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Infrastructure of audiovisual services - Communication
procedures

HSTP-CONF-H.721
Conformance testing specification for ITU-T H.721

Summary

The purpose of conformance testing is to increase the probability that different implementations are able to interconnect. Conformance testing in this document explains test specifications regarding the IPTV terminal device specified in ITU-T Rec.H.721 "IPTV Terminal Device (Basic Model)". The test involves testing both the capabilities and behaviour of an implementation, and checking what is observed against the conformance requirements in the Recommendation and against what the implementer states the implementation capabilities are.

This revision introduces support for high efficiency video coding (HEVC), DASH, MPEG-4 ALS, MPEG-4 AAC, DTS-HD, TTML, MMT and several corrections and clarifications.

Keywords

IPTV, conformance, conformance testing, IPTV terminal device, IPTV basic services

Change Log

This document contains Version 3 of the ITU-T Technical Paper on "*Conformance testing specification for ITU-T H.721*" approved on 20 February 2015 at the ITU-T Study Group 16 meeting held in Geneva, 9-20 February 2015.

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Conformance testing specification for ITU-T H.721

1   Scope

This document specifies a set of attributes and procedures designed to indicate whether IPTV terminal devices meet the requirements in ITU-T Rec. H.721. This set of conformance tests can provide a basic level of interoperability testing.

2   References

[ITU-T H.222.0]	Recommendation ITU-T H.222.0 (2014)	ISO/IEC 13818-1:2014, *Information technology – Generic coding of moving pictures and associated audio information: Systems,* including its Amd.1 - 4 (2014) *"Support for event signaling in Transport Stream in MPEG-2 systems."*
[ITU-T H.262]	Recommendation ITU-T H.262 (2012)	ISO/IEC 13818-2:2012, *Information technology – Generic coding of moving pictures and associated audio information: Video*.
[ITU-T H.264]	Recommendation ITU-T H.264 (V9) (2014), *Advanced video coding for generic audiovisual services*.
[ITU-T H.265]	Recommendation ITU-T H.265 (V2) (2014), *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 (V2) (2015), *IPTV terminal devices: Basic model*
[ITU-T H.770]	Recommendation ITU-T H.770 (V2) (2015), *Mechanisms for service discovery and selection for IPTV services*
[ITU-T X.290]	Recommendation ITU-T X.290 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – General concepts* (**Common text with** ISO/IEC 9646-2:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 2: Abstract test suite specification*.)
[ITU-T X.291]	Recommendation ITU-T X.291 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Abstract test suite specification* (**Twin text with** ISO/IEC 9646-2:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 2: Abstract test suite specification*.)
[ITU-T X.293]	Recommendation ITU-T X.293 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Test realization* (**Twin text with** ISO/IEC 9646-4:1994, Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 4: Test realization.)

[ITU-T X.509]   Recommendation ITU-T X.509 (2008) | ISO/IEC 9594-8:2008, *Information technology – Open Systems Interconnection – The Directory: Public-key and attribute certificate frameworks.*

[ITU-T X.1191]   Recommendation ITU-T X.1191 (2009), *Functional requirements and architecture for IPTV security aspects*

[ITU-T Y.1910]   Recommendation ITU-T Y.1910 (2008), *IPTV functional architecture.*

3   Definitions

3.1   Terms defined elsewhere

3.1.1   Access control [b-ITU-T X.800]: The prevention of unauthorized use of a resource, including the prevention of use of a resource in an unauthorized manner.

3.1.2   Authentication [b-ITU-T X.800]: See data origin authentication and peer-entity authentication.

3.1.3   Authorization [b-ITU-T X.800]: The granting of rights, which includes the granting of access based on access rights.

3.1.4   Conformance log [ITU-T X.290]: A human-readable record of information produced as a result of a test campaign, which is sufficient to record the observed test outcomes and verify the assignment of test results (including test verdicts).

3.1.5   Conformance testing [ITU-T X.290]: Testing the extent to which an IUT is a conforming implementation.

3.1.6   Content [ITU-T T.174]: Encoded generic value, media or non-media data

3.1.7   Content protection [ITU-T X.1191]: Ensuring that an end user can only use the content that he/she already acquired in accordance with the rights granted to him/her by the rights holder; content protection involves protecting contents from illegal copying and distribution, interception, tampering, unauthorized use, etc.

3.1.8   Data origin authentication [b-ITU-T X.800]: The corroboration that the source of data received is as claimed.

3.1.9   Dynamic conformance requirement [ITU-T X.290]: One of the requirements which specify what observable behaviour is permitted by the relevant specification(s) in instances of communication.

3.1.10   Entitlements [ITU-T X.1191]: Referring to the authorization level(s) including conditional access information that can be used by a subscriber to access certain IPTV services in his/her IPTV TD.

3.1.11   Entitlement control message (ECM) [b-ITU-T H.220.0 Amd.3]: Entitlement Control Messages are private conditional access information which specify control words and possibly other, typically stream-specific, scrambling and/or control parameters.

3.1.12   Implementation conformance statement (ICS) [ITU-T X.290]: A statement made by the supplier of an implementation or system claimed to conform to a given specification, stating which capabilities have been implemented

3.1.13   Implementation conformance statement (ICS) proforma [ITU-T X.290]: A document, in the form of a questionnaire, which when completed for an implementation or system becomes an ICS.

3.1.14   Implementation under test (IUT) [ITU-T X.290]: An implementation of one or more OSI protocols in an adjacent user/provider relationship, being that part of a real open system which is to be studied by testing.

3.1.15   IPTV [ITU-T Y.1901]: Multimedia services such as television, video, audio, text, graphics, data delivered over IP-based networks managed to support the required level of QoS/QoE, security, interactivity and reliability.

3.1.16   IPTV terminal device [ITU-T Y.1901]: A terminal device which has ITF functionality, e.g. a STB.

3.1.17   IPTV terminal function (ITF) [ITU-T Y.1901]: The functionality within the home network that is responsible for terminating the IP signal, and converting the content into a renderable format (i.e. enabling it to be seen and/or heard).

3.1.18   Key [b-ITU-T X.800]: A sequence of symbols that controls the operations of encipherment and decipherment.

3.1.19   Key management [b-ITU-T X.800]: The generation, storage, distribution, deletion, archiving and application of keys in accordance with a security policy.

