ETSI TS 103 311-1 V1.1.1 (2017-02)

Integrated broadband cable telecommunication networks (CABLE); Fourth Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 1: General; DOCSIS® 3.1

Reference
DTS/CABLE-00017-1

Keywords
access, broadband, cable, data, IP, IPcable, modem

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Integrated broadband cable telecommunication networks (CABLE).

The present document is part 1 of a multi-part deliverable covering the Fourth Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems, as identified below:

Part 1: "General; DOCSIS® 3.1";

Part 2: "Physical Layer; DOCSIS® 3.1";

Part 3: "MAC and Upper Layer Protocols Interface; DOCSIS® 3.1".

This multi-part deliverable is based on the CableLabs DOCSIS® set of specifications which are also standardized in the United States by SCTE. Table 1 indicates for the specifications in this multi-part deliverable the equivalent CableLabs DOCSIS® specifications and SCTE Standards.

Table 1

ETSI Standards	CableLabs DOCSIS® Specifications	SCTE Standards
ETSI TS 103 311-1	None	None
ETSI TS 103 311-2	CM-SP-PHYv3.1-I03-140610	TBD
ETSI TS 103 311-3	CM-SP-MULPIv3.1-I03-140610	TBD

DOCSIS® is a registered Trade Mark of Cable Television Laboratories, Inc., and is used in the present document with permission.

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 1 of a multi-part deliverable that define the fourth generation of high-speed data-over-cable systems, commonly referred to as the DOCSIS® 3.1 specifications. This specification was developed for the benefit of the cable industry, and includes contributions by operators and vendors from North and South America, Europe, and Asia.

This generation of the DOCSIS® specifications builds upon the previous generations of DOCSIS® specifications (commonly referred to as the DOCSIS® 3.0 and earlier specifications), leveraging the existing Media Access Control (MAC) and Physical (PHY) layers, but with the addition of a new PHY layer designed to improve spectral efficiency and provide better scaling for larger bandwidths (and appropriate updates to the MAC and management layers to support the new PHY layer). It includes backward compatibility for the existing PHY layers in order to enable a seamless migration to the new technology.

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] ETSI TS 103 311-2: "Integrated broadband cable telecommunication networks (CABLE); Fourth Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems Part 2: Physical Layer; DOCSIS® 3.1".

[2] ETSI TS 103 311-3: "Integrated broadband cable telecommunication networks (CABLE); Fourth Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems Part 3: MAC and Upper Layer Protocols Interface; DOCSIS® 3.1".

[3] Cable Television Laboratories, Inc. CM-SP-SECv3.1: "DOCSIS® 3.1, Security Specification".

[4] Cable Television Laboratories, Inc. CM-SP-CM-OSSIv3.1: "DOCSIS® 3.1, Cable Modem Operations Support System Interface Specification".

[5] Cable Television Laboratories, Inc. CM-SP-CCAP-OSSIv3.1: "DOCSIS® 3.1, CCAP Operations Support System Interface Specification".

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.

Not applicable.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

cable modem: Layer 2 termination device that terminates the network end of a DOCSIS® link

headend: central location on the cable network that is responsible for injecting broadcast video and other signals in the downstream direction

3.2 Abbreviations

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

CCAP	Converged Cable Access Platform
CM	Cable Modem
CMTS	Cable Modem Termination System
CPE	Customer Premise Equipment
DHCP	Dynamic Host Configuration Protocol
EQAM	Edge quadrature amplitude modulation
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
PHY	Physical Layer
SCTE	Society of Cable Telecommunications Engineers
SNMP	Simple Network Management Protocol
TBD	To Be Defined

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 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 - 25 km; and
- A maximum differential optical/electrical spacing between the CMTS and the closest and most distant modems of 160 km in each direction, although this would typically be limited to 25 km.

At a propagation velocity in fibre of approximately 5 ns/m, 160 km of fibre in each direction results in a round-trip delay of approximately 1,6 ms.

