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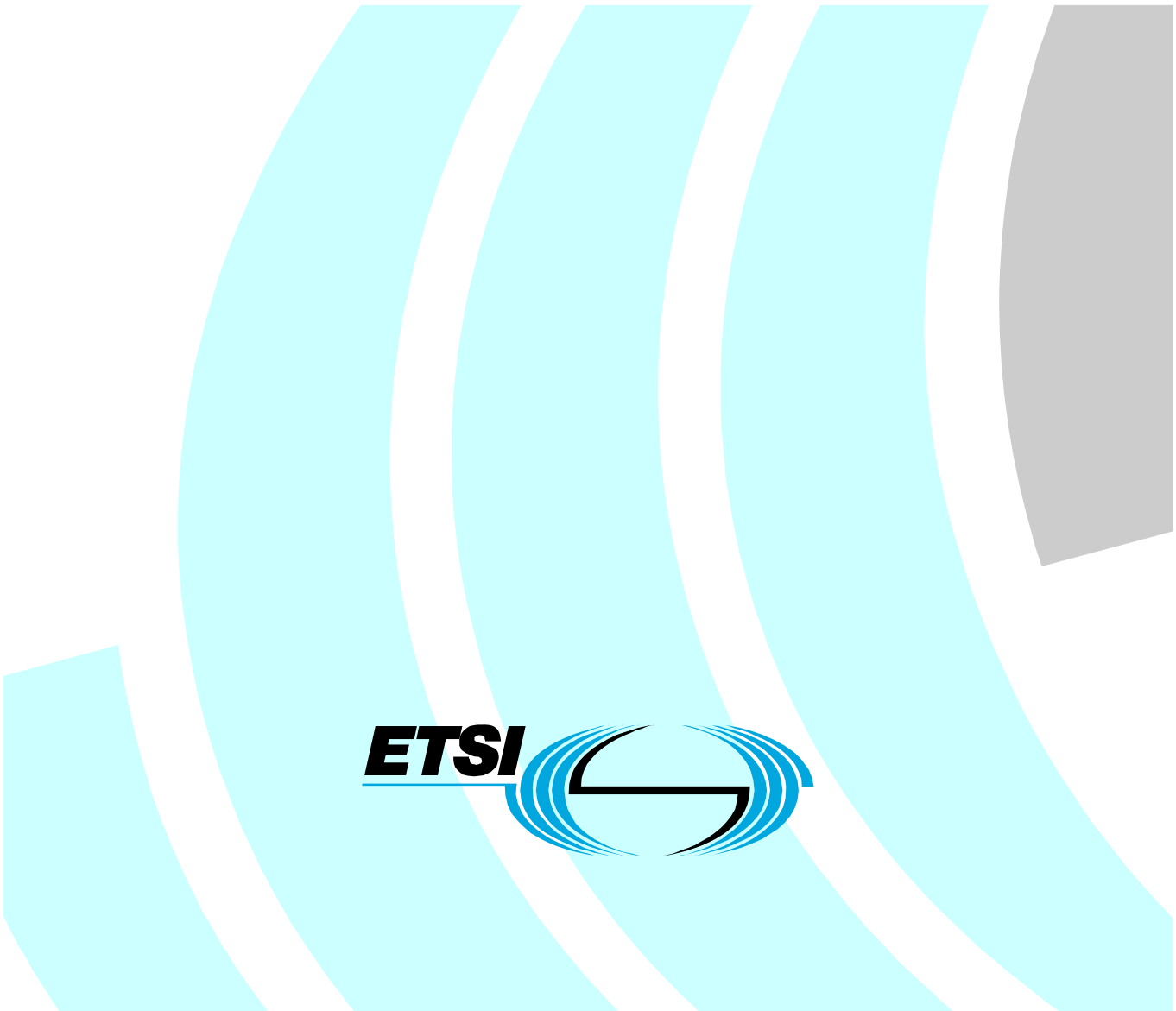
Technical Specification

Access and Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 4: MAC and Upper Layer Protocols

[ITU-T Recommendation J.222.2 (07/2007), modified]



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Foreword

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

The present document is part 4 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].

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.