3.1.20   Linear TV [ITU-T Y.1901]: A television service in which a continuous stream flows in real time from the service provider to the terminal device and where the user cannot control the temporal order in which contents are viewed.

3.1.21   Pass (verdict) [ITU-T X.290]: A test verdict given when the observed test outcome gives evidence of conformance to the conformance requirement(s) on which the test purpose of the test case is focused, and when no invalid test event has been detected.

3.1.22   Peer-entity authentication [b-ITU-T X.800]: The corroboration that a peer entity in an association is the one claimed.

3.1.23   Privacy [b-ITU-T X.800]: The right of individuals to control or influence what information related to them may be collected and stored and by whom and to whom that information may be disclosed.

3.1.24   Rights [ITU-T X.1191]: Referring to the ability to perform a predefined set of utilization functions for a content item; these utilization functions include permissions (e.g., to view/hear, copy, modify, record, excerpt, sample, keep for a certain period, distribute), restrictions (e.g., play/view/hear for multiple number of times, play/view/hear for certain number of hours), and obligations (e.g., payment, content tracing) that apply to the content and provide the liberty of use as granted to the end user.

3.1.25   Scrambling [ITU-T X.1191]: Process designed to protect multimedia content; scrambling usually uses encryption technology to protect content.

3.1.26   Service [ITU-T Y.101]: A structure set of capabilities intended to support applications.

3.1.27   Service protection [ITU-T X.1191]: Ensuring that an end user can only acquire a service and the content hosted therein by extension as what he/she is entitled to receive; service protection includes protecting service from unauthorized access as IPTV contents traverse through the IPTV service connections.

3.1.28   Service and content protection (SCP) [ITU-T X.1191]: A combination of service protection and content protection or the system or implementation thereof.

3.1.29   Static conformance requirement [ITU-T X.290]: One of the requirements that specify the limitations on the combinations of implemented capabilities permitted in a real open system which is claimed to conform to the relevant specification(s).

3.1.30   Verdict [ITU-T X.290]: A statement of "pass", "fail" or "inconclusive", as specified in an abstract test case, concerning conformance of an IUT with respect to that test case when it is executed.

3.1.31   Video on demand (VoD) [ITU-T Y.1901]: A service in which the end-user can , on demand, select and view a video content and where the end-user can control the temporal order in which the video content is viewed (e.g. the ability to start the viewing, pause, fast forward, rewind, etc.).

NOTE - The viewing may occur some time after the selection of the video content.

3.2   Terms defined in this document

None.

4   Abbreviations and acronyms

This document uses the following abbreviations and acronyms:

AAC	Advanced Audio Coding
AC-3	Audio Compression number 3
AES	Advanced Encryption Standard
ALS	Audio lossless coding
AV	Audio Video
AVC	Advanced Video Coding
CBC	Cipher Block Chaining
CRL	Certificate Revocation List
CSA	Common Scrambling Algorithm
DASH	Dynamic adaptive streaming over HTTP
DH	Diffie-Helleman protocol
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DVI	Digital Visual Interface
ECG	Electric Content Guide
EPG	Electric Program Guide
ECM	Entitlement Control Message
HDMI	High-Definition Multimedia Interface
HE AAC	High-Efficiency Advanced Audio Coding
HEVC	High Efficiency Video Coding
HTTP	Hyper Text Transport Protocol
ICMP	Internet Control Message Protocol
ICS	Implementation Conformance Statement
IGMP	Internet Group Management Protocol
IP	Internet Protocol

IPv4	IP version 4
IPv6	IP version 6
IUT	Implementation Under Test
MLD	Multicast Listener Discovery
MMT	MPEG Media Transport
OFB	Output Feedback
PKI	Public-Key Infrastructure
QoS	Quality of Service
RCA	Radio Corporation of America
RTP	Real-time Transport Protocol
RTSP	Real-time Streaming Protocol
SADS	Service and Application Discovery and Selection
SCP	Service and Content Protection
SSL	Secure Socket Layer
TS	Transport Stream
TLS	Transport Layer Security
TTML	Timed Text Markup Language
TTS	Time-stamped TS
URI	Uniform Resource Indicator
URL	Uniform Resource Locator
VoD	Video on Demand

5 Introduction

5.1 Scope of testing

A real system is said to exhibit conformance if it complies with the requirements of applicable specifications specified by ITU-T Recommendation in its communication with other real systems. ITU-T Rec. H.721 describes specifications of IPTV basic model terminal devices (hereafter referred to as just IPTV terminal devices) capable of receiving linear TV services and video-on-demand (VoD) services. Key features of IPTV terminal devices are network attachment, service discovery, service navigation, media processing, security including privacy and quality of service (QoS). The scope of this document regarding conformity testing is the same as Rec. ITU-T H.721.

5.2 Conformity requirements

To claim compliance with base specifications, an IPTV terminal device has to accept and make use of:

– all mandatory elements/attributes specified in base specifications

– all conditional elements/attributes for which at least one of them is mandatory

– all the conditional elements/attributes which are mandatory if an optional element/attribute is present

− all optional elements should be accepted even if not used

Requirements of testing in this document are categorized into followings [ITU-T X.290]:

− Static conformance requirements: specify the limitations on the combinations of implemented capabilities which are claimed to conform to the relevant specification(s) described in clauses 6 and 7, and Appendix I. These are claimed to be supported by using implementation conformance statement (ICS) which are created before conformity test executions

− Dynamic conformance requirements: specify observable behaviours which are claimed to conform to the relevant specification(s) by using test procedures described in clauses 6.8 and 7.4

5.3 Test scenarios

Linear TV and VoD are treated as basic IPTV services in [ITU-T H.721] according to [b-ITU-T Y.Sup5]; therefore, testing specifications for providing these two services are appropriate for conformity test cases. In addition, conformity testing on security requirements is also checked based on the two services.

Hence, the following variety of test cases for conformance testing is independently possible:

− Case 1: Linear TV services without SCP functionalities (e.g., authentication, authorization and content protection)

− Case 2: VoD services without SCP functionalities

− Case 3: SCP functionalities for Linear TV

− Case 4: SCP functionalities for VoD

5.4 Test methods

5.4.1 Test system

5.4.1.1 Test bed for IPTV basic services

A test environment consists of (1) a test system which has communication capabilities as a set of servers in order to provide Linear TV and/or VoD services, and (2) an IPTV terminal device as implementation under test (IUT) [ITU-T X.290].

