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Modular Headend Architecture Part 3: M-CMTS Operations Support System Interface

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1 SCOPE

1.1 Introduction and Overview

NOTE: This document is identical to SCTE 137-3 2010 except for informative components which may have been updated such as the title page, NOTICE text, headers and footers. No normative changes have been made to this document.

This specification defines the Network Management requirements to support a Modular Cable Modem Termination System (M-CMTS™) for headend components compliant to DOCSIS®. The purpose of this document is to define the management requirements for the M-CMTS architecture that enables an effective operation of the M-CMTS components.

The M-CMTS architecture separates the traditional CMTS into two parts. The first part is the downstream physical (PHY) component (known as a DOCSIS EQAM) and the second part consists of the IP networking and DOCSIS MAC functions of the CMTS (known as the M-CMTS Core). This separation of a CMTS into EQAM and M-CMTS Core introduces three new protocol interfaces to DOCSIS-compliant headend systems.

- DOCSIS Timing Interface (DTI): Provides a frequency reference for M-CMTS Core and DOCSIS EQAM via direct connections to a DTI Server.
- Downstream External PHY Interface (DEPI): Controls the delivery of DOCSIS frames from the M-CMTS Core to the EQAM devices.
- Edge Resource Management Interface (ERMI): Provides EQAM devices registration and control to the Edge Resource Management device with the purpose of sharing EQAM resources with video systems such as Video on Demand (VoD).

1.2 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

The following documents contain provisions, which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

2.1 Normative References

[DEPI] ANSI/SCTE 137-2 2007, DOCSIS Downstream External PHY Interface for Modular Cable Modem Termination Systems.

[DRFI] ANSI/SCTE 133 2007, Downstream RF Interface for Cable modem Termination Systems.

[DTI] ANSI/SCTE 137-1 2010, DOCSIS Timing Interface for Cable Modem Termination Systems.

[ERMI] SCTE 137-4 2010, Edge Resource Manager Interface.

[OSSI2.0] ANSI/SCTE 79-2 2009, DOCSIS 2.0 Part 2: Operations Support Systems Interface.

[EQAM-PMI] ANSI/SCTE 137-5 2010, Modular Headend Architecture Part 5: Edge QAM Provisioning and Management Interface.

[RFC 2011] IETF RFC 2011, Category: Standards Track SNMPv2 Management Information Base for the Internet Protocol using SMIv2, November 1996.

[RFC 2863] IETF RFC 2853, The Interfaces Group MIB, June 2000.

[RFC 3371] IETF RFC 3371, L2TPv3 Extensions Working Group, Layer Two Tunneling Protocol 'L2TP' Management Information Base, August 2002.

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

[RFC 3411] IETF RFC 3411 / STD0062, An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks, December 2002.

[RFC 3412] IETF RFC 3412 / STD0062, Message Processing and Dispatching for the Simple Network Management Protocol (SNMP), December 2002.

[RFC 3413] IETF RFC 3413 / STD0062, Simple Network Management Protocol (SNMP) Applications, December 2002.

[RFC 3414] IETF RFC 3414 / STD0062, User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3), December 2002.

[RFC 3415] IETF RFC 3415 / STD0062, View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP), December 2002.

[RFC 3418] IETF RFC 3418 / STD0062, Management Information Base (MIB) for the Simple Network Management Protocol (SNMP), December 2002.

[RFC 3584] IETF RFC 3584 / BCP0074, Coexistence between Version 1, Version 2, and Version 3 of the Internet-Standard and Network Management Framework, August 2003.

[RFC 3931] IETF RFC 3931, Layer Two Tunneling Protocol - Version 3 (L2TPv3), March 2005.

[RFC 4133] IETF RFC 4133, A. Bierman, K. and McCloghrie, Entity MIB, August 2005.

[RFC 4546] IETF RFC 4546, D. Raftus and E. Cardona, Radio Frequency (RF) Interface Management Information Base for DOCSIS 2.0 Compliant RF Interfaces, June 2006.

[RFC 4639] IETF RFC 4639, R. Woundy and K. Marez, Cable Device Management Information Base for Data-Over-Cable Service Interface Specification (DOCSIS) Compliant Cable Modems and Cable Modem Termination Systems, December 2006.

2.2 Informative References

[PW-MIB] IETF draft-ietf-pwe3-pw-mib-06.txt, Zelig, D., Nadeau, T., Pseudo Wire (PW) Management Information Base, July 2005.

[RFC 2661] IETF RFC 2661, Layer Two Tunneling Protocol "L2TP", August 1999.

[RFC 4087] IETF RFC 4087, IP Tunnel MIB, June 2005.

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
- 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

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Internet-Drafts may also be accessed at http://tools.ietf.org/html/

3 TERMS AND DEFINITIONS

This specification uses the following terms and definitions:

Cable Modem (CM)	A modulator-demodulator at subscriber locations intended for use in conveying data communications on a cable television system.
CDN	L2TPv3 Call-Disconnect-Notify message.
Converged Interconnect Network	The network (generally gigabit Ethernet) that connects an M-CMTS Core to an EQAM.
Customer Premises Equipment (CPE)	Equipment at the end user's premises; may be provided by the service provider.
Data Rate	Throughput, data transmitted in units of time usually in bits per second (bps).
Decibels (dB)	Ratio of two power levels expressed mathematically as $dB = 10\log_{10}(P_{OUT}/P_{IN})$.
Decibel-Millivolt (dBmV)	Unit of RF power expressed in decibels relative to 1 millivolt over 75 ohms, where $dBmV = 20\log_{10}$(value in mV/1 mV).
DOCSIS-MPT (D-MPT)	DOCSIS MPT Mode.
Downstream (DS)	1. Transmissions from CMTS to CM. This includes transmission from the M-CMTS Core to the EQAM as well as the RF transmissions from the EQAM to the CM. 2. RF spectrum used to transmit signals from a cable operator's headend or hub site to subscriber locations.
DTI Client	The receiver of the Timing signal from the DTI Server. Through the DTI protocol DTI clients have the same time reference.
DTI Server	Timing Signal generator for a DTI client of the point to point DOCSIS Timing Interface (DTI).
edgeQAM modulator (EQAM)	A headend or hub device that receives packets of digital video or data. It re-packetizes the video or data into an MPEG transport stream and digitally modulates the digital transport stream onto a downstream RF carrier using quadrature amplitude modulation (QAM).
Electronic Industries Alliance (EIA)	A voluntary body of manufacturers, which, among other activities, prepares and publishes standards.
Flow	A stream of packets in DEPI used to transport data of a certain priority from the M-CMTS Core to a particular QAM channel of the EQAM. In PSP operation, there can exist several flows per QAM channel.
Gigahertz (GHz)	A unit of frequency; 1,000,000,000 or 10^9 Hz.
GigE (GE)	Gigabit Ethernet (1 Gbps).

GPSSEC	The timestamp used for GPS systems. This timestamp is a 32-bit counter that increments every second and uses as initialization reference January 6, 1980.
Hertz (Hz)	A unit of frequency; formerly cycles per second.
Hybrid Fiber/Coax (HFC) System	A broadband bidirectional shared-media transmission system using optical fiber trunks between the headend and the fiber nodes, and coaxial cable distribution from the fiber nodes to the customer locations.
ICCN	L2TPv3 Incoming-Call-Connected message.
ICRP	L2TPv3 Incoming-Call-Reply message.
ICRQ	L2TPv3 Incoming-Call-Request message.
Internet Engineering Task Force (IETF)	A body responsible for, among other things, developing standards used in the Internet.
Internet Protocol (IP)	An Internet network-layer protocol.
IPv4	Internet Protocol version 4.
kilohertz (kHz)	Unit of frequency; 1,000 or 10^3 Hz; formerly kilocycles per second.
L2TP Attribute Value Pair (AVP)	The L2TP variable-length concatenation of a unique Attribute (represented by an integer), a length field, and a Value containing the actual value identified by the attribute.
L2TP Control Connection	An L2TP control connection is a reliable control channel that is used to establish, maintain, and release individual L2TP sessions as well as the control connection itself.
L2TP Control Connection Endpoint (LCCE)	An L2TP node that exists at either end of an L2TP control connection. May also be referred to as an LAC or LNS, depending on whether tunneled frames are processed at the data link (LAC) or network layer (LNS).
L2TP Control Connection ID	The Control Connection ID field contains the identifier for the control connection, a 32-bit value. The Assigned Control Connection ID AVP, Attribute Type 61, contains the ID being assigned to this control connection by the sender. The Control Connection ID specified in the AVP must be included in the Control Connection ID field of all control packets sent to the peer for the lifetime of the control connection. Because a Control Connection ID value of 0 is used in this special manner, the zero value must not be sent as an Assigned Control Connection ID value.
L2TP Control Message	An L2TP message used by the control connection.
L2TP Data Message	L2TP message used by the data channel.
L2TP Endpoint	A node that acts as one side of an L2TP tunnel.

