Network Working Group
Internet-Draft
Intended Status: Standards Track
Expires: June 13, 2014

J. Parello
B. Claise
Mouli Chandramouli
Cisco Systems, Inc.
December 13, 2013

Energy Object Context MIB
draft-ietf-eman-energy-aware-mib-12

Status of this Memo

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 relationships between reporting devices, remote devices, and monitoring 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].

Table of Contents

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.

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 required by the [EMAN-FMWK], 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. Requirements and Use Cases

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].

4. 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

5. 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.

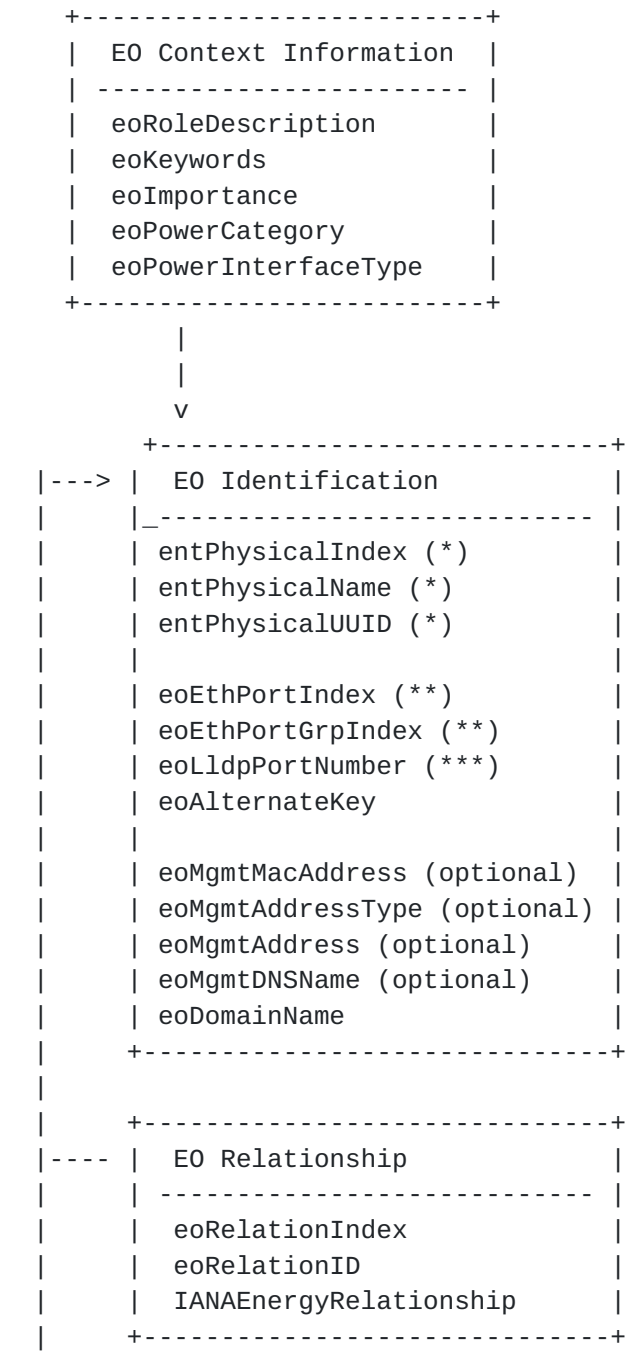
The Energy Object Context (ENERGY-OBJECT-CONTEXT-MIB) MIB module in this document specifies MIB objects for identification of Energy Objects, and reporting context and relationship of an Energy Object. The managed objects are contained in two tables eoTable and eoRelationTable.

The first table eoTable focuses on link to the other MIB modules, 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.

```
+- eoTable(2)
   |
   +- 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 SnmpAdminString              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)
   |      |  +-- --n UUIDorZero            eoRelationID(2)
```

```
   |      |  +-- rwn IANAEnergyRelationship
eoRelationship(3)
```

The following UML diagram illustrates the relationship of the MIB objects in the eoTable, eoRelationTable that describe the identity, context and relationship of an Energy Object.



(*) Compliance with the ENTITY MIB V4 [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"

5.1 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 and entPhysicalUUID from the ENTITY MIB [RFC6933]. Module Compliance with respect to entity4CRCompliance of ENTITY-MIB should be supported which require a limited number of objects supported (entPhysicalClass, entPhysicalName, entPhysicalUUID). entPhysicalIndex is used as index for the primary Energy Object information 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.

5.2 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.

5.3 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 Energy Object SNMP agent, then the Energy Object eoethPortIndex and eoethPortGrpIndex MUST contain the values of pethPsePortIndex and pethPsePortGroupIndex [RFC3621].