The test system in this document is required to be equipped with:

− Service and application discovery and selection (SADS) functionalities [ITU-T Y.1910]:

   o Service discovery: this is not a target of this document; however, this functionality is required as preparation of testing. For details, see [ITU-T H.770] and/or [b-HTSP.CONF-H770]

   o Content selection: the servers and the IPTV terminal device may provide at least one way of content navigations (e.g., Web-based browsing, a resident application such as EPG/ECG)

− Content delivery functionalities/IPTV application functions: provided as Linear TV and/or VoD servers according to the test cases

   NOTE - A Linear TV server is named as Linear TV application, and a VoD server is named as On-demand application in Figure 5-1 respectively according to [ITU-T H.721].

− IPTV Application client: processes received contents and displayed on the IPTV terminal devices

– Network functionalities: supports a unicast network for VoD services and/or multicast network for Linear TV services. IPv4 and/or IPv6 shall be selected based on the specification of the IPTV terminal device

  o Relevant network protocols for IPTV services (e.g., DNS, DHCP) are also treated by these functionalities.

– Conformance log generator: watches the details of communication between the test bed system and the IPTV terminal device, and generate logs (e.g., packet capturing software). The specifications of the test environment shall be shown to IUT suppliers or implementers (e.g., software product xyz ver. 1.2.1 as HTTP server) before the conformance testing [ITU-T X.291].
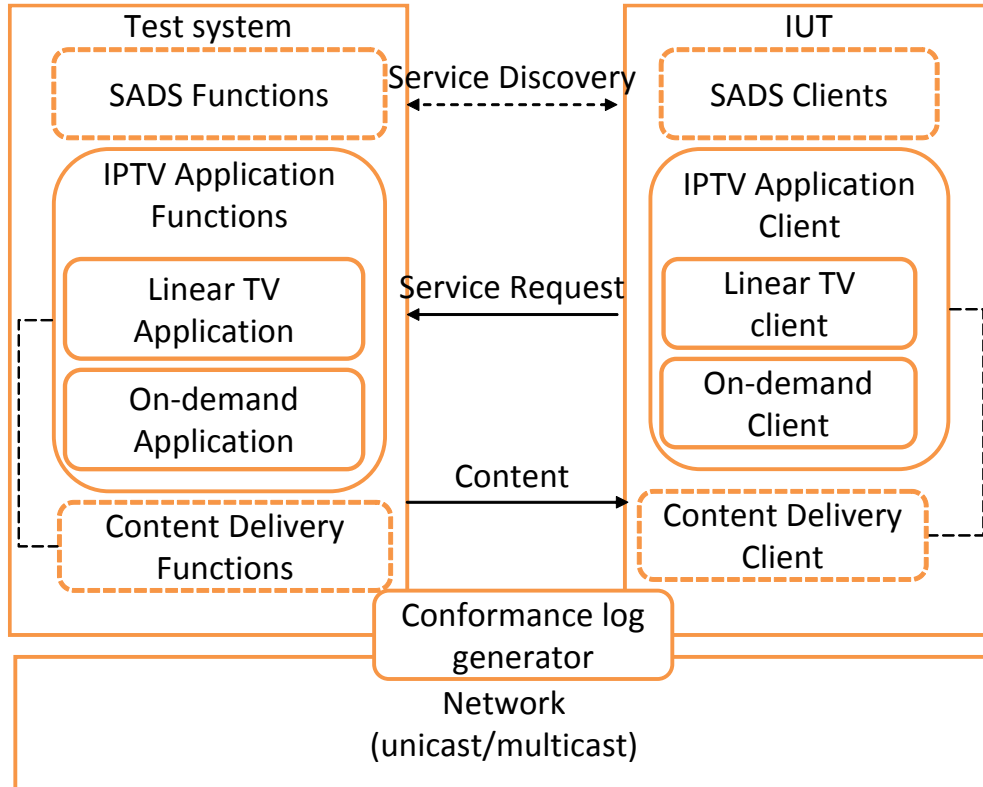
Figure 5-1: Test bed for basic IPTV services
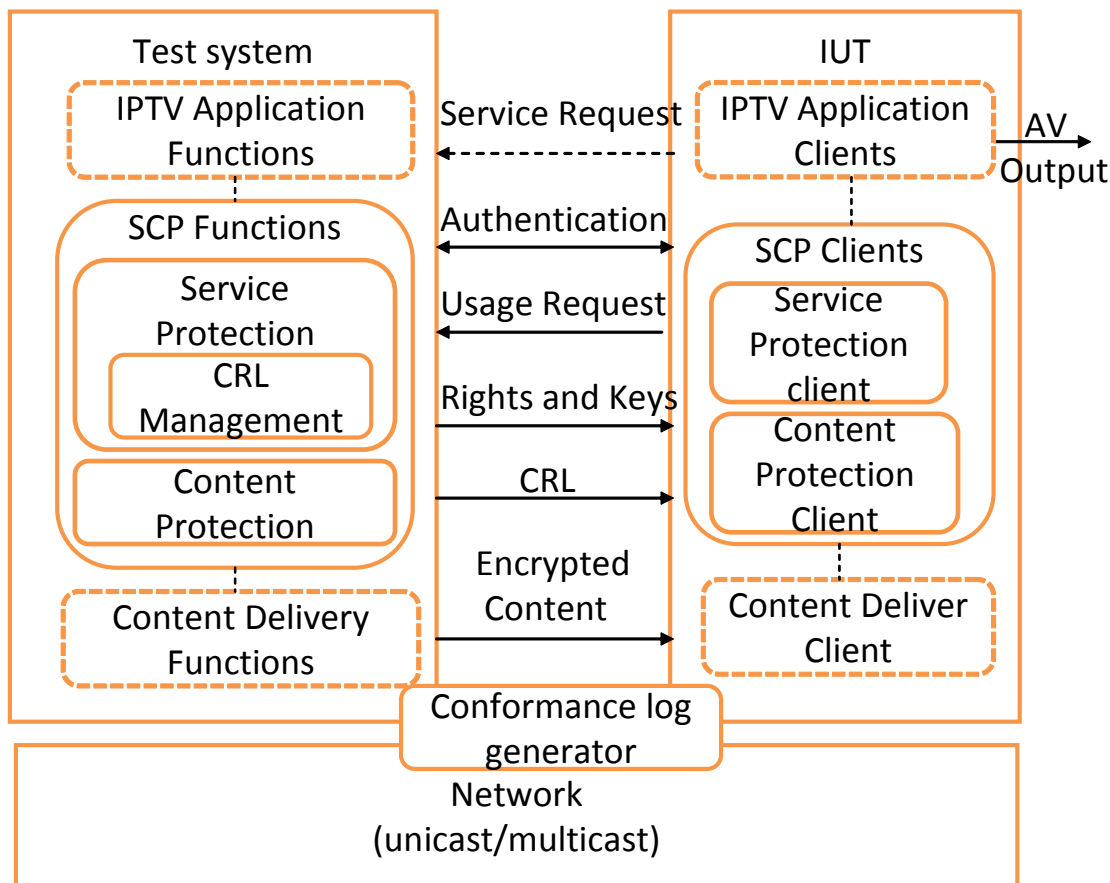
Figure 5-2: Test bed for security testing in basic IPTV services