L2TP Network Server (LNS)	If a given L2TP session is terminated at the L2TP node and the encapsulated network layer (L3) packet processed on a virtual interface, we refer to this L2TP node as an L2TP Network Server (LNS). A given LCCE may act as both an LNS for some sessions and an LAC for others, so these terms must only be used within the context of a given set of sessions unless the LCCE is in fact single purpose for a given topology.
L2TP Pseudowire (PW)	An emulated circuit as it traverses a PSN. There is one Pseudowire per L2TP Session.
L2TP Pseudowire Type	The payload type being carried within an L2TP session. Examples include PPP, Ethernet, and Frame Relay.
L2TP Session	An L2TP session is the entity that is created between two LCCEs in order to exchange parameters for and maintain an emulated L2 connection. Multiple sessions may be associated with a single Control Connection.
L2TP Session ID	A 32-bit field containing a non-zero identifier for a session. L2TP sessions are named by identifiers that have local significance only. That is, the same logical session will be given different Session IDs by each end of the control connection for the life of the session. When the L2TP control connection is used for session establishment, session IDs are selected and exchanged as Local Session ID AVPs during the creation of a session. The Session ID alone provides the necessary context for all further packet processing, including the presence, size, and value of the Cookie, the type of L2-Specific Sublayer, and the type of payload being tunneled.
MAC Domain	A grouping of layer 2 devices that can communicate with each other without using bridging or routing. In DOCSIS is the group of CMs that are using upstream and downstream channels linked together through a MAC forwarding entity.
Media Access Control (MAC)	Used to refer to the layer 2 element of the system which would include DOCSIS framing and signaling.
Megahertz (MHz)	A unit of frequency; 1,000,000 or 10^6 Hz; formerly megacycles per second.
Microsecond (µs)	10^{-6} second.
Millisecond (ms)	10^{-3} second.
M/N	Relationship of integer numbers M,N that represents the ratio of the downstream symbol clock rate to the DOCSIS master clock rate.
MPT	MPEG-TS mode of DEPI.
Multiple System Operator (MSO)	A corporate entity that owns and/or operates more than one cable system.
Nanosecond (ns)	10^{-9} second.
QAM channel (QAM ch)	Analog RF channel that uses quadrature amplitude modulation (QAM) to convey information.

Quadrature Amplitude Modulation (QAM)	A modulation technique in which an analog signal's amplitude and phase vary to convey information, such as digital data.
Radio Frequency (RF)	In cable television systems, this refers to electromagnetic signals in the range 5 to 1000 MHz.
Radio Frequency Interface (RFI)	Term encompassing the downstream and the upstream radio frequency interfaces.
Request For Comments (RFC)	A technical policy document of the IETF; these documents can be accessed on the World Wide Web at http://www.rfc-editor.org/.
SCCRN	L2TPv3 Start-Control-Connection-Connected message.
SCCRP	L2TPv3 Start-Control-Connection-Reply message.
SCCRQ	L2TPv3 Start-Control-Connection-Request message.
Session	An L2TP data plane connection from the M-CMTS Core to the QAM channel. There must be one session per QAM Channel. There is one DEPI pseudowire type per session. There may be multiple MPT flows and multiple PSP flows per session. Multiple sessions may be bound to a single control connection.
SLI	L2TPv3 Set Link Info message.
StopCCN	L2TPv3 Stop-Control-Connection-Notification message.
Upstream (US)	1. Transmissions from CM to CMTS. This includes transmission from the EQAM to M-CMTS Core as well as the RF transmissions from the CM to the EQAM. 2. RF spectrum used to transmit signals from a subscriber location to a cable operator's headend or hub site.
Upstream Channel Descriptor (UCD)	The MAC Management Message used to communicate the characteristics of the upstream physical layer to the cable modems.
Video on Demand (VoD) System	System that enables individuals to select and watch video content over a network through an interactive television system.

4 ABBREVIATIONS AND ACRONYMS

This specification uses the following abbreviations and acronyms:

CIN	Converged Interconnect Network
CMCI	Cable Modem CPE Interface
CMTS	Cable Modem Termination System
CRC	Cyclic Redundancy Check
DEPI	Downstream External-PHY Interface
DOCSIS®	Data-Over-Cable Service Interface Specifications
DRFI	Downstream Radio Frequency Interface
DSCP	Differentiated Services Code Point
DTI	DOCSIS Timing Interface
ERM	Edge Resource Manager
ERMI	Edge Resource Manager Interface
Gbps	Gigabits per second
GPS	Global Positioning System
ITU	International Telecommunications Union
ITU-T	Telecommunication Standardization Sector of the International Telecommunication Union
Kbps	Kilobits per second
LSB	Least Significant Bit
Mbps	Megabits per second
M-CMTS	Modular Cable Modem Termination System
MIB	Management Information Base
MPEG	Moving Picture Experts Group
MPEG-TS	Moving Picture Experts Group Transport Stream
MSB	Most Significant Bit
OSSI	Operations System Support Interface
PHY	Physical Layer
PSP	Packet-Streaming-Protocol
S-CDMA	Synchronous Code Division Multiple Access
SNMP	Simple Network Management Protocol
TBD	To Be Determined (or To Be Deferred)
TSID	MPEG2 Transport Stream ID
ToD	Time of Day
UDP	User Datagram Protocol

5 TECHNICAL OVERVIEW

5.1 Introduction and Overview

This section is informative.

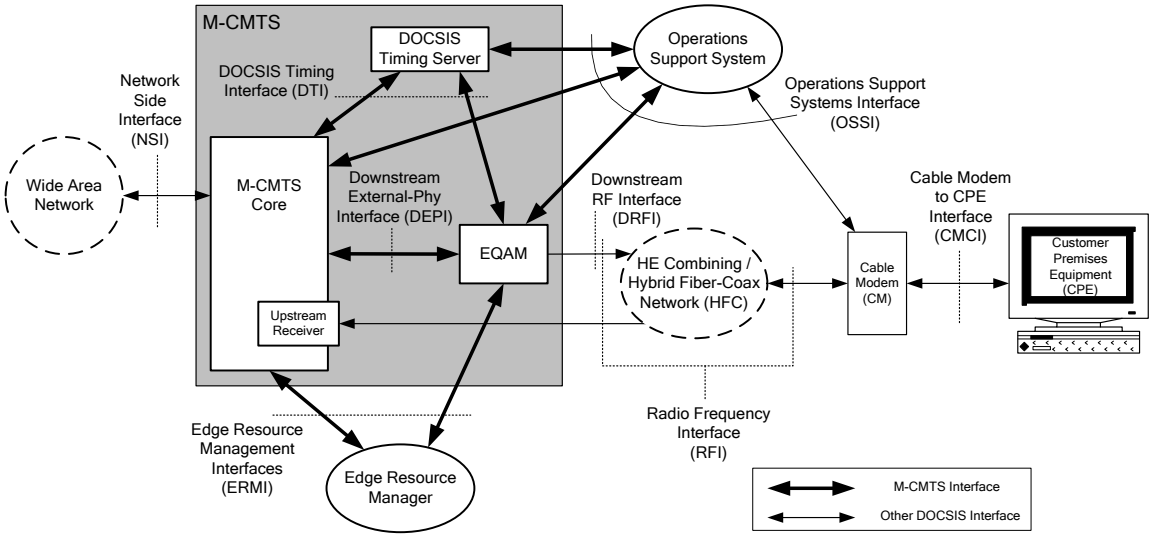


Figure 5–1 - Modular CMTS Reference Architecture

Figure 5–1 depicts the Modular CMTS architecture on which the traditional CMTS system is divided into: the M-CMTS Core and the EQAM device. The M-CMTS Core contains all the traditional DOCSIS CMTS functions, including MAC timing and framing, packet classification, service flow management, and security. The EQAM device performs the RF transmission functions such as modulation and frequency up-conversion for the transmission of Data packets over the HFC. The M-CMTS architecture includes a DOCSIS Timing server to maintain a consistent timing reference between the M-CMTS Core and EQAM, as well as to mitigate the propagation delay differences of these two components. The DOCSIS Timing Interface (DTI) runs between the DTI Server and the M-CMTS and EQAM devices, and is known as the DTI clients.

The EQAM device, as specified by the DOCSIS M-CMTS Interface specifications, is an adaptation of the Video QAM devices used for VoD service. To optimize the resource allocation of DOCSIS QAM channels for DOCSIS and VoD services, the M-CMTS architecture defines a Resource Manager to control the reservation of those QAM (Edge) resources. The Edge Resource Manager (ERM) provides reliable and optimized access to EQAM device resources The ERM interface is designed to manage the resource allocation of various EQAM resources for DOCSIS and VoD activities. In addition, the EQAM device supports a Registration Interface to ERM with the purpose of maintaining an accurate inventory of resources availability in the EQAM devices.

