Definition of Managed Objects for Battery Monitoring

Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it defines managed objects that provide information on the status of batteries in managed devices.

Status of This Memo

This is an Internet Standards Track document.

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Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc7577.

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1. Introduction

Today, more and more managed devices contain batteries that supply them with power when disconnected from electrical power distribution grids. Common examples are nomadic and mobile devices, such as notebook computers, netbooks, and smartphones. The status of batteries in such a device, particularly the charging status, is typically controlled by automatic functions that act locally on the device and manually by users of the device.

In addition to this, there is a need to monitor battery status of these devices by network management systems. This document defines a portion of the Management Information Base (MIB) that provides a means for monitoring batteries in or attached to managed devices. The Battery MIB module defined in Section 4 meets the requirements for monitoring the status of batteries specified in RFC 6988 [RFC6988].

The Battery MIB module provides for monitoring the battery status. According to the framework for energy management [RFC7326], it is an Energy Managed Object; thus, MIB modules such as the Power and Energy Monitoring MIB [RFC7460] could, in principle, be implemented for batteries. The Battery MIB extends the more generic aspects of energy management by adding battery-specific information. Amongst other things, the Battery MIB enables the monitoring of:
o the current charge of a battery,
o the age of a battery (charging cycles),
o the state of a battery (e.g., being recharged),
o last usage of a battery, and
o maximum energy provided by a battery (remaining and total capacity).

Further, means are provided for battery-powered devices to send notifications to inform the management system of needed replacement when the current battery charge has dropped below a certain threshold. The same applies to the age of a battery.

Many battery-driven devices have existing instrumentation for monitoring the battery status because this is already needed for local control of the battery by the device. This reduces the effort for implementing the managed objects defined in this document. For many devices, only additional software will be needed; no additional hardware instrumentation for battery monitoring is necessary.

Since there are a lot of devices in use that contain more than one battery, means for battery monitoring defined in this document support addressing multiple batteries within a single device. Also, batteries today often come in packages that can include identification and might contain additional hardware and firmware. The former allows tracing a battery and allows continuous monitoring even if the battery is installed in another device. The firmware version is useful information as the battery behavior might be different for different firmware versions.

Not explicitly in the scope of definitions in this document are very small backup batteries, for example, batteries used on a PC motherboard to run the clock circuit and retain configuration memory while the system is turned off. Other means may be required for reporting on these batteries. However, the MIB module defined in Section 3.1 can be used for this purpose.

A traditional type of managed device containing batteries is an Uninterruptible Power Supply (UPS) system; these supply other devices with electrical energy when the main power supply fails. There is already a MIB module for managing UPS systems defined in RFC 1628 [RFC1628]. The UPS MIB module includes managed objects for monitoring the batteries contained in a UPS system. However, the information provided by the UPS MIB objects is limited and tailored to the particular needs of UPS systems.
A huge variety of battery technologies are available, and they are evolving over time. For different applications, different battery technologies are preferable, for example, because of different weight, cost, robustness, charging time, etc. Some technologies, such as lead-acid batteries, are continuously in use for decades, while others, such as nickel-based battery technologies (nickel-cadmium and nickel-metal hydride), have, to a wide extent, been replaced by lithium-based battery technologies (lithium-ion and lithium polymer).

The Battery MIB module uses a generic abstraction of batteries that is independent of particular battery technologies and expected to be applicable to future technologies as well. While identification of a particular battery technology is supported by an extensible list of battery technology identifiers (see Section 3.2), individual properties of the technologies are not modeled by the abstraction. In particular, methods for charging a battery, and the parameters of those methods, which vary greatly between different technologies are not individually modeled.

Instead, the Battery MIB module uses a simple common charging model with batteries being in one of the following states: ‘charging’, ‘maintaining charge’, ‘not charging’, and ‘discharging’. Control of the charging process is limited to requests for transitions between these states. For charging controllers that use charging state engines with more states, implementations of the Battery MIB module need to map those states to the four listed above.

For energy management systems that require finer-grained control of the battery charging process, additional means need to be developed; for example, MIB modules that model richer sets of charging states and parameters for charging states.

All use cases sketched above assume that the batteries are contained in a managed entity. In a typical case, this entity also hosts the SNMP applications (command responder and notification generator) and the charging controller for contained batteries. For definitions in this document, it is not strictly required that batteries be contained in the same managed entity, even though the Battery MIB module (defined further below) uses the containment tree of the Entity MIB module [RFC6933] for battery indexing.

External batteries can be supported as long as the charging controller for these batteries is connected to the SNMP applications that implement the Battery MIB module. An example with an external battery is shown in the figure below. It illustrates that the Battery MIB module is designed as an interface between the management system and battery charging controller. Out of scope of this
document is the interface between the battery charging controller and controlled batteries.

![Diagram of Battery MIB as Interface between Management System and Battery-Charging Controller Supporting External Batteries](image)

Figure 1: Battery MIB as Interface between Management System and Battery-Charging Controller Supporting External Batteries

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].

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 to the SMIv2, which is described in STD
3. Design of the Battery MIB Module

3.1. MIB Module Structure

The Battery MIB module defined in this document defines objects for reporting information about batteries. All managed objects providing information on the status of a battery are contained in a single table called "batteryTable". The batteryTable contains one conceptual row per battery.

Batteries are indexed by the entPhysicalIndex of the entPhysicalTable defined in the Entity MIB module [RFC6933]. An implementation of the Entity MIB module complying with the entity4CCompliance MODULE-COMPLIANCE statement is required for compliant implementations of the Battery MIB module.

If a battery is replaced, and the replacing battery uses the same physical connector as the replaced battery, then the replacing battery MUST be indexed with the same value of object entPhysicalIndex as the replaced battery.

The kind of entity in the entPhysicalTable of the Entity MIB module is indicated by the value of enumeration object entPhysicalClass. All batteries SHOULD have the value of object entPhysicalClass set to battery(14) in their row of the entPhysicalTable.