1 Scope

The present document is part of a series of ETSI standards that define the third generation of high-speed data-over-cable systems. The third-generation transmission systems introduces a number of new features that build upon what was present in previous versions (ES 201 488 [4] and ES 202 488-2 [3]). The present document includes key new features for the MAC and Upper Layer Protocol Interface, and defines the MAC layer protocols as well as requirements for upper layer protocols (e.g. IP, DHCP, etc.).

These series of ETSI standards 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 this specification was provided by the ITU-T Recommendation J.222.2 [8] for which the most recent version can be found at http://www.itu.int/ITU-T/.

NOTE: Also refer to TS 102 639-1 [i.2] for the background and overview of the DOCSIS® 3.0 family of ETSI standards.

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.

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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 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".

[2] ETSI TS 102 639-2: "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".

[3] 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".

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

[5] 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".

[6] 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".

[7] ETSI TS 101 909-4: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 4: Network Call Signalling Protocol [Partial Endorsement of ITU-T Recommendation J.162 (11/2005), modified]".

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

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.2] ETSI TS 102 639-1: "Access and Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 1: General".

[i.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".

[i.4] ITU-T Recommendation J.222.1: "Third-generation transmission systems for interactive cable television services - IP cable modems: Physical layer specification".

[i.5] ITU-T Recommendation J.210: "Downstream RF Interface for Cable Modem Termination Systems".

[i.6] ITU-T Recommendation J.222.3: "Third-generation transmission systems for interactive cable television services - IP cable modems: Security services".

[i.7] ITU-T Recommendation J.112: "Transmission systems for interactive cable television services".

[i.8] ITU-T Recommendation J.122: "Second-generation transmission systems for interactive cable television services - IP cable modems".

[i.9] ITU-T Recommendation J.163: "Dynamic quality of service for the provision of real-time services over cable television networks using cable modems".

[i.10] ITU-T Recommendation J.162: "Network call signalling protocol for the delivery of time-critical services over cable television networks using cable modems".

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.

bonded channel(s): one or more independent RF channels whose data packets are logically combined into one higher-speed data stream

bonded channel Set: identified set of upstream or downstream channels among which a stream of packets is distributed

bonding group: list of channels providing a means to identify the specific channels bonded together

NOTE: Sometimes referred to as a "Bonded Channel Group".

cable modem service group: in the HFC plant topology, the complete set of downstream and upstream channels within a single CMTS that a single Cable Modem could potentially receive or transmit on

NOTE: In most HFC deployments, a CM-SG corresponds to a single Fiber Node. Usually, a CM-SG serves multiple CMs.

DOCSIS 1.x: abbreviation for "DOCSIS 1.0 or 1.1"

downstream bonded service flow: downstream Service Flow for which DOCSIS MAC Frames are transmitted on one or more Downstream Channels

downstream bonding group: subcomponent object of a MAC Domain that distributes packets from an assigned set of downstream bonding service flows to an associated set of downstream channels of that mac domain

downstream service extended header: DOCSIS extended header that contains a Downstream Service ID (DSID)

downstream service group: complete set of Downstream Channels (DCs) from a single CMTS that could potentially reach a single Cable Modem

NOTE: A DS-SG corresponds to a broadband forward carrier path signal from one CMTS. In an HFC deployment, a DS-SG corresponds to the downstream fiber transmission from one CMTS to one or more Fiber Nodes.

load balancing group: full or partial subset of a MAC Domain Cable Modem Service Group (MD-CM-SG) to which a CM is administratively assigned

NOTE: LBGs contain at least one upstream channel and at least one downstream channel.

modular cable modem termination system: CMTS composed of discrete functional blocks linked together using Gigabit Ethernet links

multiple outstanding requests: ability of the cable modem to make additional bandwidth request for new packets for a service flow while one or more previous requests for older packets remain unfulfilled

Pre-3.0 DOCSIS: versions of Data-Over-Cable-Service-Interface-Specifications (DOCSIS) specifications prior to the DOCSIS 3.0 suite of specifications

primary-capable downstream channel: Downstream Channel that can be used by a DOCSIS 3.0 CM as its Primary Downstream Channel, or by a DOCSIS 1.x/2.0 CM as its Downstream Channel

primary channel: See Primary Downstream Channel.

