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MULTIMEDIA SIGNALS

Cable set-top box

**Requirements and functional specification of
cable set-top box for 4K ultra high definition
television**

Recommendation ITU-T J.297

ITU-T



Recommendation ITU-T J.297

Requirements and functional specification of cable set-top box for 4K ultra high definition television

Summary

Recommendation ITU-T J.297 specifies requirements and functional specification for 4K cable set-top box (STB) that enables 4K ultra high definition television (UHDTV) service reception over cable network and considers the compatibility and differences with the existing 2K cable STB.

History

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Introduction

4K ultra high definition television (UHDTV) service provides better video quality than 2K high definition television (HDTV) service. It has been already deployed in a variety of media markets such as movies, mobile communications and personal computers. Some first commercial products (e.g., TV sets with 4K screen) and 4K IP-VoD services already are emerging on the markets.

On the other hand, a new video coding method which provides twice as much compression efficiency as AVC [ITU-T H.264] was standardized as HEVC [ITU-T H.265]. Much higher quality video services are possible in the broadcasting field thanks to this technology.

Under these circumstances, a 4K video service trial for the 2014 world cup was conducted in Brazil, and in 2015 a 4K video commercial service was started by satellite broadcasting, IPTV and cable networks. As a consequence it was expected that by the time of the next Olympic games in 2016 in Brazil, many cable customers had been enjoying higher-resolution television programmes at home by STB.

Considering the rapid development of 4K UHDTV on the global market, this Recommendation, which focuses on the requirements and functional specifications for 4K UHDTV, was needed.

The support of HEVC video decoding for 4K resolutions of the Internet protocol television (IPTV) terminal device are specified in [ITU-T H.721].

Recommendation ITU-T J.297

Requirements and functional specification of cable set-top box for 4K ultra high definition television

1 Scope

This Recommendation specifies the requirements and functional specification of cable set-top box (STB) for 4K ultra high definition television (UHDTV).

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 standalone document, the status of a Recommendation.

- [ITU-T H.222.0] Recommendation ITU-T H.222.0 (2014) | ISO/IEC 13818-1:2015, *Information technology – Generic coding of moving pictures and associated audio information – Part 1: Systems.*
- [ITU-T H.262] Recommendation ITU-T H.262 (2012) | ISO/IEC 13818-2: 2013, *Information technology – Generic coding of moving pictures and associated audio information – Part 2: Video.*
- [ITU-T H.264] Recommendation ITU-T H.264 (2016) | ISO/IEC 14496-10 (2012), *Information technology – Coding of audio-visual objects – Part 10: Advanced Video Coding.*
- [ITU-T H.265] Recommendation ITU-T H.265 (2015) | ISO/IEC 23008-2 (2013), *High Efficiency Video Coding.*
- [ITU-T H.701] Recommendation ITU-T H.701 (2009), *Content delivery error recovery for IPTV services.*
- [ITU-T H.721] Recommendation ITU-T H.721 (2015), *IPTV terminal devices: Basic model.*
- [ITU-T H.750] Recommendation ITU-T H.750 (2008), *High-level specification of metadata for IPTV services.*
- [ITU-T J.83] Recommendation ITU-T J.83 (2007), *Digital multi-programme systems for television, sound and data services for cable distribution.*
- [ITU-T J.122] Recommendation ITU-T J.122 (2007), *Second-generation transmission systems for interactive cable television services – IP cable modems.*
- [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.*
- [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.*
- [ITU-T J.288] Recommendation ITU-T J.288 (2016), *Encapsulation of type-length-value (TLV) packet for cable transmission systems.*

- [ITU-T J.295] Recommendation ITU-T J.295 (2012), *Advanced cable set-top box requirement*.
- [ITU-T J.296] Recommendation ITU-T J.296 (2012), *Specification for Hybrid Cable Set-Top Box*.
- [ITU-T J.1005] Recommendation ITU-T J.1005 (2015), *Architecture and requirements of digital rights management (DRM) for cable television multiscreen*.
- [ITU-T J.1006] Recommendation ITU-T J.1006 (2016), *Specification of IP-VOD DRM for cable television multiscreen system in Multi-DRM environment*.
- [ITU-T Y.1910] Recommendation ITU-T Y.1910 (2008), *IPTV functional architecture*.
- [ITU-R BT.709] Recommendation ITU-R BT.709 (2015), *Parameter values for the HDTV standards for production and international programme exchange*.
- [ITU-R BT.2020] Recommendation ITU-R BT.2020 (2015), *Parameter values for ultra-high definition television systems for production and international programme exchange*.
- [ISO/IEC 14496-12] ISO/IEC 14496-12:2015, *Information technology – Coding of audio-visual objects – Part 12: ISO Base Media File Format*.
- [ISO/IEC 23001-7] ISO/IEC 23001-7:2016, *Information technology – MPEG systems technologies – Part 7: Common encryption in ISO base media file format files*.
- [ISO/IEC 23008-1] ISO/IEC 23008-1:2014, *Information technology – High efficiency coding and media delivery in heterogeneous environments – Part 1: MPEG media transport*.
- [ISO/IEC 23009-1] ISO/IEC 23009-1:2014, *Information technology – Dynamic adaptive streaming over HTTP (DASH) – Part 1: Media presentation description and segment formats*.
- [BBF TR069] Broadband Forum (2013), *CPE WAN Management Protocol Version 1.4*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 ultra high definition television (UHDTV) [ITU-R BT.2020]: UHDTV provides viewers with an enhanced visual experience primarily by a wider field of view that covers a considerable part of the human natural visual field with appropriate screen sizes relevant to usage at home and in public places. Signal formats contributing to increasing the compression efficiency are desirable for UHDTV systems as they have a larger number of pixels than HDTV systems.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 4K UHDTV: supports 3,840 × 2,160 resolution and 60p frame frequency specified in [ITU-R BT.2020].

3.2.2 RCU: The equipment used by users when they operate STB remotely.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API	Application Program Interface
AVC	Advanced Video Coding
BS	Broadcast Satellite television
CAS	Conditional Access System
CDN	Content delivery Network
CENC	Common Encryption
CP	Contents Provider
DOCSIS	Data Over Cable Service Interface Specifications
DRM	Digital Rights Management
ECM	Entitlement Control Message.
EMM	Entitlement Management Message
FEC	Forward Error Correction
FTTH	Fibre To The Home
GUI	Graphical User Interface
HEVC	High Efficiency Video Coding
H/E	cable television Head-End
HFC	Hybrid of Fibre-Coaxial
HDCP	High-bandwidth Digital Content Protection system
HDMI	High-Definition Multimedia Interface
HTML	Hypertext Markup Language
IPTV	Internet Protocol Television
IP	Internet Protocol
LAN	Local Area Network
MPEG	Moving Picture Experts Group
MMT	MPEG Media Transport
PON	Passive Optical Network
PSI	Program Specific Information
QAM	Quadrature Amplitude Modulation
RCU	Remote Control Unit
RF	Radio Frequency
SI	Service Information
STB	Set-Top Box
TLV	Type Length Value
TS	Transport Stream
TTS	Timestamped TS
UHDTV	Ultra High Definition Television
UI	User Interface

5 Conventions

The keywords "**is required to**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

The keywords "**is recommended**" indicate a requirement which is recommended but which is not absolutely required. Thus this requirement need not be present to claim conformance.