In the absence of ERM, or in a transition from VOD EQAMs only to VOD and DOCSIS QAMs, the M-CMTS architecture offers the option to configure and allocate EQAM resources via the M-CMTS Core by using the Downstream External PHY Interface [DEPI]. DEPI is basically a Layer 2 encapsulation of the DOCSIS traffic for the purpose of transport from the M-CMTS Core to the EQAM device.

The [DRFI] is defined by the M-CMTS architecture for the purpose of gathering all the RF specification requirements from DOCSIS into a standalone specification to be referenced in the future for Modular or integrated CMTS implementations.

Complete details of the M-CMTS interfaces are within their respective specifications, and referenced in Section 1.1.

The Operations Support Systems requirements of the M-CMTS architecture consist of the Management Information Base (MIB), residing in the M-CMTS modules such as M-CMTS Core, EQAM device and DTI Server, with the

purpose of providing configuration, monitoring, and troubleshooting management functions of the M-CMTS interface specifications.

5.2 M-CMTS Core Management Requirements Overview

The M-CMTS Core Management requirements are of two types:

- M-CMTS Core MUST support standard OSSI CMTS requirements, as specified in [OSSI2.0].
- M-CMTS Core MUST support the M-CMTS OSS requirements defined by this specification.

For M-CMTS Core-compliant devices, conflicts of M-CMTS OSSI requirements and OSSI CMTS requirements are resolved by the prevailing M-CMTS OSSI requirements. The M-CMTS Core compliant device MUST support M-CMTS OSSI requirements over OSSI CMTS requirements in case those requirements are in conflict.

M-CMTS OSSI requirements for the M-CMTS Core are summarized below:

- Requirements for Downstream RF Interface Specification [DRFI]
- Requirements for DOCSIS External PHY Interface [DEPI]
- Requirements for DOCSIS Timing Interface [DTI]

5.3 EQAM Device Management Requirements Overview

See [EQAM-PMI].

5.4 DTI Server Management Requirements Overview

The management requirements for the M-CMTS DTI Server-compliant device are specified in this document and summarized as:

- Requirements for DOCSIS Timing Interface [DTI]
- SNMP and Management Information MIB requirements

6 SNMP PROTOCOL

6.1 SNMP Mode for M-CMTS Core

M-CMTS Core has no additional SNMP protocol requirements above those defined in the DOCSIS OSSI specifications.

6.2 SNMP Mode for DTI Server

The DTI Server MUST support SNMPv3 as described by [RFC 3411] through [RFC 3415]. The DTI Server MUST support SNMPv1 and SNMPv2c coexistence mode as described in [RFC 3584].

The DTI Server is not required to support writable configuration via SNMP SETs; therefore, DTI Server MAY support creation, deletion, or modification of SNMPv3 and [RFC 3584] configured parameters.

If the DTI Server does not provide SNMP write access to SNMPv3 and coexistence MIB objects configuration, the DTI Server MUST provide alternative Management interfaces to do so.

7 MANAGEMENT INFORMATION BASE (MIB)

This section defines the minimum set of managed objects required to be supported by M-CMTS entities.

The requirements described in this specification have priority over IETF-defined MIB modules. It includes MIB objects made mandatory in this specification, whereas the IETF standards may have defined them as deprecated, obsolete, or those with optional implementation compliances.

Unless otherwise indicated, IETF deprecated, obsolete, or optional MIB objects that are supported by the M-CMTS Core MUST be implemented correctly according to the MIB module definition.

Unless otherwise indicated, IETF deprecated, obsolete, or optional MIB objects that are supported by the DTI Server MUST be implemented correctly according to the MIB module definition.

If an M-CMTS Core device does not support a deprecated, obsolete, or optional MIB object, the device SNMP Agent MUST NOT instantiate the MIB object and MUST return the corresponding error code on SNMP PDU requests.

If a DTI Server does not support a deprecated, obsolete, or optional MIB object, the device SNMP Agent MUST NOT instantiate the MIB object and MUST return the corresponding error code on SNMP PDU requests.

The following sections provide a detailed summary of the MIB modules applicability for M-CMTS components.

Specific requirements for M-CMTS Core and DTI Server are detailed in Sections 7.3, 8, Annex A, and Annex B. For the case of M-CMTS Core, the requirements described in this specification are in addition and/or replacement of CMTS requirements outlined in the [OSSI2.0] specification.

7.1 IETF Drafts and Other Modules

Table 7–1 - IETF Drafts and Other Modules

Reference	MIB	Applicable Device(s)
[DEPI]	DOCSIS M-CMTS Interface MIB: DOCS-IF-M-CMTS-MIB	CMTS
[DTI]	DOCSIS Time Interface MIB: DTI-MIB	M-CMTS Core and DTI Server
[DRFI]	DOCSIS DRF MIB: DOCS-DRF-MIB	CMTS

7.2 IETF RFC MIB Modules

Table 7–2 - IETF RFC MIB Modules

Reference	MIB	Applicable Device(s)
[RFC 2011]	SNMPv2 Management Information Base for the Internet Protocol using SMIv2: IP-MIB	
[RFC 2863]	The Interfaces Group MIB using SMIv2: IF-MIB	M-CMTS Core and DTI Server
[RFC 3371]	Layer Two Tunneling Protocol "L2TP" Management Information Base RFC 3371, August 2002	M-CMTS Core
[RFC 3410] [RFC 3411] [RFC 3412] [RFC 3413] [RFC 3414] [RFC 3415] [RFC 3584]	SNMP v3 MIBs: SNMP-FRAMEWORK-MIB, SNMP-MPD-MIB, SNMP-NOTIFICATION-MIB, SNMP-TARGET-MIB, SNMP-USER-BASED-SM-MIB, SNMP-VIEW-BASED-ACM-MIB, SNMP-COMMUNITY-MIB	DTI Server
[RFC 3418]	Management Information Base (MIB) for the Simple Network Management Protocol (SNMP): SNMPv2-MIB	DTI Server
[RFC 4133]	Entity MIB: ENTITY-MIB	M-CMTS Core and DTI Server
[RFC 4639]	DOCSIS Cable Device MIB: DOCS-CABLE-DEVICE-MIB	DTI Server

7.3 Managed objects requirements

The following sections detail any additional implementation requirements for the MIB modules listed above. Refer to Annex A for specific object implementation requirements.

The M-CMTS Core and DTI Server -compliant devices MUST support a minimum of 10 available SNMP table rows unless otherwise specified by the corresponding IETF MIB Module document or the corresponding DOCSIS OSSI specification. The minimum number of available SNMP table rows SHOULD mean rows (per table) that are available to support device configuration. M-CMTS Core and DTI Server MUST not count default or static preconfigured row entries as part of the minimum number of available SNMP table rows.

7.3.1 Requirements for DOCS-IF-MIB

7.3.1.1 DOCS-IF-MIB M-CMTS requirements

A compliant M-CMTS Core MAY implement the table docsIfDownstreamChannelTable as read-only and defer the configuration aspects of M-CMTS Downstream interfaces to DOCS-IF-M-CMTS-MIB.

If a compliant M-CMTS Core device supports write access to docsIfDownsteamChannelTable, in the event of a SET operation in one of the writable MIB Objects of this table, the M-CMTS Core MUST update the docsIfMCmtsDepiSessionConfigTable equivalent PHY Parameter and perform the L2TPv3 parameter update signaling from there. The M-CMTS Core may reject the set parameter because the DEPI Control Table was signaled previously that a bit lock has been set for the particular PHY parameter. Thus, M-CMTS MAY reject SNMP Sets to Downstream PHY parameters that were previously signaled as locked without the need to invoke the L2TPv3 request.

If a compliant M-CMTS Core supports write access to docsIfDownsteamChannelTable, the M-CMTS Core MUST use the L2TPv3 connection control plane when instructed to set any writable MIB object in docsIfDownstreamTable. The M-CMTS MUST delay the SNMP PDU response to the SNMP requester entity until the L2TPv3 [RFC 3931] session returns the status of the execution of the SNMP request.

The M-CMTS MUST return the error "NotWritable" if the PHY parameter of the EQAM channel associated with the Downstream Interface is being reported as "locked" by the L2TPv3 Session.

If a compliant M-CMTS Core supports write access to docsIfDownsteamChannelTable, the M-CMTS Core MUST return "CommitFailed" error for a SNMP SET to any writable parameter in the docsIfDownstream Table of a Downstream Interface, with no L2TPv3 Session active.

7.3.2 Requirements for [RFC 4639]

The DTI Server MUST implement the docsDevEventGroup from [RFC 4639] as indicated in Annex A.

