

Superseded

CableLabs® Specifications

Battery Backup MIB

CL-SP-MIB-BB-I03-090811

ISSUED

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Key to Document Status Codes:

- Work in Progress** An incomplete document, designed to guide discussion and generate feedback, that may include several alternative requirements for consideration.
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1 SCOPE

This specification describes the Battery Backup Uninterrupted Power Supply (UPS) MIB requirements for CableLabs devices.

1.1 Requirements

Throughout this document, the words that are used to define the significance of particular requirements are capitalized. These words are:

"MUST"	This word means that the item is an absolute requirement of this specification.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this specification.
"SHOULD"	This word means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
"MAY"	This word means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

2 REFERENCES

2.1 Normative References

In order to claim compliance with this specification, it is necessary to conform to the following standards and other works as indicated, in addition to the other requirements of this specification. Notwithstanding, intellectual property rights may be required to use or implement such normative references.

- [1] DOCSIS 2.0 Operations Support System Interface Specification, CM-SP-OSSIV2.0-C01-081104, November 4, 2008, Cable Television Laboratories, Inc.
- [2] IETF RFC 1628, UPS Management Information Base, May 1994.

2.2 Informative References

- [3] IETF RFC 3410, Introduction and Applicability Statements for Internet-Standard Management Framework, December 2002.

2.3 Reference Acquisition

- Cable Television Laboratories, Inc., 858 Coal Creek Circle, Louisville, CO 80027; Phone +1-303-661-9100; Fax +1-303-661-9199; [http:// www.cablelabs.com](http://www.cablelabs.com).
- Internet Engineering Task Force (IETF) Secretariat 46000 Center Oak Plaza, Sterling, VA 20166, Phone: +1-571-434-3500, Fax: +1-571-434-3535, <http://www.ietf.org/Abbreviations>

3 ABBREVIATIONS

This document uses the following abbreviations and acronyms.

eDOCSIS	Embedded Data-Over-Cable Service Interface Specifications
eCM	Embedded Cable Modem
E-MTA	Embedded Multimedia Terminal Adapter
LED	Light Emitting Diode
MIB	Management Information Base
MTA	Multimedia Terminal Adapter
SNMP	Simple Network Management Protocol
UPS	Uninterrupted Power Supply

4 UPS MIB AND LED FUNCTIONALITY

4.1 Introduction

CableLabs devices MAY support battery backup capabilities with Uninterrupted Power Supply (UPS) functionality. An example of such device is a PacketCable Embedded Multimedia Terminal Adapter (MTA) eDOCSIS device. This document extends the set of CableLabs MIB modules to provide SNMP management of the UPS power source and battery backup functions.

Support for battery backup capabilities with UPS functionality is becoming important as some broadband services rely on constant uptime. The CableLabs UPS components consist of one or more battery packs and associated management functions to allow the control of power supply inputs and outputs. When the UPS is being provided power via the utility line (power outlet), the battery pack(s) are able to charge. When utility power is removed, the UPS component switches to the battery backup power source to provide power to the device until utility power has been reapplied or the battery pack(s) have been depleted.

CableLabs compliant devices that include battery backup with UPS functionality MUST include a Battery LED that relays information on the status of the UPS and battery pack(s). For more information about the Battery LED requirements, refer to Section 4.2.2.

Figure 1 describes the typical functional blocks of a UPS component connected to an eDOCSIS device.