The keywords "**is prohibited from**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

The keywords "**can optionally**" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

In the body of this document and its annexes, the words *shall*, *shall not*, *should* and *may* sometimes appear, in which case they are to be interpreted, respectively as, *is required to*, *is prohibited from*, *is recommended* and *can optionally*. The appearance of such phrases or keywords in an appendix or in material explicitly marked as *informative* are to be interpreted as having no normative intent.

6 Overview

6.1 4K cable system

See Figure 6-1 as an example of 4K cable system. 4K cable content can be obtained from 4K programs broadcasted by satellite stations. Cable operators may also capture 4K video content by themselves. In addition some providers offer 4K video.

4K video content encoded by HEVC [ITU-T H.265] is transmitted over RF/QAM-based or IP-based systems through the cable network and received at 4K cable STB. 4K video content can be transmitted via existing HFC transport network which handles 64QAM and/or 256QAM as RF transmission. 4K video content can also be transmitted via DOCSIS or FTTH as IP transmission.

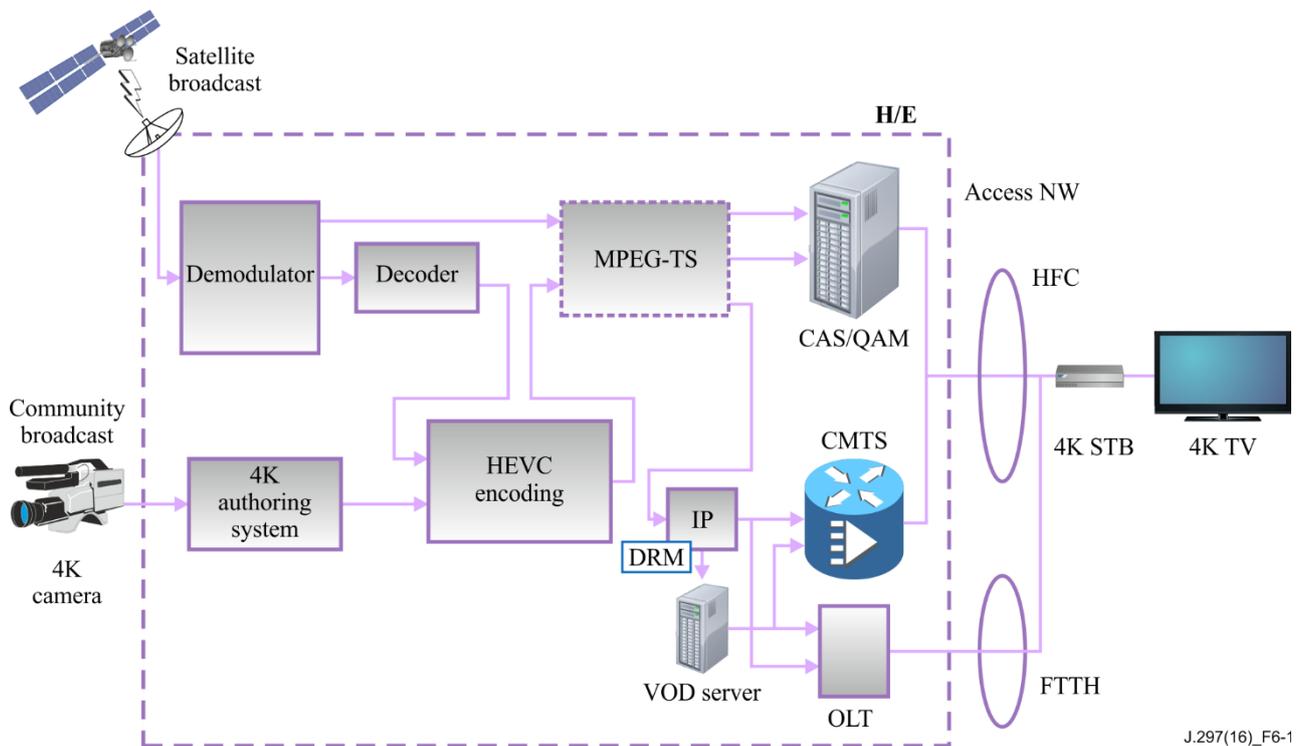


Figure 6-1 – Example of 4K cable system

6.2 Block diagram of 4K cable STB functions

Figure 6-2 shows an example of a block diagram of 4K cable STB. Functions of major components of 4K cable STB are explained as follows:

- Type of input signal is assumed to be RF or IP.
NOTE – Implementation of QAM-based 4K service reception and IP-based 4K service reception in a 4K cable STB is not always necessary and may be left to the cable operator to decide.
- For content protection CAS or DRM should be adopted.

Figure 6-2 shows a model of STB with DOCSIS modem. For other models connected to an external DOCSIS modem or an external ONU, it is also possible to receive IP signals over Ethernet.

In Figure 6-2, QAM Demod (or QAM demodulator) is the function of decoding QAM-based transport stream received from H/E. DeScrambler is the function that decodes the content-encrypted by the CAS or DRM algorithms. DeMux is the function of demultiplexing video, audio and service information. Video decoder and audio decoder are used to decode the compressed video and audio content, respectively. HDMI2.0 is used to interface with the television system as an output interface. HEVC [ITU-T H.265] has high coding efficiency and should be adopted to decode 4K content.

In the case of IP transmission, HTML5 based browser for UI should be used.