7.3.3 Requirements for [RFC 2863]

The Interface MIB [RFC 2863] MUST be implemented by compliant M-CMTS Core and DTI Server, as described in Annex A and A.1.

7.3.3.1 Requirements for M-CMTS Core

7.3.3.1.1 M-CMTS Core Interface Types

To represent the DOCSIS MAC service adaptation to the DEPI PW infrastructure, the logical interfaces M-CMTS Downstream Interface (docsCableMCmtsDownstream) is defined. The equivalent M-CMTS Upstream Interfaces (docsCableMCmtsUpstream) is defined as a term but not specified in the scope of this specification.

To guarantee backward compatibility with the DOCSIS OSSI Management framework and existing MIB Modules (see [OSSI2.0]), the logic association of the CMTS Physical interfaces, as well as the DOCSIS MAC interface IfStackTable hierarchy, is preserved. Table 7–3 shows the differences between the IfIndex for Integrated CMTS and M-CMTS Core implementations. Currently, IANA has not assigned these values, so in the interim period, IfType numbers for docsCableMCmtsDownstream and docsCableMCmtsUPstream Interfaces in M-CMTS-compliant devices, MUST report 'other' for downstream Interface DOCSIS IfType.

Table 7–3 - CMTS and M-CMTS Interfaces

DOCSIS Interface	Integrated CMTS	Modular CMTS
CATV MAC interface	docsCableMacLayer (127)	docsCableMacLayer (127)
CATV downstream channel	docsCableDownstream (128)	docsCableMCmtsDownstream (ifType 229)
CATV upstream interface	docsCableUpStream (129)	docsCableMCmtsUpStream (ifType TBD) - out of scope
CATV upstream logical channel	docsCableUpstreamChannel (205)	docsCableUpstreamChannel (205)

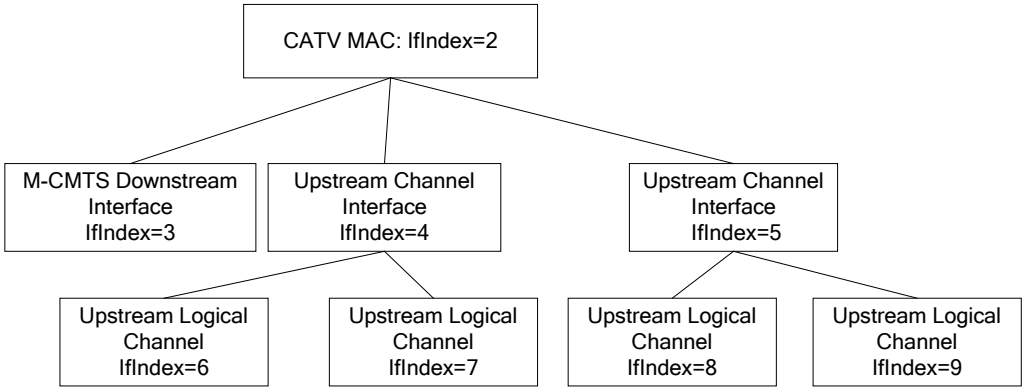
Figure 7–1 depicts the upstream interfaces attached to the M-CMTS Core. There is a possibility that in the future, upstream receivers would be external to the M-CMTS Core, but outside of the scope of this specification.

7.3.3.1.2 Interface organization and numbering

A compliant M-CMTS Core device MUST have an instance of ifEntry for each M-CMTS Downstream Interface. The M-CMTS Core-compliant device MUST include entries in the ifStackTable [RFC 2863] to identify the stack relationships of the M-CMTS Downstream interfaces.

7.3.3.1.3 M-CMTS Core Interface IfStackTable

The M-CMTS Core maintains a similar IfStackTable Structure to that defined in DOCSIS OSSI specifications. Figure 7–1 depicts an example of an M-CMTS Core Interface Stack. In Figure 7–1, the CATV interface has one M-CMTS DS Interface and two US interfaces, each one with two US logical channels.



Implementation of ifStackTable for this example:

ifStackHigherLayer	ifStackLowerLayer
0	2
2	3
2	4
2	5
3	0
4	6
4	7
5	8
5	9
6	0
7	0
8	0
9	0

Figure 7–1 - ifStackTable Example for M-CMTS Core

7.3.3.1.4 M-CMTS Core DOCSIS Interface MIB Considerations

A compliant M-CMTS Core device MUST conform to the Interface requirements from Annex A.1 of this specification.

7.3.3.2 DTI Interface Requirements

7.3.3.2.1 DTI Server Interface Types

The DTI Server MUST support instances of ifEntry for all DTI interfaces. That is, interfaces connecting to the DTI root server and DTI clients.

A compliant M-CMTS Core device MUST support an instance of ifEntry for all the DTI client interfaces residing in the device.

A compliant M-CMTS Core device MUST set the ifType of DTI Interfaces to 'other', and MUST conform to the requirements defined in Annex A of this specification.

A compliant DTI Server device MUST set the ifType of DTI Interfaces to 'other', and MUST conform to the requirements defined in Annex A of this specification.

7.3.3.2.2 Interface organization and numbering

A compliant M-CMTS Core device MUST include entries in the ifStackTable [RFC 2863] for the DTI interfaces.

A compliant DTI Server device MUST include entries in the ifStackTable [RFC 2863] for the DTI interfaces.

7.3.3.2.3 DTI Interface IfStackTable

Compliant DTI Server devices MUST implement the DTI interfaces at the top of the Interface stack with no sub-interfaces. Figure 7–2 depicts an example of the IfStackTable entries corresponding to two DTI interfaces in the DTI Server.

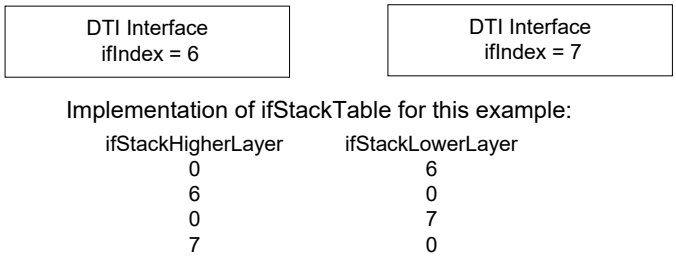


Figure 7–2 - ifStackTable Example for DTI Interfaces

7.3.4 Requirements for [RFC 2011]

A compliant DTI Server MUST support the ipAddrTable from [RFC 2011].

A compliant DTI Server MAY support the ipNetToMediaTable [RFC 2011], although it is unnecessary as an IP Host. DTI has other mechanisms to discover the DTI network topology (see [DTI]).

7.3.5 Requirements for [RFC 3418]

7.3.5.1 The System Group

The DTI-compliant device MUST support the systemGroup of [RFC 3418].

7.3.5.2 MP Group and Notification Group

Compliant DTI Servers MUST support the MIB object snmpEnableAuthenTraps from the snmpGroup and the notifications coldStart and authenticationFailure from the snmpBasicNotificationsGroup of [RFC 3418].

7.3.6 Requirements for DOCS-IF-M-CMTS-MIB

A compliant M-CMTS Core device MUST support the DOCS-IF-M-CMTS-MIB module as described in Annex A.

7.3.7 Requirements for DTI-MIB

A compliant M-CMTS Core device MUST support the DTI-MIB module as described in Annex A.

A compliant EQAM device MUST support the DTI-MIB module as described in Annex A.

A compliant DTI server device MUST support the DTI-MIB module as described in Annex A.

7.3.8 Requirements for [RFC 3371]

The M-CMTS Core MAY implement the groups in the L2TP-MIB.

7.3.8.1 Relationship of DOCS-IF-M-CMTS-MIB and L2TP-MIB

The DOCS-IF-M-CMTS-MIB provides mechanisms for static configuration of DEPI L2TPv3 tunnels as well as providing status information on dynamic DEPI L2TPv3 sessions created by other means such as ERMI [ERMI]. The MIB table docsIfMCmtsDepiSessionConfigTable follows a similar structure of Pseudo Wire (PW) MIB [PW-MIB]. Therefore, the current L2TP-MIB [RFC 3371] reference to the TUNNEL-MIB [RFC 4087] is no longer needed.

The current L2TP-MIB is based on L2TP protocol [RFC 2661] and has not been updated for L2TPv3 Pseudowire framework. As a result, some information and capability developed for L2TPv3 has not been reflected in the MIB. Because of this, the use of the L2TP-MIB [RFC 3371] is not required for a compliant M-CMTS devices.

7.3.9 Requirements for ENTITY-MIB

A compliant M-CMTS Core MAY implement the ENTITY-MIB module as described in Annex A. The formal requirements for the ENTITY-MIB module are in [RFC 4133].