The batteryTable contains three groups of objects. The first group (OIDs ending with 1-9) provides information on static properties of the battery. The second group of objects (OIDs ending with 10-18) provides information on the current battery state, if it is charging or discharging, how much it is charged, its remaining capacity, the number of experienced charging cycles, etc.
batteryTable(1)
  +=- batteryEntry(1)  [entPhysicalIndex]
     +=- r-n SnmpAdminString batteryIdentifier(1)
     +=- r-n SnmpAdminString batteryFirmwareVersion(2)
     +=- r-n Enumeration   batteryType(3)
     +=- r-n Unsigned32    batteryTechnology(4)
     +=- r-n Unsigned32    batteryDesignVoltage(5)
     +=- r-n Unsigned32    batteryNumberOfCells(6)
     +=- r-n Unsigned32    batteryDesignCapacity(7)
     +=- r-n Unsigned32    batteryMaxChargingCurrent(8)
     +=- r-n Unsigned32    batteryTrickleChargingCurrent(9)
     +=- r-n Unsigned32    batteryActualCapacity(10)
     +=- r-n Unsigned32    batteryChargingCycleCount(11)
     +=- r-n DateAndTime   batteryLastChargingCycleTime(12)
     +=- r-n Enumeration   batteryChargingOperState(13)
     +=- rwn Enumeration   batteryChargingAdminState(14)
     +=- r-n Unsigned32    batteryActualCharge(15)
     +=- r-n Unsigned32    batteryActualVoltage(16)
     +=- r-n Integer32     batteryActualCurrent(17)
     +=- r-n Integer32     batteryTemperature(18)
     +=- rwn Unsigned32    batteryAlarmLowCharge(19)
     +=- rwn Unsigned32    batteryAlarmLowVoltage(20)
     +=- rwn Unsigned32    batteryAlarmLowCapacity(21)
     +=- rwn Integer32     batteryAlarmHighCycleCount(22)
     +=- rwn Integer32     batteryAlarmHighTemperature(23)
     +=- rwn Integer32     batteryAlarmLowTemperature(24)
     +=- r-n SnmpAdminString batteryCellIdentifier(25)

The third group of objects in this table (OIDs ending with 19-25) is used for notifications. Threshold objects (OIDs ending with 19-24) indicate thresholds that can be used to raise an alarm if a property of the battery exceeds one of them. Raising an alarm may include sending a notification.

The Battery MIB defines seven notifications for indicating:

1. a battery-charging state change that was not triggered by writing to object batteryChargingAdminState,
2. a low-battery charging state,
3. a critical-battery state in which it cannot be used for power supply,
4. an aged battery that may need to be replaced,
5. a battery that has exceeded a temperature threshold,
6. a battery that has been connected, and

7. disconnection of one or more batteries.

Notifications 2-5 can use object batteryCellIdentifier to indicate a specific cell or a set of cells within the battery that have triggered the notification.

3.2. Battery Technologies

Static information in the batteryTable includes battery type and technology. The battery type distinguishes primary (not rechargeable) batteries from rechargeable (secondary) batteries and capacitors. The battery technology describes the actual technology of a battery, which typically is a chemical technology.

Since battery technologies are the subject of intensive research and widely used technologies are often replaced by successor technologies within a few years, the list of battery technologies was not chosen as a fixed list. Instead, IANA has created a registry for battery technologies at <http://www.iana.org/assignments/battery-technologies> where numbers are assigned to battery technologies.

The table below shows battery technologies known today that are in commercial use with the numbers assigned to them by IANA. New entries can be added to the IANA registry if new technologies are developed or if missing technologies are identified. Note that there exists a huge number of battery types that are not listed in the IANA registry. Many of them are experimental or cannot be used in an economically useful way. New entries should be added to the IANA registry only if the respective technologies are in commercial use and relevant to standardized battery monitoring over the Internet.
###电池技术

<table>
<thead>
<tr>
<th>电池技术</th>
<th>值</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>未知</td>
<td>1</td>
</tr>
<tr>
<td>其他</td>
<td>2</td>
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</tr>
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</tr>
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<tr>
<td>锂-铜氧化物</td>
<td>6</td>
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</tr>
<tr>
<td>锌-空气</td>
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</tr>
<tr>
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</tr>
<tr>
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<td>11</td>
</tr>
<tr>
<td>铅酸</td>
<td>12</td>
</tr>
<tr>
<td>调节型铅酸电池,凝胶</td>
<td>13</td>
</tr>
<tr>
<td>调节型铅酸电池,AGM</td>
<td>14</td>
</tr>
<tr>
<td>镍镉</td>
<td>15</td>
</tr>
<tr>
<td>镍-金属氢化物</td>
<td>16</td>
</tr>
<tr>
<td>镍锌</td>
<td>17</td>
</tr>
<tr>
<td>锂-锂</td>
<td>18</td>
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<tr>
<td>锂-聚合物</td>
<td>19</td>
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<td>双层电容器</td>
<td>20</td>
</tr>
<tr>
<td>未分配</td>
<td>21-4294967295</td>
</tr>
</tbody>
</table>

####3.2.1. 添加电池技术的指南

新条目可以添加到IANA注册表中，如果新出现的电池技术是已开发的或缺失的电池技术是被确定的。注意，存在一个巨大的电池类型列表，这些类型未在IANA注册表中列出。它们中的许多是实验性的或无法以经济上有利的方式使用。新条目应该只在相关的技术在商业上使用并且对标准电池监控在互联网上是有关的时才添加到IANA注册表中。

####3.3. 电池标识

有两条标识符可以使用：entPhysicalUUID在Entity MIB [RFC6933]模块中的定义和batteryIdentifier在本模块中的定义。电池通过entPhysicalUUID和entPhysicalIndex共享。

电池Identifier独特地标识电池本身而entPhysicalUUID标识设备中电池所在的槽。对于非可替换电池，两个标识符总是与同一物理电池相关联。但对于可替换电池，每个电池可能有多个电池Identifier标识不同的物理电池。
for batteries that can be replaced, the identifiers have different functions.

