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Integrated broadband cable telecommunication networks (CABLE); Cabinet DOCSIS (C-DOCSIS) System Specification

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Foreword

This final draft ETSI Standard (ES) has been produced by ETSI Technical Committee Integrated broadband cable telecommunication networks (CABLE) and is now submitted for the ETSI standards Membership Approval Procedure.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**may not**", "**need**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

The present document describes a method for distributed deployment and centralized control of a DOCSIS cable broadband access system in which the cable network equipment is used in a plant where fibre is run to the cabinet (e.g. in the basement of a customer's multiple dwelling unit) and coax to each customer. This architecture is collectively referred to as Cabinet DOCSIS or "C-DOCSIS". It has been developed to meet the operability and manageability requirements for cable networks that offer a variety of high-bandwidth services and provide QoS guarantees for these services in a distributed architecture. This architecture applies to the operations, administration and management (OAM) of cable broadband access networks.

The present document defines optional implementation architectures for CMTS equipment intended for use in distributed deployments. It defines the functional modules within the CMTS, three different system architectures utilizing the functional modules and the data and control interfaces between these modules for each of those architectures. It also defines general device requirements for the different distributed CMTS architectures.

The present document corresponds to the CableLabs C-DOCSIS specification [i.4].

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2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] IEEE Std 802.1Q (August 2011): "IEEE Standard for Local and metropolitan area networks - Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks".

[2] CableLabs DHCP Options Registry: "CL-SP-CANN-DHCP-Reg-I10-130808", August 8, 2013, Cable Television Laboratories, Inc.

[3] Control Point Discovery Interface Specification: "PKT-SP-CPD-C01-140314", March 14, 2014, Cable Television Laboratories, Inc.

[4] ETSI TS 101 909-5: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 5: Dynamic Quality of Service for the Provision of Real Time Services over Cable Television Networks using Cable Modems".

[5] ETSI EN 302 878-3: "Access, Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 3: Downstream Radio Frequency Interface; DOCSIS 3.0".

[6] ETSI TS 102 879: "Access, Terminals, Transmission and Multiplexing (ATTM); IPCablecom Services for delivering multimedia and voice over DOCSIS network infrastructure".

[7] ETSI EN 302 878-4: "Access, Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 4: MAC and Upper Layer Protocols; DOCSIS 3.0".

[8] ETSI EN 302 878-2: "Access, Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 2: Physical Layer; DOCSIS 3.0".

[9] IETF RFC 2236: "Internet Group Management Protocol", Version 2", November 1997.

[10] IETF RFC 2710: "Multicast Listener Discovery (MLD) for IPv6", October 1999.

[11] IETF RFC 2748: "The COPS (Common Open Policy Service) Protocol".

[12] IETF RFC 3376: "Internet Group Management Protocol, Version 3".

[13] IETF RFC 3810: "Multicast Listener Discovery Version 2 (MLDv2) for IPv6", June 2004.

[14] ETSI EN 302 878-5: "Access, Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 5: Security Services; DOCSIS 3.0".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] IEEE Std 802.3-2012: "IEEE Standard for Ethernet, Section Five".

[i.2] IETF RFC 791/STD0005: "Internet Protocol". J. Postel. September 1981.

[i.3] IEFT RFC 793/STD0007: "Transmission Control Protocol". J. Postel. September 1981.

[i.4] Cable Television Laboratories: "Inc. C-DOCSIS System Specification, CM-SP-CDOCSIS-I01-140829", August 29, 2014.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Access Control: process for connecting CMCs and controlling data communication

NOTE: Used to control the cable modems defined in the present document to access networks.

aggregation and forwarding: an aggregation network device, such as a PON optical line terminal (OLT), a router, or a switch, receives data from CMCs and forwards the data to different uplinks for transmission based on the preset QoS priorities

CDMM: used for exchanging configurations, status and management information between the system control module and the radio frequency interface (RFI) module

C-DOCSIS CM: cable modem that complies with the requirements of DOCSIS 3.0

NOTE: See [5], [7], [8] and [14].

C-DOCSIS CMTS: CMTS that complies with the CMTS requirements of DOCSIS 3.0

NOTE 1: See [5], [7], [8] and [14].

NOTE 2: In the context of the present document, it consists of a CMC Controller and a CMC or multiple CMCs operating together.