5.4.1.2 Test bed for security

A test environment consists of (1) a test system which has communication and security capabilities as a set of servers in order to provide Linear TV and/or VoD services, and (2) an IPTV terminal device as implementation under test (IUT). See Figure 5-2.

The test system in this document is required to be equipped with:

– All basic IPTV service functionalities mentioned in clause 5.4.1.1

– Service and content protection (SCP) functionalities

    o Service protection functionalities: the servers and the IPTV terminal device provide authentication and authorization for the services:

        ▪ Certificates for mutual authentication in a PKI manner have to be treated appropriately in these functionalities

        ▪ Content revocation list (CRL) functionalities: the servers and the IPTV terminal devices can control services offering based on expiration terms of the rights of service consumption

    o Content protection functionalities: the servers and the IPTV terminal devices provide a way of content protection

NOTE: Multiple keys may be are handled if relevant SCP functionalities are implemented (e.g., work key, scramble key). Details of key hierarchy and its management are out of the scope of this document.

The specifications of the test environment shall be shown to the IUT suppliers or implementers (e.g., software product xyz ver. 1.2.1 as HTTP server) before the conformance testing [ITU-T X.291].

SCP functions contain the following detailed functions:

– Generating and managing sets of keys and rights

– Establishing secure communication with SCP clients

– Judging whether or not to issue a license based on requests from the SCP client and transferring the set of key and rights when issued

– Generating scramble keys and rights (e.g., ECM) in the case of Linear TV

CRL management functional block generates, manages and issues CRL relating to the SCP functions and SCP client. It has the following functions:

– Generating, updating and managing CRLs [ITU-T X.509] of the SCP functions and SCP client

– Transferring CRLs based on requests from the SCP functions to the SCP client

SCP client functional block inside the IUT has following functions:

– Establishing a secure communication link through mutual authentication with the SCP functions

– Acquiring the sets of rights and keys from the SCP functions, and managing them

– Supplying the keys and relevant information about the conditions for usage of content to the renderer. Extracting a scramble key from ECM in advance of the process in the case of Linear TV

– Updating and managing CRLs through communication with the CRL management block

IPTV service delivery functions for Linear TV security testing are required to support following functions:

– Generating and managing an encrypted stream of content by using the appropriate content key generated by the SCP functions

– Multiplexing ECM and transmitting service streams encrypted by a scramble key in the case of Linear TV

– Sending out an encrypted stream in response to a request from the IUT in the case of VoD

5.4.2 Conformance log

A conformance log is a human-readable record of information produced as a result of a test campaign, sufficient to record the observed test outcomes and verify the assignments of test verdicts. This information combines the observations of the actual test events which occur when the test system is run against an IPTV terminal device, with information which relates those events to the test cases concerned [ITU-T X.293].

In each steps when the IPTV terminal device communicate with the test system, especially described in clauses 6.8 and 7.4, conformance logs should be collected and checked in a verdict process regarding both static and dynamic conformance requirements.

5.5 Implementation conformance statement (ICS) proformas

The specific requirements to be met by suppliers (in respect of each ICS they are to provide) shall be stated in base specifications. The ICS proforma shown in Appendix I are in the form of a questionnaire to be completed by the supplier or implementer [ITU-T X.291].

6 Conformance for basic IPTV services

6.1 Media formats and streaming methods for Linear TV

Media formats and streaming methods for Linear TV are specified in clause 7.1.1 of [ITU-T H.721]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table I.1 in Appendix I).

6.2 Media formats and streaming methods for VoD

Media formats and streaming methods for VoD are specified in clause 7.1.2 of [ITU-T H.721]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table I.2 in Appendix I).

6.3 Network attachment and initialization

Network attachment and initialization are specified in clauses 7.2.1 and 7.2.1.1 of [ITU-T H.721]. Service discovery is specified in clauses 7.2.1.2 and 7.2.1.3 of [ITU-T H.721]. For more details, refer to [ITU-T H.770] and [b-HTSP.CONF-H770]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table I.3 in Appendix I).

6.4 Service discovery and service consumption

Specifications of service discovery are described in clauses 7.2.1.2 and 7.2.1.3 of [ITU-T H.721]. [ITU-T H.770] consults with the details of service discovery. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table I.4 in Appendix I).

6.5 Service navigation

Service navigation is specified in clause 7.1.3 of [ITU-T H.721]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table I.9 in Appendix I).

6.6 Content delivery

Specifications of content delivery are described in clause 9.2 of [ITU-T H.721]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table.I.5 in Appendix I).

6.7 Media decoding formats

Specifications of video decoding and audio decoding by codec implemented in IPTV terminal devices are described in clauses 9.3.3.1 and 9.3.3.2 of [ITU-T H.721]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table.I.6 and I.7 in Appendix I).

6.8   Procedures for testing basic IPTV services

Functionalities regarding basic IPTV services (i.e. Linear TV and VoD) that claim conformance to base specifications shall pass the following normative test as observation of behaviours of an IPTV terminal device:

Advance preparation:

1) Detailed specifications which are difficult to be measured or to be observed (e.g., details of media decoding formats) through the conformity testing should be filled in check-lists

2) Ingest the video and audio contents to the test system, and set a network environment for the testing

3) A test IPTV terminal device connects to the test system over an IP network (see NOTE 1)

4) The test IPTV terminal device executes service discovery processes (see NOTE 2)

Testing:

5) The test IPTV terminal device acquires a list of contents over the network and select a content

6) The test IPTV terminal device acquires the contents over the network and display the content (see NOTE 3)

7) Test pass if the IPTV terminal device successes steps 1, 5 and 6 according to the completed check-lists (see NOTE 4)

NOTE 1 – Details of network attachment specifications are out of the scope of this document.