The entPhysicalUUID is always the same for a certain battery slot of a containing device even if the contained battery is replaced by another. The batteryIdentifier is a representation of the battery identifier set by the battery manufacturer. It is tied to the battery and usually cannot be changed.

Many manufacturers deliver not just plain batteries but battery packages including additional hardware and firmware. Typically, these modules include a battery identifier that can be retrieved by a device in which a battery has been installed. The value of the object batteryIdentifier is an exact representation of this identifier. The batteryIdentifier is useful when batteries are removed and reinstalled in the same device or in other devices. Then, the device or the network management system can trace batteries and achieve continuity of battery monitoring.

3.4. Charging Cycles

The lifetime of a battery can be approximated using the measure of charging cycles. A commonly used definition of a charging cycle is the amount of discharge equal to the design (or nominal) capacity of the battery [SBS]. This means that a single charging cycle may include several steps of partial charging and discharging until the amount of discharging has reached the design capacity of the battery. After that, the next charging cycle immediately starts.

3.5. Charge Control

Managed object batteryChargingOperState indicates the current operational charging state of a battery and is a read-only object. For controlling the charging state, object batteryChargingAdminState can be used. Writing to this object initiates a request to adapt the operational state according to the value that has been written.

By default, the batteryChargingAdminState object is set to notSet(1). In this state, the charging controller is using its predefined policies to decide which operational state is suitable in the current situation.

Setting the value of object batteryChargingAdminState may result in not changing the state of the battery to this value or even in setting the charging state to another value than the requested one. Due to operational conditions and limitations of the implementation of the Battery MIB module, changing the battery status according to a set value of object batteryChargingAdminState might not be possible.
For example, the charging controller might, at any time, decide to enter state discharging(5), if there is an operational need to use the battery for supplying power.

The object batteryChargingAdminState will not automatically change when the object batteryChargingOperState changes. If the operational state is changed, e.g., to the state discharging(5) due to operational conditions, the admin state will remain in its current state. The charging controller SHOULD change the operational state to the state indicated by the object batteryChargingAdminState as soon as operational conditions allow this change.

If a state change of the object batteryChargingAdminState is desired upon change of the operational state, the object batteryChargingOperState must be polled or the notification batteryChargingStateNotification must be used to get notified about the state change. This could be used, e.g., if maintaining charge is not desired after fully charging a battery even if the charging controller and battery support it. The object batteryChargingAdminState can then be set to doNotCharge(3) when the object batteryChargingOperState changes from charging(2) to maintainingCharge(3). Another use case would be when performing several charge and discharge cycles for battery maintenance.

3.6. Imported Definitions

The BATTERY-MIB module defined in this document imports definitions from the following MIB modules: SNMPv2-SMI [RFC2578], SNMPv2-TC [RFC2579], SNMPv2-CONF [RFC2580], SNMP-FRAMEWORK-MIB [RFC3411], and ENTITY-MIB [RFC6933].

4. Definitions

BATTERY-MIB DEFINITIONS ::= BEGIN

IMPORTS
MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE, mib-2, Integer32, Unsigned32
FROM SNMPv2-SMI -- RFC 2578
DateAndTime
FROM SNMPv2-TC -- RFC 2579
MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
FROM SNMPv2-CONF -- RFC 2580
SnmpAdminString
FROM SNMP-FRAMEWORK-MIB -- RFC 3411
entPhysicalIndex
FROM ENTITY-MIB; -- RFC 6933
batteryMIB MODULE-IDENTITY
LAST-UPDATED "201506150000Z" -- 15 June 2015
ORGANIZATION "IETF EMAN Working Group"
CONTACT-INFO
"General Discussion: eman@ietf.org
To Subscribe: <http://www.ietf.org/mailman/listinfo/eman>
Archive: <http://www.ietf.org/mail-archive/web/eman>

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Email: quittek@neclab.eu"

DESCRIPTION
"This MIB module defines a set of objects for monitoring batteries of networked devices and of their components.

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This version of this MIB module is part of RFC 7577; see the RFC itself for full legal notices."

-- Revision history

REVISION "201506150000Z" -- 15 June 2015
DESCRIPTION
"Initial version published as RFC 7577."

::= { mib-2 233 }
Top-Level Structure of the MIB Module

batteryNotifications OBJECT IDENTIFIER ::= { batteryMIB 0 }
batteryObjects OBJECT IDENTIFIER ::= { batteryMIB 1 }
batteryConformance OBJECT IDENTIFIER ::= { batteryMIB 2 }

Object Definitions

1. Battery Table

batteryTable OBJECT-TYPE
SYNTAX  SEQUENCE OF BatteryEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"This table provides information on batteries. It contains one conceptual row per battery in a managed entity.

Batteries are indexed by the entPhysicalIndex of the entPhysicalTable defined in the ENTITY-MIB (RFC 6933).

For implementations of the BATTERY-MIB, an implementation of the ENTITY-MIB complying with the entity4CRCompliance MODULE-COMPLIANCE statement of the ENTITY-MIB is required.

If batteries are replaced, and the replacing battery uses the same physical connector as the replaced battery, then the replacing battery SHOULD be indexed with the same value of object entPhysicalIndex as the replaced battery."

::= { batteryObjects 1 }

batteryEntry OBJECT-TYPE
SYNTAX  BatteryEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"An entry providing information on a battery."
INDEX  { entPhysicalIndex }
::= { batteryTable 1 }
BatteryEntry ::= SEQUENCE {
batteryIdentifier SnmpAdminString,
batteryFirmwareVersion SnmpAdminString,
batteryType INTEGER,
batteryTechnology Unsigned32,
batteryDesignVoltage Unsigned32,
batteryNumberOfCells Unsigned32,
batteryDesignCapacity Unsigned32,
batteryMaxChargingCurrent Unsigned32,
batteryTrickleChargingCurrent Unsigned32,
batteryActualCapacity Unsigned32,
batteryChargingCycleCount Unsigned32,
batteryLastChargingCycleTime DateAndTime,
batteryChargingOperState INTEGER,
batteryChargingAdminState INTEGER,
batteryActualCharge Unsigned32,
batteryActualVoltage Unsigned32,
batteryActualCurrent Integer32,
batteryTemperature Integer32,
batteryAlarmLowCharge Unsigned32,
batteryAlarmLowVoltage Unsigned32,
batteryAlarmLowCapacity Unsigned32,
batteryAlarmHighCycleCount Unsigned32,
batteryAlarmHighTemperature Integer32,
batteryAlarmLowTemperature Integer32,
batteryCellIdentifier SnmpAdminString}

batteryIdentifier OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object contains an identifier for the battery."