4.2 DOCSIS® Network and System Architecture

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

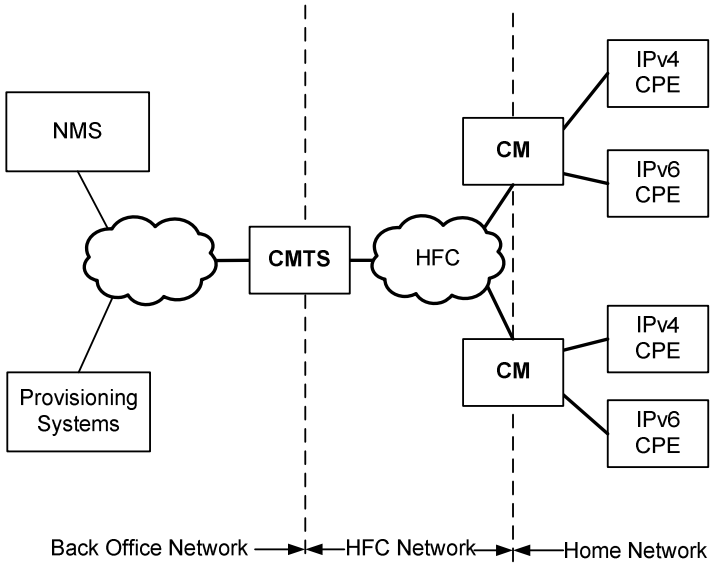

Figure 1: The DOCSIS® Network

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 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 between upstream and downstream channels on the cable network.

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 IP address(es), when the CM boots.
- The Config 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.
- Certificate Revocation server provides certificate status.

Network Management

- 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, enhancing network security, 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.

