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Integrated broadband cable telecommunication networks (CABLE); Sixth generation transmission systems for interactive cable television services - IP cable modem; Part 1: General; DOCSIS® 4.0

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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.

The present document is part 1 of a multi-part deliverable covering the sixth generation transmission systems for interactive cable television services - IP cable modems, as identified below:

Part 1: "General; DOCSIS® 4.0";

Part 2: "Physical layer; DOCSIS® 4.0 [ANSI/SCTE 262-1 2020]";

Part 3: "MAC and upper layer protocols interface; DOCSIS® 4.0 [ANSI/SCTE 262-2 2020]";

Part 4: "Cable modem operations support system interface; DOCSIS® 4.0 [ANSI/SCTE 262-3 2020]";

Part 5: "Converged Cable Access Platform (CCAP) operations support system interface; Part 5: Converged Cable Access Platform (CCAP) operations support system interface; DOCSIS® 4.0 [ANSI/SCTE 262-4 2020]";

Part 6: "Security; DOCSIS® 4.0 [ANSI/SCTE 262-5 2020]".

This multi-part deliverable is based on the CableLabs DOCSIS® 4.0 specifications and endorses the corresponding ANSI/SCTE standards. Table 1 indicates for the standards in this multi-part deliverable the endorsed ANSI/SCTE standards and the corresponding CableLabs DOCSIS® 4.0 specifications.

Table 1: Mapping of DOCSIS standards and specifications

ETSI standard	ANSI/SCTE standard	CableLabs DOCSIS® specification
ETSI ES 203 811-1	None	None
ETSI ES 203 811-2 [1]	ANSI/SCTE 262-1 2020	CM-SP-PHYv4.0-I02-200429 [i.1]
ETSI ES 203 811-3 [2]	ANSI/SCTE 262-2 2020	CM-SP-MULPIv4.0-I01-190815 [i.2]
ETSI ES 203 811-4 [3]	ANSI/SCTE 262-3 2020	CM-SP-CM-OSSIv4.0-I02-200311 [i.3]
ETSI ES 203 811-5 [4]	ANSI/SCTE 262-4 2020	CM-SP-CCAP-OSSIv4.0-I02-200311 [i.4]
ETSI ES 203 811-6 [5]	ANSI/SCTE 262-5 2020	CM-SP-SECv4.0-I01-190815 [i.5]

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Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document is part of a multi-part deliverable that defines the sixth generation of high-speed data-over-cable systems and is based on a set of specifications commonly referred to as DOCSIS 4.0 specifications.

This generation of the DOCSIS specifications [i.1] to [i.5] builds upon the previous generations of DOCSIS specifications (commonly referred to as the DOCSIS 3.1 and earlier specifications), leveraging the existing Media Access Control (MAC) and Physical (PHY) layers. It includes backward compatibility for the existing PHY layers in order to enable a seamless migration to the new technology. Further, the DOCSIS 4.0 specifications introduce Full Duplex (FDX) DOCSIS PHY layer technology as an expansion of the OFDM PHY layer introduced in the DOCSIS 3.1 PHY specification to increase upstream capacity without significant loss of downstream capacity versus DOCSIS 3.1. The DOCSIS 4.0 specification also builds upon DOCSIS 3.1 OFDM and OFDMA technology with an extended Frequency Division Duplex (FDD) DOCSIS alternative. DOCSIS 4.0 FDD supports legacy high split and also provides extended splits up to 684 MHz in an operational band plan which is referred to as Ultra-High Split (UHS). DOCSIS 4.0 FDD also introduces expansion of usable downstream spectrum up to 1 794 MHz. Both the FDX and FDD DOCSIS 4.0 alternatives are based on OFDM PHY. The DOCSIS 4.0 specifications also define appropriate updates to the MAC and management layers to support new PHY functionality.

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 referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://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] ETSI ES 203 811-2: "Integrated broadband cable telecommunication networks (CABLE); Sixth generation transmission systems for interactive cable television services - IP cable modem; Part 2: Physical layer; DOCSIS® 4.0 [ANSI/SCTE 262-1 2020]".

[2] ETSI ES 203 811-3: "Integrated broadband cable telecommunication networks (CABLE); Sixth generation transmission systems for interactive cable television services - IP cable modem; Part 3: MAC and upper layer protocol interfaces; DOCSIS® 4.0 [ANSI/SCTE 262-2 2020]".

[3] ETSI ES 203 811-4: "Integrated broadband cable telecommunication networks (CABLE); Sixth generation transmission systems for interactive cable television services - IP cable modem; Part 4: Cable modem operations support system interface; DOCSIS® 4.0 [ANSI/SCTE 262-3 2020]".