NOTE 2 – Details of service discovery specifications are out of scope of this document, see [ITU-T H.770].

NOTE 3 – The order of steps 5 and 6 can be exchanged based on the content selection mechanisms implemented in the IPTV terminal devices.

NOTE 4 – Conformance logs shall be recorded through steps 5 and 6 for subsequent checking.

7   Conformance for service and content protection

7.1   Service protection

Specifications of service protection are described in clauses 7.2.2 and 9.4.1 of [ITU-T H.721]. For details of service protection, refer to [ITU-T X.1191] and relevant ITU-T Recommendations ([ITU-T X.509] et al.). The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table.I.10 in Appendix I).

7.2   Content protection

Specifications of content protection are described in clauses 7.2.2 and 9.4.2 of [ITU-T H.721]. For details of content protection, refer to [ITU-T X.1191]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table.I.10 in Appendix I).

7.3   Other security items

Privacy, parental control and copy control of output interfaces are described in clauses 7.2.3, 9.3.5.4 and 10.2 of [ITU-T H.721] respectively. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table.I.10 in Appendix I).

7.4 Procedures for security testing of basic IPTV services

Functionalities regarding security of basic IPTV services that claim conformance to security specifications shall pass the following normative test as observation of behaviours of an IPTV terminal device:

Advance preparation:

1) Create sets of keys and rights, CRLs for a testing, and operate SCP servers to manage relevant data (see NOTE 1)

2) A test IPTV terminal device and a SCP server hold certificates for mutual authentication in a PKI manner (see NOTE 2)

3) Ingest the video and audio contents, which are encrypted by the keys in step 1, to the test system, and set an IP network environment for testing

4) The test IPTV terminal device connects to the test system over the network

5) The test IPTV terminal device executes service discovery processes

6) Detailed specifications which depend on implementations (e.g., methods for mutual authentication, key management) should be declared as supplement information for verdicts

Testing:

7) The SCP servers change the usage conditions and send them to the test IPTV terminal (see NOTE 2):

    –   Register/un-register the service subscriptions of IPTV services

    –   Activate/Revoke the usage rights by using the CRLs

8) The test IPTV terminal device acquires a list of contents over the network and select a content

9) The test IPTV terminal device acquires the contents, the sets of keys and rights and CRLs over the network and display the content

10) Observe the status of service consumption (or selection) in accordance with step 7 (see NOTE 2)

11) Check a function for copy protection of analogue output if analogue interface is implemented

12) Test pass if the IPTV terminal device successes in steps 6, 10 and 11 according to the completed check-lists (see NOTE 4).

NOTE 1 – Details of treating and checking certificates are out of scope of this document.

NOTE 2 – Details of methods for changing the usage condition and checking the results of the changing are for further study.

NOTE 3 – The order of steps 8 and 9 is exchangeable.

NOTE 4 – Conformance log shall be recorded through step 9 for subsequent checking.

8 Conformance for physical interface

8.1 Input interface

Specifications concerning input interfaces implemented in IPTV terminal devices are described in clause 10.1 of [ITU-T H.721]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g. Table.I.9 in Appendix I).

8.2 Output interface

Specifications concerning output interface implemented in IPTV terminal devices are described in clause 10.2 of [ITU-T H.721]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., Table.I.9 in Appendix I).

8.3 Procedures for testing output interface

For details, see step 11 in clause 7.4 for testing protection mechanisms of analogue output interface.

9 Conformance for QoS

QoS for IPTV terminal devices are described in clauses 7.2.4 and 9.2.4 of [ITU-T H.721]. For details, refer to [ITU-T H.701] and [b-ITU-T H.IPTV-CONF.1]. The observed test outcomes and the results of evaluations (including verdicts) shall be filled in on the corresponding check list (e.g., [b-ITU-T H.IPTV-CONF.1]).

Appendix I:
H.721 conformance checklist

The followings are preliminary checklists for a conformance testing of basic IPTV terminal devices. It is intended to be gradually incorporated to the main text of this document as specific testing procedures are made.

Columns "Status" in tables described below show requirement levels of elements/attributes for reference. Mandatory elements/attributes are shown "M", optional ones are shown as "O" and conditional requirements are shown as "C".

Columns "Support" are used to fill in whether specifications of ITU-T H.721 are used or not [b-ITU-T X.296].

The common notations for support answers are:

– supported: Y, y, YES or yes

– not supported: N, n, NO, no

– no answer required: N/A, n/a or "-"

Columns "Remarks" is used to fill in additional information for clarifying relevancies to ITU-T Rec. H.721 specifications if necessary.

NOTE 2 – If optional specifications are used under specific conditions, the conditions should be also described for verdicts (e.g., only if Linear TV is served).

I.1   Linear TV checklist

Table I.1: Checklist concerning formats and streaming in Linear TV

Category	Specifications	Reference	Status	Support	Remarks
Monomedia	Video MPEG-2	7.1.1	C*1		
	Video H.264 (AVC)	7.1.1	C*1		
	Video H.265 (HEVC)	7.1.1	C*1		
	Audio MPEG2 AAC	7.1.1	C*2		
	Audio MPEG1 Layer II	7.1.1	C*2		
	Audio MPEG-4 AAC	7.1.1	C*2		
	Audio MPEG-4 HE AAC v1	7.1.1	C*2		
	Audio MPEG-4 ALS	7.1.1	C*2		
	Audio Dolby AC-3	7.1.1	C*2		
	Audio DTS-HD	7.1.1	C*2		
	ARIB Captioning	7.1.1	O		
	9.1.1 ARIB Captioning	7.1.1	O		
	ATSC Closed Captioning	7.1.1	O		
	EBU Teletext Subtitles	7.1.1	O		
	DVB Subtitling		O		

Category	Specifications	Reference	Status	Support	Remarks
Multiplex format	MPEG-2 TS	7.1.1	M		
	TTS	7.1.1	O		
	MMT	7.1.1	O		
Streaming	RTP	7.1.1	M		

NOTE 1 – At least one of video formats is required.