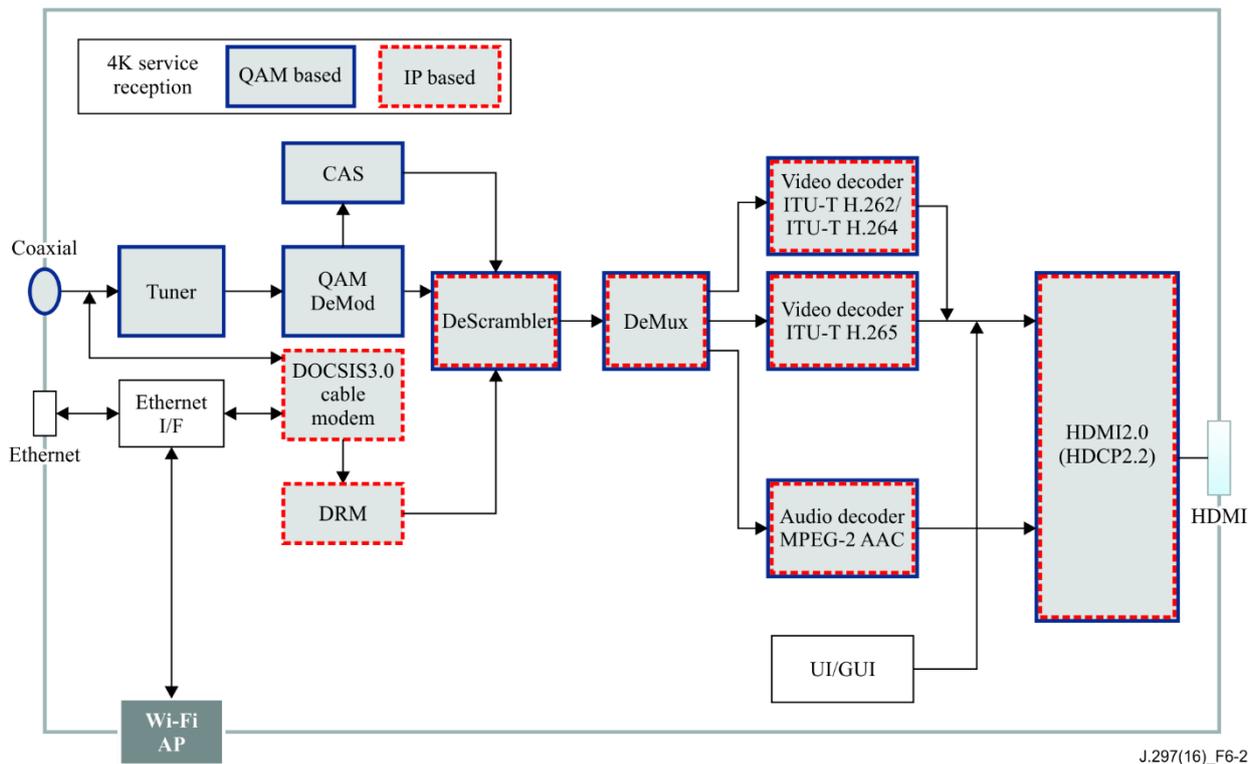


Figure 6-2 – Example of 4K cable STB block diagram

7 Requirements

This clause describes requirements for 4K cable STB in QAM-based 4K linear video service, IP-based 4K linear video service and IP VOD service, respectively. In addition, requirements for backward compatibility of 2K video service is also described.

NOTE – Choice among QAM-based 4K linear video service, IP-based 4K linear video service and IP VOD service is left to cable operators' decision.

7.1 QAM-based 4K linear video service

[QLR-001] 4K cable STB is required to receive 4K content broadcasted by cable H/E.

NOTE – Downlink is essentially used and uplink is not necessarily used for this requirement.

[QLR-002] 4K cable STB is required to equip a function of tuner that selects broadcasting channels.

[QLR-003] 4K cable STB is required to equip QAM decoding (de-modulation) function.

[QLR-004] 4K cable STB is required to equip CAS decoding (de-scrambling) function used for content protection.

[QLR-005] 4K cable STB is required to equip de-multiplexing function for video, audio and service information (SI/PSI).

[QLR-006] 4K cable STB can optionally support synchronization of plural media transported among different streams such as RF transmission and IP transmission.

[QLR-007] 4K cable STB is required to equip a function of decoding 4K video.

[QLR-008] 4K cable STB is required to equip decoding advanced audio of 5.1 channels.

[QLR-009] 4K cable STB is required to equip output interface (such as HDMI 2.0) which supports 4K video.

[QLR-010] 4K cable STB is required to support UI for TV channel selection operated with RCU.

[QLR-011] 4K cable STB can optionally equip a function of software download over RF transmission.

[QLR-012] 4K cable STB can optionally support remote management function.

7.2 IP-based 4K linear video service

[ILR-001] 4K cable STB is required to receive 4K content on IP transmission sent by cable H/E.

NOTE – In order to get information for video service operation from server, uplink of IP transmission is used.

[ILR-002] 4K cable STB is required to equip DOCSIS (2.0 [ITU-T J.122] or 3.0 [ITU-T J.222.1], [ITU-T J.222.2] or beyond version) modem, or connect an external cable modem supporting DOCSIS (2.0 [ITU-T J.122] or 3.0 [ITU-T J.222.1], [ITU-T J.222.2] or beyond version) or connect an external ONU, in order to receive IP signals over Ethernet.

[ILR-003] 4K cable STB is required to equip DRM decoding (de-scramble) function used for content protection.

[ILR-004] 4K cable STB is required to equip de-multiplexing function for video, audio and service information (PSI/SI).

[ILR-005] 4K cable STB can optionally support synchronization of plural media transported among different streams such as IP transmission and RF transmission.

[ILR-006] 4K cable STB is required to equip a function of decoding 4K video.

[ILR-007] 4K cable STB is required to equip decoding advanced audio of 5.1 channels.

[ILR-008] 4K cable STB is required to equip output interface (such as HDMI 2.0) which supports 4K video.

[ILR-009] 4K cable STB is required to support UI for TV channel selection operated with RCU.

[ILR-010] 4K cable STB is recommended to support functions for jitter compensation and forward error correction (FEC) over IP transmission.

[ILR-011] 4K cable STB is recommended to equip a function of software download.

[ILR-012] 4K cable STB is recommended to support remote management function.

7.3 IP-VOD service

[IVR-001] 4K cable STB is recommended to receive 4K video content.

[IVR-002] 4K cable STB is required to equip DOCSIS (2.0 [ITU-T J.122] or 3.0 [ITU-T J.222.1], [ITU-T J.222.2] or beyond version) modem or connect an external cable modem supporting DOCSIS (2.0 [ITU-T J.122] or 3.0 [ITU-T J.222.1], [ITU-T J.222.2] or beyond version) or connect an external ONU, in order to receive IP signals over Ethernet.

[IVR-003] 4K cable STB is required to equip DRM de-coding (De-scramble) function used for content protection.

[IVR-004] 4K cable STB is required to equip de-multiplexing function for video and audio.

[IVR-005] 4K cable STB is required to equip a function of decoding 4K video.

[IVR-006] 4K cable STB is required to equip decoding advanced audio of 5.1 channels.

[IVR-007] 4K cable STB is required to equip output interface (such as HDMI 2.0) which supports 4K video.

[IVR-008] 4K cable STB is required to support UI for content selection and video playback operated with RCU.

[IVR-009] 4K cable STB is required to adapt contents delivery to the network situation (such as congestion and jitter).

[IVR-010] 4K cable STB is recommended to equip a function of software download.

[IVR-011] 4K cable STB is recommended to support remote management function.

