International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.216

(07/2019)

SERIES J: CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Interactive systems for digital television distribution (DOCSIS third to fifth generations)

Second-generation modular headend architecture in systems for interactive cable television services – IP cable modems

Recommendation ITU-T J.216

Recommendation ITU-T J.216

Second-generation modular headend architecture in systems for interactive cable television services – IP cable modems

Summary

Recommendation ITU-T J.216 defines the second generation of headend architectures for high-speed data-over-cable systems. The second-generation of headend architecture introduces a number of new features that build upon what was present in previous Cabinet DOCSIS Recommendations ITU-T J.223.1 and ITU-T J.223.2. This Recommendation includes key new features for the CMC III device (also known as the remote-PHY device).

NOTE – The structure and content of this Recommendation have been organized for ease of use through direct reference to the original source material, based on the recognition of CableLabs by ITU as an ITU-T A.5 organization (https://www.itu.int/en/ITU-T/extcoop/Pages/sdo.aspx).

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T J.216	2019-07-29	9	11.1002/1000/13969

Keywords

CMC (cable media converter), Data over Cable Service Interface Specification, DOCSIS.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T J.216

Second-generation modular headend architecture in systems for interactive cable television services – IP cable modems

1 Scope

This Recommendation defines the second generation of headend architectures for high-speed data-over-cable systems. The second-generation of headend architecture introduces a number of new features that build upon what was present in previous Cabinet DOCSIS Recommendations [b-ITU-T J.223.1] and [b-ITU-T J.223.2]. This Recommendation includes key new features for the CMC III device (also known as the remote-PHY device).

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[DOCSIS MHAv2 GCP] Cable Television Laboratories, Inc., CM-SP-GCP-I04-180509, 9 May 2018, *Generic Control Plane Specification*.

[DOCSIS R-DEPI] Cable Television Laboratories, Inc., CM-SP-R-DEPI-I12-190307, 7 March, 2019, *Remote Downstream External PHY Interface Specification*.

[DOCSIS R-DTI] Cable Television Laboratories, Inc., CM-SP-R-DTI-I07-180509, 9 May 2018, *Remote DOCSIS Timing Interface*.

[DOCSIS R-OOB] Cable Television Laboratories, Inc., CM-SP-R-OOB-I10-180926, 26 September 2018, *Remote Out-of-Band Specification*.

[DOCSIS R-OSSI] Cable Television Laboratories, Inc., CM-SP-R-OSSI-I11-190121, 21 January 2019, *Remote PHY OSS Interface Specification*.

[DOCSIS R-PHY] Cable Television Laboratories, Inc., CM-SP-R-PHY-I12-190307, 7 March 7 2019, *Remote PHY Specification*.

[DOCSIS R-UEPI] Cable Television Laboratories, Inc., CM-SP-R-UEPI-I10-190307, 7 March 2019, *Remote Upstream External PHY Interface Specification*.

3 Definitions

3.1 Terms defined elsewhere

See *Section 3 – Terms and Definitions* in each of the Specifications listed in clause 2.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 remote PHY device: Equipment in the network that implements the second-generation modular headend architecture (MHAv2) specifications technology to provide conversion from digital Ethernet transport to analogue radio frequency (RF) transport.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CMC Cable Media Converter

DOCSIS Data over Cable Service Interface Specification

IP Internet Protocol

MHAv2 Second-generation Modular Headend Architecture

PHY Physical layer

RF Radio Frequency

For other abbreviationss, see Section 4 – *Abbreviations and Acronyms* in each of the Specifications listed in clause 2.

5 Conventions

None.

6 Second-generation modular headend architecture (MHAv2) in high-speed data-over-cable systems

6.1 Specifications for second generation modular headend architecture

The second-generation modular headend architecture (MHAv2) suite of Specifications are also known as DOCSIS MHAv2 Specifications. They have been readily and widely available since 2015. DOCSIS® is a registered trademark of Cable Television Laboratories, Inc. and is used in ITU-T Recommendations with permission.

