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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>

Note: Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time.
The list of current Internet-Drafts can be accessed at <http://www.ietf.org/ietf/1id-abstracts.txt>.
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 $\text{dB} = 10\log_{10}(P_{\text{OUT}}/P_{\text{IN}})$.
Decibel-Millivolt (dBmV)	Unit of RF power expressed in decibels relative to 1 millivolt over 75 ohms, where $\text{dBmV} = 20\log_{10}(\text{value in mV}/1 \text{ mV})$.
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.