Table 7-1 – Summary of requirements

Requirements	QAM-based 4K linear video service	IP-based 4K linear video service	IP-VOD service
Required to receive 4K content broadcasted by cable H/E.	[QLR-001]	N/A	N/A
Required to equip a function of tuner that selects broadcasting channels.	[QLR-002]	N/A	N/A
Required to equip QAM decoding (de-modulation) function.	[QLR-003]	N/A	N/A
Required to equip CAS decoding (de-scrambling) function used for content protection.	[QLR-004]	N/A	N/A
Required to receive 4K content on IP transmission sent by cable H/E.	N/A	[ILR-001]	N/A
Required to equip DOCSIS modem or connect an external cable modem supporting DOCSIS or connect an external ONU in order to receive IP signals over Ethernet.	N/A	[ILR-002]	[IVR-002]
Required to equip DRM decoding (de-scramble) function used for content protection.	N/A	[ILR-003]	[IVR-003]
Required to receive 4K video content.	N/A	N/A	[IVR-001]
Recommended to support synchronization of plural media transported among different streams such as RF transmission and IP transmission.	[QLR-006]	[ILR-005]	N/A
Required to equip de-multiplexing function for video and audio and service information (PSI/SI).	[QLR-005]	[ILR-004]	NA
Required to equip de-multiplexing function for video and audio.	NA	NA	[IVR-004]
Required to equip a function of decoding 4K video.	[QLR-007]	[ILR-006]	[IVR-005]
Required to equip decoding advanced audio of 5.1 channels.	[QLR-008]	[ILR-007]	[IVR-006]
Required to equip output interface (such as HDMI 2.0) which supports 4K video.	[QLR-009]	[ILR-008]	[IVR-007]
Required to support UI for TV channel selection operated with RCU.	[QLR-010]	[ILR-009]	N/A
Required to support UI for content selection and video playback operated with RCU.	N/A	N/A	[IVR-008]
Recommended to support functions for jitter compensation and forward error correction (FEC) over IP transmission.	N/A	[ILR-010]	N/A
Recommended to adapt content delivery to the network situation (such as congestion and jitter).	N/A	N/A	[IVR-009]

Table 7-1 – Summary of requirements

Requirements	QAM-based 4K linear video service	IP-based 4K linear video service	IP-VOD service
Recommended to equip a function of software download.	[QLR-011]	[ILR-011]	[IVR-010]
Recommended to support remote management function.	[QLR-012]	[ILR-012]	[IVR-011]

7.4 Backward compatibility for 2K cable STB

[BCR-001] 4K cable STB is recommended to support the existing 2K content broadcasting service for the purpose of interoperability.

QAM-based 4k linear video service, IP based 4k linear video service and IP VOD service are available also for 2K content.

NOTE – This Recommendation does not specify the system for compatibility purpose, which is left to cable operators’ decision. The requirements for 2K STB can be referred to in [ITU-T J.295] and the specifications can be referred to in [ITU-T J.296].

8 Functional specifications

8.1 Specifications common to QAM-based and IP-based 4K cable STB for linear video service

As shown in Figure 8-1 there are many commonalities between QAM-based 4K linear video service and IP-based 4K linear video service. However, technical factors applied to both services are not the same, even at the application layer which has the highest commonality, due to the difference in usage of the network layer. Therefore, this recommendation doesn't request to adopt the same technology methods to both QAM-based 4K linear video service and IP-based 4K linear video service.

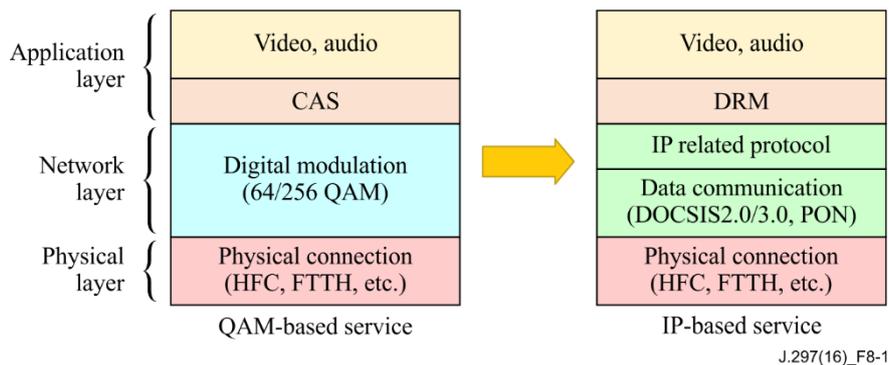


Figure 8-1 – Relationship between QAM-based and IP-based 4K linear video service

The common functions of both QAM-based 4K cable STB and IP-based 4K cable STB are outlined below.

8.1.1 4K video coding

Specification for 4K video coding is required to:

- Resolution: 3,840 × 2,160
- Frame rate: 60P
- Colour: [ITU-R BT.709] or [ITU-R BT.2020]
- Bit depth: 10 bit

For the coding method for 4K video content, HEVC [ITU-T H.265] (Main 10 profile) is required to be complied, which provides compression efficiency twice as much as AVC [ITU-T H.264].

In addition, HEVC 4K cable STB is recommended to support both MPEG2 Video [ITU-T H.262] and AVC [ITU-T H.264] in order to maintain the interoperability with 2K video service.

8.1.2 Audio coding

MPEG-2 AAC is required to be adopted as in 2K service. MPEG-4 AAC or MPEG-4 ALS (22.2 channels) can optionally be supported.

8.1.3 Multiplex method

4K cable STB is required to equip MPEG-TS decoding function in order to execute de-multiplexing of video, audio and PSI/SI.

4K cable STB can optionally support MMT [ISO/IEC 23008-1] / TLV [ITU-T J.288] de-multiplexing which can synchronize plural media transported among different streams such as RF transmission and IP transmission.

NOTE – The details of MMT/TLV support in 4K Cable STB are currently for further study.

8.1.4 Content protection

4K cable STB is required to support a conditional access CA/DRM (digital right management) module interface compliant with broadcasting standards defined by each region, as described in Appendices I, II and III.

Scramble key used for content encryption is recommended to support AES 128 bit.

NOTE – Key management method for encrypting scramble key is out of the scope of this recommendation.

8.1.5 Output interface

4K cable STB is required to support appropriate output interface (e.g., HDMI 2.0) with content protection technology (e.g., HDCP 2.2) corresponding to the requirement from content provider and/or broadcasting operator, based on the regional regulation policy.

8.1.6 Summary of common function elements

Table 8-1 summarizes common function elements of video, audio and multiplex method between QAM-based 4K cable STB and IP-based 4K cable STB.

**Table 8-1 – 4K service specification
(applies to both QAM-based and IP-based service)**

	Item	Spec
Multiplex	Method	MPEG2-TS
Video	Resolution/ Scanning	4K 60P (max)
	Color	ITU-R BT709/BT.2020
	Color depth	10 bits
	Coding	H.265 (Main 10)
Audio	Coding	MPEG-2 AAC

8.2 Specifications peculiar to QAM-based and IP-based 4K cable STB for linear video service

8.2.1 Specifications peculiar to QAM-based 4K cable STB for linear video service

8.2.1.1 TV broadcasting

4K cable STB is required to support TV broadcasting reception capabilities compliant with standards defined by specified region. TV broadcasting specifications for regions are described in Appendices I, II and III.