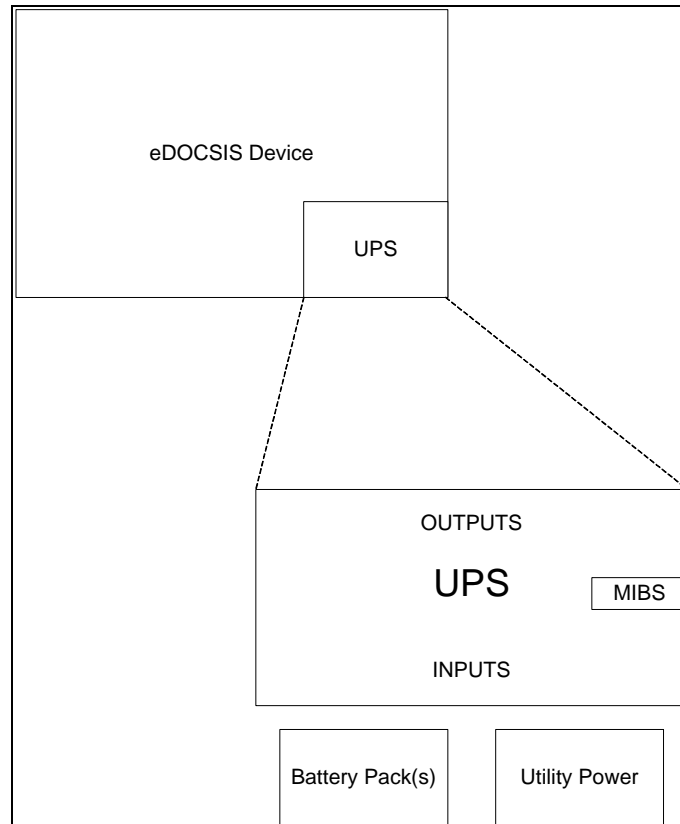


Figure 1 - UPS Components in eDOCSIS Devices

4.2 UPS Management

The purpose of this section is to define the UPS management requirements for CableLabs devices supporting battery backup UPS functionality.

CableLabs compliant devices supporting battery backup functionality **MUST** support UPS management and **MUST** comply with the SNMP MIB requirements of IETF RFC 1628 [2] as defined in this section. RFC 1628 [2] contains more information than is required for the simple UPS devices used for PacketCable digital voice or DOCSIS broadband data services. This document defines an SMI compliance statement for IETF RFC 1628 [2] that **MUST** be supported by CableLabs compliant devices with UPS functionality. Further, access to the UPS MIB objects **MUST** be provided via the eCM interface.

4.2.1 CableLabs Battery Backup UPS MIB Requirements

The Battery Backup and UPS MIB objects **MUST** be implemented as defined below.

```
CLAB-UPS-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY          FROM SNMPv2-SMI          -- RFC 2578
    MODULE-COMPLIANCE       FROM SNMPv2-CONF         -- RFC 2580

    clabCommonMibs          FROM CLAB-DEF-MIB

    upsIdentManufacturer,
    upsIdentModel,
```

```

upsIdentAgentSoftwareVersion,
upsIdentName,
upsIdentAttachedDevices,
upsBatteryStatus,
upsSecondsOnBattery,
upsEstimatedMinutesRemaining,
upsEstimatedChargeRemaining,
upsInputLineBads,                -- optional
upsInputNumLines,
upsInputFrequency,                -- optional
upsInputVoltage,                  -- optional
upsOutputSource,
upsOutputFrequency,              -- optional
upsOutputNumLines,
upsOutputVoltage,                 -- optional
upsAlarmsPresent,
upsAlarmDescr,
upsAlarmTime,
upsShutdownType,
upsShutdownAfterDelay,
upsStartupAfterDelay,
upsRebootWithDuration,
upsAutoRestart,                  -- optional
upsConfigInputVoltage,           -- optional
upsConfigInputFreq,              -- optional
upsConfigOutputVoltage,         -- optional
upsConfigOutputFreq,            -- optional
upsConfigOutputVA,               -- optional
upsConfigOutputPower,           -- optional
upsConfigLowBattTime,
upsConfigAudibleStatus           -- optional
FROM UPS-MIB;                    -- RFC 1628

```

clabUpsMib MODULE-IDENTITY

```

LAST-UPDATED "200905060000Z" -- May 6, 2009
ORGANIZATION "Cable Television Laboratories, Inc."
CONTACT-INFO

```

```

    "Postal: Cable Television Laboratories, Inc
    858 Coal Creek Circle
    Louisville, CO 80027
    U.S.A.
    Phone: +1-303-661-9100
    Fax:   +1-303-661-9199
    E-mail:mibs@cablelabs.com

```

```

    Acknowledgements:
    Sumanth Channabasappa - CableLabs
    Jean-Francois Mule, CableLabs.
    Kevin Marez, Motorola, Inc."

```

DESCRIPTION

```

    "This MIB module provides the management objects for the
    configuration and monitoring of the battery backup & UPS
    functionality for CableLabs compliant devices.

```

```

    Copyright 2004-2009 Cable Television Laboratories, Inc.
    All rights reserved."

```

```

REVISION "200905060000Z" -- May 6, 2009

```

DESCRIPTION

```

    "Revised Version includes ECNs MIB-BB-N-09.0042-2

```

and MIB-BB-N-0044-1, published as part of
CL-SP-MIB-BB-I03-090811."

REVISION "200701191700Z" -- January 19, 2007

DESCRIPTION

"This revision published as CL-SP-MIB-BB-I02-070119."

