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Technical Specification

Access and Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 2: Physical Layer

[ITU-T Recommendation J.222.1 (07/2007), modified]

Reference

DTS/ATTM-02006-2

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

Introduction

This European Standard (Cable DOCSIS 3.0 Network series) has been produced by ETSI Access, Terminals, Transmission and Multiplexing Technical Committee (ATTM), Cable Access Network sub-group.

The present document is part 2 of a multi-part deliverable covering Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable modems. Full details of the entire series can be found in part 1 [i.1].

1   Scope

The present document defines the physical layer requirements as part of a series of specifications for the third generation of high-speed Data-Over-Cable Systems Interface Specifications (DOCSIS®).

They were developed for the benefit of the cable industry, including contributions by operators and vendors from, Europe, North America and other regions.

The source material for the present document was provided by the ITU-T Recommendation J.222.1 [5] for which the most recent version can be found at http://www.itu.int/ITU-T/.

There are differences in the cable spectrum planning practices adopted for different networks in the world. Therefore two definitions for physical layer technology are included, which have equal priority and are not required to be interoperable. One technology definition is based on the downstream multi-programme television distribution that is deployed using 8 MHz channelling, and supports upstream transmission in the 5 MHz to 65 MHz region. The second technology definition is based on a multi-programme television distribution using 6 MHz channel spacing and supports upstream in the 5 MHz to 42 MHz region. Both options have equal status.

The choices of physical-layer technologies allow operators some flexibility within any frequency planning, EMC and safety requirements that are mandated for their area of operation.

> EXAMPLE: The 6 MHz downstream-based option might be deployable within an 8 MHz channel plan. It is the network operator's choice of which technology definition to deploy.

> NOTE: The current document references both physical layer technologies and where there are parameter differences both are specified for both options:
>
> > i)   8 MHz channel spacing; and.
> >
> > ii)   6 MHz channel spacing.

All optional physical-layer technologies are required to be backwards compatible with the earlier versions of those options defined in ES 201 488 [i.4] and ES 202 488 [i.5].

Requirements for EMC and safety are outside the scope of the present document. EMC and safety standards for European applications are published by CENELEC.

> NOTE 1:   Examples of such CENELEC product safety standards are EN 60950 [i.6] and EN 50083-1 [i.6].

> NOTE 2:   For CENELEC safety categories of interfaces, see EG 201 212 [i.2].

> NOTE 3:   Examples of such CENELEC product EMC standards are EN 50081-1 [i.7], EN 50082-1 [i.8] and EN 50083-2 [i.3].

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:

  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;

  - for informative references.

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 indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ETSI ES 202 488-2: "Access and Terminals (AT); Second Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 2: Radio frequency interface specification".

[2] ETSI TS 102 639-3: "Access and Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 3: Downstream Interface [ITU-T Recommendation J.210 (11/2006), modified]".

[3] ETSI TS 102 639-4: "Access and Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 4: MAC and Upper Layer Protocols ITU-T Recommendation J.222.2 (07/2007), modified]".

[4] ETSI TS 102 639-5: "Access and Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 5: Security Services [ITU-T Recommendation J.222.3 (07/2007), modified]".

[5] ITU-T Recommendation J.222.1: "Third-generation transmission systems for interactive cable television services - IP cable modems: Physical layer specification".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ITU-T Recommendation J.214 (2007): "Cable modem TDM emulation interface".

[i.2] ETSI EG 201 212: "Electrical safety; Classification of interfaces for equipment to be connected to telecommunication networks".

[i.3] CENELEC EN 50083-2:2006: "Cable networks for television signals, sound signals and interactive services - Part 2: Electromagnetic compatibility for equipment".

[i.4] ETSI ES 201 488: "Access and Terminals (AT); Data Over Cable Systems".

[i.5]   ETSI ES 202 488: "Access and Terminals (AT); Second Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modemsl".

[i.6]   EN 60950: "Information technology equipment - Safety".

[i.7]   BS EN 61000-6-3:200: "Electromagnetic compatibility (EMC). Generic standards. Emission

[i.8]   BS EN 61000-6-4:2001: "Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments".

[i.9]   ITU-T Recommendation J.222.2: "MAC and Upper Layer protocols for third-generation transmission systems for interactive cable television services - IP cable modems".

[i.10]   ITU-T Recommendation J.210: "Downstream RF Interface for Cable Modem Termination Systems".

[i.11]   ITU-T Recommendation J.222.3: " Third-generation transmission systems for interactive cable television services - IP cable modems: Security services".