8.2.1.2 Tuner

The tuner portion is required to support at least one of the broadcasting-related specifications listed in Appendices I, II and III.

8.2.1.3 Decoder

4K cable STB is required to support 64QAM specified in [ITU-T J.83] for decoding on received stream.

4K cable STB is recommended to support 256QAM specified in [ITU-T J.83] for decoding on received stream.

4K cable STB can optionally support non-quadrature amplitude modulation (QAM) tuners in accordance with the broadcasting-related specifications defined by each region, as described in Appendices I, II and III.

8.2.1.4 UI

UI for channel selection operated with RCU is required. The details such as protocols applied are not specified in this recommendation and it is left to cable operators to decide.

8.2.1.5 Software download

Software download is recommended to be supported by RF broadcasting system.

The details such as protocols applied are not specified in this recommendation because of deferent RF specification in the regions.

8.2.1.6 STB remote management

The details of remote management function such as protocols applied are not specified in this recommendation because of deferent RF specification in the regions.

8.2.2 Specifications peculiar to IP-based 4K cable STB for linear video service

8.2.2.1 IPTV broadcasting

4K cable STB is required to support IPTV broadcasting reception capabilities compliant with the standards defined by specified region. Examples of IPTV broadcasting specifications for specified regions are described in Appendices I, II and III.

8.2.2.2 Cable modem

When 4K cable STB equips cable modem inside, specification for the cable modem are required to conform to [ITU-T J.112], [ITU-T J.122] and [ITU-T J.222].

8.2.2.3 High-speed communication interface

If 4K cable STB does not have a cable modem function inside, high-speed communication interface such as Ethernet and Wi-Fi are required to be equipped in order to receive an IP-based stream.

8.2.2.4 IP-based protocols

Figure 8-2 is protocol stack model used for IP linear service.

4K cable STB is required to support RTP, UDP, HTTP, TCP/IP and ICMP.

4K cable STB is recommended to support TLS/SSL.

4K cable STB is recommended to support IGMPv2, IGMPv3 and MLDv2 when IP broadcasting service is operated in multi-cast.

NOTE – HTML is used for online subscription of IP broadcasting service and HTTP protocol is used for license update.

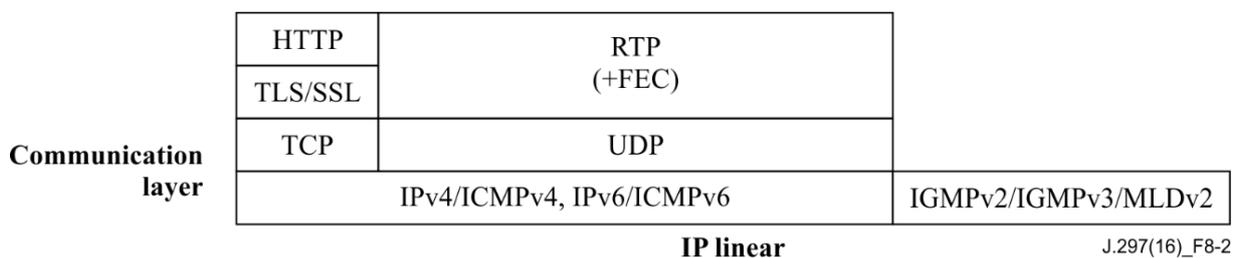


Figure 8-2 – IP linear protocol stack model

Table 8-2 – Protocol reference

RTP	RFC3550: RTP: A Transport protocol for Real-Time Applications
HTTP	RFC2616: Hyper Text Transport Protocol-HTTP1.1
UDP	RFC768: User Datagram Protocol
TCP	RFC793: Transmission Control Protocol
IP	RFC791: Internet Protocol
ICMPv4	RFC792: Internet Control Message Protocol for IPv4
ICMPv6	RFC4443: Internet Control Message Protocol for IPv6
IGMP	RFC2236: Internet Group Management Protocol, Version 2
	RFC3376: Internet Group Management Protocol, Version 3
	RFC3228: IANA Considerations for IPv4 Internet Group Management Protocol
MLDv2	RFC3810: Multicast Listener Discovery Version 2 (MLDv2) for IPv6
IPv6	RFC2460: Internet Protocol Version 6 (IPv6) Specification

8.2.2.5 Error correction of received IP packet

It is optionally recommended to equip FEC function, which helps to minimize packet loss occurred in the network. If there is no FEC function, STB is required to ignore FEC packet and only the media packet is processed.

Mechanism and supplemental information of FEC adopted to content error delivery can be referred to in [ITU-T H.701].

8.2.2.6 Support of TTS format

4K cable STB is recommended to receive both TS and TTS formats.

NOTE – Implementation of the function to transform from TTS which compensates jitter of received IP packets to MPEG-2 TS is left to STB vendor.

8.2.2.7 UI

HTML5-based browser is recommended to be equipped on 4K cable STB as UI for content selection by RCU.

High-level specification of metadata to describe IPTV service, end-user preference and so on can be referred to in [ITU-T H.750] as an example of implementation of channel selection function.

NOTE – In this Recommendation, software platform within 4K cable STB is not specified and left to cable operator's decision. Software architecture of STB can be referred to in [ITU-T J.296] for example.

8.2.2.8 STB remote management

Remote management function of 4K cable STB is recommended to be conducted and complied with [BBF TR069] protocol.

8.3 Specifications of 4K IP-VOD STB

This clause describes the specification specific to 4K IP-VOD STB.

8.3.1 Content decoding

4K video content format dealt by 4K IP-VOD STB is required to conform to the specifications described in clause 8.1.1.

The decoding methods and container formats for each media is required to conform to the following standards:

- Video: H.264 MPEG-4 AVC, H.265 HEVC
- Audio: MPEG-2 AAC, MPEG-4 AAC
- Container format: ISO base media file format MP4 [ISO/IEC 14496-12] (mandatory), MPEG-2 TS [ITU-T H.222.0] (optional).

8.3.2 Content delivery method

MPEG-DASH (dynamic adaptive streaming over HTTP) standardized as [ISO/IEC 23009-1] is required to be supported as the content delivery method.

NOTE – MPEG DASH is a sort of adaptive streaming method that can adjust the content delivery, depending on the network circumstances and conduct stable content delivery.

8.3.3 Content protection

Common encryption scheme (CENC) standardized in [ISO/IEC 23001-7] is required to be supported as the content protection method. The detailed specification is required to follow the [ITU-T J.1006].

NOTE – CENC specifies the common encryption format to commonly use encrypted content in the environment using different DRM systems among different cable operators and/or different devices, as shown Figure 8-2. The content encrypted by the CENC scheme can be decrypted by a common encrypted key, which is independent of DRM systems. The client software equipped in 4K cable STB acquires a licence from DRM server, then obtains a scramble key based on the licence to decrypt the content.