Many manufacturers deliver not only simple batteries but battery packages including additional hardware and firmware. Typically, these modules include an identifier that can be retrieved by a device in which a battery has been installed. The identifier is useful when batteries are removed and reinstalled in the same or other devices. Then, the device or the network management system can trace batteries and achieve continuity of battery monitoring.

If the battery is identified by more than one value, for example, by a model number and a serial number, then the value of this object is a concatenation of these
values, separated by the colon symbol ‘:’. The values should be ordered so that a more significant value comes before a less significant one. In the example above, the (more significant) model number would be first, and the serial number would follow: ‘<model number>:<serial number>’.

If the battery identifier cannot be represented using the ISO/IEC IS 10646-1 character set, then a hexadecimal encoding of a binary representation of the entire battery identifier must be used.

The value of this object must be an empty string if there is no battery identifier or if the battery identifier is unknown.

::= { batteryEntry 1 }

batteryFirmwareVersion OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-only
STATUS current
DESCRIPTION "This object indicates the version number of the firmware that is included in a battery module.

Many manufacturers deliver not pure batteries but battery packages including additional hardware and firmware.

Since the behavior of the battery may change with the firmware, it may be useful to retrieve the firmware version number.

The value of this object must be an empty string if there is no firmware or if the version number of the firmware is unknown."

::= { batteryEntry 2 }

batteryType OBJECT-TYPE
SYNTAX INTEGER {
    unknown(1),
    other(2),
    primary(3),
    rechargeable(4),
    capacitor(5)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION "This object indicates the type of battery."
It distinguishes between primary (not rechargeable) batteries, rechargeable (secondary) batteries, and capacitors. Capacitors are not really batteries but are often used in the same way as a battery.

The value other(2) can be used if the battery type is known but is none of the ones above. Value unknown(1) is to be used if the type of battery cannot be determined.

::= { batteryEntry 3 }

batteryTechnology OBJECT-TYPE
SYNTAX      Unsigned32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "This object indicates the technology used by the battery. Numbers identifying battery technologies are registered at IANA. A current list of assignments can be found at <http://www.iana.org/assignments/battery-technologies>.

  Value unknown(1) MUST be used if the technology of the battery cannot be determined.

  Value other(2) can be used if the battery technology is known but is not one of the types already registered at IANA."
::= { batteryEntry 4 }

batteryDesignVoltage OBJECT-TYPE
SYNTAX      Unsigned32
UNITS       "millivolt"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "This object provides the design (or nominal) voltage of the battery in units of millivolt (mV).

  Note that the design voltage is a constant value and typically different from the actual voltage of the battery.

  A value of 0 indicates that the design voltage is unknown."
::= { batteryEntry 5 }

batteryNumberOfCells OBJECT-TYPE
SYNTAX      Unsigned32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"This object indicates the number of cells contained in the battery.
A value of 0 indicates that the number of cells is unknown." ::= { batteryEntry 6 }

batteryDesignCapacity OBJECT-TYPE
SYNTAX   Unsigned32
UNITS    "milliampere hours"
MAX-ACCESS read-only
STATUS   current
DESCRIPTION
"This object provides the design (or nominal) capacity of the battery in units of milliampere hours (mAh).
Note that the design capacity is a constant value and typically different from the actual capacity of the battery. Usually, this is a value provided by the manufacturer of the battery.
A value of 0 indicates that the design capacity is unknown." ::= { batteryEntry 7 }

batteryMaxChargingCurrent OBJECT-TYPE
SYNTAX   Unsigned32
UNITS    "milliampere"
MAX-ACCESS read-only
STATUS   current
DESCRIPTION
"This object provides the maximum current to be used for charging the battery in units of milliampere (mA).
Note that the maximum charging current may not lead to optimal charge of the battery and that some batteries can only be charged with the maximum current for a limited amount of time.
A value of 0 indicates that the maximum charging current is unknown." ::= { batteryEntry 8 }

batteryTrickleChargingCurrent OBJECT-TYPE
SYNTAX   Unsigned32
UNITS    "milliampere"
MAX-ACCESS read-only
STATUS   current
DESCRIPTION
"This object provides the recommended average current to be used for trickle charging the battery in units of mA.

Typically, this is a value recommended by the manufacturer of the battery or by the manufacturer of the charging circuit.

A value of 0 indicates that the recommended trickle charging current is unknown."

::= { batteryEntry 9 }

batteryActualCapacity OBJECT-TYPE
SYNTAX      Unsigned32
UNITS       "milliampere hours"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"This object provides the actual capacity of the battery in units of mAh.

Typically, the actual capacity of a battery decreases with time and with usage of the battery. It is usually lower than the design capacity.

Note that the actual capacity needs to be measured and is typically an estimate based on observed discharging and charging cycles of the battery.

A value of 'ffffffff'H indicates that the actual capacity cannot be determined."

::= { batteryEntry 10 }

batteryChargingCycleCount OBJECT-TYPE
SYNTAX      Unsigned32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
"This object indicates the number of completed charging cycles that the battery underwent. In line with the Smart Battery Data Specification Revision 1.1, a charging cycle is defined as the process of discharging the battery by a total amount equal to the battery design capacity as given by object batteryDesignCapacity. A charging cycle may include several steps of charging and discharging the battery until the discharging amount given by batteryDesignCapacity has been reached. As soon as a
charging cycle has been completed, the next one starts immediately, independent of the battery’s current charge at the end of the cycle.