A Compliant DTI server device MUST support the ENTITY-MIB objects as described in Annex A and [RFC 4133]

In particular, the ENTITY-MIB requirements in Annex A include MIB objects from the Entity object groups entityGeneralGroup, entityMappingGroup, entityPhysicalGroup, entityPhysical2Group, and entityPhysical3Group.

A DTI server is not required to implement Logical Management Entities as defined in [RFC 4133]. Therefore, support of MIB objects from entLogical2Group is not required.

A Compliant M-CMTS Core device MAY implement Logical Management Entities, in which case the entLogical2Group MUST be supported.

A Compliant DTI Server device MAY implement Logical Management Entities, in which case the entLogical2Group MUST be supported.

7.3.9.1 IfTable Interfaces and ENTITY MIB physical component

ENTITY-MIB mapping of physical components of Entity PhysicalClass 'port' and ifTable interfaces are completed through the entAliasMappingTable.

A simple example of this mapping is presented in Table 7–4. The example shows QAM channel PhysicalIndex = m to ifIndex = n mapping.

Note: entAliasLogicalIndexOrZero is set to zero to indicate "all" logical entities; including devices with only one Logical Management Entity.

Table 7–4 - Entity Physical Index and IfIndex mapping

entAliasPhysicalIndex QAM channel (PhysicalClass = 'port')	entAliasLogicalIndexOrZero	entAliasMappingIdentifier
m	0	ifIndex.n

7.3.9.2 Implementation of ENTITY MIB for DTI Server

A compliant DTI Server MUST assign the ENTITY-MIB PhysicalClass type of 'port' to DTI ports for ports destined to RootServer and DTI Clients. Other Physical Class types such 'stack,' 'chassis,' 'backplane,' and 'module,' are used as ENTITY-MIB [RFC 4133] describes them.

7.3.9.3 Implementation of ENTITY MIB for M-CMTS Core

In order for a compliant M-CMTS Core to claim support of the DEPI control objects docsIfMCmtsDepiControlCableMacEntDescriptor and docsIfMCmtsDepiControlCableDownEntId, the M-CMTS Core MUST support the ENTITY-MIB Annex A. Specifically, the MIB objects from the Entity object groups: entityGeneralGroup, entityMappingGroup, entityPhysicalGroup, entityPhysical2Group, and entityPhysical3Group, with the exception of entLPPhysicalIndex, which is needed if multiple Logical Management Entities are supported.

7.3.10 Requirements for DOCS-DRF-MIB

A compliant M-CMTS Core device MUST support the DOCS-DRF-MIB module as described in Annex A.

8 FAULT MANAGEMENT

8.1 Event Notification and Control mechanisms

A compliant DTI server device MUST support the Event notification requirements described in sections 7.4.2 and 7.4.3 of the DOCSIS OSSI specification [OSSI2.0].

A compliant DTI server device MUST support the event reporting mechanism defined for DOCSIS-compliant CMTS in [OSSI2.0].

A compliant DTI Server device MUST NOT implement the CM provisioning described in section 7.4.2.3, "Standard DOCSIS events for CMs" in [OSSI2.0].

An M-CMTS Core compliant device MUST support the events described in the event DEPI process, DEPI-CDN sub-process described in [DEPI].

An M-CMTS Core SHOULD support the events in the event DEPI Process, sub-processes L2TP-Stop-CCN and L2TP-CDN.

Annex A Detailed MIB Requirements (normative)

The following abbreviations and rules apply in this Annex:

ACC-FN	Accessible for Notify.
ATRAP	Accessible through SNMP trap.
D	Deprecated. Deprecated objects are optional. That is, a vendor can choose to implement or not implement the object. If a vendor chooses to implement the object, the object MUST be implemented correctly according to the MIB definition. If a vendor chooses not to implement the object, an agent MUST NOT instantiate such object and MUST respond with the appropriate error/exception condition (e.g., no such object for SNMPv2c).
M	Mandatory. The object MUST be implemented correctly according to the MIB definition.
N-Acc	Not accessible. The object is not accessible and is usually an index in a table.
NA	Not Applicable (to the device).
N-Sup	MUST not support. The device MUST NOT support the object. That is, an agent MUST NOT instantiate such object and MUST respond with the appropriate error/exception condition (e.g., no such object for SNMPv2c).
O	Optional. A vendor can choose to implement or not implement the object. If a vendor chooses to implement the object, the object MUST be implemented correctly according to the MIB definition. If a vendor chooses not to implement the object, an agent MUST NOT instantiate such object and MUST respond with the appropriate error/exception condition (e.g., no such object for SNMPv2c).
Ob	Obsolete. It is optional. Though in SNMP convention, obsolete objects should not be implemented, DOCSIS 2.0 OSSI lets vendors choose whether or not to support the obsolete object. That is, a vendor can choose to implement or not implement the object. If a vendor chooses to implement the object, the object MUST be implemented correctly according to the MIB definition. If a vendor chooses not to implement the object, the SNMP agent MUST NOT instantiate such object and MUST respond with the appropriate error/exception condition (e.g., no such object for SNMPv2c).
RC	Read-Create. The access of the object MUST be implemented as Read-Create.
RO	Read-Only. The access of the object MUST be implemented as Read-Only.
RW	Read-Write. The access of the object MUST be implemented as Read-Write.
RC/RO	Read-Create or Read-Only. The access of the object MUST be implemented as either Read-Create or Read-Only as described in the MIB definition.
RW/RO	Read-Write or Read-Only. The access of the object MUST be implemented as either Read-Write or Read-Only as described in the MIB definition.

The table below lists the M-CMTS modules M-CMTS Core and DTI Server Compliance requirements summary.

Table A–1 - Requirements

DOCS-IF-MIB [RFC 4546]		
docsIfDownstreamChannelTable		
Object	**M-CMTS Core**	**Access**
docsIfDownChannelId	M	RW
docsIfDownChannelFrequency	M	RW/RO
docsIfDownChannelWidth	M	RW/RO
docsIfDownChannelModulation	M	RW
docsIfDownChannelInterleave	M	RW
docsIfDownChannelPower	M	RW/RO
docsIfDownChannelAnnex	O	RW/RO
DOCS-IF-M-CMTS-MIB [DEPI]		
docsIfMCmtsCoreDownstreamTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsCoreDownstreamType	D	RO
docsIfMCmtsCoreDownstreamPhyDependencies	D	RO
docsIfMCmtsEqamDownstreamTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsEqamDownstreamTSID	NA	NA
docsIfMCmtsEqamDownstreamPhyDependencies	NA	NA
docsIfMCmtsEqamDownstreamDevicePhyParamLock	NA	NA
docsIfMCmtsEqamDownstreamDeviceConfigPhyParamLock	NA	NA
docsIfMCmtsEqamDownstreamAllocationType	NA	NA
docsIfMCmtsEqamDownstreamAllocationStatus	NA	NA
docsIfMCmtsEqamDownstreamAllocationTimeout	NA	NA
docsIfMCmtsEqamDownstreamDRRPAdvertizing	NA	NA
docsIfMCmtsEqamDownstreamUdpPortMapping	NA	NA
docsIfMCmtsEqamDownstreamCapabilitiesTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsEqamDownstreamCapabFrequency	NA	NA
docsIfMCmtsEqamDownstreamCapabBandwidth	NA	NA
docsIfMCmtsEqamDownstreamCapabPower	NA	NA
docsIfMCmtsEqamDownstreamCapabModulation	NA	NA
docsIfMCmtsEqamDownstreamCapabInterleaver	NA	NA
docsIfMCmtsEqamDownstreamCapabJ83Annex	NA	NA
docsIfMCmtsEqamDownstreamCapabConcurrentServices	NA	NA
docsIfMCmtsEqamDownstreamCapabServicesTransport	NA	NA
docsIfMCmtsEqamDownstreamCapabMuting	NA	NA
docsIfMCmtsEqamGroupDependencyTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsEqamGroupDependencyPhyParam	NA	NA
docsIfMCmtsEqamGroupDependencyPhysicalIndex	NA	NA
docsIfMCmtsEqamGroupDependencyGroupID	NA	NA
docsIfMCmtsEqamGroupDependencyType	NA	NA

docsIfMCmtsEqamGlobCfgDownTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsEqamGlobCfgDownIndex	NA	NA
docsIfMCmtsEqamGlobCfgDownPhysicalIndex	NA	NA
docsIfMCmtsEqamGlobCfgDownBandwidth	NA	NA
docsIfMCmtsEqamGlobCfgDownPower	NA	NA
docsIfMCmtsEqamGlobCfgDownModulation	NA	NA
docsIfMCmtsEqamGlobCfgDownInterleave	NA	NA
docsIfMCmtsEqamGlogCfgDownAnnex	NA	NA
docsIfMCmtsEqamGlobCfgDownSymbolRateM	NA	NA
docsIfMCmtsEqamGlobCfgDownSymbolRateN	NA	NA
docsIfMCmtsEqamGlobCfgDownLockParams	NA	NA
docsIfMCmtsEqamGlobCfgDownExecutionCode	NA	NA
docsIfMCmtsEqamGlobCfgDownErrorsCount	NA	NA
docsIfMCmtsEqamGlobCfgDownRowStatus	NA	NA
docsIfMCmtsChannelBlockTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsChannelBlockPhysicalIndex	NA	NA
docsIfMCmtsChannelBlockNumberChannels	NA	NA
docsIfMCmtsChannelBlockCfgNumberChannels	NA	NA
docsIfMCmtsChannelBlockMute	NA	NA
docsIfMCmtsChannelBlockTestType	NA	NA
docsIfMCmtsChannelBlockTestIfIndex	NA	NA
docsIfMCmtsDepiSessionConfigTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsDepiSessionConfigIndex	M	N-Acc
docsIfMCmtsDepiSessionConfigCableMacIfIndex	M	RO
docsIfMCmtsDepiSessionConfigCableDownfIndex	M	RC
docsIfMCmtsDepiSessionConfigAddrType	M	RC
docsIfMCmtsDepiSessionConfigLocalAddr	M	RC
docsIfMCmtsDepiSessionConfigRemoteAddr	M	RC
docsIfMCmtsDepiSessionConfigL2TPv3HeaderType	M	RC
docsIfMCmtsDepiSessionConfigMethod	M	RC
docsIfMCmtsDepiSessionConfigTSID	M	RC
docsIfMCmtsDepiSessionConfigDEPIMode	M	RC
docsIfMCmtsDepiSessionConfigRsrcAllocReq	M	RC
docsIfMCmtsDepiSessionConfigCinPhbIdPolicy	M	RC
docsIfMCmtsDepiSessionConfigSyncEnabled	M	RC
docsIfMCmtsDepiSessionConfigSyncInterval	M	RC
docsIfMCmtsDepiSessionConfigPhyParamsFlag	M	RC
docsIfMCmtsDepiSessionConfigChannelFrequency	M	RC
docsIfMCmtsDepiSessionConfigChannelModulation	M	RC
docsIfMCmtsDepiSessionConfigChannelInterleave	M	RC
docsIfMCmtsDepiSessionConfigChannelPower	M	RC
docsIfMCmtsDepiSessionConfigChannelAnnex	M	RC
docsIfMCmtsDepiSessionConfigChannelSymbolRateM	M	RC
docsIfMCmtsDepiSessionConfigChannelSymbolRateN	M	RC
docsIfMCmtsDepiSessionConfigChannelOutputRate	M	RC
docsIfMCmtsDepiSessionConfigChannelBurstSize	M	RC
docsIfMCmtsDepiSessionConfigStorage	M	RC
docsIfMCmtsDepiSessionConfigRowStatus	M	RC
docsIfMCmtsDepiSessionConfigChannelId	M	RC

docsIfMCmtsDepiSessionInfoTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsDepiSessionInfoCfgIndex	M	RO
docsIfMCmtsDepiSessionInfoUdpPort	M	RO
docsIfMCmtsDepiSessionInfoMaxPayload	M	RO
docsIfMCmtsDepiSessionInfoPathPayload	M	RO
docsIfMCmtsDepiSessionInfoIncludeDOCSISMsgs	M	RO
docsIfMCmtsDepiSessionInfoRsrcAllocResp	M	RO
docsIfMCmtsDepiSessionInfoConnCtrlID	M	RO
docsIfMCmtsDepiSessionInfoEQAMSessionID	M	RO
docsIfMCmtsDepiSessionInfoOwner	M	RO
docsIfMCmtsDepiSessionInfoState	M	RO
docsIfMCmtsDepiSessionInfoErrorCode	M	RO
docsIfMCmtsDepiSessionInfoCreationTime	M	RO
docsIfMCmtsDepiSessionInfoStorage	M	RO
docsIfMCmtsDepiRsrcAllocTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsDepiRsrcAllocIndex	M	RC
docsIfMCmtsDepiRsrcAllocSeq	M	RC
docsIfMCmtsDepiRsrcAllocPhbId	M	RC
docsIfMCmtsDepiRsrcAllocFlowId	M	RC
docsIfMCmtsDepiRsrcAllocUdpPort	M	RC
docsIfMCmtsDepiRsrcAllocPolicyScnTags	M	RC
docsIfMCmtsDepiRsrcAllocStorage	M	RC
docsIfMCmtsDepiRsrcAllocRowStatus	M	RC
docsIfMCmtsDepiSessionStatsTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsDepiSessionInfoOutOfSequencePkts	NA	NA
docsIfMCmtsDepiSessionCinLatency		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsDepiSessionCinLatencyInterval	M	RW
docsIfMCmtsDepiSessionCinLatencyThrshId	M	RW
docsIfMCmtsDepiSessionCinEventLevel	M	RW
docsIfMCmtsDepiSessionCinLastValue	M	RO
docsIfMCmtsDepiSessionCinLastValueIfIndex	M	RO
docsIfMCmtsDepiSessionCinLatencyValueLastTime	M	RO
docsIfMCmtsDepiSessionCinLatency		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsDepiSessionCinLatencyPerfIntervalSeq	M	RO
docsIfMCmtsDepiSessionCinLatencyPerfValue	M	RO
docsIfMCmtsDepiSessionCinLatencyTime	M	RO

docsIfMCmtsDepiPhbPolicyTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsDepiPhbPolicyTag	M	N-Acc
docsIfMCmtsDepiPhbPolicySCN	M	RC
docsIfMCmtsDepiPhbPolicyCinPhbId	M	RC
docsIfMCmtsDepiPhbPolicyStorage	M	RC
docsIfMCmtsDepiPhbPolicyRowStatus	M	RC

docsIfMCmtsQosServiceFlowExtTable

Object	M-CMTS Core	Access
docsIfMCmtsQosServiceFlowExtDepiFlowId	M	RO
docsIfMCmtsQosServiceFlowExtCinPhbId	M	RO
docsIfMCmtsQosServiceFlowExtDepiIfIndex	M	RO

DTI-MIB [DTI]

dtiProtocolTable

Object	M-CMTS Core	Access	DTI Server	Access
dtiProtocolEntityType	M	RO	M	RO
dtiProtocolClientClockType	M	RO	M	RO
dtiProtocolServerStatusFlag	M	RO	M	RO
dtiProtocolClientStatusFlag	M	RO	M	RO
dtiProtocolServerToDState	M	RO	M	RO
dtiProtocolServerToDType	M	RO	M	RO
dtiProtocolServerToDValue	M	RO	M	RO
dtiProtocolServerCableAdvanceFlag	M	RO	M	RO
dtiProtocolServerCableAdvanceValue	M	RW	M	RO
dtiProtocolClientPhaseError	M	RO	M	RO
dtiProtocolClientVersion	M	RO	M	RO
dtiProtocolClientPathTraceability	M	RO	M	RO

dtiProtocolControlTable

Object	M-CMTS Core	Access	DTI Server	Access
dtiProtocolControlTimeInterval	NA	NA	M	RW
dtiProtocolControlErrorRateInterval	M	RW/RO	M	RW
dtiProtocolControlJitterTimeInterval	NA	NA	M	RW
dtiProtocolControlTestMode	NA	NA	M	RW
dtiProtocolControlToDValue	NA	NA	M	RW

dtiProtocolPerformanceTable

Object	M-CMTS Core	Access	DTI Server	Access
dtiProtocolPerformanceDelay	NA	NA	M	RO
dtiProtocolPerformanceFrameErrorRate	M	RO	M	RO
dtiProtocolPerformancePeakToPeakJitter	NA	NA	M	RO
dtiProtocolPerformanceWander35Second	NA	NA	M	RO
dtiProtocolPerformanceWanderTSeconds	NA	NA	M	RO
dtiProtocolPerformanceFrameErrorRateScale	M	RO	M	RO

dtiPathTraceabilityTable

Object	M-CMTS Core	Access	DTI Server	Access
dtiPathTraceabilityIndex	M	RO	M	RO
dtiPathTraceabilityRootServerInetAddrType	M	RO	M	RO
dtiPathTraceabilityRootServerInetAddr	M	RO	M	RO
dtiPathTraceabilityRootServerOutPhyIdx	M	RO	M	RO
dtiPathTraceabilityServerInetAddrType	M	RO	M	RO
dtiPathTraceabilityServerInetAddr	M	RO	M	RO
dtiPathTraceabilityServerOutPhyIdx	M	RO	M	RO
dtiPathTraceabilityRootServerProtVersion	M	RO	M	RO
dtiPathTraceabilityServerProtVersion	M	RO	M	RO