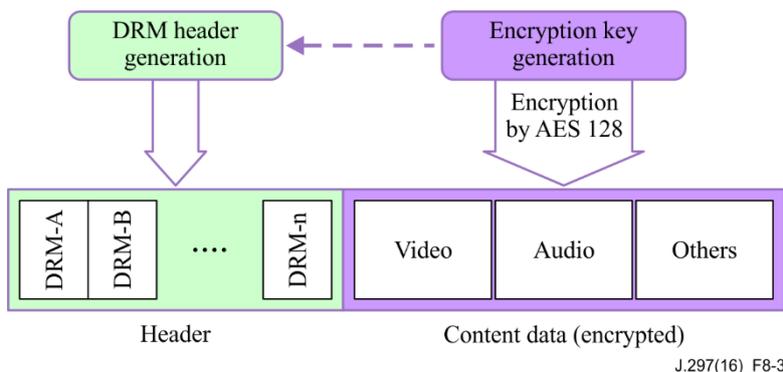


Figure 8-3 – conceptual model of CENC format

8.3.4 IP-based protocols

Specification of physical communication interface (Ethernet, DOCSIS, HiNoC, etc.) is required to be followed to the description in clauses 8.2.2.2 cable modem and 8.2.2.3 high speed digital communication interface in the IP-based broadcasting specification part of this document.

Specification of de-multiplex (MPEG-TS and MMT) is required to follow 8.1.3 multiplex method in specifications common to QAM-based and IP-based 4K cable STB for linear video service in this Recommendation.

STB has communication protocol functions such as HTTP, TLS, TCP and IP, and capabilities of a variety of communication processing. The assumed communication protocol stack of IP communication layer is shown in Figure 8-3, and the referenced standards are shown in Table 8-4.

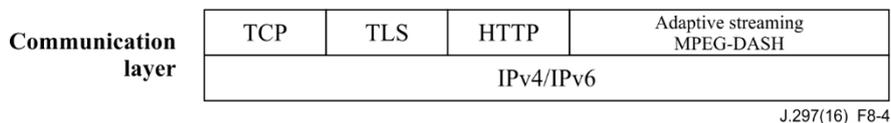


Figure 8-4 – Communication protocol stack of IP layer

Table 8-4 – Referenced standards of IP communication protocol

HTTP	RFC2616 Hypertext Transfer Protocol-HTTP/1.1
TCP	RFC793 Transmission Control Protocol
IP	RFC791 Internet Protocol
IPv6	RFC2460 Internet Protocol Version 6 (IPv6) Specification
TLS	RFC5246 Transport Layer Security

8.3.5 Output interface

4K IP-VOD STB is required to support appropriate output interface (e.g., HDMI 2.0) with content protection technology (e.g., HDCP 2.2) corresponding to the requirement from content provider, based on the regional regulation.

8.3.6 UI

A HTML5-based browser is recommended to be supported as UI for content selection by RCU, play-back of audio/video content.

NOTE – In this Recommendation, software platform within 4K cable STB is not specified and left to cable operator to decide. Software architecture of STB can be referred to in [ITU-T J.296].

When a HTML5-based browser is used for playback of audio/video content, the use of media source extensions (MSE) as the API for the provision of media streams to 4K cable STB and encrypted media extensions (EME) as the API for DRM processing are recommended.

8.3.7 STB remote management

Remote management function of 4K cable STB is recommended to be conducted and complied with [BBF TR069] protocol.

8.3.8 Summary of IP-VoD specifications

Table 8-5 shows the summary of the major specifications applied to 4K IP-VOD.

Table 8-5 – Summary of IP-VOD specifications

Items		Specifications
Delivery method		[ISO/IEC 23009-1]: MPEG-DASH
Content decoding	Container format	[ISO/IEC 14496-12]: Base Media File Format MP4 (mandatory) [ITU-T H.222.0]: MPEG-2 TS (optional)
	Video decoding	[ISO/IEC 14496-10]: H.264 MPEG-4 AVC [ISO/IEC 23008-2]: H.265 HEVC
	Audio decoding	[ISO/IEC 13818-7]: MPEG-2 AAC [ISO/IEC 14496-3]: MPEG-4 AAC
Content protection		[ISO/IEC 23009-1]: CENC [ITU-T J.1006] Scramble key: AES 128bit Encryption mode: CTR mode (mandatory), CBC mode (optional)

Appendix I

Broadcasting standards (Region A)

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

This appendix provides Region A specific issues. The STB for Region A is required to support the content listed in this appendix.

I.1 ETSI/DVB

ETSI/DVB specifications are listed in Table I.1.

Table I.1 – ETSI/DVB specifications

Spec no.	Name
[b-ETSI TS 101 154]	Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream
[b-ETSI TS 102 154]	Implementation Guidelines for the use of MPEG-2 Systems, Video and Audio in Contribution Applications
[b-ETSI EN 300 429]	Framing structure, channel coding and modulation for cable systems
[b-ETSI EN 302 769]	Frame structure channel coding and modulation for a second generation digital transmission system for cable systems (DVB-C2)
[b-ETSI EN 300 468]	Specification for Service Information (SI) in DVB systems
[b-ETSI TS 101 211]	Guidelines on implementation and usage of Service Information (SI)
[b-ETSI TS 101 162]	Allocation of Service Information (SI) codes for DVB systems
[b-ETSI EN 300 743]	Subtitling systems
[b-ETSI TR 101 290]	Measurement guidelines for DVB systems
[b-ETSI TR 289]	Support for use of scrambling and Conditional Access (CA) within digital broadcasting systems
[b-ETSI TS 103 197]	Head-end implementation of DVB SimulCrypt
[b-ETSI TS 101 699]	Extensions to the Common Interface Specification
[b-ETSI ES 201 812]	Multimedia Home Platform (MHP) Specification 1.03
[b-ETSI TS 102 812]	Multimedia Home Platform (MHP) Specification 1.1
[b-ETSI TS 102 727]	Multimedia Home Platform (MHP) Specification 1.22
[b-ETSI TS 102 606]	Generic Stream Encapsulation (GSE) Protocol
[b-ETSI TS 102 991]	DVB-C2 Implementation Guidelines
[b-ETSI TS 103 127]	Digital Video Broadcasting (DVB) content scrambling algorithms for DVB-IPTV services using MPEG-2 Transport Streaming

I.2 IEC/CENELEC

IEC/CENELEC specifications are listed in Table I.2.

Table I.2 – IEC/CENELEC specifications

Spec no.	Name
[b-IEC/EN 60728-1]	Cable networks for television signals, sound signals and interactive services – Part 1: System performance of forward paths
[b-IEC/EN 60728-2]	Cable networks for television signals, sound signals and interactive services – Part 2: Electromagnetic compatibility for equipment
[b-IEC/EN 60728-3]	Cable networks for television signals, sound signals and interactive services – Part 3: Active wideband equipment for coaxial cable networks
[b-IEC/EN 60728-4]	Cable networks for television signals, sound signals and interactive services – Part 4: Passive wideband equipment for coaxial cable networks
[b-IEC/EN 60728-10]	Cable networks for television signals, sound signals and 1 interactive services – Part 10: System performance of return paths
[b-IEC/EN 60728-11]	Cable networks for television signals, sound signals and interactive services – Part 11: Safety
[b-IEC/EN 60728-12]	Cabled distribution systems for television and sound signals - Part 12: Electromagnetic compatibility of systems

I.3 CENELEC

CENELEC specifications are listed in Table I.3.

