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Recommendation

ITU-T J.224 (07/2023)

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)

Fifth-generation transmission systems for interactive cable television services – IP cable modems

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Recommendation ITU-T J.224

Fifth-generation transmission systems for interactive cable television services – IP cable modems

Summary

Recommendation ITU-T J.224 specifies the fifth-generation of high-speed data-over-cable systems. Fifth-generation transmission systems introduce a number of new features that build upon what was present in previous ITU-T Recommendations, namely ITU-T J.112, ITU-T J.122, the ITU-T J.222.x-series and the ITU-T J.223.x-series. Recommendation ITU-T J.224 includes key new features for the physical (PHY) layer and establishes a full duplex data-over-cable service interface specification (DOCSIS) mode of operation, including enhancements to media access control (MAC) layer protocols, as well as requirements for those in the upper layer, e.g., the Internet protocol (IP) and dynamic host configuration protocol (DHCP). Fifth-generation cable modem specifications fully incorporate those of the fourth generation.

NOTE – The structure and content of Recommendation ITU-T J.224 has been organized for ease of use through direct reference to the original source material, based on the recognition of CableLabs by ITU in accordance with Recommendation ITU-T A.5.

History *

Edition	Recommendation	Approval	Study Group	Unique ID
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Data-over-cable service interface specification, DOCSIS.

* To access the Recommendation, type the URL https://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID.

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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.

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Recommendation ITU-T J.224

Fifth-generation transmission systems for interactive cable television services – IP cable modems

1 Scope

This Recommendation specifies the fifth-generation of high-speed data-over-cable systems. Fifth-generation transmission systems introduce a number of new features that build upon what was present in previous ITU-T Recommendations, namely [b-ITU-T J.112], [b-ITU-T J.122], [b-ITU-T J.222.x] and [b-ITU-T J.223.x] listed in Appendix I. This Recommendation includes key new features for the physical (PHY) layer and establishes full duplex (FDX) and frequency division duplex (FDD) data-over-cable service interface specification (DOCSIS) modes of operation, including enhancements to the media access control (MAC) layer protocols, as well as requirements for those in the upper layer, e.g., the Internet protocol (IP) and dynamic host configuration protocol (DHCP). Fifth-generation cable modem specifications fully incorporate those of the fourth generation. [b-ITU-T J-Sup.10] records the correspondence between DOCSIS specifications and ITU-T Recommendations.

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 CCAP-OSSIv4.0] Cable Television Laboratories, Inc., CM-SP-CCAP-OSSIv4.0-I08-221116 (2022), *Data-over-cable service interface specifications, DOCSIS 4.0 – CCAP operations support system interface, specification*. Cable Television Laboratories, Inc.

[DOCSIS CM-OSSIv4.0] Cable Television Laboratories, Inc., CM-SP-CM-OSSIv4.0-I07-221116 (2022), *Data-over-cable service interface specifications, DOCSIS 4.0 – Cable modem operations support system interface, specification*. Cable Television Laboratories, Inc.

[DOCSIS MULPIv4.0] Cable Television Laboratories, Inc., CM-SP-MULPIv4.0-I06-221019 (2022), *Data-over-cable service interface specifications, DOCSIS 4.0 – MAC and upper layer protocols interface, specification*. Cable Television Laboratories, Inc.

[DOCSIS PHYv4.0] Cable Television Laboratories, Inc., CM-SP-PHYv4.0-I06-221019 (2022), *Data-over-cable service interface specifications, DOCSIS 4.0 – Physical layer specification*. Cable Television Laboratories, Inc.

[DOCSIS SECv4.0] Cable Television Laboratories, Inc., CM-SP-SECv4.0-I05-221019 (2022), *Data-over-cable service interface specifications, DOCSIS 4.0 – Security specification*. Cable Television Laboratories, Inc.

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3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 frequency division duplex (FDD) data-over-cable service interface specification (DOCSIS) mode: An extension of the fourth generation of cable modem specifications supporting legacy high-split and also providing extended splits up to 684 MHz in an operational band plan which is referred to as ultra-high split (UHS). The FDD mode of operation also introduces expansion of usable downstream spectrum up to 1794 MHz.