dtiProtocolClientFsmStatsTable				
Object	**M-CMTS Core**	**Access**	**DTI Server**	**Access**
dtiProtocolClientFsmStatsT3Count	M	RO	M	RO
dtiProtocolClientFsmStatsT4Count	M	RO	M	RO
dtiProtocolClientFsmStatsT6Count	M	RO	M	RO
dtiProtocolClientFsmStatsT7Count	M	RO	M	RO
dtiProtocolClientFsmStatsNormalActiveTime	M	RO	M	RO
dtiProtocolClientFsmStatsHoldoverActiveTime	M	RO	M	RO
dtiServerProperties				
Object	**M-CMTS Core**	**Access**	**DTI Server**	**Access**
dtiServerRootClockType	NA	NA	M	RO
dtiServerHopCount	NA	NA	M	RO
dtiServerExternalTimingSource	NA	NA	M	RO
dtiServerToDSources	NA	NA	M	RO
dtiServerGlobalParameters				
Object	**M-CMTS Core**	**Access**	**DTI Server**	**Access**
dtiServerGlobalTimeInterval	NA	NA	M	RW
dtiServerGlobalErrorRateInterval	NA	NA	M	RW
dtiServerGlobalJitterTimeInterval	NA	NA	M	RW
dtiServerGlobalToDMethod	NA	NA	M	RW
dtiServerGlobalToDValue	NA	NA	M	RW
DOCS-CABLE-DEVICE-MIB [RFC 4639]				
docsDevEventGroup				
Objects			**DTI Server**	**Access**
docsDevEvControl			M	RW
docsDevEvSyslog			M	RW
docsDevEvThrottleAdminStatus			M	RW
docsDevEvThrottleInhibited			M	RW
docsDevEvThrottleThreshold			M	RW
docsDevEvThrottleInterval			M	RW
docsDevEvControlTable				
Objects			**DTI Server**	**Access**
docsDevEvPriority			M	N-Acc
docsDevEvReporting			M	RW
docsDevEvControlTable				
Objects			**DTI Server**	**Access**
docsDevEvIndex			M	N-Acc
docsDevEvFirstTime			M	RO
docsDevEvLastTime			M	RO
docsDevEvCounts			M	RO
docsDevEvLevel			M	RO
docsDevEvId			M	RO
docsDevEvText			M	RO

IF-MIB [RFC 2863]

interfaces

Object	M-CMTS Core	Access	DTI Server	Access
ifNumber	M	RO	M	RO
ifTableLastChange	M	RO	M	RO

ifTable

Object	DTI Server	Access
ifIndex	M	RO
ifDescr	M	RO
ifType	M	RO
ifMtu	M	RO
ifSpeed	M	RO
ifPhysAddress	M	RO
ifAdminStatus	M	RO
ifOperStatus	M	RO
ifLastChange	M	RO
ifInOctets	N-Sup	NA
ifInUcastPkts	M	RO
ifInNUcastPkts	N-Sup	NA
ifInDiscards	N-Sup	NA
ifInErrors	M	RO
ifInUnknownProtos	N-Sup	NA
ifOutOctets	N-Sup	NA
ifOutUcastPkts	M	RO
ifOutNUcastPkts	N-Sup	NA
ifOutDiscards	N-Sup	NA
ifOutErrors	M	RO
ifOutQLen	N-Sup	NA
ifSpecific	N-Sup	NA

ifStackTable

Object	DTI Server	Access
ifStackHigherLayer	M	N-Acc
ifStackLowerLayer	M	N-Acc
ifStackStatus	M	RC/RO

ifMIBObjects

Object	DTI Server	Access
ifStackLastChange	M	RC/RO

snmpTraps

Notification	DTI Server	Access
linkup	M	
linkDown	M	

ENTITY-MIB [RFC 4133]

entPhysicalTable

Object	M-CMTS Core	Access	DTI Server	Access
entPhysicalIndex	O	N-Acc	O	N-Acc
entPhysicalDescr	O	RO	M	RO
entPhysicalVendorType	O	RO	M	RO
entPhysicalContainedIn	O	RO	M	RO
entPhysicalClass	O	RO	M	RO
entPhysicalParentRelPos	O	RO	M	RO
entPhysicalName	O	RO	M	RO
entPhysicalHardwareRev	O	RO	M	RO
entPhysicalFirmwareRev	O	RO	M	RO
entPhysicalSoftwareRev	O	RO	M	RO
entPhysicalSerialNum	O	RW/RO	M	RW/RO
entPhysicalMfgName	O	RO	M	RO
entPhysicalModelName	O	RO	M	RO
entPhysicalAlias	O	RW/RO	M	RW/RO
entPhysicalAssetID	O	RW/RO	M	RW/RO
entPhysicalIsFRU	O	RO	M	RO
entPhysicalMfgDate	O	RO	M	RO
entPhysicalUris	O	RW/RO	M	RW/RO

entAliasMappingTable

Object	M-CMTS Core	Access	DTI Server	Access
entAliasLogicalIndexOrZero	O	N-Acc	O	N-Acc
entAliasMappingIdentifier	O	RO	M	RO

entPhysicalContainsTable

Object	M-CMTS Core	Access	DTI Server	Access
entPhysicalChildIndex	O	RO	M	RO

SNMPv2-MIB [RFC 3418]

System Group

Objects	DTI Server	Access
sysDescr	M	RO
sysObjectID	M	RO
sysUpTime	M	RO
sysContact	M	RW
sysName	M	RW
sysLocation	M	RW
sysServices	M	RO
sysORLastChange	M	RO

sysORTable

Objects	DTI Server	Access
sysORIndex	M	N-Acc
sysORID	M	RO
sysORDescr	M	RO
sysORUpTime	M	RO

SNMP Group

Objects	DTI Server	Access
snmpEnableAuthenTraps	M	RW

IP-MIB [RFC 2011]		
ipAddrTable		
Objects	**DTI Server**	**Access**
ipAdEntAddr	M	RO
ipAdEntIfIndex	M	RO
ipAdEntNetMask	M	RO
ipAdEntBcastAddr	M	RO
ipAdEntReasmMaxSize	M	RO
IpNetToMediaTable		
Objects	**DTI Server**	**Access**
ipNetToMediaIfIndex	O	RC/RO
ipNetToMediaPhysAddress	O	RC/RO
ipNetToMediaNetAddress	O	RC/RO
ipNetToMediaType	O	RC/RO
SNMP-VIEW-BASED-ACM-MIB [RFC 3415]		
vacmContextTable		
Objects	**DTI Server**	**Access**
vacmContextName	M	RO
vacmSecurityToGroupTable		
Objects	**DTI Server**	**Access**
vacmSecurityModel	M	N-Acc
vacmSecurityName	M	N-Acc
vacmGroupName	M	RC/RO
vacmSecurityToGroupStorageType	M	RC/RO
vacmSecurityToGroupStatus	M	RC/RO
vacmAccessTable		
Objects	**DTI Server**	**Access**
vacmAccessContextPrefix	M	N-Acc
vacmAccessSecurityModel	M	N-Acc
vacmAccessSecurityLevel	M	N-Acc
vacmAccessContextMatch	M	RC/RO
vacmAccessReadViewName	M	RC/RO
vacmAccessWriteViewName	M	RC/RO
vacmAccessNotifyViewName	M	RC/RO
vacmAccessStorageType	M	RC/RO
vacmAccessStatus	M	RC/RO
vacmViewSpinLock	M	RW/RO
vacmViewTreeFamilyTable		
Objects	**DTI Server**	**Access**
vacmViewTreeFamilyViewName	M	N-Acc
vacmViewTreeFamilySubtree	M	N-Acc
vacmViewTreeFamilyMask	M	RC/RO
vacmViewTreeFamilyType	M	RC/RO
vacmViewTreeFamilyStorageType	M	RC/RO
vacmViewTreeFamilyStatus	M	RC/RO