Table I.3 – CENELEC specifications

Spec no.	Name
[b-EN 50221]	Common Interface Specification for Conditional Access and other Digital Video Broadcasting Decoder Applications
[b-R206 001]	Guidelines for implementation & use of the Common Interface for DVB Decoder Applications

I.4 ISO/IEC

ISO/IEC specifications are listed in Table I.4.

Table I.4 – ISO/IEC specifications

Spec no.	Name
[ITU-T H.222.0]	Generic coding of moving pictures and associated audio information – Part 1: Systems
[b-ISO/IEC 13818-2]	Generic coding of moving pictures and associated audio information – Part 2: Video
[b-ISO/IEC 13818-4]	Information technology – Generic coding of moving pictures and associated audio information – Part 4: Conformance testing
[b-ISO/IEC 14496-1]	Coding of audio-visual objects – Part 1: Systems
[b-ISO/IEC 14496-4]	Coding of audio-visual objects – Part 4: Conformance testing

Appendix II

Broadcasting standards (Region B)

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

This appendix provides Region B specific issues. The STB for Region B supports the content listed in this appendix.

II.1 ATSC

ATSC specifications are listed in Table II.1.

Table II.1 – ATSC specifications

Spec no.	Name
[b-ATSC A/53]	ATSC Digital Television Standard Part 1: Digital Television System Part 2: RF/Transmission System Characteristics Part 3: Service Multiplex and Transport Subsystem Characteristics Part 4: MPEG-2 Video System Characteristics Part 5: AC-3 Audio System Characteristics Part 6: Enhanced AC-3 Audio System Characteristics
[b-ATSC A/65]	Program and System Information Protocol for Terrestrial Broadcast and Cable
[b-ATSC A/70]	Conditional Access System for Terrestrial Broadcast
[b-ATSC A/71]	ATSC Standard: Parameterized Services Standard
[b-ATSC A/72]	Video System Characteristics of AVC in the ATSC Digital Television System
[b-ATSC A/90]	Data Broadcast Standard
[b-ATSC A/92]	Delivery of IP Multicast Sessions over Data Broadcast Standard
[b-ATSC A/96]	ATSC Interaction Channel Protocols
[b-ATSC A/97]	Software Data Download Service
[b-ATSC A/98]	System Renewability Message Transport
[b-ATSC A/101]	Advanced Common Application Platform (ACAP)
[b-ATSC A/103]	Non-Real-Time Delivery
[b-ATSC A/105]	Interactive Services Standard
[b-ATSC A/106]	ATSC Security and Service Protection Standard
[b-ATSC A/107]	ATSC 2.0 Standard
[b-ATSC A/321]	System Discovery and Signalling

NOTE – Other related ATSC A/300 series standards for Ultra HD with High Definition and standard definition multicast are being developed in ATSC.

II.2 IEEE

IEEE specification is listed in Table II.2.

Table II.2 – IEEE specifications

Spec no.	Name
[b-IEEE SI 10]	Use of the International System of Units (SI): The Modern Metric System

II.3 SCTE

SCTE specifications are listed in Table II.3.

Table II.3 – I SCTE specifications

Spec no.	Name
[b-ANSI/SCTE 193-1]	MPEG-4 AAC Family Audio System – Part 1: Coding Constraints for Cable Television,
[b-ANSI/SCTE 193-2]	MPEG-4 AAC Family Audio System – Part 2: Constraints for Carriage over MPEG-2 Transport
[b-SCTE 194-1]	DTS-HD Audio System – Part 1: Coding Constraints for Cable Television DTS-HD Audio System – Part 1: Coding Constraints for Cable Television
[b-SCTE 194-2]	DTS-HD Audio System – Part 2: Constraints for Carriage over MPEG-2 Transport

Appendix III

Broadcasting standards (Region C)

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

This appendix provides Region C specific issues. The STB for Region C supports the content listed in this appendix.

III.1 Broadcasting related specifications for Region C (see clause 8.2.1)

JLabs specifications are listed in Table III.1.

Table III.1 – JLabs specifications

Spec no.	Name
[b-JLabs SPEC-001]	Operation Spec for the transmodulation of BS digital broadcasting
[b-JLabs SPEC-001-01]	Detail Spec to protect the using without due authorization
[b-JLabs SPEC-001-02]	Operation spec for down load functionality
[b-JLabs SPEC-002]	Operation spec for transmodulation of east 110 degree of east longitude
[b-JLabs SPEC-003]	Operation spec for remux of digital broadcasting(cable broadcasting)
[b-JLabs SPEC-004]	Operation spec for remux of digital broadcasting (i-HITS)
[b-JLabs SPEC-005]	Operation spec for transmodulation of JC-HITS
[b-JLabs SPEC-006]	Operation spec for pass-through of DTT broadcasting
[b-JLabs SPEC-007]	Operation spec for transmodulation of DTT broadcasting
[b-JLabs SPEC-010]	Operation spec for interactive digital broadcasting
[b-JLabs SPEC-011]	Operation spec for interactive digital cable TV (maintenance operation, web, PPV)
[b-JLabs SPEC-017]	Operation spec for high level remux digital broadcasting (Cablebroadcasting)
[b-JLabs SPEC-018]	Operation spec for high level remux digital broadcasting (i-HITS)
[b-JLabs SPEC-019]	Operation spec for high level remux digital broadcasting (JC-HITS)
[b-JLabs SPEC-028]	Operational Specification for Internet Protocol Broadcasting(Independent Broadcasting)
[b-JLabs SPEC-030]	Operational Specification for Internet Protocol Video on Demand Services

JCTEA specifications are listed in Table III.2.

Table III.2 – JCTEA specifications

Spec no.	Name
[b-JCTEA STD-001]	Conditional Access System for Digital Cable Television
[b-JCTEA STD-002]	Multiplex System for Digital Cable Television
[b-JCTEA STD-003]	Standards for Service Information Structure and the Operation of Identifiers for Digital Cable TV Broadcasting
[b-JCTEA STD-007]	Digital Cable TV Sets for Digital Cable TV Broadcasting
[b-JCTEA STD-008]	Pass-through Method for Transmission of BS Digital Signals Over Cable Television System

Table III.2 – JCTEA specifications

Spec no.	Name
[b-JCTEA STD-011]	Pass-through Method for Digital Terrestrial Television Broadcasting Signals over Cable Television System

ARIB specifications are listed in Table III.3.