For batteries of type primary(3), the value of this object is always 0.

A value of ‘ffffffff’H indicates that the number of charging cycles cannot be determined.

::= { batteryEntry 11 }

batteryLastChargingCycleTime OBJECT-TYPE
SYNTAX    DateAndTime
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
"The date and time of the last charging cycle. The value ‘0000000000000000’H is returned if the battery has not been charged yet or if the last charging time cannot be determined.

For batteries of type primary(1), the value of this object is always ‘0000000000000000’H."

::= { batteryEntry 12 }

batteryChargingOperState OBJECT-TYPE
SYNTAX    INTEGER {
    unknown(1),
    charging(2),
    maintainingCharge(3),
    noCharging(4),
    discharging(5)
}
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
"This object indicates the current charging state of the battery.

Value unknown(1) indicates that the charging state of the battery cannot be determined.

Value charging(2) indicates that the battery is being charged in a way such that the charge of the battery increases.

Value maintainingCharge(3) indicates that the battery is being charged with a low-average current that compensates
self-discharging. This includes trickle charging, float charging, and other methods for maintaining the current charge of a battery. In typical implementations of charging controllers, state maintainingCharge(3) is only applied if the battery is fully charged or almost fully charged.

Value noCharging(4) indicates that the battery is not being charged or discharged by electric current between the battery and electric circuits external to the battery. Note that the battery may still be subject to self-discharging.

Value discharging(5) indicates that the battery is either used as the power source for electric circuits external to the battery or discharged intentionally by the charging controller, e.g., for the purpose of battery maintenance. In any case, the charge of the battery decreases."

::= { batteryEntry 13 }

batteryChargingAdminState OBJECT-TYPE
SYNTAX INTEGER {
    notSet(1),
    charge(2),
    doNotCharge(3),
    discharge(4)
}
MAX-ACCESS read-write
STATUS current
DESCRIPTION "The value of this object indicates the desired charging state of the battery. The real state is indicated by object batteryChargingOperState. See the definition of object batteryChargingOperState for a description of the values.

When this object is initialized by an implementation of the BATTERY-MIB module, its value is set to notSet(1). In this case, the charging controller is free to choose which operational state is suitable.

When the batteryChargingAdminState object is set, then the BATTERY-MIB implementation must try to set the battery to the indicated state. The result will be indicated by object batteryChargingOperState.

Setting object batteryChargingAdminState to value notSet(1) is a request to the charging controller to operate
autonomously and choose the operational state that is suitable.

Setting object batteryChargingAdminState to value charge(2) is a request to enter the operational state charging(2) until the battery is fully charged. When the battery is fully charged, or if the battery was already fully charged or almost fully charged at the time of the request, the operational state will change to maintainingCharge(3) if the charging controller and the battery support the functionality of maintaining the charge, or it will change to noCharging(4) otherwise.

Setting object batteryChargingAdminState to value doNotCharge(3) is a request for entering operational state noCharging(4).

Setting object batteryChargingAdminState to value discharge(4) is a request for entering operational state discharging(5). Discharging can be accomplished by ordinary use, applying a dedicated load, or any other means. An example for applying this state is battery maintenance. If the battery is empty or almost empty, the operational state will change to noCharging(4). The charging controller will decide which charge condition will be considered empty dependent on the battery technology used. This is done to avoid damage on the battery due to deep discharge.

Due to operational conditions and limitations of the implementation of the BATTERY-MIB module, changing the battery status according to a set value of object batteryChargingAdminState may not be possible. Setting the value of object batteryChargingAdminState may result in not changing the state of the battery to this value or even in setting the charging state to another value than the requested one. For example, the charging controller might at any time decide to enter state discharging(5), if there is an operational need to use the battery for supplying power."

```
::= { batteryEntry 14 }

batteryActualCharge OBJECT-TYPE
SYNTAX    Unsigned32
UNITS     "milliampere hours"
MAX-ACCESS read-only
STATUS    current
```

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DESCRIPTION

"This object provides the actual charge of the battery in units of mAh.

Note that the actual charge needs to be measured and is typically an estimate based on observed discharging and charging cycles of the battery.

A value of 'ffffffff'H indicates that the actual charge cannot be determined."

::= { batteryEntry 15 }

batteryActualVoltage OBJECT-TYPE
SYNTAX Unsigned32
UNITS "millivolt"
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"This object provides the actual voltage of the battery in units of mV.

A value of 'ffffffff'H indicates that the actual voltage cannot be determined."

::= { batteryEntry 16 }

batteryActualCurrent OBJECT-TYPE
SYNTAX Integer32
UNITS "milliampere"
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"This object provides the actual charging or discharging current of the battery in units of mA.
The charging current is represented by positive values, and the discharging current is represented by negative values.

A value of '7fffffff'H indicates that the actual current cannot be determined."

::= { batteryEntry 17 }

batteryTemperature OBJECT-TYPE
SYNTAX Integer32
UNITS "deci-degrees Celsius"
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"The ambient temperature at or within close proximity of the battery."
A value of ‘7fffffff’H indicates that the temperature cannot be determined.

::= { batteryEntry 18 }

batteryAlarmLowCharge OBJECT-TYPE
SYNTAX      Unsigned32
UNITS       "milliampere hours"
MAX-ACCESS  read-write
STATUS      current
DESCRIPTION
"This object provides the lower-threshold value for object batteryActualCharge. If the value of object batteryActualCharge falls below this threshold, a low-battery alarm will be raised. The alarm procedure may include generating a batteryLowNotification.

This object should be set to a value such that when the batteryLowNotification is generated, the battery is still sufficiently charged to keep the device(s) that it powers operational for a time long enough to take actions before the powered device(s) enters a 'sleep' or 'off' state.

A value of 0 indicates that no alarm will be raised for any value of object batteryActualVoltage."