The Energy Object eoLldpPortNumber MUST contain the lldpLocPortNum from the LLDP MIB [LLDP-MIB], if the LLDP-MED MIB is supported on the Energy Object SNMP agent.

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 alternate key object specifies a manufacturer defined 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.

5.4 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. 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

Each Energy object can have one or more Energy Object relationships with other Energy Objects. The relations between Energy Objects are specified in eoRelationTable. The relationship between the Energy Objects is specified with an arbitrary index 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 IANA Energy Relationship MIB module specifies the first version of the IANA-maintained definitions of relationships between Energy Objects, as textual conventions. This way, for Energy Relationships, new textual conventions can be specified, without updating the primary Energy Object Context MIB module.

Since the communication between the Energy Objects may not be SNMP and is left to the choice of the device manufacturer, 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.

5.5 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.

6. 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
    TEXTUAL-CONVENTION, MacAddress, TruthValue
        FROM SNMPv2-TC
    MODULE-COMPLIANCE,
    OBJECT-GROUP
```

```
           FROM SNMPv2-CONF
       SnmpAdminString
           FROM SNMP-FRAMEWORK-MIB
       InetAddressType, InetAddress
          FROM INET-ADDRESS-MIB
       entPhysicalIndex
          FROM ENTITY-MIB
       UUIDorZero
          FROM UUID-TC-MIB
       IANAEnergyRelationship
          FROM IANA-ENERGY-RELATION-MIB;

   energyObjectContextMib MODULE-IDENTITY
       LAST-UPDATED    "201311290000Z"

       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
           Archive: http://www.ietf.org/mail-archive/web/eman

          Editors:
             John Parello
             Cisco Systems, Inc.
             3550 Cisco Way
             San Jose, California 95134
             US
             Phone: +1 408 525 2339
             Email: jparello@cisco.com


             Benoit Claise
             Cisco Systems, Inc.
             De Kleetlaan 6a b1
             Degem 1831
             Belgium
             Phone:  +32 2 704 5622
             Email: bclaise@cisco.com


             Mouli Chandramouli
```

Cisco Systems, Inc.
Sarjapur Outer Ring Road
Bangalore 560103
IN
Phone: +91 80 4429 2409
Email: moulchan@cisco.com"

```
     DESCRIPTION
        "This MIB is used for describing the identity and the
        context information of Energy Objects"
     REVISION
         "201311290000Z"
     DESCRIPTION
        "Initial version, published as RFC XXXX."


    ::= { energyMIB 1 }

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 [RFC3621], 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               SnmpAdminString,
           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 the attached device is connected [RFC3621].
          In addition, PoE MIB should be instantiated on the
          device. If such a power Ethernet port cannot be specified
          or is not known then the object is zero."
       ::= { 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 Ethernet PSE is connected
          [RFC3621]. In addition, PoE MIB should be instantiated on
          the device. If such a group cannot be specified or is not
          known then the object is zero."
       ::= { 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]. In addition, LLDP MIB should be
         instantiated on the device If such a port number cannot
         be specified or is not known then the object is zero."
      ::= { 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          SnmpAdminString
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
           "This object specifies the 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)."
        ::= { 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.  This object specifies a
           zero-length string value if no Energy Management Domain
           name is configured. 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 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  entity 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 functioning as a
          distributor of Energy that category of the Energy Object
```

```
          is distributor (3). If a device is a store of 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
          "This object specifies a manufacturer defined 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 describes the relationship
         between Energy objects."
       INDEX        { entPhysicalIndex, eoRelationIndex }
       ::= { eoRelationTable 1 }


   EoRelationEntry ::= SEQUENCE {
                  eoRelationIndex    Integer32,
                  eoRelationID       UUIDorZero,
                  eoRelationship     IANAEnergyRelationship
                 }

   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-only
       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."

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

```
   eoRelationship      OBJECT-TYPE
       SYNTAX          IANAEnergyRelationship
       MAX-ACCESS      read-write
       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 }

   -- 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          -- this module
       MANDATORY-GROUPS {
                   energyObjectContextMibTableGroup,
                  energyObjectRelationTableGroup
                        }

      GROUP     energyObjectOptionalMIBTableGroup
                DESCRIPTION
                "A compliant implementation does not have to
                implement. Module Compliance of ENTITY-MIB
                with respect to entity4CRCompliance should
                 be supported. "
       ::= { 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 should 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.
         Module Compliance of ENTITY-MIB
         with respect to entity4CRCompliance should
         be supported. "
      ::= { 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.
           Module Compliance of ENTITY-MIB
           with respect to entity4CRCompliance should
           be supported.  "
       ::= { 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         {
                       -- Note that object eoRelationIndex is not
                       -- included since it is not-accessible

                       eoRelationID,
                       eoRelationship
                        }
        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 "201306300000Z"  -- June 30, 2013
         ORGANIZATION "IANA"
         CONTACT-INFO "
                       Internet Assigned Numbers Authority
                       Postal: ICANN
                       4676 Admiralty Way, Suite 330
                       Marina del Rey, CA 90292
                       Tel: +1-310-823-9358
                       EMail: iana&iana.org"


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

```
        REVISION     "201306300000Z"  -- June 30, 2013
        DESCRIPTION  "Initial version of this MIB as published in
                      RFC yyyy."
        ::= { energyMIB 2 }

      -- RFC Editor, please replace xxx 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 specifies the type of
               relationship between Energy Objects.