[i.12]   ITU-T Recommendation J.112: "Transmission systems for interactive cable television services".

[i.13]   ITU-T Recommendation J.122: " Second-generation transmission systems for interactive cable television services - IP cable modems".

[i.14]   ITU-T Recommendation J.83, Annex B: "Digital multi-programme systems for television, sound and data services for cable distribution, Annex B - Digital multi-programme system B".

3   Definitions and abbreviations

3.1   Definitions

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

active codes: set of spreading codes which carry information in an S-CDMA upstream

NOTE: The complementary set, the unused codes, are idle and are not transmitted. Reducing the number of active codes below the maximum value of 128 may provide advantages including more robust operation in the presence of coloured noise.

allocation: group of contiguous mini-slots in a MAP which constitutes a single transmit opportunity

bandwidth allocation map (MAP): MAC management message that the CMTS uses to allocate transmission opportunities to cable modems

Capture BandWidth (CBW): sum of the tuning bands in the TB list in MHz

channel bonding: logical process that combines the data packets received on multiple independent channels into one higher-speed data stream

NOTE: Channel bonding can be implemented independently on upstream channels or downstream channels.

demodulator module: physical entity in the CM that demodulates a block of one or more contiguous channels of a single bandwidth (6 MHz or 8 MHz) within the output from a single tuner

DOCSIS 1.x: Abbreviation for "DOCSIS 1.0 or 1.1". DOCSIS stands for data-over-cable service interface specifications

extended upstream frequency range: optional upstream frequency range over which a CM may be capable of transmitting

NOTE: In the technology option that uses 6 MHz downstream channelization, this is 5-85 MHz. In the technology option that uses 8 MHz downstream channelization, no extended upstream frequency range is defined.

interval usage code (IUC): field in MAPs and UCDs to link burst profiles to grants

maximum downstream bonded channels (MDBC): maximum number of downstream bonded channels supported by the cable modem

NOTE: See channel bonding.

number of allocated codes: total number of codes which a single CM uses in a single S-CDMA frame

NOTE: This number is determined by the size of the grants in mini-slots and the mapping of these mini-slots to S-CDMA frames (note that a CM may receive multiple grants which are mapped to a single S-CDMA frame). The number of allocated codes can be in the range of the number of codes per mini-slot to the number of active codes, and may vary from frame to frame, but is constant within an S-CDMA frame.

S-CDMA frame: two-dimensional representation of mini-slots, where the dimensions are codes and time

NOTE: An S-CDMA frame is composed of p active codes in the code dimension and K spreading intervals in the time dimension. Within the S-CDMA frame, the number of mini-slots is determined by the number of codes per mini-slot (c) and p, the number of active codes in the S-CDMA frame. Each S-CDMA frame thus contains s mini-slots, where s = p/c, and each mini-slot contains c*K information (QAM) symbols.

S-CDMA subframe: subframe is a vertically-smaller subset of an S-CDMA frame over which interleaving is performed, where the vertical dimension is R' codes, where R' ≤ p (the number of active codes)

NOTE: A subframe is generally used to constrain the interleaving region to be of a similar size to the Reed-Solomon codeword in order to provide protection from impulse noise.

Selectable Active Codes (SAC): methodology to determine the set of active codes and its complement, the set of unused codes. In SAC mode 1, a consecutive set of codes starting with code 0 are unused.

NOTE: In SAC mode 2, the active codes are selectable via a 128-bit string.

spread symbol: output of the spreader, a group of 128 chips which comprises a single S-CDMA spreading code, and is the result of spreading a single information (QAM constellation) symbol, which is referred to as a "spread symbol"

spreader-off S-CDMA burst: transmission from a single CM in a spreader-off frame on an S-CDMA channel defined by the time in which the cable modem's transmitter turns on to the time it turns off

NOTE: There will generally be several spreader off bursts in a spreader-off frame.

spreader-off S-CDMA frame: TDMA mini-slots on an S-CDMA channel in which the spreader is turned off

NOTE: These are differentiated from TDMA bursts on a TDMA channel in that, for example, the number of mini-slots per spreader-off S-CDMA burst frame is constrained to be the same as the number of mini-slots in a spreader-on S-CDMA frame(s). This number of mini-slots will be less than the number of TDMA mini-slots in a TDMA channel over the same time interval if the number of active codes is significantly less than 128.

spreading codes: family of orthogonal digital codewords used in S-CDMA direct-sequence spread-spectrum modulation

spreading interval: period of a spread symbol (128 chips) is called a "spreading interval"

standard upstream frequency range: required upstream frequency range over which a CM is to be capable of transmitting

NOTE: In the technology option that uses 6 MHz downstream channelization, this is 5-42 MHz. In the technology option that uses 8 MHz downstream channelization, this is 5-65 MHz.

