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Access, Terminals, Transmission and Multiplexing (ATTM);
Third Generation Transmission Systems for
Interactive Cable Television Services - IP Cable Modems;
Part 1: General;
DOCSIS 3.0

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Contents

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Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

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

Part 1: "General; DOCSIS 3.0";

Part 2: "Physical Layer; DOCSIS 3.0";

Part 3: "Downstream Radio Frequency Interface; DOCSIS 3.0";

Part 4: "MAC and Upper Layer Protocols; DOCSIS 3.0";

Part 5: "Security Services; DOCSIS 3.0".

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 series the equivalent CableLabs DOCSIS specifications and SCTE Standards.

Table 1

ETSI Standards	CableLabs DOCSIS Specifications	SCTE Standards
EN 302 878-1 (V1.1.1)	None	None
EN 302 878-2 [1] (V1.1.1)	CM-SP-PHYv3.0-I09-101008 [i.7]	ANSI/SCTE 135-1 [i.3]
EN 302 878-3 [2] (V1.1.1)	CM-SP-DRFI-I10-100611 [i.8]	ANSI/SCTE 133 [i.6]
EN 302 878-4 [3] (V1.1.1)	CM-SP-MULPIv3.0-I14-101008 [i.9]	ANSI/SCTE 135-2 [i.4]
EN 302 878-5 [4] (V1.1.1)	CM-SP-SECv3.0-I13-100611 [i.10]	ANSI/SCTE 135-3 [i.5]

Historically, these were also standardized in the ITU-T Recommendations J.210 [i.1] and the J.221.x series [i.2].

National transposition dates	
Date of adoption of this EN:	14 November 2011
Date of latest announcement of this EN (doa):	29 February 2012
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 August 2012
Date of withdrawal of any conflicting National Standard (dow):	31 August 2012

1 Scope

The present document is part 1 of a multi-part series of specifications that define the third generation of high-speed data-over-cable systems. This series was developed for the benefit of the cable industry, and includes contributions by operators and vendors from North America, Europe, and other regions. All documents in this series are required to implement the third-generation transmission system for interactive cable television services.

1.1 Technology Options

This multi-part deliverable includes two technology options that have equal priority and are not required to be interoperable. One technology option is based on the downstream multi-program television distribution that is deployed in North America using 6 MHz channelling. The other technology option is based on the corresponding European multi-program television distribution. Both options have the same status. Compliance with the present document requires compliance with the one or the other of these implementations, not with both. It is not required that equipment built to one option will interoperate with equipment built to the other.

These technology options allow operators flexibility in mandated areas of operation, including any frequency planning, EMC (electromagnetic compatibility), and safety requirements. For instance, the 6 MHz downstream based option defined in EN 302 878-2 [1] might be deployable within an 8 MHz channel plan.

Backwards compatibility with earlier versions of that technology is only ensured within the same technology options referred to above and not between the two options.

1.2 Background

1.2.1 Broadband Access Network

A coaxial-based broadband access network is assumed. This may take the form of either an all-coax or Hybrid Fibre/Coaxial network. The generic term "cable network" is used here to cover all cases.

A cable network uses a tree-and-branch architecture with analog 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 100 miles (160 km) in each direction, although typical maximum separation may be 10 miles to 15 miles (16 km to 24 km).
- A maximum differential optical/electrical spacing between the CMTS and the closest and most distant modems of 100 miles (160 km) in each direction, although this would typically be limited to 15 miles (24 km).

At a propagation velocity in fibre of approximately 1,5 ns/ft (5 ns/m), 100 miles (160 km) of fibre in each direction results in a round-trip delay of approximately 1,6 ms.