This Recommendation is comprised of the specifications identified in clause 2. Preceding relevant ITU-T Recommendations are provided in Appendix I. Other references for the specifications listed in clause 2 are provided in the bibliography of this Recommendation.

Appendix I

Preceding relevant ITU-T Recommendations

(This appendix does not form an integral part of this Recommendation.)

The following is the list of preceding relevant ITU-T Recommendations:

[b-ITU-T G.8260] Recommendation ITU-T G.8260 (2015), *Definitions and terminology for synchronization in packet networks*.

[b-ITU-T G.8261] Recommendation ITU-T G.8261/Y.1361 (2019), *Timing and synchronization aspects in packet networks*.

[b-ITU-T G.8275.2] Recommendation ITU-T G.8275.2/Y.1369.2 (2016), *Precision time protocol telecom profile for phase/time synchronization with partial timing support from the network*.

[b-ITU-T J.112] Recommendation ITU-T J.112 (1998), *Transmission systems for interactive cable television services*.

[b-ITU-T J.122] Recommendation ITU-T J.122 (2007), *Second-generation transmission systems for interactive cable television services – IP cable modems*.

[b-ITU-T J.126] Recommendation ITU-T J.126 (2007), *Embedded Cable Modem device specification*.

[b-ITU-T J.162] Recommendation ITU-T J.162 (2007), *Network call signalling protocol for the delivery of time-critical services over cable television networks using cable modems*.

[b-ITU-T J.163] Recommendation ITU-T J.163 (2007), *Dynamic quality of service for the provision of real-time services over cable television networks using cable modems.*

[b-ITU-T J.179] Recommendation ITU-T J.179 (2005), *IPCablecom support for multimedia*.

[b-ITU-T J.210] Recommendation ITU-T J.210 (2006), *Downstream RF interface for cable modem termination systems*.

[b-ITU-T J.211] Recommendation ITU-T J.211 (2006), *Timing interface for cable modem termination systems*.

[b-ITU-T J.212] Recommendation ITU-T J.212 (2006), *Downstream external Physical layer interface for modular cable modem termination systems*.

[b-ITU-T J.213] Recommendation ITU-T J.213 (2006), *Layer 2 virtual private networks for IP cable modem systems*.

[b-ITU-T J.222.1] Recommendation ITU-T J.222.1 (2007), *Third-generation transmission systems for interactive cable television services – IP cable modems: Physical layer specification*.

[b-ITU-T J.222.2] Recommendation ITU-T J.222.2 (2007), *Third generation transmission systems for interactive cable television services – IP cable modems: MAC and Upper Layer protocols*.

[b-ITU-T J.222.3] Recommendation ITU-T J.222.3 (2007), *Third-generation transmission systems for interactive cable television services – IP cable modems Security services*.

[b-ITU-T J.223.1] Recommendation ITU-T J.223.1 (2016), *Functional requirements for Cabinet DOCSIS (C-DOCSIS)*.

[b-ITU-T J.223.2] Recommendation ITU-T J.223.2 (2016), *Cabinet DOCSIS (C-DOCSIS) system specification*.

[b-ITU-T X.25] Recommendation ITU-T X.25 (1996), *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit*.

[b-ITU-T X.509] Recommendation ITU-T X.509 (2016), *Information technology – Open Systems Interconnection – The Directory: Public-key and attribute certificate frameworks*.

[b-ITU-T Z.100] Recommendation ITU-T Z.100 (2016), *Specification and Description Language – Overview of SDL-2010*.

Bibliography

Other references for specifications listed in clause 2

This bibliography lists other references for the specifications listed in clause 2 of this Recommendation:

[b-ARPD] Advanced Return Path Demodulator (ARPD) Interface Protocol, Revision x.1, 8/10/2015. For details on obtaining this document and the concomitant ARPD MIB contact Jorge Salinger, VP Access Architecture, Comcast. jorge_salinger@cable.comcast.com

[b-CANN] CableLabs Assigned Names and Numbers, CL-SP-CANN-I19-1900422, April 22, 2019, Cable Television Laboratories, Inc.

