Implementations MAY also provide support for the Transport Security Model (TSM) [RFC5591] in combination with a secure transport such as SSH [RFC5592] or TLS/DTLS [RFC6353].

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

8. IANA Considerations

The MIB modules in this document use the following IANA-assigned OBJECT IDENTIFIER values recorded in the SMI Numbers registry:

Descriptor	OBJECT IDENTIFIER value
energyObjectContextMIB	{ mib-2 xxx1 }

Editor's Note (to be removed prior to publication): IANA is requested to assign a value for "xxx1" under the 'mib-2' subtree

and to record the assignment in the SMI Numbers registry. When the assignment has been made, the RFC Editor is asked to replace "xxx1" (here and in the MIB module) with the assigned value and to remove this note.

This document defines the first version of the IANA-maintained IANA-ENERGY-RELATION-MIB module, which allows new definitions of relationships between Energy Objects.

A Specification Required as defined in RFC 5226 [RFC5226], is REQUIRED for each modification of the energy relationships.

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER values recorded in the SMI Numbers registry.

Descriptor	OBJECT IDENTIFIER value
ianaEnergyRelationMIB	{ mib-2 xxx2 }

Editor's Note (to be removed prior to publication): IANA is requested to assign a value for "xxx2" under the 'mib-2' subtree and to record the assignment in the SMI Numbers registry. When the assignment has been made, the RFC Editor is asked to replace "xxx2" (here and in the MIB module) with the assigned value and to remove this note.

9. Acknowledgement

We would like to thank Juergen Quittek and Juergen Schoenwalder for their suggestions on the new design of eoRelationTable which was a proposed solution for the open issue on the representation of Energy Object as a UUIDlist.

Many thanks to Juergen Quittek for many comments on the wording, text and design of the MIB thus resulting in an improved draft.

Many thanks to Alan Luchuk for the review of the MIB and his comments.

In addition the authors thank Bill Mielke for his multiple reviews, Brad Schoening and Juergen Schoenwaelder for their suggestions and Michael Brown for dramatically improving this draft.

And finally thanks the EMAN WG chairs: Nevil Brownlee and Tom Nadeau.

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