[4] ETSI ES 203 811-5: "Integrated broadband cable telecommunication networks (CABLE); Sixth generation transmission systems for interactive cable television services - IP cable modem; Part 5: Converged Cable Access Platform (CCAP) operations support system interface; DOCSIS® 4.0 [ANSI/SCTE 262-4 2020]".

[5] ETSI ES 203 811-6: "Integrated broadband cable telecommunication networks (CABLE); Sixth generation transmission systems for interactive cable television services - IP cable modem; Part 6: Security; DOCSIS® 4.0 [ANSI/SCTE 262-5 2020]".

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 referenced 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] Cable Television Laboratories, Inc.: "DOCSIS 4.0 Physical Layer Specification", CM-SP-PHYv4.0-I02-200429.

[i.2] Cable Television Laboratories, Inc.: "DOCSIS 4.0 MAC and Upper Layer Protocols Interface Specification", CM-SP-MULPIv4.0-I01-190815.

[i.3] Cable Television Laboratories, Inc.: "DOCSIS 4.0 Cable Modem Operations Support System Interface Specification", CM-SP-CM-OSSIv4.0-I02-200311.

[i.4] Cable Television Laboratories, Inc.: "DOCSIS 4.0 CCAP Operations Support System Interface Specification", CM-SP-CCAP-OSSIv4.0-I02-200311.

[i.5] Cable Television Laboratories, Inc.: "DOCSIS 4.0 Security Specification", CM-SP-SECv4.0-I01-190815.

3 Definition of terms, symbols and abbreviations

3.1 Definitions

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

cable modem: modulator-demodulator at the subscriber premises intended for use in conveying data communication on a cable television system

cable modem termination system: device located at the cable television system headend or distribution hub, which provides complementary functionality to the cable modems to enable data connectivity to a wide-area network

converged cable access platform: device located at the cable television system headend or distribution hub that combines the functionality of a cable modem termination system with that of an Edge QAM, providing high-density services to cable subscribers

distribution hub: facility in a cable network which performs the functions of a headend for customers in their immediate area, and which receives some or all of its content for transmission from a master headend in the same metropolitan or regional area

Edge QAM (EQAM): device that receives packets of digital video or data, repacketizes the video or data into an MPEG transport stream and digitally modulates the transport stream onto a downstream RF carrier using Quadrature Amplitude Modulation (QAM)

headend: central facility that is used for receiving, processing and combining broadcast, narrowcast and other signals to be carried on a cable network

3.2 Symbols

Void.

3.3 Abbreviations

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

ANSI	American National Standards Institute
CCAP	Converged Cable Access Platform
CM	Cable Modem
CMTS	Cable Modem Termination System
CPE	Customer Premise Equipment
DHCP	Dynamic Host Configuration Protocol
EQAM	Edge QAM
FDD	Frequency Division Duplex
FDX	Full Duplex
HFC	Hybrid Fibre Coax
IP	Internet Protocol
IPDR	Internet Protocol Detail Record
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
LAN	Local Area Network
MAC	Media Access Control
NMS	Network Management System
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
PHY	Physical Layer
QAM	Quadrature Amplitude Modulation
SCTE	Society of Cable Telecommunications Engineers
SNMP	Simple Network Management Protocol
UHS	Ultra High Split

4 Background

4.1 Broadband Access Network

A coaxial-based broadband access network is assumed. This may take the form of either an all-coax or Hybrid-fibre/coax (HFC) network. The generic term "cable network" is used in the present document to cover all cases.

A cable network uses a tree-and-branch architecture with analogue transmission. The key functional characteristics assumed in the present document are the following:

- Two-way transmission.
- A maximum optical/electrical spacing between the CMTS and the most distant CM of 160 km in each direction, although typical maximum separation may be 15 km to 25 km.

4.2 DOCSIS Network and System Architecture

The elements that participate in the provisioning of DOCSIS services are shown in figure 1.