1.2.2 Network and System Architecture

1.2.2.1 The DOCSIS Network

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

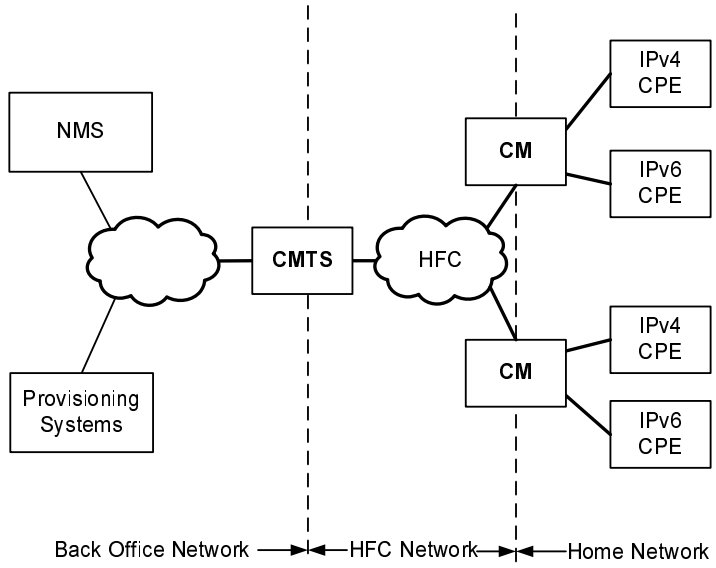

Figure 1: The DOCSIS Network

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.

NMS

- The SNMP Manager allows the 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.

1.2.3 Service Goals

As cable operators have widely deployed high-speed data services on cable television systems, the demand for bandwidth has increased. Additionally, networks have scaled to such a degree that IPv4 address space limitations have become a constraint on network operations. To this end, it was decided to add new features to the DOCSIS specification for the purpose of increasing channel capacity, enhancing network security, expanding addressability of network elements, and deploying new service offerings.

The DOCSIS system allows transparent bi-directional transfer of Internet Protocol (IP) traffic, between the cable system head-end and customer locations, over an all-coaxial or Hybrid Fibre/Coaxial (HFC) cable network. This is shown in simplified form in figure 2.

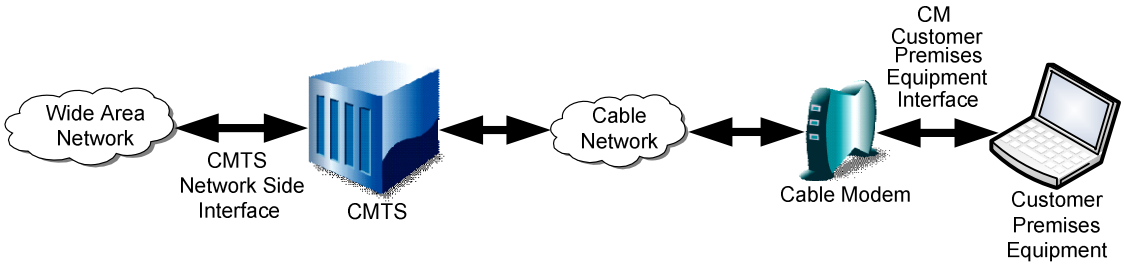

Figure 2: Transparent IP Traffic Through the Data-Over-Cable System

1.2.4 Statement of Compatibility

This specification defines the DOCSIS 3.0 interface. Prior generations of DOCSIS were commonly referred to as DOCSIS 1.0, 1.1 and 2.0. DOCSIS 3.0 is backward-compatible with equipment built to the previous specifications. DOCSIS 3.0-compliant CMs interoperate seamlessly with DOCSIS 2.0, DOCSIS 1.1 and DOCSIS 1.0 CMTSs. DOCSIS 3.0-compliant CMTSs seamlessly support DOCSIS 2.0, DOCSIS 1.1 and DOCSIS 1.0 CMs.

Refer to EN 302 878-5 [4] for BPI/BPI+ compatibility requirements.