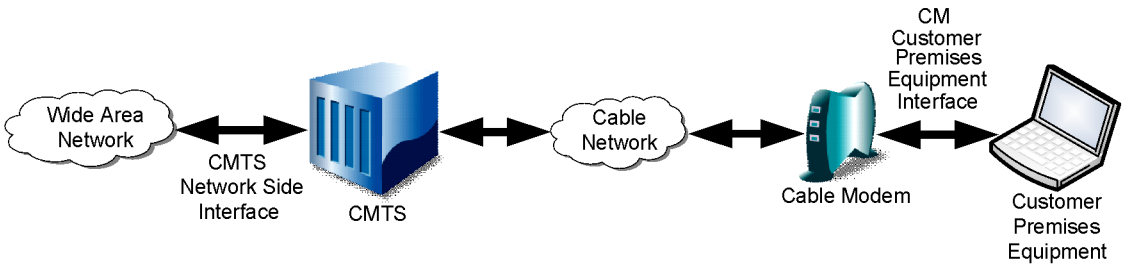

Figure 2: Transparent IP Traffic Through the Data-Over-Cable System

4.4 Backward Compatibility

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

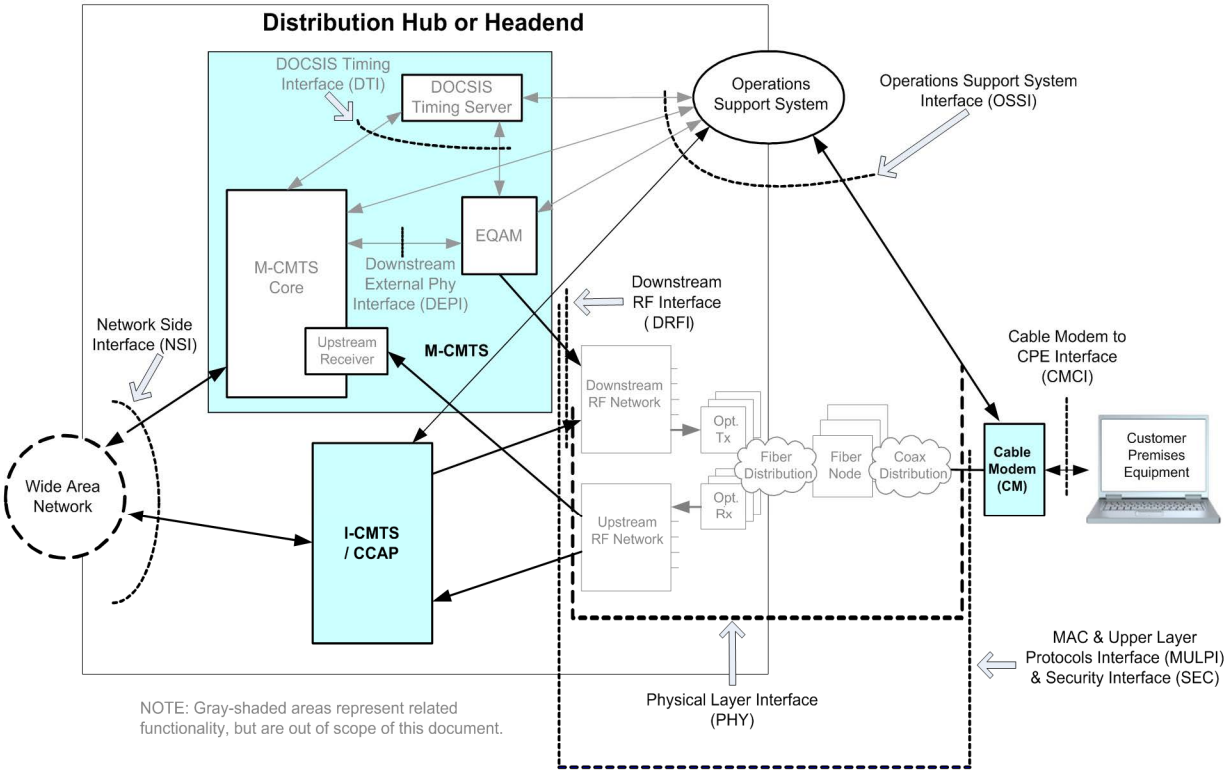

Figure 3: Data-over-Cable Reference Architecture

The lighter shaded areas are related functionality, but are out of the scope of DOCSIS® specifications. Boxes represent functional components and arrows represent interfaces. Interfaces are identified using dashed lines.

5 Overview of the Multi-part ETSI Standard

5.1 Part 1: General; DOCSIS® 3.1

The present document.

5.2 Part 2: Physical Layer; DOCSIS® 3.1

There are differences in the cable spectrum planning practices adopted for different regions of the world. For the new PHY layer defined in this specification, there is flexibility to deploy the technology in any spectrum plan; therefore, no special accommodation for different regions of the world is required for this new PHY layer.

However, due to the inclusion of the DOCSIS® 3.0 PHY layers for backward compatibility purposes, there is still a need for different region-specific physical layer technologies. Therefore, three options for physical layer technologies are included in this specification, which have equal priority and are not required to be interoperable. One technology option is based on the downstream channel identification plan that is deployed in North America using 6 MHz spacing. The second technology option is based on the corresponding European multi-program television distribution. The third technology option is based on the corresponding Chinese multi-program television distribution. All three options have the same status, notwithstanding that the document structure does not reflect this equal priority. It is not required that equipment built to one option interoperate with equipment built to another.

5.3 Part 3: MAC and Upper Layer Protocols; DOCSIS® 3.1

Part 3 defines the MAC layer protocols of DOCSIS® 3.1 as well as requirements for upper layer protocols (e.g. IP, DHCP, etc.). DOCSIS® 3.0 introduced new MAC layer features beyond what were present in earlier versions of DOCSIS®. DOCSIS® 3.1 introduces a new PHY layer feature to further increase the peak downstream and upstream data rates with a few MAC enhancements. It also includes MAC layer protocol definitions for support of additional DOCSIS® 3.1 features defined in the other DOCSIS® specifications: [2], [3], [4] and [5].

6 Requirements for Compliance

To claim compliance to ETSI TS 103 311, implementations shall comply with the requirements statements in all three parts of the present multi-part deliverable, and in addition shall comply with the DOCSIS® 3.1 Security Specification [3], the DOCSIS® 3.1 CM-OSSI Specification [4] and the DOCSIS® 3.1 CCAP-OSSI Specification [5].

History

Document history		
V1.1.1	February 2017	Publication