[b-CCAP-CONFIG-YANG] CCAP YANG Configuration Module, rphy@2018-04-12.yang. http://www.cablelabs.com/YANG/DOCSIS/rphy/

[b-CCAP-EVENTS-YANG] CCAP YANG Module for Event Messaging, CCAPevents.yang. http://www.cablelabs.com/YANG/DOCSIS

[b-CCAP-OSSIv3.1] DOCSIS 3.1 CCAP OSSI Specification, CM-SP-CCAP-OSSIv3.1-I15-190422, April 22, 2019, Cable Television Laboratories, Inc.

[b-CLAB-DEF-MIB] CableLabs Definition MIB Specification, CLAB-DEF-MIB. http://www.cablelabs.com/MIBs/common/

[b-CLAB-TOPO-MIB] CableLabs Topology MIB, CLAB-TOPO-MIB. http://www.cablelabs.com/MIBs/common/

[b-CM-OSSIv3.1] DOCSIS 3.1 Cable Modem OSSI Specification, CM-SP-CM-OSSIv3.1- I15-190422, April 22, 2019, Cable Television Laboratories, Inc.

[b-DEPI] Downstream External PHY Interface Specification, CM-SP-DEPI-I08-100611, June 11, 2010, Cable Television Laboratories, Inc.

[b-DOCS-BPI2EXT-MIB] DOCSIS Baseline Privacy Plus Extension MIB Module, DOCS-BPI2EXT-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCS-DIAG-MIB] DOCSIS Diagnostic Log MIB, DOCS-DIAG-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCS-IF3-MIB] DOCSIS Interface 3 MIB Module, DOCS-IF3-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCS-IF31-MIB] DOCSIS Interface 3.1 MIB Module, DOCS-IF31-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCS-IFEXT2-MIB] DOCSIS Interface Extension 2 MIB Module, DOCS-IFEXT2-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCSIS PHY] Refers to both [PHYv3.0] and [PHYv3.1].

[b-DOCS-PNM-MIB] DOCSIS PNM MIB Module, DOCS-PNM-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCS-RPHY-CTRL-MIB] DOCSIS Remote PHY Control MIB Module, DOCS-RPHY-CTRL-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCS-RPHY-MIB] DOCSIS Remote PHY MIB Module, DOCS-RPHY-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCS-RPHY-PTP-MIB] DOCSIS Remote PHY PTP MIB Module, DOCS-RPHY-PTP-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCS-RPHY-SEC-MIB] DOCSIS Remote PHY Security MIB Module, DOCS-RPHY-SEC-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DOCS-RPHY-ST-MIB] DOCSIS Remote PHY Statistics MIB Module, DOCS-RPHY-STATS-MIB. http://www.cablelabs.com/MIBs/DOCSIS/

[b-DRFI] DOCSIS Downstream Radio Frequency Interface, CM-SP-DRFI-I16-170111, January 11, 2017, Cable Television Laboratories, Inc.

[b-DSG] DOCSIS Set-top Gateway, CM-SP-DSG-I25-170906, September 6, 2017, Cable Television Laboratories, Inc.

[b-DTI] DOCSIS Timing Interface, CM-SP-DTI-I06-150305, March 5, 2015, Cable Television Laboratories, Inc.

[b-EQAM-VSI] Edge QAM Video Stream Interface Specification, CM-SP-EQAM-VSI-I01-081107, November 7, 2008, Cable Television Laboratories, Inc.

[b-FIPS-46-3] Federal Information Processing Standards Publications 46-3, Data Encryption Standard (DES), October 25, 1999. http://csrc.nist.gov/publications/fips/archive/fips46-3/fips46-3.pdf

[b-FIPS-140-2] Federal Information Processing Standards Publication (FIPS PUB) 140-2, Security Requirements for Cryptographic Modules, May 2001.

[b-FIPS 180-4] Federal Information Processing Standards Publication (FIPS PUB) 180-4, Secure Hash Standard, August 2015.

[b-FIPS-197] Federal Information Processing Standards Publications 197, Specification for the Advanced Encryption Standard (AES), November 26, 2001.

[b-IANA-PORTS] IANA, Port Numbers, June 2004.