1.2.5 Reference Architecture

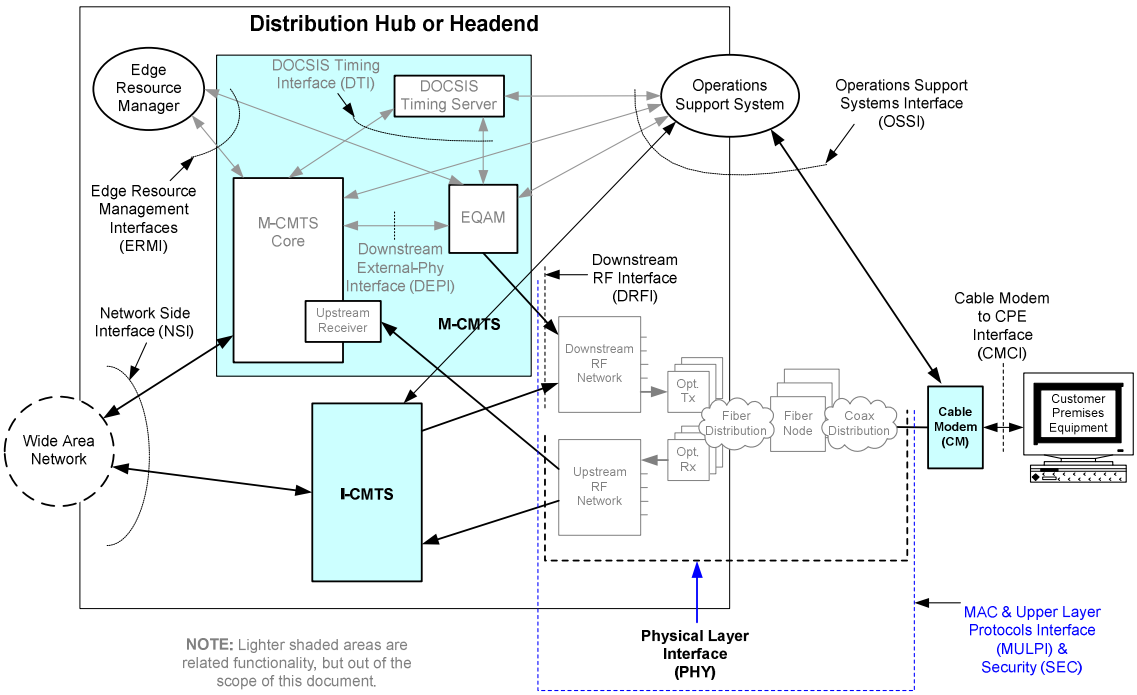

Figure 3: Data-over-Cable Reference Architecture

The reference architecture for data-over-cable services and interfaces is shown in figure 3. The lighter shaded areas are related functionality, but are out of the scope of DOCSIS specifications. Boxes represent functional components and arrows represent interfaces.

2 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.

2.1 Normative references

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

[1] 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".

[2] 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".

[3] 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".

[4] 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

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] ITU-T Recommendation J.210: "Downstream RF Interface for Cable Modem Termination Systems".

[i.2] ITU-T Recommendation J.221 (series): "IP cable modems".

[i.3] ANSI/SCTE 135-1: "DOCSIS 3.0 Part 1: Physical Layer Specification".

[i.4] ANSI/SCTE 135-2: "DOCSIS 3.0 Part 2: MAC and Upper Layer Protocols".

[i.5] ANSI/SCTE 135-3: "DOCSIS 3.0 Part 3: Security Services".

[i.6] ANSI/SCTE 133: "Downstream RF Interface for Cable Modem Termination Systems".

[i.7] Cable Television Laboratories, Inc., CM-SP-PHYv3.0-I09-101008: "Data Over Cable Service Interface Specifications - DOCSIS 3.0 - Physical Layer Specification".

[i.8] Cable Television Laboratories, Inc., CM-SP-DRFI-I10-100611: "Data-Over-Cable Service Interface Specifications - Downstream RF Interface Specification".

[i.9] Cable Television Laboratories, Inc., CM-SP-MULPIv3.0-I14-101008: "Data-Over-Cable Service Interface Specifications - DOCSIS 3.0 - MAC and Upper Layer Protocols Interface Specification".

[i.10] Cable Television Laboratories, Inc., CM-SP-SECv3.0-I13-100611: "Data-Over-Cable Service Interface Specifications - DOCSIS 3.0 - Security Specification".

3 Definitions and abbreviations

3.1 Definitions

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

cable modem: layer two termination device that terminates the network end of a third generation DOCSIS

3.2 Abbreviations

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

BPI+	Baseline Privacy Interface Plus
CM	Cable Modem
CMTS	Cable Modem Termination System
CPE	Customer Premises Equipment
DHCP	Dynamic Host Configuration Protocol
DOCSIS	Data-Over-Cable Service Interface Specifications
EAE	Early Authentication and Encryption
EQAM	Edge QAM
HFC	Hybrid Fibre/Coaxial
IP	Internet Protocol
IPDR	Internet Protocol Detail Record
IPv6	Internet Protocol version 6
MAC	Media Access Control
NMS	Network Management System
RF	Radio Frequency
SNMP	Simple Network Management Protocol
SSD	Secure Software Download

4 Overview of the multi-part deliverable

4.1 Part 1: General; DOCSIS 3.0

The present document.