REVISION "200501280000Z" -- January 28, 2005

DESCRIPTION

"This revision published as CL-SP-MIB-BB-I01-050128."

::= { clabCommonMibs 1 }

-- Administrative assignments

```
clabUpsNotifications OBJECT IDENTIFIER ::= { clabUpsMib 0 }
clabUpsObjects        OBJECT IDENTIFIER ::= { clabUpsMib 1 }
clabUpsConformance   OBJECT IDENTIFIER ::= { clabUpsMib 2 }
```

-- Object Groups

-- The object groups used in this MIB module are imported from
-- the IETF RFC 1628, see the module compliance statement

-- Conformance Statements

```
clabUpsCompliances OBJECT IDENTIFIER ::=
                                { clabUpsConformance 1 }
clabUpsGroups OBJECT IDENTIFIER   ::=
                                { clabUpsConformance 2 }
```

clabUpsMibCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"The compliance statement for CableLabs compliant
devices that implement battery backup and UPS
functionality."

MODULE UPS-MIB -- RFC 1628

```
MANDATORY-GROUPS {
    upsSubsetIdentGroup,
    upsFullBatteryGroup,
    upsBasicInputGroup,
    upsBasicOutputGroup,
    upsBasicAlarmGroup,
    upsBasicControlGroup,
    upsBasicConfigGroup
}
```

-- upsSubsetIdentGroup OBJECT-GROUP

```
-- OBJECTS { upsIdentManufacturer, upsIdentModel,
--           upsIdentAgentSoftwareVersion, upsIdentName,
--           upsIdentAttachedDevices }
```