NOTE 2 – At least one of audio formats is required.

I.2 VoD checklist

Table I.2: Checklist concerning formats and streaming in VoD

Category	Specifications	Reference	Status	Support	Remarks
Monomedia	Video MPEG-2	7.1.2	C*1		
	Video H.264 (AVC)	7.1.2	C*1		
	Video H.265 (HEVC)	7.1.2	C*1		
	Audio MPEG2 AAC	7.1.2	C*2		
	Audio MPEG1 Layer II	7.1.2	C*2		
	Audio MPEG-4 AAC	7.1.2	C*2		
	Audio MPEG-4 ALS	7.1.2	C*2		
	Audio DTS-HD	7.1.2	C*2		
	ARIB Captioning	7.1.2	O		
	ARIB TTML Captioning	7.1.2	O		
	ATSC Closed Captioning	7.1.2	O		
Multiplex format	MPEG-2 TS	7.1.2	M		
	TTS	7.1.2	O		
	MP4	7.1.2	O		
	MMT	7.1.2	O		
Streaming	RTP, RTSP	7.1.2	M		
	DASH	7.1.2	O		

NOTE 1 – At least one of the video formats is required.

NOTE 2 – At least one of the audio formats is required.

I.3 Terminal device attachment and initialization

Table I.3 Checklist concerning network attachment protocols

Category	Protocols	Reference	Status	Support	Remarks
Monomedia	IP, ICMP	7.2.1.1	M		
	IPv6, ICMPv6	7.2.1.1	O		
	DHCP	7.2.1.1	M		
	DNS	7.2.1.1	M		

I.4 Service provider discovery and service attachment

Table I.4: Checklist concerning service discovery

Category	Specifications	Reference	Status	Support	Remarks
Multiplex Format	MPEG-2 TS	7.2.1.3	M		
	TTS	7.2.1.3	O		
	MMT	7.2.1.3	O		
Streaming	RTP, RTSP	7.2.1.3	M		
Multicast	IGMPv2	7.2.1.3	C*1		
	MLDv2	7.2.1.3	C*1		
Portal	HTTP	7.2.1.3	C*2		

NOTE 1 – At least one of them is required when Linear TV services are provided.

NOTE 2 – HTTP is required when portal is used in IPTV services.

I.5 Content delivery

Table I.5: Checklist concerning content delivery

Category	Protocols	Reference	Status	Support	Remarks
Multicast	IGMPv2	9.2.2	C*1		
	MLDv2	9.2.2	C*1		
Unicast	RTP, RTSP	9.2.3	C*2		
	HTTP	9.2.3	C*3		
	DASH	9.2.3	C*4		

NOTE 1 – At least one of them is required when Linear TV services are provided.

NOTE 2 – RTP/RTSP are required when VoD services are provided.

NOTE 3 – HTTP is required when portal is used in IPTV service.

NOTE 4 – If HTTP is used for streaming, DASH is recommended to support.

I.6 Video decoding

Table I.6.1: Checklist concerning video decoding by codec category

Category	Implementation	Reference	Status	Support	Remarks
0	ITU-T H.262	9.3.3.1.1	M		
	ITU-T H.264	9.3.3.1.2	M		
1	ITU-T H.262	9.3.3.1.1	O*1		
	ITU-T H.264	9.3.3.1.2	M		
	ITU-T H.265 with special resolution 1920x1080 or less	9.3.3.1.3	M		

Category	Implementation	Reference	Status	Support	Remarks
2	ITU-T H.262	9.3.3.1.1	O*1		
	ITU-T H.264	9.3.3.1.2	M		
	ITU-T H.265 with special resolution 3840x2160 or less	9.3.3.1.3	O		
3	ITU-T H.262	9.3.3.1.1	O*1		
	ITU-T H.264	9.3.3.1.2	M		
	ITU-T H.265 with special resolution 3840x2160 or less	9.3.3.1.3	M		

NOTE 1 – It is recommended to be supported in ITU-T H.721.

Table I.6.2: Checklist concerning video decoding by an ITU-T H.262 codec

Category	Spatial resolution	Frame frequency	Profile	Level (minimum)	Reference	Status	Support	Remarks
ITU-T H.262	1920 × 1080	50, 60/1.001, 60 Hz (progressive)	Main	High	9.3.3.1.1	C*1		
		24/1.001, 24, 25, 30/1.001, 30 Hz (progressive, interlace, or segmented-frame)	Main	High	9.3.3.1.1	C*1		
	1440 × 1080 *	50, 60/1.001, 60 Hz (progressive)	Main	High1440	9.3.3.1.1	C*1		
		24/1.001, 24, 25, 30/1.001, 30 Hz (progressive, interlace, or segmented-frame)	Main	High1440	9.3.3.1.1	C*1		
	1280 × 720	50, 60/1.001, 60 Hz (progressive)	Main	High1440	9.3.3.1.1	C*1		
	720 × 576	50Hz (progressive)	Main	High1440	9.3.3.1.1	C*1		
		25 Hz (interlace)	Main	Main	9.3.3.1.1	C*1		
	720 × 480	60/1.001 Hz (progressive)	Main	High1440	9.3.3.1.1	C*1		
		30/1.001 Hz (interlace)	Main	Main	9.3.3.1.1	C*1		

NOTE 1 – At least one of <u>resolutions and its frame frequency</u> is required.

Table I.6.3: Checklist concerning video decoding by ITU-T H.264 codec

Category	Spatial resolution	Frame frequency	Profile	Level (minimum)	Reference	Status	Support	Remarks
ITU-T H.264	1920 × 1080	50, 60/1.001, 60 Hz (progressive)	High 422, High10, High or Main	4.2	9.3.3.1.2	C*1		
		24/1.001, 24, 25, 30/1.001, 30 Hz (progressive, interlace, or segmented-frame)	High 422, High10, High or Main	4.0	9.3.3.1.2	C*1		
	1440 × 1080 *	50, 60/1.001, 60 Hz (progressive)	High 422, High10, High or Main	4.2	9.3.3.1.2	C*1		
		24/1.001, 24, 25, 30/1.001, 30 Hz (progressive, interlace, or segmented-frame)	High 422, High10, High or Main	3.2	9.3.3.1.2	C*1		
	1280 × 720	50, 60/1.001, 60 Hz (progressive)	High 422, High10, High or Main	3.2	9.3.3.1.2	C*1		
	720 × 576	50Hz (progressive)	High 422, High10, High or Main	3.1	9.3.3.1.2	C*1		
		25 Hz (interlace)	High 422, High10, High or Main	3.0	9.3.3.1.2	C*1		
	720 × 480	60/1.001 Hz (progressive)	High 422, High10, High or Main	3.1	9.3.3.1.2	C*1		
		30/1.001 Hz (interlace)	High 422, High10, High or Main	3.0	9.3.3.1.2	C*1		

NOTE 1 – At least one of resolutions and its frame frequency is required.