::= { batteryEntry 19 }

batteryAlarmLowVoltage OBJECT-TYPE
SYNTAX      Unsigned32
UNITS       "millivolt"
MAX-ACCESS  read-write
STATUS      current
DESCRIPTION
"This object provides the lower-threshold value for object batteryActualVoltage. If the value of object batteryActualVoltage falls below this threshold, a low-battery alarm will be raised. The alarm procedure may include generating a batteryLowNotification.

This object should be set to a value such that when the batteryLowNotification is generated, the battery is still sufficiently charged to keep the device(s) that it powers operational for a time long enough to take actions before the powered device(s) enters a 'sleep' or 'off' state.

A value of 0 indicates that no alarm will be raised for any value of object batteryActualVoltage."

::= { batteryEntry 20 }
batteryAlarmLowCapacity OBJECT-TYPE
SYNTAX Unsigned32
UNITS "milliampere hours"
MAX-ACCESS read-write
STATUS current
DESCRIPTION "This object provides the lower-threshold value for object batteryActualCapacity. If the value of object batteryActualCapacity falls below this threshold, a battery aging alarm will be raised. The alarm procedure may include generating a batteryAgingNotification. A value of 0 indicates that no alarm will be raised for any value of object batteryActualCapacity."
::= { batteryEntry 21 }

batteryAlarmHighCycleCount OBJECT-TYPE
SYNTAX Unsigned32
MAX-ACCESS read-write
STATUS current
DESCRIPTION "This object provides the upper-threshold value for object batteryChargingCycleCount. If the value of object batteryChargingCycleCount rises above this threshold, a battery aging alarm will be raised. The alarm procedure may include generating a batteryAgingNotification. A value of 0 indicates that no alarm will be raised for any value of object batteryChargingCycleCount."
::= { batteryEntry 22 }

batteryAlarmHighTemperature OBJECT-TYPE
SYNTAX Integer32
UNITS "deci-degrees Celsius"
MAX-ACCESS read-write
STATUS current
DESCRIPTION "This object provides the upper-threshold value for object batteryTemperature. If the value of object batteryTemperature rises above this threshold, a battery high temperature alarm will be raised. The alarm procedure may include generating a batteryTemperatureNotification. A value of ‘7fffffff’H indicates that no alarm will be raised for any value of object batteryTemperature."
::= { batteryEntry 23 }
batteryAlarmLowTemperature OBJECT-TYPE
SYNTAX     Integer32
UNITS      "deci-degrees Celsius"
MAX-ACCESS read-write
STATUS     current
DESCRIPTION
   "This object provides the lower-threshold value for object
   batteryTemperature. If the value of object
   batteryTemperature falls below this threshold, a battery
   low temperature alarm will be raised. The alarm procedure
   may include generating a batteryTemperatureNotification.

   A value of '7fffffff'H indicates that no alarm will be
   raised for any value of object batteryTemperature."
 ::= { batteryEntry 24 }

batteryCellIdentifier OBJECT-TYPE
SYNTAX     SnmpAdminString
MAX-ACCESS read-only
STATUS     current
DESCRIPTION
   "The value of this object identifies one or more cells of a
   battery. The format of the cell identifier may vary between
different implementations. It should uniquely identify one
or more cells of the indexed battery.

   This object can be used for batteries, such as lithium
polymer batteries for which battery controllers monitor
cells individually.

   This object is used by notifications of types
   batteryLowNotification, batteryTemperatureNotification,
batteryCriticalNotification, and batteryAgingNotification.
   These notifications can use the value of this object to
   indicate the event that triggered the generation of the
   notification in more detail by specifying a single cell
   or a set of cells within the battery that is specifically
   addressed by the notification.

   An example use case for this object is a single cell in a
   battery that exceeds the temperature indicated by object
   batteryAlarmHighTemperature. In such a case, a
   batteryTemperatureNotification can be generated that not
   only indicates the battery for which the temperature limit
   has been exceeded but also the particular cell.

   The initial value of this object is the empty string. The
   value of this object is set each time a
When a notification is generated that does not indicate a specific cell or set of cells, the value of this object is set to the empty string.

\[
\text{::= \{ batteryEntry 25 \}}
\]

--==================================================================
-- 2. Notifications
--==================================================================

batteryChargingStateNotification NOTIFICATION-TYPE
OBJECTS

\{
  batteryChargingOperState
\}

STATUS current

DESCRIPTION

"This notification can be generated when a charging state of the battery (indicated by the value of object batteryChargingOperState) is triggered by an event other than a write action to object batteryChargingAdminState. Such an event may, for example, be triggered by a local battery controller."

\[
\text{::= \{ batteryNotifications 1 \}}
\]

batteryLowNotification NOTIFICATION-TYPE
OBJECTS

\{
  batteryActualCharge,
  batteryActualVoltage,
  batteryCellIdentifier
\}

STATUS current

DESCRIPTION

"This notification can be generated when the current charge (batteryActualCharge) or the current voltage (batteryActualVoltage) of the battery falls below a threshold defined by object batteryAlarmLowCharge or object batteryAlarmLowVoltage, respectively.

Note that, typically, this notification is generated in a state where the battery is still sufficiently charged to keep the device(s) that it powers operational for some time. If the charging state of the battery has become critical, i.e., the device(s) powered by the battery must go to a 'sleep' or 'off' state, then the batteryCriticalNotification should be used instead."
If the low charge or voltage has been detected for a single cell or a set of cells of the battery and not for the entire battery, then object batteryCellIdentifier should be set to a value that identifies the cell or set of cells. Otherwise, the value of object batteryCellIdentifier should be set to the empty string when this notification is generated.

The notification should not be sent again for the same battery or cell before either (a) the current voltage or the current charge, respectively, has become higher than the corresponding threshold through charging or (b) an indication of a maintenance action has been detected, such as a battery disconnection event or a reinitialization of the battery monitoring system.