OBJECT upsIdentManufacturer

DESCRIPTION

"The value of the upsIdentManufacturer object MUST contain the
name of the device manufacturer."

```

OBJECT      upsIdentModel          -- same as RFC 1628
DESCRIPTION
    "The UPS Model designation."

OBJECT      upsIdentAgentSoftwareVersion  -- same as RFC 1628
DESCRIPTION
    "The UPS agent software version.
    This object may have the same value as the
    upsIdentUPSSoftwareVersion object."

OBJECT      upsIdentName
DESCRIPTION
    "The upsIdentName object identifies the UPS and its value
    SHOULD be provided in the device configuration file.  If the
    upsIdentName value is not provided in the configuration file,
    the default value MUST be an empty string "

OBJECT      upsIdentAttachedDevices
DESCRIPTION
    "The upsIdentAttachedDevices MUST contain a column separated list of the
    names of the embedded devices attached to the UPS power output as specified in
    CableLabs' DHCP Options Registry.

    For example, if the eDOCSIS device is an E-MTA with an integrated
    eCM, eMTA eSAFE, and a vendor device named
    'VendorXEmbeddedDevice', this object must contain the value
    'ECM:EMTA:vVendorXEmbeddedDevice' (without the single quotes)."
```

```

--      upsFullBatteryGroup OBJECT-GROUP
--      OBJECTS { upsBatteryStatus, upsSecondsOnBattery,
--                upsEstimatedMinutesRemaining,
--                upsEstimatedChargeRemaining }
```

```

OBJECT      upsBatteryStatus
SYNTAX      INTEGER {
    batteryNormal(2),
    batteryLow(3),
    batteryDepleted(4)
}
DESCRIPTION
    "The support of the upsBatteryStatus object value unknown(1) is
    not required."
```

```

OBJECT      upsSecondsOnBattery
DESCRIPTION
    "If the device is on battery power, the upsSecondsOnBattery
    object MUST return the elapsed time since the UPS last
    switched to battery power, or the time since the device was
    last restarted, whichever is less.

    The upsSecondsOnBattery object MUST return a value of 0 if
    the attached devices are not on battery power."
```

```

OBJECT      upsEstimatedMinutesRemaining  -- same as RFC 1628
DESCRIPTION
    "An estimate of the time to battery charge depletion
    under the present load conditions if the utility power
    is off and remains off, or if it were to be lost and
    remain off."
```

```

OBJECT      upsEstimatedChargeRemaining  -- same as RFC 1628
DESCRIPTION
    "An estimate of the battery charge remaining expressed
```

```
    as a percent of full charge."

--  upsBasicInputGroup OBJECT-GROUP
--      OBJECTS { upsInputLineBads, upsInputNumLines,
--                upsInputFrequency, upsInputVoltage }

OBJECT      upsInputLineBads
DESCRIPTION
    "The upsInputLineBads object MAY be supported."

OBJECT      upsInputNumLines
DESCRIPTION
    "The upsInputNumLines object specifies the number of input
    lines utilized in this device.
    For example, for an eDOCSIS E-MTA device with 1 battery pack
    and 1 AC power source, this object value must be 2."

OBJECT      upsInputFrequency
DESCRIPTION
    "The upsInputFrequency object MAY be supported."

OBJECT      upsInputVoltage
DESCRIPTION
    "The upsInputVoltage object MAY be supported."

--  upsBasicOutputGroup OBJECT-GROUP
--      OBJECTS { upsOutputSource, upsOutputFrequency,
--                upsOutputNumLines, upsOutputVoltage }

OBJECT      upsOutputSource
SYNTAX INTEGER {
    none(2),
    normal(3),
    battery(5)
}
DESCRIPTION
    "The devices capable of supporting battery backup and UPS
    functionality MUST support the upsOutputSource values of
    none(2), normal(3), battery(5). The upsOutputSource value of
    other(1) may be used to represent transient states."

OBJECT      upsOutputFrequency
DESCRIPTION
    "The upsOutputFrequency object MAY be supported."

OBJECT      upsOutputNumLines
DESCRIPTION
    "The upsOutputNumLines object specifies the number of output
    lines utilized in this eDOCSIS device.
    For example, for an eDOCSIS E-MTA devices with both the eCM and
    eMTA attached to the UPS, this object value must be 2."

OBJECT      upsOutputVoltage
DESCRIPTION
    "The upsOutputVoltage object MAY be supported."

--  upsBasicAlarmGroup OBJECT-GROUP
--      OBJECTS { upsAlarmsPresent, upsAlarmDescr, upsAlarmTime }

OBJECT      upsAlarmsPresent                -- same as RFC 1628
```

```

DESCRIPTION
    "The upsAlarmsPresent object indicates the current number of
    active alarm conditions."

OBJECT      upsAlarmDescr
DESCRIPTION
    "The following well known alarm types MUST be supported by
    the CableLabs UPS capable devices:

        upsAlarmBatteryBad,
        upsAlarmOnBattery,
        upsAlarmLowBattery,
        upsAlarmDepletedBattery,
        upsAlarmOutputOffAsRequested,
        upsAlarmUpsOutputOff,
        upsAlarmGeneralFault,
        upsAlarmAwaitingPower,
        upsAlarmShutdownPending,
        and upsAlarmShutdownImminent."

OBJECT      upsAlarmTime          -- same as RFC 1628
DESCRIPTION
    "The upsAlarmTime object indicates the value of sysUpTime when
    the alarm condition was detected."

-- upsBasicControlGroup OBJECT-GROUP
--     OBJECTS { upsShutdownType, upsShutdownAfterDelay,
--               upsStartupAfterDelay, upsRebootWithDuration,
--               upsAutoRestart }

OBJECT      upsShutdownType
SYNTAX     INTEGER {
                output(1)
            }

DESCRIPTION
    "The upsShutdownType object defines the nature of the action to
    be taken at the time when the countdown of the
    upsShutdownAfterDelay and upsRebootWithDuration object values
    reach zero.
    The support for the upsShutdownType value system is not
    required (for CableLabs compliant devices, a system shutdown or
    reset can be achieved using other mechanisms."

OBJECT      upsStartupAfterDelay
SYNTAX     INTEGER (-1..604800) -- max range is 7 days or 604800s
DESCRIPTION
    "The upsStartupAfterDelay MUST be supported.

    The CableLabs devices capable of support battery backup and
    UPS functionality MUST support a maximum upsStartupAfterDelay
    value of 604800 seconds, equivalent to 7 days."

OBJECT      upsRebootWithDuration -- same as RFC 1628
DESCRIPTION
    "The upsRebootWithDuration controls a reboot procedure with
    a countdown. It also indicates whether a reboot procedure is in
    progress and the number of seconds remaining in the countdown."

OBJECT      upsAutoRestart        -- same as RFC 1628
DESCRIPTION
    "The upsAutoRestart is only applicable for UPS system shutdown;