Table III.3 – ARIB specifications

Spec no.	Name
[b-ARIB STD-B10]	Service Information for Digital Broadcasting System
[b-ARIB STD-B20]	Transmission System for Digital Satellite Broadcasting
[b-ARIB STD-B21]	Receiver for Digital Broadcasting
[b-ARIB STD-B24]	Data Coding and Transmission Specification for Digital Broadcasting
[b-ARIB STD-B25]	Conditional Access System Specifications for Digital Broadcasting
[b-ARIB STD-B31]	Transmission System for Digital Terrestrial Television Broadcasting
[b-ARIB STD-B44]	Transmission system for advanced wide band digital satellite broadcasting
[b-ARIB STD-B45]	Content download system for digital broadcasting
[b-ARIB STD-B60]	MMT-based media transport scheme in digital broadcasting systems
[b-ARIB STD-B61]	Conditional access system (second generation) and CAS program download system specifications for digital broadcasting
[b-ARIB TR-B14]	Operational Guidelines for Digital Terrestrial Television Broadcasting
[b-ARIB TR-B15]	Operational Guidelines for Digital Satellite Television Broadcasting

IPTV Forum Japan specifications are listed in Table III.4.

Table III.4 – IPTV Forum Japan specifications (informative)

Specification No.	Name
[b-IPTV-FJ STD-0001]	IPTV general specification
[b-IPTV-FJ STD-0002]	Specification for VOD of IPTV
[b-IPTV-FJ STD-0003]	Specification for download of IPTV
[b-IPTV-FJ STD-0004]	Specification for IP broadcasting of IPTV
[b-IPTV-FJ STD-0005]	Specification for IP re-transmission of terrestrial digital television broadcasting IP
[b-IPTV-FJ STD-0006]	Specification for CDN scope service approach of IPTV
[b-IPTV-FJ STD-0007]	Specification for Internet scope service approach of IPTV
[b-IPTV-FJ STD-0009]	Specification for IP re-transmission of BS digital broadcasting

III.2 Tuner (see clause 8.2.1.2)

The STB is required to be equipped with QAM tuners compliant with [b-JCTEA STD-007].

The STB can optionally be equipped with OFDM tuners as non-QAM tuners compliant with [b-JCTEA STD-011].

III.3 External interface (see clauses 8.1.5 and 8.3.5)

The STB is required to support content protection mechanisms compliant with [b-ARIB TR-B15] volume 8 clause 6.3 for all the output interfaces equipped with the STB.

III.4 Software management (see clause 8.2.1.5)

STB is required to support the BS-TS engineering download scheme defined in [b-JCL SPEC-001] for STB software downloading through broadcasting channel.

III.5 Content protection (see clause 8.1.4)

STB is required to support the specification of conditional access listed in Table III.5.

Table III.5 – Specifications of conditional access

Type of broadcasting	Standard	Transmission method
Overall (STB specification)	[b-JCTEA STD-001]	QAM and OFDM*
BS transmodulation	[b-JLabs SPEC-001]	QAM
Remux (Own program)	[b-JLabs SPEC-003]	QAM
Remux (i-Hits)	[b-JLabs SPEC-004]	QAM
Remux (JC-HITS)	[b-JLabs SPEC-005]	QAM
Terrestrial digital path through	[b-JLabs SPEC-006]	OFDM*
Terrestrial digital transmodulation	[b-JLabs SPEC-007]	QAM
IP broadcasting	[b-JLabs SPEC-028]	IP* (multicast)
* The transmission method description given for OFDM and IP is required to be applied only for the STBs accommodating an OFDM tuner and/or IPTV forum signal reception function, respectively.		

The STB in Region C has two types: (1) with two slots for both B-CAS and C-CAS; and (2) with only one C-CAS slot. In case the STB has both B-CAS and C-CAS slots, selection of the CAS card is required to be done autonomously according to the CA system_ID (accommodated in the PMT primary loop). Fixed allocation or distinction with other ID, as 'when network_id is 0x7F, B-CAS is used', shall not be applied. However, when the STB accommodates the OFDM tuner, it is possible for the STB to always apply B-CAS for receiving programmes by the OFDM tuner. (In this case, it also requires the autonomous selection upon receiving the QAM signal.) Types of CAS are listed in Table III.6.

Table III.6 – Types of CAS

CA_system_ID value	CAS type
0x0003	C-CAS(1) ([b-JCL SPEC-003, 004, 005, JLabs SPEC-017, 018, 019])
0x0004	C-CAS(2) ([b-JCL SPEC-003, 004, 005, JLabs SPEC-017, 018, 019])
0x0005	B-CAS ([b-JCL SPEC-001, 006] BS-TM and DTT pass through)
0x0006	C-CAS(3) ([b-JCL SPEC-003, 004, 005, JLabs SPEC-017, 018, 019])
0x0007	B-CAS ([b-JCL SPEC-007] DTT transmodulation)
0x000D	Marlin IPTV-ES ([b-IPTVFJ STD-0004] IPTV forum IP broadcasting)

Regarding C-CAS (1) ~ (3) (0x0003, 0x0004, and 0x0006), these are uniquely decided according to the restricted receiving facility used. Although a changeover among three methods is never done when a programme is being received, the STB shall nonetheless correspond to any one of them.

In addition, in the case where only one C-CAS slot is equipped, C-CAS card shall be applied to any of the CA_system_ID value (0x0003 ~ 0x0007). In this case, even for the programme to which the B-CAS is applied in nature, the cable NW operator shall apply any measure to make the C-CAS card applicable (alteration of ECM, or sending Kw to C-CAS card with EMM).

STB is required to support copy control and content protection rules compliant with the specifications listed in Table III.7.

Table III.7 – Copy control and contents protection

Programs	Standards	Transmission method	Contents
BS transmodulation Remux (including community channel, i-Hits) JC-HITS transmodulation	[b-ARIB TR-B15] Part 1, vol. 2, clause 5.10	QAM	Copy control
	[b-ARIB TR-B15] Part 1, vol.8	QAM	Contents protection rule
DTT pass through, Terrestrial transmodulation	[b-ARIB TR-B14] Part 2, vol.2, clause 7.10	OFDM (pass through) QAM (transmodulation)	Copy control
	[b-ARIB TR-B14] vol. 8	OFDM (pass through) and QAM (transmodulation)	Contents protection rule

III.6 Decoder for broadcasting type service (see clauses 8.1.1 and 8.1.2)

The STB is required to support a media decoder for broadcasting services compliant with [b-JCTEA STD-007] with [b-ARIB STD-B1] and [b-ARIB STD-B21], [b-ARIB STD-B10], [b-ARIB STD-B20] and [b-ARIB TR-B15].

Video decoder

- STB is required to support [b-JLabs SPEC-017].

Audio decoder

- STB is required to support [b-JCTEA STD-007].

III.7 Forward error correction (see clause 8.2.2.1)

If FEC is equipped, [b-Pro-MPEG FEC CoP3] is required and [b-Pro-MPEG 1D FEC] is recommended.

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