3.2.2 full duplex (FDX) data-over-cable service interface specification (DOCSIS) mode: An extension of the fourth generation of cable modem specifications that is targeted at significantly increasing upstream capacity by using the spectrum currently used for downstream transmission for simultaneous upstream and downstream communications.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

DHCP	Dynamic Host Configuration Protocol
DOCSIS	Data-Over-Cable Service Interface Specification
FDD	Frequency Division Duplex
FDX	Full Duplex
IP	Internet Protocol
MAC	Media Access Control
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
PHY	Physical
QAM	Quadrature Amplitude Modulation
UHS	Ultra-High Split

For other abbreviations, see clause 4 – *Abbreviations and Acronyms* in each of the specifications listed in clause 2.

5 Conventions

None.

6 Overview of fifth-generation high-speed data-over-cable systems

6.1 Specifications for fifth-generation high-speed data-over-cable systems

With fifth-generation high-speed data-over-cable systems, global technical specifications have been achieved. As such, it is a general practice of cable operators worldwide to reference the same high quality CableLabs specifications when making purchasing decisions. These specifications have

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been readily and widely available since late 2019, but certification of cable modem devices has not yet occurred.

The fifth-generation high-speed data-over-cable systems specifications are also known as DOCSIS 4.0 specifications.[1]

The DOCSIS 4.0 specifications introduce several features that increase the capability and application of the technology as follows.

1) The use of orthogonal frequency division multiplexing (OFDM) in the downstream and orthogonal frequency division multiple access (OFDMA) in the upstream, increases the transmission efficiency (expressed in bits per hertz) over single carrier quadrature amplitude modulation (QAM). OFDM enables higher bandwidth capacity over the same amount of spectrum when compared to previous generations of DOCSIS with the potential for 10 Gbit/s service tiers over coax.

2) The specification of a full duplex (FDX) mode of operation enabling the concurrent use of spectrum for both upstream and downstream transmission, thereby greatly increasing the upstream capacity. This provides the ability to provide symmetric multi-gigabit services over coax.

3) The specification of a frequency division duplex (FDD) mode of operation supporting legacy high-split and also providing extended splits up to 684 MHz in an operational band plan is referred to as an ultra-high split (UHS). The FDD mode of operation also introduces the expansion of usable downstream spectrum up to 1 794 MHz.

4) The specification of multiple modulation profiles enabling cable modems to operate at different modulation orders and to dynamically optimize the transmission capacity for the channel conditions it is experiencing. This improves the operational efficiency by not constraining all cable modems to operate at the lowest modulation order supported by the network.

5) The specification of a full-band spectrum capture that enables the analysis of the full spectrum as measured from the cable modem enabling sophisticated proactive diagnostics of network issues prior to customer impacting events.

6) The specification of additional security features to enhance the robustness of the DOCSIS network in the face of malicious cyberattacks.

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

6.2 CableLabs DOCSIS certification programme

In addition to developing the specifications for DOCSIS, CableLabs also conducts interoperability and compliance testing to validate products that implement the DOCSIS specifications. Details of the CableLabs certification programme can be found at: https://www.cablelabs.com/certification.

The DOCSIS specifications are living documents and are updated three to four times per year under a strict engineering change request and document control process. Consequently, it is important that manufacturers of DOCSIS products understand exactly the requirements against which they are being tested for certification. The CableLabs specification and certification process links the engineering change requests with the certification testing with sufficient time allowed for manufacturers to implement the required changes. In this way, knowing when a product has been certified, it is possible to know exactly which version of the DOCSIS specifications was used.

[1] DOCSIS® is a registered trademark of Cable Television Laboratories, Inc. and is used in ITU-T Recommendations with permission.

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Appendix I

Preceding relevant ITU-T Recommendations

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

The following list provides preceding relevant ITU-T Recommendations:

[b-ITU-T G.8275.1] Recommendation ITU-T G.8275.1/Y.1369.1 (2022), *Precision time protocol telecom profile for phase/time synchronization with full timing support from the network*.

[b-ITU-T J.83] Recommendation ITU-T J.83 (2007), *Digital multi-programme systems for television, sound and data services for cable distribution*.

[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.x] Recommendations ITU-T J.222.x-series (2007), *Third-generation transmission systems for interactive cable television services – IP cable modems*.

[b-ITU-T J.223.x] Recommendation ITU-T J.223.x-series (2016), *Cabinet DOCSIS (C-DOCSIS) functional requirements; 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 (2019) | ISO/IEC 9594-8:2020, *Information technology – Open systems interconnection – Part 8: The Directory: Public key and attribute certificate frameworks*.

[b-ITU-T X.690] Recommendation ITU-T X.690 (2021) | ISO/IEC 8825-1:2021, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*.

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