4.2 Part 2: Physical Layer; DOCSIS 3.0

EN 302 878-2 [1] defines the Physical Layer and RF characteristics required in the downstream receiver and upstream transmitter of DOCSIS 3.0 CMs, as well as the upstream receiver of DOCSIS 3.0 CMTSs. These requirements are defined as to permit vendors to build devices that meet the needs of cable operators around the world, and to allow CMs and CMTSs that implement the same technology option to interoperate with each other.

EN 302 878-2 [1] defines some changes relative to previous versions of the DOCSIS specifications. For instance, it defines new power level requirements that apply when upstream channel bonding is being used.

4.3 Part 3: Downstream Radio Frequency Interface; DOCSIS 3.0

EN 302 878-3 [2] defines the RF characteristics required in the downstream transmitter(s) of DOCSIS 3.0 CMTSs and EQAMs, sufficiently enough to permit vendors to build devices that meet the needs of cable operators around the world.

In addition to defining these requirements for a DOCSIS 3.0 device, EN 302 878-3 [2] could also be applicable to other devices such as:

- an Edge QAM (EQAM) not being used for DOCSIS 3.0 services; or
- an integrated Cable Modem Termination System (CMTS) with multiple downstream channels per RF port previous to DOCSIS 3.0.

4.4 Part 4: MAC and Upper Layer Protocols; DOCSIS 3.0

EN 302 878-4 [3] defines the MAC layer protocols of DOCSIS 3.0 as well as requirements for upper layer protocols (e.g. IP, DHCP, etc.). DOCSIS 3.0 introduces new MAC layer features beyond what were present in earlier versions of DOCSIS.

Specifically, DOCSIS 3.0 defines a mechanism to increase the peak rate of upstream and downstream forwarding between the CMTS and a CM by utilizing multiple independent physical layer channels. This feature is termed channel bonding. Due to the inherent differences in the MAC layer definition for upstream transmission relative to downstream, the bonding mechanisms are themselves quite different in the two directions. EN 302 878-4 [3] defines the requirements for CMs and CMTSs to support both upstream and downstream channel bonding.

DOCSIS 3.0 introduces a number of enhancements to the operation of upstream request and grant scheduling, including the ability to request in terms of bytes instead of mini-slots and to have multiple outstanding requests per upstream service flow. The set of upstream enhancements introduced with DOCSIS 3.0 is collectively called the "Multiple Transmit Channel Mode" of operation on the CM.

Additionally, DOCSIS 3.0 introduces enhancements to the way that IP multicast is handled. DOCSIS 1.1 and 2.0 required that cable modems actively participate in tracking layer-3 IP multicast group membership. DOCSIS 3.0, in contrast, provides a CMTS controlled layer-2 multicast forwarding mechanism. DOCSIS 3.0 also introduces the ability for cable operators to configure Quality of Service guarantees for multicast traffic. These features can be used to reliably deliver source-specific as well as any-source multicast sessions to clients behind the cable modem.

Finally, DOCSIS 3.0 introduces full support for IPv6, including the provisioning and management of a cable modem with an IPv6 address, and the ability to manage and transport IPv6 traffic.

4.5 Part 5: Security Services; DOCSIS 3.0

EN 302 878-5 [4] defines the Baseline Privacy Interface Plus (BPI+) architecture which covers CM authentication, key exchange, and establishing encrypted traffic sessions between the CM and CMTS. Early Authentication and Encryption (EAE) applies BPI+, earlier in the provisioning process. EN 302 878-5 [4] also defines security features for the CM provisioning process, which includes Secure Software Download (SSD).

History

Document history				
V1.1.0	April 2011	Public Enquiry	PE 20110818:	2011-04-20 to 2011-08-18
V1.1.0	September 2011	Vote	V 20111112:	2011-09-13 to 2011-11-14
V1.1.1	November 2011	Publication		