This notification should not be sent when the battery is in a charging mode, i.e., the value of object batteryChargingOperState is charging(2)." ::= { batteryNotifications 2 } batteryCriticalNotification NOTIFICATION-TYPE OBJECTS {
   batteryActualCharge,
   batteryActualVoltage,
   batteryCellIdentifier
} STATUS current DESCRIPTION
"This notification can be generated when the current charge of the battery falls so low that it cannot provide a sufficient power supply function for regular operation of the powered device(s). The battery needs to be charged before it can be used for regular power supply again. The battery may still provide sufficient power for a ‘sleep’ mode of a powered device(s) or for a transition into an ‘off’ mode.

If the critical state is caused by a single cell or a set of cells of the battery, then object batteryCellIdentifier should be set to a value that identifies the cell or set of cells. Otherwise, the value of object batteryCellIdentifier should be set to the empty string when this notification is generated.

The notification should not be sent again for the same battery before either the battery charge has increased through charging to a non-critical value or an indication
of a maintenance action has been detected, such as a battery
disconnection event or a reinitialization of the battery
monitoring system.

This notification should not be sent when the battery is in
a charging mode, i.e., the value of object
batteryChargingOperState is charging(2).

::= { batteryNotifications 3 }

batteryTemperatureNotification NOTIFICATION-TYPE
OBJECTS     {
        batteryTemperature,
        batteryCellIdentifier
}
STATUS      current
DESCRIPTION
"This notification can be generated when the measured
temperature (batteryTemperature) rises above the threshold
defined by object batteryAlarmHighTemperature or falls
below the threshold defined by object
batteryAlarmLowTemperature.

If the low or high temperature has been detected for a
single cell or a set of cells of the battery and not for the
entire battery, then object batteryCellIdentifier should be
set to a value that identifies the cell or set of cells.
Otherwise, the value of object batteryCellIdentifier should
be set to the empty string when this notification is
generated.

It may occur that the temperature alternates between values
slightly below and slightly above a threshold. For limiting
the notification rate in such a case, this notification
should not be sent again for the same battery or cell,
respectively, within a time interval of 10 minutes.

An exception to the rate limitations occurs immediately
after the reinitialization of the battery monitoring system.
At this point in time, if the battery temperature is above
the threshold defined by object batteryAlarmHighTemperature
or below the threshold defined by object
batteryAlarmLowTemperature, respectively, then this
notification should be sent, independent of the time at
which previous notifications for the same battery or cell,
respectively, had been sent."

::= { batteryNotifications 4 }

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batteryAgingNotification NOTIFICATION-TYPE
OBJECTS
   { batteryActualCapacity,
     batteryChargingCycleCount,
     batteryCellIdentifier
   }
STATUS current
DESCRIPTION
"This notification can be generated when the actual
capacity (batteryActualCapacity) falls below a threshold
defined by object batteryAlarmLowCapacity
or when the charging cycle count of the battery
(batteryChargingCycleCount) exceeds the threshold defined
by object batteryAlarmHighCycleCount.

If the aging has been detected for a single cell or a set
of cells of the battery and not for the entire battery, then
object batteryCellIdentifier should be set to a value that
identifies the cell or set of cells. Otherwise, the value
of object batteryCellIdentifier should be set to the empty
string when this notification is generated.

This notification should not be sent again for the same
battery or cell, respectively, before an indication of a
maintenance action has been detected, such as a battery
disconnection event or a reinitialization of the battery
monitoring system."
::= { batteryNotifications 5 }

batteryConnectedNotification NOTIFICATION-TYPE
OBJECTS
   { batteryIdentifier
   }
STATUS current
DESCRIPTION
"This notification can be generated when it has been
detected that a battery has been connected. The battery
can be identified by the value of object batteryIdentifier
as well as by the value of index entPhysicalIndex that is
contained in the OID of object batteryIdentifier."
::= { batteryNotifications 6 }

batteryDisconnectedNotification NOTIFICATION-TYPE
STATUS current
DESCRIPTION
"This notification can be generated when it has been
detected that one or more batteries have been disconnected."
::= { batteryNotifications 7 }
-- 3. Conformance Information

batteryCompliances OBJECT IDENTIFIER ::= { batteryConformance 1 }
batteryGroups OBJECT IDENTIFIER ::= { batteryConformance 2 }

-- 3.1. Compliance Statements

batteryCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION "The compliance statement for implementations of the BATTERY-MIB module. A compliant implementation MUST implement the objects defined in the mandatory groups batteryDescriptionGroup and batteryStatusGroup.

  Note that this compliance statement requires compliance with the entity4CRCompliance MODULE-COMPLIANCE statement of the ENTITY-MIB (RFC 6933)."

  MODULE -- this module
  MANDATORY-GROUPS {
    batteryDescriptionGroup,
    batteryStatusGroup
  }

  GROUP batteryAlarmThresholdsGroup
  DESCRIPTION "A compliant implementation does not have to implement the batteryAlarmThresholdsGroup."

  GROUP batteryNotificationsGroup
  DESCRIPTION "A compliant implementation does not have to implement the batteryNotificationsGroup."

  GROUP batteryPerCellNotificationsGroup
  DESCRIPTION "A compliant implementation does not have to implement the batteryPerCellNotificationsGroup."

  GROUP batteryAdminGroup
  DESCRIPTION
"A compliant implementation does not have to implement the batteryAdminGroup."
batteryFirmwareVersion,
batteryType,
batteryTechnology,
batteryDesignVoltage,
batteryNumberOfCells,
batteryDesignCapacity,
batteryMaxChargingCurrent,
batteryTrickleChargingCurrent
}

DESCRIPTION
"A compliant implementation MUST implement the objects contained in this group."
::= { batteryGroups 1 }

batteryStatusGroup OBJECT-GROUP

OBJECTS {
batteryActualCapacity,
batteryChargingCycleCount,
batteryLastChargingCycleTime,
batteryChargingOperState,
batteryActualCharge,
batteryActualVoltage,
batteryActualCurrent,
batteryTemperature
}