C-DOCSIS Data Tags (CDTs): used to identify a service flow to which each data packet belongs

C-DOCSIS System: method for distributed deployment and centralized control of a DOCSIS cable broadband access system

NOTE: The C-DOCSIS system consists of the CMC Controller, CMC and CMs. It implements broadband data access and forwarding, service configuration, as well as management and maintenance of coaxial cable networks. It is synonymous with the term "distributed system architecture" which separates and distributes the components of a CMTS in the various parts of the HFC network.

classified mapping: mapping process during which data packets are classified according to preset rules, CDTs are added to the Ethernet frame header of the data packets to identify the service flows to which they belong and the classified forwarding module maps the CDTs to the service flags, such as service VLAN (S-VLAN), IP ToS and EPON Logical Link ID (LLID), supported by the aggregation network

CMC controller: forwards upstream and downstream service data and manages the configuration of the Cable Media Converter

Coax Media Converter (CMC): converts data from a coaxial cable network to a digital optical packet network (such as PON or Ethernet)

NOTE: The CMC connects to a cable modem through the coaxial cable network in the downstream direction and to the CMC Controller through the digital optical packet network in the upstream direction.

data encapsulation and decapsulation: data processing method for converting data from one format to another where the conversion is implemented by adding or deleting data for identification in the header or tail of the original data packets

Dynamic QoS (DQoS): Quality of Service mechanism which dynamically creates, modifies and deletes DOCSIS service flows based on call signalling to ensure the QoS for multimedia sessions, such as voice sessions

NOTE: With this mechanism, the system provides guaranteed bandwidth resources during a session and releases the resources when the session ends.

management control: process for CMC Controllers and CMCs to manage the access, data, status and configurations of CMCs and CMs

NOTE: The management control is based on the network architecture in distributed deployment mode defined in the present document.

physical framing: process of collating data according to the fixed data encapsulation format to meet the requirements of data transmission on the physical layer

service flow: transmits services at the MAC layer

NOTE: The system shapes and polices traffic and classifies traffic priorities based on QoS parameters defined in the service flow.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ATDMA	Advanced Time Division Multiple Access
BPI+	Baseline Privacy Interface Plus
BPKM	Baseline Privacy Key Management
CCI	Control and Classifier Interface
CDMM	C-DOCSIS Management Message
C-DOCSIS	Cabinet DOCSIS

CDT	C-DOCSIS Data Tag
CFI	Canonical Format Indicator
CLI	Command Line Interface
CM	Cable Modem
CMC	Coax Media Converter
CMTS	Cable Modem Termination System
COPS	Common Open Policy Service
CoS	Class of Service
CPD	Control Point Discovery
CPE	Consumer Premises Equipment
CRC	Cyclic Redundancy Check
DEPI	Downstream External PHY Interface
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DOCSIS	Data-over-Cable Service Interface Specification
DQoS	Dynamic QoS
DS	Downstream
DSA	Dynamic Service Addition
DSC	Dynamic Service Change
DSD	Dynamic Service Deletion
DSID	Downstream Service Identifier
DSx	Dynamic Service Operations
EAE	Early Authentication and Encryption
eDVA	Embedded Digital Voice Adapter
eMTA	Embedded Media Terminal Adapter
EPON	Ethernet Passive Optical Network
FTTx	Fibre To The "x"

NOTE: "x" includes node (FTTN), premise (FTTP), cabinet (FTTC), home (FTTH).

GCP	Generic Control Plane
GE	Gigabit Ethernet
GPON	Gigabit-capable Passive Optical Network
HFC	Hybrid Fibre-Coaxial
IEEE	Institute of Electrical and Electronics Engineers
IGMP	Internet Group Management Protocol
IMS	IP Multimedia Subsystem
IP	Internet Protocol
LLC	Logical Link Control
LLID	Logical Link IDentifier
MAC	Media Access Control
MAN	Metropolitan Area Network
MDD	MAC Domain Descriptor
MLD	Multicast Listener Discovery
MPI	Main Path Interface
MTU	Maximum Transmission Unit
MULPI	MAC and Upper Layer Protocols Interface
NAT	Network Address Translation
NLS	Network Layer Signalling protocol
NMS	Network Management System
NSI	Network Side Interface
OAM	Operations, Administration and Maintenance
OLT	Optical Line Terminal
OMCI	ONT Management and Control Interface
OMI	Operation and Management Interface
ONU	Optical Network Unit
OSSI	Operations Support System Interface
OTT	Over-the-Top
OUI	Organizationally Unique Identifier
PCMM	IPCablecom Multimedia
PCP	Priority Code Point
PDU	Protocol Data Unit

PHY	Physical Layer
PON	Passive Optical Network
QoS	Quality of Service
RCC-ID	Receive Channel Configuration Identifier
RCP	Receive Channel Profile
RCP-ID	Receive Channel Profile Identifier
RCS	Receive Channel Set
RF	Radio Frequency
RFI	Radio Frequency Interface
RSP	Response
SCDMA	Synchronous Code Division Multiple Access
SFID	Service Flow Identifier
SID	Service Identifier
SNMP	Simple Network Management Protocol
SNR	Signal-to-Noise Ratio
STB	Set-top Box
S-VLAN	Service Virtual Local Area Network
TCP	Transmission Control Protocol
TCS	Transmit Channel Set
TFTP	Trivial File Transfer Protocol
TLV	Type Length Value
ToS	Type of Service
TPID	Tag Protocol IDentifier
UCID	Upstream Channel IDentifier
UDP	User Datagram Protocol
UEPI	Upstream External PHY Interface
US	Upstream
VID	VLAN ID
VLAN	Virtual Local Area Network

4 Requirements

In the present document, the following words are used to define the significance of particular requirements:

"shall"	This word means that the item is an absolute requirement of the present document.
"shall not"	This word means that the item is an absolute prohibition of the present document.
"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 behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour 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.