```

```
it MAY be supported."

-- upsBasicConfigGroup OBJECT-GROUP
--   OBJECTS { upsConfigInputVoltage, upsConfigInputFreq,
--             upsConfigOutputVoltage, upsConfigOutputFreq,
--             upsConfigOutputVA, upsConfigOutputPower,
--             upsConfigLowBattTime, upsConfigAudibleStatus }

OBJECT      upsConfigInputVoltage
DESCRIPTION
  "The upsConfigInputVoltage MAY be supported."

OBJECT      upsConfigInputFreq
DESCRIPTION
  "The upsConfigInputFreq MAY be supported."

OBJECT      upsConfigOutputVoltage
DESCRIPTION
  "The upsConfigOutputVoltage MAY be supported."

OBJECT      upsConfigOutputFreq
DESCRIPTION
  "The upsConfigOutputFreq MAY be supported."

OBJECT      upsConfigOutputVA
DESCRIPTION
  "The upsConfigOutputVA MAY be supported."

OBJECT      upsConfigOutputPower
DESCRIPTION
  "The upsConfigOutputPower MAY be supported."

OBJECT      upsConfigLowBattTime      -- same as RFC 1628
DESCRIPTION
  "The upsConfigLowBattTime specifies the value of
  upsEstimatedMinutesRemaining at which a lowBattery condition is
  declared.
  Implementation of all possible values may be onerous for some
  systems. Consequently, not all possible values must be
  supported. However, at least two different manufacturer-
  selected values for upsConfigLowBattTime MUST be supported."

OBJECT      upsConfigAudibleStatus
DESCRIPTION
  "The upsConfigAudibleStatus MAY be supported."

  ::= { clabUpsCompliances 1 }

--
-- Units of conformance for CableLabs UPS capable devices
-- Adapted from RFC 1628, a column was added for CableLabs devices
-- An 'x' in the column means the object MUST be supported; all the
-- rest is optional and left for vendor decision.
```

-- Summary at a glance:

	subset	basic	adv	CLAB-UPS	COMPLIANCE
				MUST	GROUP
--upsIdentManufacturer	x	x	x	x	upsSubsetIdentGroup
--upsIdentModel	x	x	x	x	upsSubsetIdentGroup
--upsIdentUPSSoftwareVersion		x	x		
--upsIdentAgentSoftwareVersion	x	x	x	x	upsSubsetIdentGroup
--upsIdentName	x	x	x	x	upsSubsetIdentGroup
--upsIdentAttachedDevices	x		x	x	upsSubsetIdentGroup
--upsBatteryStatus	x	x	x	x	upsFullBatteryGroup
--upsSecondsOnBattery	x	x	x	x	upsFullBatteryGroup
--upsEstimatedMinutesRemaining			x	x	upsFullBatteryGroup
--upsEstimatedChargeRemaining			x	x	upsFullBatteryGroup
--upsBatteryVoltage					
--upsBatteryCurrent					
--upsBatteryTemperature					
--upsInputLineBads	x	x	x		
--upsInputNumLines		x	x	x	upsBasicInputGroup
--upsInputFrequency		x	x		
--upsInputVoltage		x	x		
--upsInputCurrent					
--upsInputTruePower					
--upsOutputSource	x	x	x	x	upsBasicOutputGroup
--upsOutputFrequency		x	x		
--upsOutputNumLines		x	x	x	upsBasicOutputGroup
--upsOutputVoltage		x	x		
--upsOutputCurrent			x		
--upsOutputPower			x		
--upsOutputPercentLoad			x		
--upsBypassFrequency		x	x		
--upsBypassNumLines		x	x		
--upsBypassVoltage		x	x		
--upsBypassCurrent					
--upsBypassPower					
--upsAlarmsPresent	x	x	x	x	upsBasicAlarmGroup
--upsAlarmDescr	x	x	x	x	upsBasicAlarmGroup
--upsAlarmTime	x	x	x	x	upsBasicAlarmGroup
--upsTestId		x	x		
--upsTestSpinLock		x	x		
--upsTestResultsSummary		x	x		
--upsTestResultsDetail		x	x		
--upsTestStartTime		x	x		
--upsTestElapsedTime		x	x		
--upsShutdownType	x	x	x	x	upsBasicControlGroup
--upsShutdownAfterDelay	x	x	x	x	upsBasicControlGroup
--upsStartupAfterDelay		x	x	x	upsBasicControlGroup
--upsRebootWithDuration		x	x	x	upsBasicControlGroup
--upsAutoRestart	x	x	x		
--upsConfigInputVoltage	x	x	x		
--upsConfigInputFreq	x	x	x		
--upsConfigOutputVoltage	x	x	x		
--upsConfigOutputFreq	x	x	x		

```
--upsConfigOutputVA          x   x   x
--upsConfigOutputPower       x   x   x

--upsConfigLowBattTime              x   upsBasicConfigGroup

END
```

4.2.2 Power and Battery LED requirements

CableLabs devices with UPS functionality **MUST** provide a special LED labeled as "BATTERY" (referred to as BATTERY LED or Battery LED in this document). The BATTERY LED conventions **MUST** comply with the requirements defined in this section in Table 1. The "POWER" LED of CableLabs devices with UPS functionality **MUST** also support the additional requirements defined in Table 1 of this section when the device is running on battery backup power.