[b-IEEE 1588] IEEE-1588-2008, *Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*, July 2008. http://standards.ieee.org/findstds/standard/1588-2008.html

[b-IEEE 802.1ab] IEEE Std 802.1ab-2016, *IEEE Standard for Station and Media Access Control Connectivity Discovery*, March 2016.

[b-IEEE 802.1ae] IEEE Std 802.1ae-2006, *IEEE Standard for Local and metropolitan area networks-Media Access Control (MAC) Security*, August 2006.

[b-IEEE 802.1q] IEEE Std 802.1Q-2003, *Virtual Bridged Local Area Networks*, May 2003.

[b-IEEE 802.1x] IEEE Std 802.1x-2010, *IEEE Standard for Local and metropolitan area networks – Port-Based Network Access Control*, February 2010.

[b-IEEE 802.3] IEEE Std 802.3-2002, *Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*, March 2002.

[b-IEEE 802.3as] 802.3as-2006 – *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*.

[b-IETF RFC 768] IETF RFC 768, *User Datagram Protocol*, August 1980.

[b-IETF RFC 791] IETF RFC 791, *Internet Protocol-DARPA*, September 1981.

[b-IETF RFC 793] IETF RFC 793, *Transmission Control Protocol-DARPA*, September 1981.

[b-IETF RFC 868] IETF RFC 768, *Time Protocol*, May 1983.

[b-IETF RFC 1191] IETF RFC 1191, *MTU Path Discovery*, November 1990.

[b-IETF RFC 1350] IETF RFC 1350/STD0033, *The TFTP Protocol* (Revision 2), July 1992.

[b-IETF RFC 1700] IETF RFC 1700, *Assigned Numbers*, October 1994.

[b-IETF RFC 1945] IETF RFC 1945, *Hypertext Transfer Protocol* – HTTP/1.0, May 1996.

[b-IETF RFC 1981] IETF RFC 1981, *Path MTU Discovery for IP version 6*, August 1996.

[b-IETF RFC 2131] IETF RFC 2131, *Dynamic Host Configuration Protocol*, March 1997.

[b-IETF RFC 2313] IETF RFC 2313, *PKCS #1: RSA Encryption Version 1.5*, March 1998.

[b-IETF RFC 2315] IETF RFC 2315, *Cryptographic Message Syntax Version 1.5*, March 1998.

[b-IETF RFC 2348] IETF RFC 2348, *TFTP Blocksize Option*, May 1998.

[b-IETF RFC 2460] IETF RFC 2460, *Internet Protocol, Version 6 (IPv6) Specification*, December 1998.

[b-IETF RFC 2474] IETF RFC 2474, *Differentiated Services Field (DS Field)*, December 1998.

[b-IETF RFC 2560] IETF RFC 2560, *X.509 Internet Public Key Infrastructure Online Certification Status Protocol – OCSP*, June 1999.

[b-IETF RFC 2573] IETF RFC 2573, *SNMP Applications*, April 1999.

[b-IETF RFC 2575] IETF RFC 2575, *View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)*, April 1999.

[b-IETF RFC 2578] IETF RFC 2578, *Structure of Management Information Version 2 (SMIv2)*, April 1999.

[b-IETF RFC 2597] IETF RFC 2597, *Assured Forwarding PHB Group*, June 1999.

[b-IETF RFC 2616] IETF RFC 2616, *Hypertext Transfer Protocol – HTTP/1.1*, June 1999.

[b-IETF RFC 2669] IETF RFC 2669, *DOCSIS Cable Device MIB Cable Device Management Information Base for DOCSIS compliant Cable Modems and Cable Modem Termination Systems*, August 1999.

[b-IETF RFC 2684] IETF RFC 2684, *Multiprotocol Encapsulation over ATM Adaptation Layer 5*, September 1999.

[b-IETF RFC 2786] IETF RFC 2786, *Diffie-Helman USM Key Management*, March 2000.

[b-IETF RFC 2790] IETF RFC 2790, *Host Resources MIB*, March 2000.