Table I.6.3: Checklist concerning video decoding by ITU-T H.265 codec

Category	Spatial resolution	Frame frequency	Bit depth	Profile	Level (minimum)	Reference	Status	Support	Remarks
ITU-T H.265	3840 × 2160	100, 120/1.001, 120Hz (progressive)	8 bit	Main 10 or Main	5.2	9.3.3.1.3	C*1		
			10 bit	Main 10					
		24/1.001, 24, 25, 30/1.001, 30, 50, 60/1.001, 60Hz (progressive)	8 bit	Main 10 or Main	5.1	9.3.3.1.3	C*1		
			10 bit	Main 10					
	1920 × 1080	50, 60/1.001, 60 Hz (progressive)	8 bit	Main 10 or Main	4.1	9.3.3.1.3	C*1		
			10 bit	Main 10					
		24/1.001, 24, 25, 30/1.001, 30 Hz (progressive, interlace, or segmented-frame)	8 bit	Main 10 or Main	4	9.3.3.1.3	C*1		
			10 bit	Main 10					
	1280 × 720 720 × 576	50, 60/1.001, 60Hz (progressive)	8 bit	Main 10 or Main	4	9.3.3.1.3	C*1		
			10 bit	Main 10					
		50Hz (progressive)	8 bit	Main 10 or Main	3.1	9.3.3.1.3	C*1		
			10 bit	Main 10					
	1280 × 720	25 Hz (interlace)	8 bit	Main 10 or Main	3	9.3.3.1.3	C*1		
			10 bit	Main 10					
	720 × 480	60/1.001 Hz (progressive)	8 bit	Main 10 or Main	3.1	9.3.3.1.3	C*1		
			10 bit	Main 10					
		30/1.001 Hz (interlace)	8 bit	Main 10 or Main	3	9.3.3.1.3	C*1		
			10 bit	Main 10					

NOTE 1 – At least one of resolutions and its frame frequency is required.

I.7 Audio decoding

Table I.7: Checklist concerning audio decoding by codec

Category	Implementations	Reference	Status	Support	Remarks
Audio format	MPEG-2 AAC	9.3.3.2	C*1		
	MPEG-1 Layer II	9.3.3.2	C*1		
	MPEG-4 AAC	9.3.3.2	C*1		
	MPEG-4 HE AAC v1	9.3.3.2	C*1		
	MPEG-4 ALS	9.3.3.2	C*1		
	Dolby AC-3	9.3.3.2	C*1		
	DTS-HD	9.3.3.2	C*1		

NOTE 1 – At least one of audio decoding is required.

I.8 Service navigation

Table I.8: Checklist concerning service navigation

Category	Means for navigation	Reference	Status	Support	Remarks
Service navigation	Content selection using a remote controller	7.1.3	O		
	Content selection with EPG	7.1.3	C*1		
	Content selection with ECG	7.1.3	C*1		
	Content selection with portal	7.1.3	C*1		

NOTE 1– At least one of them is required.

I.9 Physical interfaces

Table I.9: Checklist concerning physical interfaces

Category	Implementations	Reference	Status	Support	Remarks
Input interfaces	Reset button	10.1.1	O		
	Remote controller	10.1.2	O		
Output Interfaces	RGB analogue output (e.g., RCA, S-Video connectors)	10.2.1	O		
	DVI as digital video output	10.2.2	O		
	HDMI as high-definition digital video output	10.2.4	O		

I.10   Security

Table I.10: Checklist concerning security

Category	Functions/protocols	Reference	Status	Support	Remarks
Service protection	Server-side SCP functions authentication using PKI for mutual authentication	7.2.2, 9.4.1.1	M*1		
	Service access control to restrict acquisition and access to services by using SCP functionalities (e.g., scrambling and encrypted for Linear TV)	7.2.2, 9.4.1.1	M		
	Encryption for protecting access control information	7.2.2, 9.4.1.1	M		
	Secure communication using SSL/TLS when IPTV terminal devices connect to security-related application servers (e.g., connection between portal and IPTV terminal devices)	7.2.2	M		
	Communicate with CRL server for update and management of CRL	7.2.2	M*15		
	Client certificate and root certificate	9.4.1.1	M*1		
	Share the key for encryption by standardized key exchange protocol (e.g., Diffie-Hellman (DH) protocol [b-RFC 2539])	9.4.1.1	M		
	Acquire the newest CRL	9.4.1.2	O		
Content protection	Request an individual set of rights and keys with transmitting to sever-side SCP functionalities a message which includes the ID that identifies the targeted set of rights and keys	7.2.2, 9.4.2.1	M		
	Robust secure communication for keys and rights transmission with mutual authentication using PKI, key exchange protocol, and key encryption.	7.2.2, 9.4.2.1	M		
	Rights and keys management for VoD (e.g., An Individual set of rights and keys are treated during playback and encrypted content is decrypted by using the keys)	7.2.2, 9.4.2.2	M*2		
	Rights and keys management for Linear TV (e.g., Extracting a scramble key and supplying the key and information about the conditions for use of content to the renderer)	7.2.2, 9.4.2.3	M*2		
	AES encryption with CBC and OFB for a residual block for Linear TV and VoD	7.2.2	M*16		
	CSA encryption for Linear TV	7.2.2	O*2		

Category	Functions/protocols	Reference	Status	Support	Remarks
Others	SCP client restricts the viewing of certain content and the associated information according to parental control information	9.3.5.4	O		
	Audio/Video output interfaces of the IPTV terminal device provide appropriate copy protection	10.2	M		

NOTE 1 - In case wherein X.509 base certificates are used as credentials for authentication, a revocation function is required [ITU-T X.1191].