The Power and Battery LED requirements and location on CableLabs devices with UPS functionality **MUST** be consistent with the requirements in Section 7 of the DOCSIS 2.0 OSSI specification [1].

The following table defines the LED functionality used to relay power and battery status information:

Table 1 - Power and Battery LED Operations By State

Mode of Operation	UPS Power Input Source	Battery Status	POWER LED Requirements	BATTERY LED Requirements
Device Initialization			Unlit	Lit
Normal Operation	AC Power (AC Power is ON)	Good Battery	Lit	Lit
		Low Battery	Lit	Flash
		Bad Battery	Lit	Unlit
	Battery Power (AC Power is OFF, battery input source is ON)	Good Battery	Flash	Unlit
		Low Battery	Flash	Flash
		Bad Battery	Unlit (see Note 1*)	Unlit

**Note 1:* During AC Power Fail with a bad battery, device operation may not be possible due to lack of battery power; the POWER and BATTERY LEDs may be 'Unlit'.

The Battery LED **MUST** be 'Lit' under the following conditions:

- The Battery LED **MUST** be 'Lit' during the initialization of all the components attached to the UPS (the list of components or eSAFE devices attached to the UPS is defined by the `upsIdentAttachedDevices` object in the CLAB-UPS-MIB module).
- The Battery LED **MUST** be 'Lit' if the eDOCSIS UPS is operating on AC power and the battery is functioning normally.

The Battery LED **MUST** be 'Unlit' under the following conditions:

- One or more batteries are determined to be in "bad" condition. A battery "bad" condition occurs when one or more batteries have been determined to require replacement, for example when a battery is malfunctioning or may not be rechargeable. Such condition also triggers the `upsAlarmBatteryBad` alarm in the CLAB-UPS-MIB module.
- The UPS is operating on battery power and the battery is functioning normally.

The Battery LED **MUST** 'Flash' under the following condition:

- The Battery LED **MUST** 'Flash' if the battery is low. A low battery condition is reached when the remaining battery run-time is less than or equal to the value of the `upsConfigLowBattTime` MIB object in the CLAB-UPS-MIB module (such condition also triggers the `upsAlarmLowBattery` alarm condition).

4.2.3 Applicability of the CableLabs Battery Backup UPS MIB requirements

The battery backup and UPS functionality may be implemented in various CableLabs devices, for example a PacketCable Embedded Multimedia Terminal Adapter (E-MTA), a standalone Cable Modem or any eDOCSIS device. This section specifies additional applicability statements.

4.2.3.1 PacketCable E-MTA devices

In the case of a PacketCable Embedded Multimedia Terminal Adapter (E-MTA) device used to provide telephony services, service uptime is critical and the usage of battery backup UPS components may be an operator requirement.

A PacketCable E-MTA supporting battery backup UPS functionality **MUST** provide UPS output power to both the embedded cable modem (eCM) and the MTA eSAFE device (eMTA). Therefore, the `upsIdentAttachedDevices` object **MUST** contain the value 'ECM:EMTA' (without the single quotes).

Appendix I Acknowledgements

On behalf of CableLabs and its participating member companies, we would like to extend our thanks to all those who contributed to the development of this specification. Certainly all the participants of the provisioning focus team have added value to this effort by participating in the review and weekly conference calls. Particular thanks are given to:

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Paul Duffy (Cisco Systems)

Satish Kumar (Texas Instruments)

Kevin Marez (Motorola, Inc.)

Jean-François Mulé, Sumanth Channabasappa (CableLabs)

Appendix II Revision History

The following ECNs have been incorporated in CL-SP-MIB-BB-I02-070119.

ECN	Date Accepted	Summary
MIB-BB-N-06.0022-2	3/13/06	Clarification of UPS MIB SNMP access
MIB-BB-N-07.0026-1	1/18/07	Editorial Changes

The following ECN has been incorporated in CL-SP-MIB-BB-I03-090811.

ECN	Date Accepted	Summary
MIB-BB-N-09.0042-2	5/6/2009	Editorial updates
MIB-BB-N-09.0044-1	8/12/2009	Update to the BB-MIB to fix compilation issues