[b-IETF RFC 2856] IETF RFC 2856, *Textual Conventions for Additional High Capacity Data Types*, June 2000.

[b-IETF RFC 2863] IETF RFC 2863, *The Interfaces Group MIB*, June 2000.

[b-IETF RFC 2983] IETF RFC 2983, *Differentiated Services and Tunnels*, October 2000.

[b-IETF RFC 3164] IETF RFC 3164, *The BSD Syslog Protocol*, August 2001.

[b-IETF RFC 3246] IETF RFC 3246, *An Expedited Forwarding PHB (Per-Hop Behavior)*, March 2002.

[b-IETF RFC 3260] IETF RFC 3260, *New Terminology and Clarifications for Diffserv*, April 2002.

[b-IETF RFC 3289] IETF RFC 3289, *Management Information Base for the Differentiated Services Architecture*, June 2002.

[b-IETF RFC 3308] IETF RFC 3308, *Layer Two Tunneling Protocol (L2TP) Differentiated Services Extension*, November 2002.

[b-IETF RFC 3315] IETF RFC 3315, *Dynamic Host Configuration Protocol for IPv6*, July 2003.

[b-IETF RFC 3412] IETF RFC 3412, *Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)*, December 2002.

[b-IETF RFC 3418] IETF RFC 3418/STD0062, *Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)*, December 2002.

[b-IETF RFC 3433] IETF RFC 3433, *Entity Sensor Management Information Base*, December 2002.

[b-IETF RFC 3584] IETF RFC 3584, *Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework*, August 2003.

[b-IETF RFC 3635] IETF RFC 3635, *Definitions of Managed Objects for the Ethernet-like Interface Types*, October 2003.

[b-IETF RFC 3748] IETF RFC 3748, *Extensible Authentication Protocol (EAP)*, June 2004.

[b-IETF RFC 3931] IETF RFC 3931, *Layer Two Tunneling Protocol – Version 3 (L2TPv3)*, March 2005.

[b-IETF RFC 3986] IETF RFC 3986, *Uniform Resource Identifier (URI): Generic Syntax*, January 2005.

[b-IETF RFC 4022] IETF RFC 4022, *Management Information Base for the Transmission Control Protocol (TCP)*, March 2005.

[b-IETF RFC 4113] IETF RFC 4113, *Management Information Base for the User Datagram Protocol (UDP)*, June 2005.

[b-IETF RFC 4122] IETF RFC 4122, *A Universally Unique IDentifier (UUID) URN Namespace*, July 2005.

[b-IETF RFC 4131] IETF RFC 4131, *Management Information Base for Data Over Cable Service Interface Specification (DOCSIS) Cable Modems and Cable Modem Termination Systems for Baseline Privacy Plus*, September 2005.

[b-IETF RFC 4188] IETF RFC 4188, *Definitions of Managed Objects for Bridges*, September 2005.

[b-IETF RFC 4250] IETF RFC 4250, *The Secure Shell (SSH) Protocol Assigned Numbers*, January 2006.

[b-IETF RFC 4251] IETF RFC 4251, *The Secure Shell (SSH) Protocol Architecture*, January 2006.

[b-IETF RFC 4252] IETF RFC 4252, *The Secure Shell (SSH) Authentication Protocol*, January 2006.

[b-IETF RFC 4253] IETF RFC 4253, *The Secure Shell (SSH) Transport Layer Protocol*, January 2006.

[b-IETF RFC 4254] IETF RFC 4254, *The Secure Shell (SSH) Connection Protocol*, January 2006.

[b-IETF RFC 4291] IETF RFC 4291, *IP Version 6 Addressing Architecture*, February 2006.

[b-IETF RFC 4293] IETF RFC 4293, *Management Information Base for the Internet Protocol (IP)*, April 2006.

[b-IETF RFC 4307] IETF RFC 4307, *Cryptographic Algorithms for Use in the Internet Key Exchange Version 2 (IKEv2)*, December 2005.

[b-IETF RFC 4546] IETF RFC 4546, *Radio Frequency (RF) Interface Management Information Base for Data over Cable Service Interface Specifications (DOCSIS) 2.0 Compliant RF Interfaces*, June 2006.