NOTE 2 - It is required or recommended based on IPTV service actually provided.

Appendix II:
Reference points for conformance test

Figure II-1 shows reference points concerning IPTV terminal devices [b-ITU-T HTSP.PITD] or details of functionalities, see [ITU-T Y.1910]. Right-side round square boxes are server-side or network-side functionalities. Following reference points E0, E2, E4, E5 and E6, are related to this document.
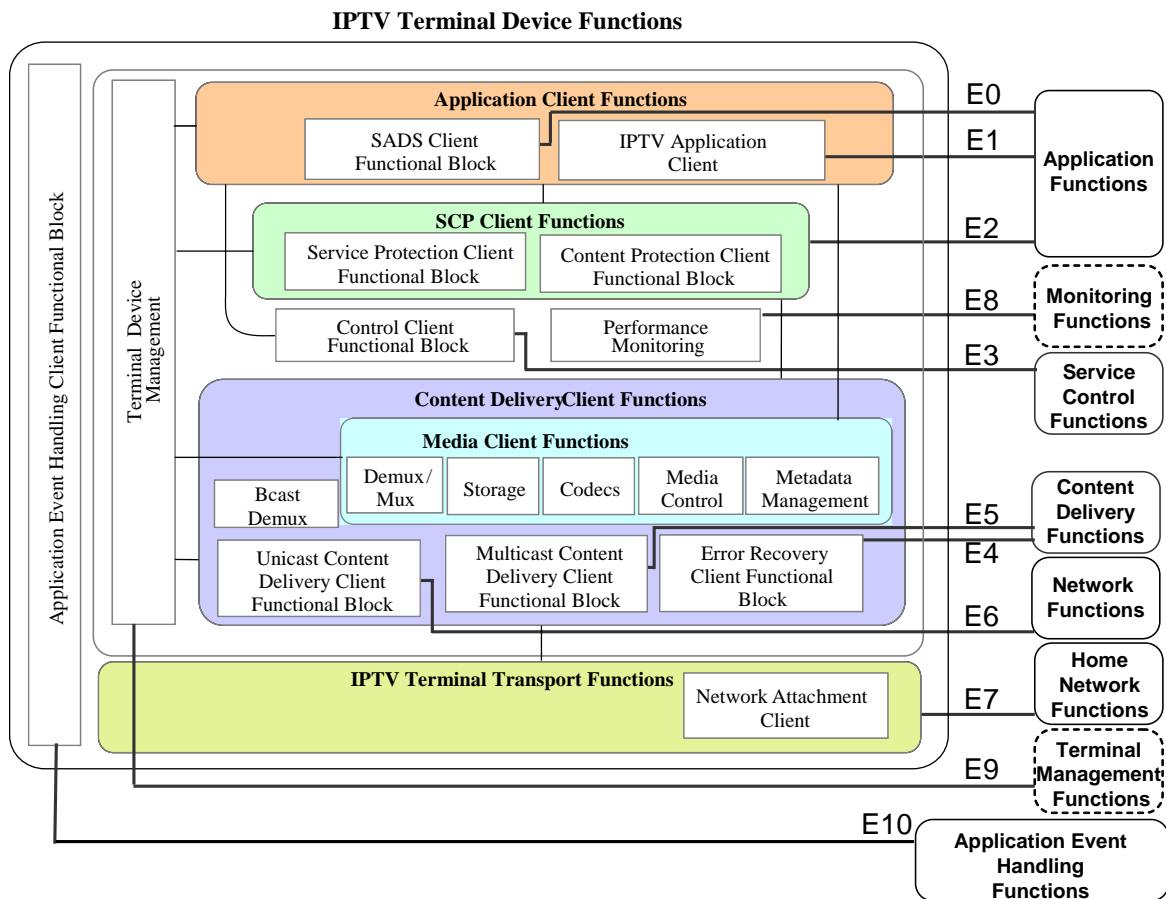

Figure II-1: Reference points on conformity testing of IPTV terminal devices

II.1   Reference point E0

The E0 reference point is between service and application discovery and selection (SADS) client functional block and the server-side SADS functional block.

This reference point is used to discover service provider/services themselves, and select IPTV services and applications. For details of service discovery, see [ITU-T H.770].

II.2   Reference point E2

The E2 reference point is between service and content protection (SCP) client functions and server-side SCP functions.

This reference point is used for delivering security information (e.g. rights object or keys) from SCP functions to SCP client functions. For details of SCP, see [ITU-T X.1191]

II.3   Reference point E4

The E4 reference point is between error recovery functional block and error recovery client functional block.

This reference point is used to exchange messages for requesting and delivering error recovery information, for example forward error correction (FEC) repair data or retransmission data. For detail of FEC and retransmission, see [ITU-T H.701].

II.4   Reference Point E5

The E5 reference point is between the multicast content delivery client functional block and the multicast control point functional block.

This reference point is used to exchange messages for joining multicast channels, e.g. IGMP messages.

II.5   Reference point E6

The E6 reference point is between the unicast content delivery client functional block and the content delivery control functional block.

This reference point is used to exchange content control message, e.g. video recording commands.

NOTE - The information exchanged between the unicast content delivery client functional block and the content delivery control functional block can optionally be transferred via the IPTV service control functions, e.g. in the case where the IPTV service control functions proxy all requests between the unicast content delivery client functional block and the content delivery control functional block.

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[b-ITU-T X.800]	Recommendation ITU-T X.800 (1991), *Security architecture for open systems interconnection for CCITT applications*
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[b-ITU-T Y.Sup5]	ITU-T Y.1900-series-Supplement 5 (2008), *Supplement on IPTV service use cases*
[b-RFC 2539]	IETF RFC 2539 (1999), *Storage of Diffie-Hellman Keys in the Domain Name System (DNS)*
[b-HSTP.CONF-H701]	Technical Paper ITU-T HSTP.CONF-H701 (2010), *Conformance testing specification for H.701*
[b-HTSP.CONF-H770]	Technical Paper ITU-T HTSP.CONF-H770 (2010), *Conformance testing specification for H.770*
[b-HTSP.PITD]	Technical Paper ITU-T HTSP.IPTV-PITD (2011), *Delivery and control protocols handled by IPTV terminal devices*

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