              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
```

7. 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.

11.1 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/

11.2 Python

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

8. Security Considerations

Some of the readable objects in these MIB modules (i.e., objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP.

There are a number of management objects defined in these MIB modules 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. The following 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 still no secure control over who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in these MIB modules.

It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [RFC3410], section 8), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

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 these MIB modules is properly configured to give access to the objects only to those principals (users) that have legitimate rights to GET or SET (change/create/delete) them.

9. IANA Considerations

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

Descriptor	OBJECT IDENTIFIER value
energyMIB	{ mib-2 xxx }

Additions to the ENERGY-OBJECT-CONTEXT-MIB module are subject to Expert Review [RFC5226], i.e., review by one of a group of experts designated by an IETF Area Director. The group of experts MUST check the requested MIB objects for completeness and accuracy of the description. Requests for MIB objects that duplicate the functionality of existing objects SHOULD be declined. The smallest available OID SHOULD be assigned to new MIB objects. The specification of new MIB objects SHOULD follow the structure specified in Section 6 and MUST be published using a well-established and persistent publication medium.

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.

10. 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.

11. References

11.1. Normative References

[RFC2119] S. Bradner, Key words for use in RFCs to Indicate Requirement Levels, BCP 14, RFC 2119, March 1997.

[RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, April 1999.

[RFC2579] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Textual Conventions for SMIv2", STD 58, RFC 2579, April 1999.

[RFC2580] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Conformance Statements for SMIv2", STD 58, RFC 2580, April 1999.

[RFC3621] Berger, A., and D. Romascanu, "Power Ethernet MIB", RFC3621, December 2003.

[RFC4122] Leach, P., Mealling, M., and R. Salz, "A Universally Unique IDentifier (UUID) URN Namespace ", RFC 4122, July 2005.

[RFC6933] Bierman, A. Romascanu,D. Quittek, J. and M. Chandramouli, "Entity MIB (Version 4)", RFC 6933, May 2013.

[LLDP-MIB] IEEE 802.1AB-2005, "Management Information Base module for LLDP configuration, statistics, local system data and remote systems data components", May 2005.

[LLDP-MED-MIB] ANSI/TIA-1057, "The LLDP Management Information Base extension module for TIA-TR41.4 media endpoint discovery information", July 2005.

[EMAN-MON-MIB] M. Chandramouli, Schoening, B., Quittek, J., Dietz, T., and B. Claise "Power and Energy Monitoring MIB", draft-ietf-eman-energy-monitoring-mib-07, October 2013.

11.2. Informative References

[RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet Standard Management Framework", RFC 3410, December 2002.

[RFC3433] Bierman, A., Romascanu, D., and K.C. Norseth, "Entity Sensor Management Information Base", RFC 3433, December 2002.

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

[RFC6988] Quittek, J., Winter, R., Dietz, T., Claise, B., and M. Chandramouli, "Requirements for Energy Management", RFC 6988, September 2013.

[EMAN-FMWK] Claise, B., Parello, J., Schoening, B., and J. Quittek, "Energy Management Framework", draft-ietf-eman-framework-11, work in progress, November 2013.

[EMAN-AS] Schoening, B., Chandramouli, M, and B. Nordman, "Energy Management (EMAN) Applicability Statement", draft-ietf-eman-applicability-statement-04.txt, work in progress, October 2013.

[RFC6982] Sheffer, Y. and A. Farrel, "Improving Awareness of Running Code: The Implementation Status Section", RFC 6982, July 2013.

Authors' Addresses

Benoit Claise
Cisco Systems, Inc.
De Kleetlaan 6a b1

Diegem 1813
BE

Phone: +32 2 704 5622
Email: bclaise@cisco.com

John Parello
Cisco Systems, Inc.
3550 Cisco Way
San Jose, California 95134
US

Phone: +1 408 525 2339
Email: jparello@cisco.com

Mouli Chandramouli
Cisco Systems, Inc.
Sarjapur Outer Ring Road
Bangalore 560103
IN

Phone: +91 80 4429 2409
Email: moulchan@cisco.com