DESCRIPTION
"A compliant implementation MUST implement the objects contained in this group."
::= { batteryGroups 2 }

batteryAdminGroup OBJECT-GROUP

OBJECTS {
batteryChargingAdminState
}

DESCRIPTION
"A compliant implementation does not have to implement the object contained in this group."
::= { batteryGroups 3 }

batteryAlarmThresholdsGroup OBJECT-GROUP

OBJECTS {
batteryAlarmLowCharge,
batteryAlarmLowVoltage,
batteryAlarmLowCapacity,
batteryAlarmHighCycleCount,
batteryAlarmHighTemperature,
batteryAlarmLowTemperature
}
STATUS current
DESCRIPTION
"A compliant implementation does not have to implement the
objects contained in this group."
::= { batteryGroups 4 }
batteryNotificationsGroup NOTIFICATION-GROUP
NOTIFICATIONS {
batteryChargingStateNotification,
batteryLowNotification,
batteryCriticalNotification,
batteryAgingNotification,
batteryTemperatureNotification,
batteryConnectedNotification,
batteryDisconnectedNotification
}
STATUS current
DESCRIPTION
"A compliant implementation does not have to implement the
notifications contained in this group."
::= { batteryGroups 5 }
batteryPerCellNotificationsGroup OBJECT-GROUP
OBJECTS {
batteryCellIdentifier
}
STATUS current
DESCRIPTION
"A compliant implementation does not have to implement the
object contained in this group."
::= { batteryGroups 6 }
END

5. Security Considerations

There are a number of management objects defined in this MIB module
with a MAX-ACCESS clause of read-write. 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 opens devices to attack. These are the tables and objects
and their sensitivity/vulnerability:

- batteryChargingAdminState:
  Setting the battery charging state can be beneficial for an
  operator for various reasons such as charging batteries when the
price of electricity is low. However, setting the charging state can be used by an attacker to discharge batteries of devices and thereby switching these devices off if they are powered solely by batteries. In particular, if the batteryAlarmLowCharge and batteryAlarmLowVoltage can also be set, this attack will go unnoticed (i.e., no notifications are sent).

- batteryAlarmLowCharge and batteryAlarmLowVoltage:
  These objects set the threshold for an alarm to be raised when the battery charge or voltage falls below the corresponding one of them. An attacker setting one of these alarm values can switch off the alarm by setting it to the ‘off’ value 0, or it can modify the alarm behavior by setting it to any other value. The result may be loss of data if the battery runs empty without warning to a recipient expecting such a notification.

- batteryAlarmLowCapacity and batteryAlarmHighCycleCount:
  These objects set the threshold for an alarm to be raised when the battery becomes older and less performant than required for stable operation. An attacker setting this alarm value can switch off the alarm by setting it to the ‘off’ value 0 or modify the alarm behavior by setting it to any other value. This may lead to either a costly replacement of a working battery or use of batteries that are too old or too weak. The consequence of the latter could be that, e.g., a battery cannot provide power long enough between two scheduled charging actions causing the powered device to shut down and potentially lose data.

- batteryAlarmHighTemperature and batteryAlarmLowTemperature:
  These objects set thresholds for an alarm to be raised when the battery rises above / falls below them. An attacker setting one of these alarm values can switch off these alarms by setting them to the ‘off’ value ‘7fffffff’H, or it can modify the alarm behavior by setting them to any other value. The result may be, e.g., an unnecessary shutdown of a device if batteryAlarmHighTemperature is set too low, there is damage to the device by temperatures that are too high if switched off or set to values that are too high, or there is damage to the battery when, e.g., it is being charged. Batteries can also be damaged, e.g., in an attempt to charge them at temperatures that are too low.

Some of the readable objects in this MIB module (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. These are the tables and objects and their sensitivity/vulnerability:
All potentially sensible or vulnerable objects of this MIB module are in the batteryTable. In general, there are no serious operational vulnerabilities foreseen in case of an unauthorized read access to this table. However, corporate confidentiality issues need to be considered. The following information or parts of it might be a trade secret:

- the number of batteries installed in a managed node (batteryIndex)
- properties of these batteries (batteryActualCapacity and batteryChargingCycleCount)
- the time at which the next replacement cycle for batteries can be expected (batteryAlarmLowCapacity and batteryAlarmHighCycleCount)
- the types of batteries in use and their firmware versions (batteryIdentifier, batteryFirmwareVersion, batteryType, and batteryTechnology)

For any battery-powered device whose use can be correlated to an individual or a small group of individuals, the following objects have the potential to reveal information about those individuals’ activities or habits (e.g., if they are near a power outlet, if they have been using their devices heavily, etc.):

- batteryChargingCycleCount
- batteryLastChargingCycleTime
- batteryChargingOperState
- batteryActualCharge
- batteryActualVoltage
- batteryActualCurrent
- batteryTemperature
- batteryAlarmLowCharge
- batteryAlarmLowVoltage
- batteryAlarmLowCapacity
- batteryAlarmHighCycleCount
- batteryAlarmHighTemperature
Implementers of this specification should use appropriate privacy protections as discussed in Section 9 of "Requirements for Energy Management" [RFC6988]. Battery monitoring of devices used by individuals or in homes should only occur with proper authorization.

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.

6. IANA Considerations

6.1. SMI Object Identifier Registration

The Battery MIB module defined in this document uses the following IANA-assigned OBJECT IDENTIFIER value recorded in the SMI Numbers registry:

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>OBJECT IDENTIFIER value</th>
</tr>
</thead>
<tbody>
<tr>
<td>batteryMIB</td>
<td>{ mib-2 233 }</td>
</tr>
</tbody>
</table>

6.2. Battery Technology Registration

Object batteryTechnology defined in Section 4 reports battery technologies. Eighteen values for battery technologies have initially been defined. They are listed in a table in Section 3.2.
For ensuring extensibility of this list, IANA has created a registry for battery technologies at <http://www.iana.org/assignments/battery-technologies> and filled it with the initial list given in Section 3.2.

New assignments of numbers for battery technologies will be administered by IANA through Expert Review [RFC5226]. Experts must check for sufficient relevance of a battery technology to be added according to the guidelines in Section 3.2.1.

7. References

7.1. Normative References


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7.2. Informative References


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