primary downstream channel: downstream channel from which a CM derives CMTS master clock timing for upstream transmission

NOTE: All other concurrently received channels are called "secondary downstream channels".

primary service flow: first service flow, in each direction, defined in the CM configuration file

queue-depth based request: request in multiples of bytes based on the CM’s queue depth and QoS parameters for a specific service flow

NOTE: This request does not include any estimation of physical layer overhead.

receive channel configuration: CMTS send the RCC encoding in the REG-RSP message. The RCC contains TLVs to initially configure a CM's Receive Channels (RCs) and Receive Modules (RMs)

receive channel profile: RCP describes a logical representation of the CM's downstream physical layer in terms of Receive Channels (RCs) and Receive Modules (RMs)

NOTE: A Cable Modem reports its ability to receive multiple channels with one or more RCP Encodings in a REG-REQ message.

receive channel set: set of downstream channels assigned to an individual CM is called its Receive Channel Set, and is explicitly configured by the CMTS using the RCC encodings

receive module: component in the CM physical layer implementation shared by multiple Receive Channels

resequencing channel list: this is a list of channels on which the CM receives packets labelled with that DSID

resequencing context: CM Resequencing Context, identified by a Resequencing DSID, is the set of Downstream Resequencing Channel List, Sequence Change Count, and DSID Resequencing Wait time

NOTE: Downstream packets containing a Resequencing DSID and a sequence number are delivered, resequenced and forwarded according to the attributes of the Resequencing Context.

resequencing downstream service identifier: downstream service identifier for which the CMTS signals packet resequencing attributes

routing CMTS: CMTS that makes traffic forwarding decisions between its Network System Interfaces and MAC Domain Interfaces based upon the Layer 3 (network) address of a packet

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.

segment header ON: mode of Upstream DOCSIS3.0 Operation where segment headers are used for each segment. This mode is provisioned per upstream service flow

segment header OFF: mode of Upstream DOCSIS3.0 Operation where segment headers are not used for any segment

NOTE: This mode is provisioned per upstream service flow and prohibits fragmenting a packet across segment boundaries.

selectable active codes: methodology to determine the set of active codes and its complement, the set of unused codes

NOTE: In SAC mode 1, a consecutive set of codes starting with code 0 are unused. In SAC mode 2, the active codes are selectable via a 128-bit string.

Service Group (SG): is formally defined as the complete set of upstream and downstream channels that can provide service to a single subscriber device

NOTE: This includes channels from different DOCSIS MAC Domains and even different CMTSs as well as video EQAMs.

service identifier: Service Flow Identifier assigned by the CMTS (in addition to a Service Flow Identifier) to an Active or Admitted Upstream Service Flow. [14 bits] (SID)

SID cluster: group of SIDs containing one and only one SID for each upstream channel within an upstream bonding group and treated the same from a request/grant perspective

SID Cluster Group: set of all SID Clusters associated with a specific service flow

spreading codes: set of 128 binary sequences of 128 bits each which may be used to carry information in the S-CDMA upstream

NOTE: The spreading codes are orthogonal, meaning their cross-correlation is zero. Each code carries a single QAM symbol of information when the code's amplitude and phase are modulated.

spreading interval: Time to transmit a single complete S-CDMA spreading code, equal to the time to transmit 128 chips

NOTE: Also, time to transmit a single information (QAM) symbol on an S-CDMA channel.

timebase tick: 6.25-microsecond or 6.94-microsecond time intervals that are the reference for upstream mini-slot definition and upstream transmission times for TDMA channels

upstream bonded channel: one of a group of independent upstream RF channels whose data packets are logically combined into one higher-speed data stream

upstream bonding group: subcomponent object of a MAC Domain that collects and resequences/reassembles upstream segments from a ubsf from an administered set of ucs

upstream bonded service flow: upstream Service Flow for which Upstream MAC Frames or Segments are transmitted on one or more Upstream Channels

upstream service group: complete set of Upstream Channels (UCs) within a single CMTS potentially reachable by the transmission of a single Cable Modem

NOTE: In an HFC deployment, a US-SG corresponds to the physical combining of the upstream reverse carrier path signal from one or more Fiber Nodes reaching a single CMTS.