5 Overview

C-DOCSIS is based on proven DOCSIS3.0 technology and with the objectives of carrying high bandwidth services and enabling cost effective system operation. C-DOCSIS presents a logical architecture of distributed deployment and centralized management for the cable broadband access system. It defines the logical functional modules of the system as well as related interfaces and protocols that support the architecture, through different combinations of the logical functional modules; it specifies three different system implementations and the corresponding systems devices.

As the key to implementing the architecture of distributed deployment and centralized management, C-DOCSIS defines the CMTS with a Coax Media Converter (CMC) and the CMC Controller to achieve the DOCSIS CMTS functionality, as shown in figure 1. The CMC Controller implements the Metropolitan Area Network (MAN) interfaces and the CMC implements the RF interfaces specified in [5], [7], [8] and [14], which are a part of C-DOCSIS. The CMC Controller and CMC can be interconnected via a layer-2 or layer-3 network, such as digital optical packet network.

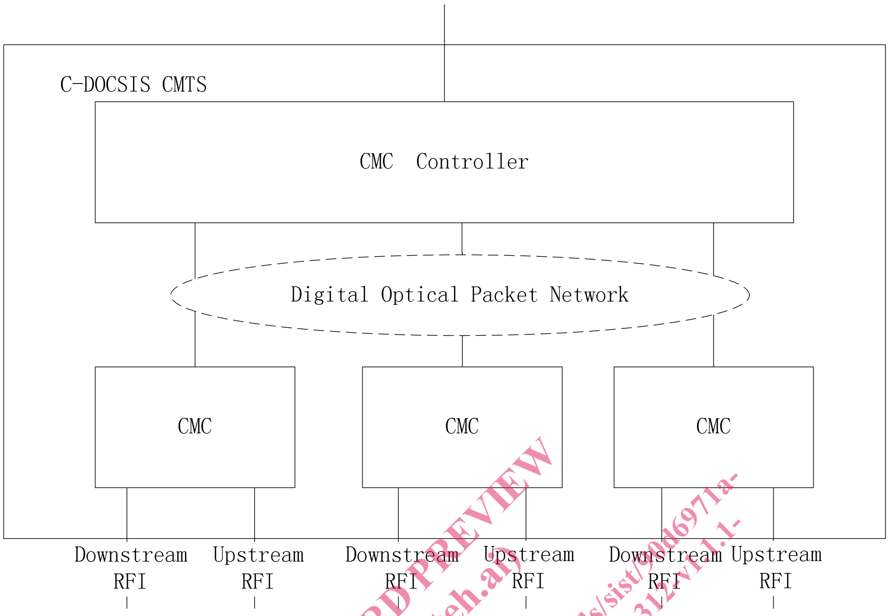

Figure 1: C-DOCSIS CMTS Network Diagram

The CMC Controller is deployed in the central office or headend to realize the centralized system management, configuration and scheduling, thus enabling the distributed CMTS to inherit the advantages of a centralized DOCSIS CMTS system. The CMC itself is distributed; it is deployed in the optical node, enabling the CMTS to introduce the space-division multiplexing on top of the time-division multiplexing and frequency-division multiplexing utilized by the centralized DOCSIS CMTS to achieve higher access bandwidth per user, which is highly desirable for the applications with large upstream bandwidth consumption. With the distributed deployment of CMC and coupled with the technical advantages of the digital optical packet network, the system can fully utilize the resources of the HFC network and existing CMs to realize a cost-effective system deployment and operation, it reduces the return noise and enhances the CMTS downlink channel SNR and is thus able to implement a higher order modulation scheme to obtain higher bandwidth.

The present document describes three different types of CMC controllers and CMCs to implement the distributed CMTS:

- Type I CMC implements all the DOCSIS CMTS functions and Type I CMC controller implements high-level and partial-system management and configuration functions.
- Type II CMC implements the data forwarding and CM access functions and Type II CMC controller implements the system management, configuration and scheduling functions.
- Type III CMC only implements the CMTS PHY function and the Type III CMC controller implements the rest of the functions of the CMTS.

The distributed CMTS architecture is an open architecture, which nicely aligns with the traditional DOCSIS architectures and with the HFC migration toward the FTTx network. The implementation of the various system components is flexible. The CMC controller and CMC can be realized as stand-alone devices in accordance with the provisions of the specification, or they can be integrated with other existing devices to meet the needs of future development, such as the combination of CMC Controller with OLT, router and switches and the combination of CMC with ONU, light stations and IP QAMs.