[b-IETF RFC 4639] IETF RFC 4639, *Cable Device Management Information Base for Data-Over-Cable Service Interface Specification (DOCSIS) Compliant Cable Modems and Cable Modem Termination Systems*, December 2006.

[b-IETF RFC 4821] IETF RFC 4821, *Packetization Layer Path MTU Discovery*, March 2007.

[b-IETF RFC 4861] IETF RFC 4861, *Neighbor Discovery for IP version 6*, September 2007.

[b-IETF RFC 4862] IETF RFC 4862, *IPv6 Stateless Address Autoconfiguration*, September 2007.

[b-IETF RFC 4868] IETF RFC 4868, *Using HMAC-SHA-256, HMAC-SHA-384, and HMAC-SHA-512 with IPsec*, May 2007.

[b-IETF RFC 4941] IETF RFC 4941, *Privacy Extensions for Stateless Address Autoconfiguration in IPv6*, September 2007.

[b-IETF RFC 5085] IETF RFC 5085, *Pseudowire Virtual Circuit Connectivity Verification (VCCV): A Control Channel for Pseudowires*, December 2007.

[b-IETF RFC 5216] IETF RFC 5216, *IEAP-TLS Authentication Protocol*, March 2008.

[b-IETF RFC 5247] IETF RFC 5247, *EAP Key Management Framework*, August 2008.

[b-IETF RFC 5277] IETF RFC 5277, *NETCONF Event Notifications*, July 2008.

[b-IETF RFC 5280] IETF RFC 5280, *Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile*, May 2008.

[b-IETF RFC 5601] IETF RFC 5601, *Pseudowire (PW) Management Information Base (MIB)*, July 2009.

[b-IETF RFC 5612] IETF RFC 5612, *Enterprise Number for Documentation Use*, August 2009.

[b-IETF RFC 6021] IETF RFC 6021, *Common YANG Data Types*, October 2010.

[b-IETF RFC 6668] IETF RFC 6668, *SHA-2 Data Integrity Verification for the Secure Shell (SSH) Transport Layer Protocol*.

[b-IETF RFC 6933] IETF RFC 6933, *Entity MIB (Version 4)*, May 2013.

[b-IETF RFC 6935] IETF RFC 6935, *IPv6 and UDP Checksums for Tunneled Packets*, April 2013.

[b-IETF RFC 6960] IETF RFC 6960, *I.509 Internet Public Key Infrastructure Online Certificate Status Protocol – OCSP*, June 2013.

[b-IETF RFC 6991] IETF RFC 6991, *Common YANG Data Types*, July 2013.

[b-IETF RFC 7296] IETF RFC 7296, *Internet Key Exchange Protocol Version 2 (IKEv2)*, October 2014.

[b-IETF RFC 7880] IETF RFC 7880, *Seamless Bidirectional Forwarding Detection (S-BFD)*, July 2016.

[b-IETF RFC 7885] IETF RFC 7885, *Seamless Bidirectional Forwarding Detection (S-BFD) for Virtual Circuit Connectivity Verification (VCCV)*, July 2016.

[b-IETF RFC 7886] IETF RFC 7886, *Advertising Seamless Bidirectional Forwarding Detection (S-BFD) Discriminators in the Layer Two Tunneling Protocol Version 3 (L2TPv3)*, July 2016.

[b-IETF RFC 8017] IETF RFC 8017, *PKCS #1: RSA Cryptography Specifications Version 2.2*, November 2016

[b-ISO 13818-1] ISO/IEC 13818-1:2013, *Information technology, Generic Coding of Moving Pictures and Associated Audio Information. Part 1: System*, May 23, 2013.

[b-ISO 6709] ISO 6709:2008, *Standard representation of geographic point location by coordinates*.

[b-ISO/IEC-61169-24] ISO/IEC-61169-24, *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)*, February 1, 2009.

[b-L2VPN] Layer 2 Virtual Private Networks, CM-SP-L2VPN-I15-150528, May 28, 2015, Cable Television Laboratories, Inc.