Synchronous-Code Division Multiple Access (S-CDMA): multiple access physical layer technology in which different transmitters can share a channel simultaneously

NOTE: The individual transmissions are kept distinct by assigning each transmission an orthogonal "code". Orthogonality is maintained by all transmitters being precisely synchronized with one another.

tick: 6,25 µs time intervals that are the reference for upstream mini-slot definition and upstream transmission times

Upstream Channel Descriptor (UCD): MAC management message used to communicate the characteristics of the upstream physical layer to the cable modems

3.2 Abbreviations

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

CBW   Capture Bandwidth
CM   Cable Modem
CMTS   Cable Modem Termination System
dBc   Decibels relative to carrier power
DOCSIS 1.x   Data-Over-Cable Service Interface Specification version 1.0 or 1.1
DOCSIS   Data-Over-Cable Service Interface Specification
EMC   Electromagnetic Compatibility
I   In-phase modulation component
IP   Internet Protocol
IUC   Interval Usage Code
MAC   Media Access Control
MDBC   Maximum Downstream Bonded Channels
NCTA   National Cable and Telecommunications Association
QAM   Quadrature Amplitude Modulation
R-S   Reed Solomon
SAC   Selectable Active Codes
S-CDMA   Synchronous-Code Division Multiple Access
SCTE   Society of Cable Telecommunications Engineers
TB   Tuning Band
TDM   Time Division Multiplexing
TDMA   Time Division Multiple Access
UCD   Upstream Channel Descriptor

Endorsement notice

Modifications to ITU-T Recommendation J.222.1

The elements of ITU-T Recommendation J.222.1 [5] (07/2007) apply, with the following modifications:

NOTE: Underlining and/or strike-out are used to highlight detailed modifications where necessary.

Replace references given in J.222.1 as shown in table 1.

Table 1

	Reference(s) in J.222.1 [5]	Replaced reference(s)
1	ITU-T Recommendation J.222.1	ETSI TS 102 639-2
2	ITU-T Recommendation J.222.2	ETSI TS 102 639-3
3	ITU-T Recommendation J.210	ETSI TS 102 639-4
4	ITU-T Recommendation J.222.3	ETSI TS 102 639-5
5	ITU-T Recommendation J.112	ETSI TS 201 488
6	ITU-T Recommendation J.122	ETSI TS 202 488-2

Delete annex D as it is not applicable.

Delete reference ITU-T Recommendation J.83 [i.15] as it is not applicable.

Delete reference to Article 23/26 as it is not applicable.

Annex A (informative):
Bibliography

ITU-T Recommendation H.222.0 | ISO/IEC 13818-1:2007: "Information technology - Generic coding of moving pictures and associated audio information: Systems".

ETSI EN 300 429: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for cable systems".

IEC 61169-24 (2001): "Radio-frequency connectors - Part 24: Sectional specification - Radio frequency coaxial connectors with screw coupling, typically for use in 75 ohm cable distribution systems (type F)".

ANSI/SCTE 02 2006: "Specification for "F" Port, Female, Indoor".

SCTE 135-4 (2007): "DOCSIS 3.0 Part 4: Operations Support System Interface".

Cable Television Laboratories, Inc. (November 1994): "Digital Transmission Characterization of Cable Television Systems".

CEA-542-B (July 2003): "CEA Standard: Cable Television Channel Identification Plan".

CENELEC EN 50083-1:1993: "Cable networks for television signals, sound signals and interactive services - Part 1: Safety requirements".

CENELEC EN 50083-7:1996: "Cable networks for television signals, sound signals and interactive services - Part 7: System performance".

CENELEC EN 50083-10:2002: "Cable networks for television signals, sound signals and interactive services - Part 10: System performance for return paths".

CENELEC EN 60950-1:2002: "Information technology equipment - Safety - Part 1: General requirements".

CENELEC EN 61000-6-1:2007: "Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments".

CENELEC EN 61000-6-3:2007: "Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments".

National Cable and Telecommunications Association, Washington DC: "NCTA Recommended Practices for measurements on Cable Television Systems", 2nd Edition, revised October 1993.

History

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