SNMP-COMMUNITY-MIB [RFC 3584]		
snmpCommunityTable		
Objects	**DTI Server**	**Access**
snmpCommunityIndex	M	N-Acc
snmpCommunityName	M	RC/RO
snmpCommunitySecurityName	M	RC/RO
snmpCommunityContextEngineID	M	RC/RO
snmpCommunityContextName	M	RC/RO
snmpCommunityTransportTag	M	RC/RO
snmpCommunityStorageType	M	RC/RO
snmpCommunityStatus	M	RC/RO
snmpTargetExtTable		
Objects	**DTI Server**	**Access**
snmpTargetAddrTMask	M	RC/RO
snmpTargetAddrMMS	M	RC/RO
snmpTrapAddress	O	ACC-FN
snmpTrapCommunity	O	ACC-FN
SNMP Management Framework architecture [RFC 3411]		
snmpEngine Group		
Objects	**DTI Server**	**Access**
snmpEngineID	M	RO
snmpEngineBoots	M	RO
snmpEngineTime	M	RO
snmpEngineMaxMessageSize	M	RO
SNMP Message Processing and Dispatching MIB [RFC 3412]		
snmpMPDStats		
Objects	**DTI Server**	**Access**
snmpUnknownSecurityModels	M	RO
snmpInvalidMsgs	M	RO
snmpUnknownPDUHandlers	M	RO
SNMP Applications [RFC 3413]		
Objects	**DTI Server**	**Access**
snmpTargetSpinLock	M	RW/RO
snmpTargetAddrTable		
Objects	**DTI Server**	**Access**
snmpTargetAddrName	M	N-Acc
snmpTargetAddrTDomain	M	RC/RO
snmpTargetAddrTAddress	M	RC/RO
snmpTargetAddrTimeout	M	RC/RO
snmpTargetAddrRetryCount	M	RC/RO
snmpTargetAddrTagList	M	RC/RO
snmpTargetAddrParams	M	RC/RO
snmpTargetAddrStorageType	M	RC/RO
snmpTargetAddrRowStatus	M	RC/RO

snmpTargetParamsTable		
Objects	**DTI Server**	**Access**
snmpTargetParamsName	M	N-Acc
snmpTargetParamsMPModel	M	RC/RO
snmpTargetParamsSecurityModel	M	RC/RO
snmpTargetParamsSecurityName	M	RC/RO
snmpTargetParamsSecurityLevel	M	RC/RO
snmpTargetParamsStorageType	M	RC/RO
snmpTargetParamsRowStatus	M	RC/RO
snmpUnavailableContexts	M	RC/RO
snmpUnknownContexts	M	RC/RO
snmpNotifyTable		
Objects	**DTI Server**	**Access**
snmpNotifyName	M	N-Acc
snmpNotifyTag	M	RC/RO
snmpNotifyType	M	RC/RO
snmpNotifyStorageType	M	RC/RO
snmpNotifyRowStatus	M	RC/RO
snmpNotifyFilterProfileTable		
Objects	**DTI Server**	**Access**
snmpNotifyFilterProfileName	M	RC/RO
snmpNotifyFilterProfileStorType	M	RC/RO
snmpNotifyFilterProfileRowStatus	M	RC/RO
snmpNotifyFilterTable		
Objects	**DTI Server**	**Access**
snmpNotifyFilterSubtree	M	N-Acc
snmpNotifyFilterMask	M	RC/RO
snmpNotifyFilterType	M	RC/RO
snmpNotifyFilterStorageType	M	RC/RO
snmpNotifyFilterRowStatus	M	RC/RO
SNMP-USER-BASED-SM-MIB [RFC 3414]		
usmStats		
Objects	**DTI Server**	**Access**
usmStatsUnsupportedSecLevels	M	RO
usmStatsNotInTimeWindows	M	RO
usmStatsUnknownUserNames	M	RO
usmStatsUnknownEngineIDs	M	RO
usmStatsWrongDigests	M	RO
usmStatsDecryptionErrors	M	RO
usmUser		
Objects	**DTI Server**	**Access**
usmUserSpinLock	M	RW/RO

usmUserTable		
Objects	**DTI Server**	**Access**
usmUserEngineID	M	N-Acc
usmUserName	M	N-Acc
usmUserSecurityName	M	RC/RO
usmUserCloneFrom	M	RC/RO
usmUserAuthProtocol	M	RC/RO
usmUserAuthKeyChange	M	RC/RO
usmUserOwnAuthKeyChange	M	RC/RO
usmUserPrivProtocol	M	RC/RO
usmUserPrivKeyChange	M	RC/RO
usmUserOwnPrivKeyChange	M	RC/RO
usmUserPublic	M	RC/RO
usmUserStorageType	M	RC/RO
DOCS-DRF-MIB		
docsDrfDownstreamTable		
Object	**M-CMTS Core**	**Access**
docsDrfDownstreamPhyDependencies	M	RO
docsDrfDownstreamCapabilitiesTable		
Object	**M-CMTS Core**	**Access**
docsIfMCmtsEqamDownstreamCapabFrequency	NA	NA
docsIfMCmtsEqamDownstreamCapabBandwidth	NA	NA
docsIfMCmtsEqamDownstreamCapabPower	NA	NA
docsIfMCmtsEqamDownstreamCapabModulation	NA	NA
docsIfMCmtsEqamDownstreamCapabInterleaver	NA	NA
docsIfMCmtsEqamDownstreamCapabJ83Annex	NA	NA
docsIfMCmtsEqamDownstreamCapabConcurrentServices	NA	NA
docsIfMCmtsEqamDownstreamCapabServicesTransport	NA	NA
docsIfMCmtsEqamDownstreamCapabMuting	NA	NA
docsDrfGroupDependencyTable		
Object	**M-CMTS Core**	**Access**
docsDrfGroupDependencyPhyParam	NA	NA
docsDrfGroupDependencyPhysicalIndex	NA	NA
docsDrfGroupDependencyGroupID	NA	NA
docsDrfGroupDependencyType	NA	NA
docsDrfChannelBlockTable		
Object	**M-CMTS Core**	**Access**
docsDrfChannelBlockPhysicalIndex	NA	NA
docsDrfChannelBlockNumberChannels	NA	NA
docsDrfChannelBlockCfgNumberChannels	NA	NA
docsDrfChannelBlockMute	NA	NA
docsDrfChannelBlockTestType	NA	NA
docsDrfChannelBlockTestIfIndex	NA	NA

A.1 IF-MIB ifTable MIB-Object details

Table A–2 - IF-MIB ifTable MIB-Object details

IF-MIB Object details for Cable Device using 1000 Mbps Ethernet	M-CMTS Core NSI Ethernet-100/1000	CMTS-Downstream M-CMTS Core, M-CMTS EQAM	EQAM GigE	DTI/ M-CMTS/ EQAM Client
ifIndex	(n)	(n)	(n)	(n)
ifType	6	229	6	other(1)
ifSpeed	100,000,000 - 1000,000,000	~64-QAM=30,341,646 ~256-QAM=42,884,296	1000,000,000	5,000,000
ifHighSpeed	100- 1000	~64-QAM=30 ~256-QAM=43	1000	5
ifPhysAddress	Eth MAC	Empty-String	Eth MAC	Empty-String
ifAdminStatus	Up(1), Down(2), Testing(3)	Up(1), Down(2), Testing(3)	Up(1), Down(2), Testing(3)	Up(1), Down(2), Testing(3)
ifOperStatus	Up(1), Down(2), Testing(3), Dormant(5), notPresent(6)	Up(1), Down(2), Testing(3), Dormant(5), notPresent(6)	Up(1), Down(2), Testing(3), Dormant(5), notPresent(6)	Up(1), Down(2), Testing(3), Dormant(5), notPresent(6)
ifMtu	1500	1464, (n)	1500, (n)	256
ifInOctets	(n)	0	(n)	(n)
ifHCInOctets	(n)	0	(n)	(n)
ifOutOctets	(n)	(n)	(n)	(n)
ifHCOutOctets	(n)	(n)	(n)	(n)
ifInUcastPkts	(n)	0	(n)	(n)
ifHCInUcastPkts	(n)	0	(n)	(n)
ifInMulticastPkts	(n)	0	(n)	(n)
ifHCInMulticastPkts	(n)	0	(n)	(n)
ifInBroadcastPkts	(n)	0	(n)	(n)
ifHCInBroadcastPkts	(n)	0	(n)	(n)
ifInDiscards	(n)	0	(n)	(n)
ifInErrors	(n)	0	(n)	(n)
ifInUnknownProtos	(n)	0	(n)	(n)
ifOutUcastPkts	(n)	(n)	(n)	(n)
ifHCOutUcastPkts	(n)	(n)	(n)	(n)
ifOutMulticastPkts	(n)	(n)	(n)	(n)
ifHCOutMulticastPkts	(n)	(n)	(n)	(n)
ifOutBroadcastPkts	(n)	(n)	(n)	(n)
ifHCOutBroadcastPkts	(n)	(n)	(n)	(n)
ifOutDiscards	(n)	(n)	(n)	(n)
ifOutErrors	(n)	(n)	(n)	(n)
ifPromiscuousMode	True(1), false(2)	True(1), false(2)	True(1), false(2)	True(1), false(2)

Annex B Format and Content for Event, SYSLOG, and SNMP Trap (normative)

This annex contains management events for detection of failures or operational condition changes of relevance for the Modular CMTS architecture.

B.1 M-CMTS Extensions Description

This section applies to an M-CMTS-compliant device and is an extension to the OSS event management requirements specified in Annex D, Format and Content for Event, SYSLOG, and SNMP Trap (normative) of [OSSI2.0]. Events in this list are applicable to M-CMTS Core and/or DTI Server, as detailed in Section B.2.

B.2 M-CMTS Devices Event Extensions

There are no currently defined events.