[b-MULPIv3.0] DOCSIS MAC and Upper Layer Protocols Interface Specification, CM-SP-MULPIv3.0-C01-171207, December 7, 2017, Cable Television Laboratories, Inc.

[b-MULPIv3.1] DOCSIS 3.1 MAC and Upper Layer Protocols Interface Specification, CM-SP-MULPIv3.1-I18-190422, April 22, 2019, Cable Television Laboratories, Inc.

[b-OSSIv3.0] Operations Support System Interface Specification, CM-SP-OSSIv3.0-C01-171207, December 7, 2017, Cable Television Laboratories, Inc.

[b-PHYv3.0] DOCSIS 3.0 Physical Layer Specification, CM-SP-PHYv3.0-C01-171207, December 07, 2017, Cable Television Laboratories, Inc.

[b-PHYv3.1] DOCSIS 3.1 Physical Layer Specification, CM-SP-PHYv3.1-I16-190121, January 21, 2019, Cable Television Laboratories, Inc.

[b-RFIv2.0] DOCSIS Radio Frequency Interface Specification, CM-SP-RFIv2.0-C02-090422, April 22, 2009, Cable Television Laboratories, Inc.

[b-RMI-ERM-EDGE] Edge Resource Manager – Edge Device Interface Specification, CM-SP-RMI-ERM-EDGE-I02-150528, May 28, 2015, Cable Television Laboratories, Inc.

[b-RSA 3] RSA Laboratories, PKCS #3: Diffie-Hellman Key Agreement Standard, Version 1.4, RSA Security, Inc., Bedford, MA, November 1993.

[b-S-BFD-BASE] S-BFD Base Internet draft http://datatracker.ietf.org/doc/draft-ietf-bfd-seamless-base

[b-S-BFD-DSR-L2TP] S-BFD discriminator for L2TPv3, http://tools.ietf.org/html/draft-gp-l2tpext-sbfd-discriminator-00

[b-S-BFD-VCCV] S-BFD for VCCV, http://tools.ietf.org/html/draft-gp-pals-seamless-vccv-00

[b-SCTE 02] ANSI/SCTE 02, *Specification for "F" Port*, Female Indoor, 2015.

[b-SCTE 55-1] ANSI/SCTE 55-2009, *Digital Broadband Delivery System: Out of Band Transport Part 1: Mode A.*

[b-SCTE 55-2] ANSI/SCTE 55-2-2008, *Digital Broadband Delivery System: Out of Band Transport Part 2: Mode B.*

[b-SCTE 154-2] ANSI SCTE 154-2 2008, *SCTE-HMS-QAM-MIB.*

[b-SCTE 154-5] ANSI SCTE 154-5 2008, *SCTE-HMS-HEADENDIDENT TEXTUAL CONVENTIONS MIB.*

[b-SECv3.0] DOCSIS 3.0 Security Specification, CM-SP-SECv3.0-C01-171207, December 7, 2017, Cable Television Laboratories, Inc.

[b-SECv3.1] DOCSIS 3.1 Security Specification, CM-SP-SECv3.1-I07-170111, January 11, 2017, Cable Television Laboratories, Inc.

[b-SFF 8472] SFF Committee, SFF-8472 Specification for Diagnostic Monitoring Interface for Optical Transceivers, Rev 11.0, September 14, 2010.

[b-SYNC]	Synchronization Techniques for DOCSIS Technology Specification, CM-SP-SYNC-D01-180730, July 30, 2018, Cable Television Laboratories, Inc.
[b-Vendor ID]	Refers to IETF RFC 3232 "Assigned Number" by the IETF, Jan 2002. This spec refers to the IANA web page which is http://www.iana.org/assignments/enterprise-numbers
[b-W3 XML1.0]	Extensible Markup Language (XML) 1.0 (Third Edition), W3C Recommendation 04, February 2004.
[b-W3 XSD1.0]	XML Schema Part 1: Structures Second Edition, W3C Recommendation 28, October 2004.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	**Cable networks and transmission of television, sound programme and other multimedia signals**
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2019