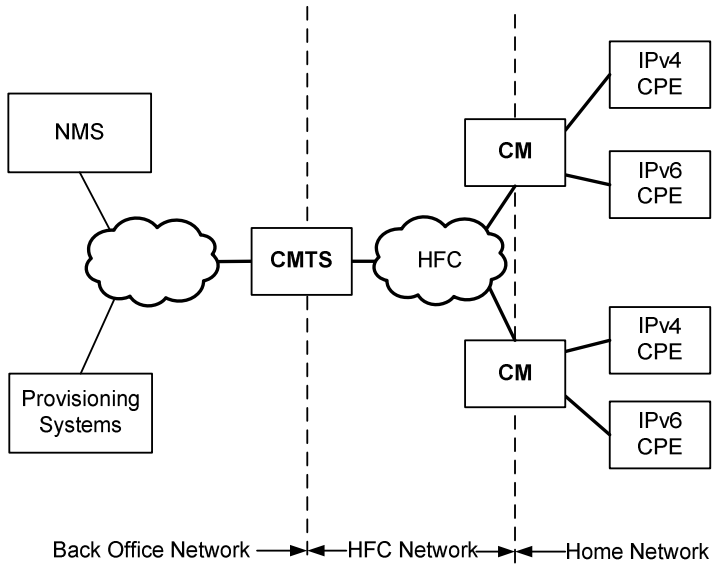

Figure 1: DOCSIS network

The CM connects to the operator's cable network and to a home network, bridging packets between them. Many CPE devices can connect to the CM's LAN interfaces. CPE devices can be embedded with the CM in a single device, or they can be separate, standalone devices (as shown in figure 1). CPE devices may use IPv4, IPv6, or both forms of IP addressing. Examples of typical CPE devices are gateways, home routers, set-top devices, personal computers, etc.

The CMTS connects the operator's back office and core network with the cable network. Its main function is to forward packets between these two domains, and optionally to forward packets between upstream and downstream channels on the cable network.

For a DOCSIS 4.0 system, a distributed architecture is assumed. Thus, where DOCSIS 4.0 specifications use the "CMTS" terminology it is implied to refer to legacy CMTS functionality as instantiated in the elements of the distributed architecture.

Various applications are used in the back office to provide configuration and other support to the devices on the DOCSIS network. These applications use IPv4 and/or IPv6 as appropriate to the particular operator's deployment. Applications include:

Provisioning Systems:

- The DHCP servers provide the CM with initial configuration information, including the device IP address(es), when the CM boots.
- The Configuration File server is used to download configuration files to CMs when they boot. Configuration files are in binary format and permit the configuration of the CM's parameters.
- The Software Download server is used to download software upgrades to the CM.
- The Time Protocol server provides time protocol clients, typically CMs, with the current time of day.
- The Certificate Revocation server provides certificate status.

Network Management System (NMS):

- The SNMP Manager allows the cable operator to configure and monitor SNMP Agents, typically the CM and the CMTS.
- The Syslog server collects messages pertaining to the operation of devices.
- The IPDR Collector server allows the operator to collect bulk statistics in an efficient manner.

4.3 Service Goals

As cable operators have widely deployed high-speed data services on cable television systems, the demand for bandwidth has increased. To this end, it was decided to add new features to the DOCSIS specification for the purpose of increasing system and channel capacity, increasing peak speeds, improving scalability, enhancing network security and network maintenance practices and deploying new service offerings.

The DOCSIS system allows transparent bidirectional transfer of Internet Protocol (IP) traffic, between the cable system headend and customer locations, over an all-coaxial or hybrid-fibre/coax (HFC) cable network. The flow of traffic is shown in simplified form in figure 2.

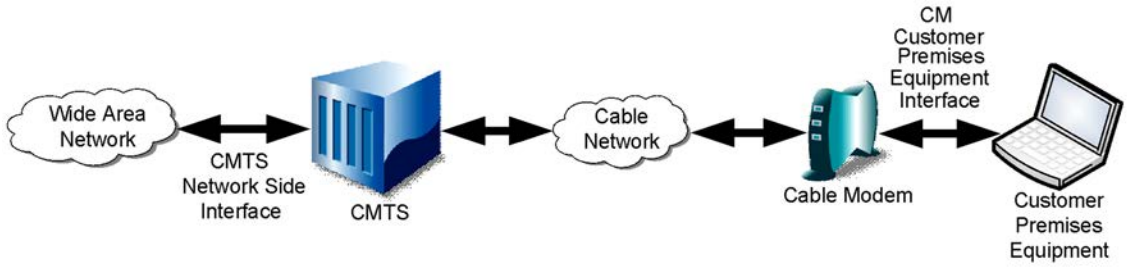

Figure 2: Transparent IP traffic through the Data-Over-Cable System

4.4 Backward Compatibility

The present document defines the DOCSIS 4.0 interface. Prior generations of DOCSIS were commonly referred to as the DOCSIS 1.0, 1.1, 2.0, 3.0 and 3.1 interfaces. DOCSIS 4.0 is backward-compatible with some equipment built to the previous versions. DOCSIS 4.0-compliant CMs interoperate seamlessly with DOCSIS 4.0, DOCSIS 3.1 and DOCSIS 3.0 CMTSs. DOCSIS 4.0-compliant CMTSs seamlessly support DOCSIS 4.0, DOCSIS 3.1, DOCSIS 3.0, DOCSIS 2.0, and DOCSIS 1.1 CMs.

4.5 Reference Architecture

The reference architecture for data-over-cable services and interfaces is shown in figure 3.