3.2 Abbreviations

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

ANSI	American National Standards Institute
ASN.1	Abstract Syntax Notation 1
BPI	Baseline Privacy Interface
CableLabs	Cable Television Laboratories, Inc.
CM	Cable Modem
CM-SG	Cable Modem Service Group
CMTS	Cable Modem Termination System
DCS	Downstream Channel Set
DER	Distinguished Encoding Rules
DES	Data Encryption Standard
DHCP	Dynamic Host Configuration Protocol
DHCPv4	IPv4 version of the Dynamic Host Configuration Protocol
DHCPv6	IPv6 version of the Dynamic Host Configuration Protocol
DOCSIS	Data-Over-Cable Service Interface Specifications
DS	Downstream
DSID	Downstream Service Identifier
DS-SG	Downstream Service Group
EH	Extended Header
EHDR	Extended MAC Header
FIPS	Federal Information Processing Standard
HFC	Hybrid Fiber-Coaxial
HMAC	Keyed-Hash Message Authentication Code
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISO	International Standards Organization
ITU	International Telecommunications Union
ITU-T	Telecommunication Standardization Sector of the International Telecommunication Union
MAC	Media Access Control
MD	Media Access Control Domain
MD-CM-SG	Media Access Control Domain Cable Modem Service Group

MD-DS-SG	Media Access Control Domain Downstream Service Group
MD-US-SG	Media Access Control Domain Upstream Service Group
MIB	Management Information Base
MLD	Multicast Listener Discovery
NSI	Network-Side Interface
PER	Packet Error Rate
PHY	Physical Layer
PIM	Protocol Independent Multicast
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
RCC	Receive Channel Configuration
RCP	Receive Channel Profile
RCS	Receive Channel Set
RF	Radio Frequency
RFC	Request For Comments
SA	Source Address
SAC	Selectable Active Codes
S-CDMA	Synchronous Code Division Multiple Access
SDL	Specification and Description Language
SG	Service Group
SID	Service Identifier
SM	Station Maintenance
SNMP	Simple Network Management Protocol
TDMA	Time Division Multiple Access
TFTP	Trivial File Transfer Protocol
US	Upstream
US-SG	Upstream Service Group

Endorsement notice

Modifications to ITU-T Recommendation J.222.2

The elements of ITU-T Recommendation J.222.2 [9] (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.222.2 as shown in table 1.

Table 1

	Reference(s) in J.222.2 [10]	Replaced reference(s)
1	ITU-T Recommendation J.222.1	ETSI TS 102 639-2
2	ITU-T Recommendation J.210	ETSI TS 102 639-3
3	ITU-T Recommendation J.222.2	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
7	ITU-T Recommendation J.163	ETSI TS 101 909-5
8	ITU-T Recommendation J.162	ETSI TS 101 909-4

Annex A (informative): Bibliography

ITU-T Recommendation J.212: "Downstream External PHY Interface for Modular Cable Modem Termination Systems".

ITU-T Recommendation J.211: "Timing Interface for Cable Modem Termination Systems".

ITU-T Recommendation J.126 : "eDOCSIS Specification".

ITU-T Recommendation J.213: "Layer 2 Virtual Private Networks for IP Cable Modem Systems".

ANSI/SCTE 79-2-2002: "DOCSIS 2.0 Operations Support System Interface" .

IETF RFC 4607: "Source-Specific Multicast for IPRFC", H. Holbrook, B. Cain.

IEEE 802.1D-2004: "IEEE standard for local and metropolitan area networks--Media access control (MAC) Bridges (Incorporates IEEE 802.1t-2001 and IEEE 802.1w)".

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ISO/IEC 10038 (ANSI/IEEE Std 802.1D): 1993: "Information technology -Telecommunications and information exchange between systems - Local area networks - Media access control (MAC) bridges.

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ITU-T Recommendation Z.100 (08/2002): "Formal description techniques (FDT) - Specification and Description Language (SDL)".

ITU-T Recommendation J.179: "IPCablecom Multimedia Specification".

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History

Document history		
V1.1.1	April 2009	Publication