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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

IPTV multimedia services and applications for IPTV –
IPTV terminal devices

IPTV terminal devices: Basic model

Recommendation ITU-T H.721



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Recommendation ITU-T H.721

IPTV terminal devices: Basic model

Summary

Recommendation ITU-T H.721 describes and specifies the functionalities of the IPTV terminal devices for the IPTV basic services defined in Recommendation ITU-T H.720. This Recommendation is targeted at IPTV terminal devices capable of receiving linear TV service and video-on-demand services, with additional data content (such as text) using a managed content delivery network. The service definition takes into consideration conditions on content delivery such as QoS. The expected types of IPTV terminal devices are set-top boxes and digital TV sets with embedded IPTV capabilities.

Source

Recommendation ITU-T H.721 was approved on 16 March 2009 by ITU-T Study Group 16 (2009-2012) under Recommendation ITU-T A.8 procedures.

FOREWORD

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Recommendation ITU-T H.721

IPTV terminal devices: Basic model

1 Scope

This Recommendation describes and specifies the functionalities of the IPTV terminal devices for IPTV basic services defined in [ITU-T H.720] over a dedicated content delivery network, which takes into consideration conditions on content delivery such as QoS. The expected types of terminal devices are set-top boxes and digital TV sets with embedded IPTV capabilities.

2 References

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

- [ITU-T H.222.0] Recommendation ITU-T H.222.0 (2006) | ISO/IEC 13818-1:2007, *Information technology – Generic coding of moving pictures and associated audio information: Systems.*
- [ITU-T H.262] Recommendation ITU-T H.262 (2000) | ISO/IEC 13818-2:2000, *Information technology – Generic coding of moving pictures and associated audio information: Video.*
- [ITU-T H.264] Recommendation ITU-T H.264 (2007), *Advanced video coding for generic audiovisual services.*
- [ITU-T H.701] Recommendation ITU-T H.701 (2009), *Content delivery error recovery for IPTV services.*
- [ITU-T H.720] Recommendation ITU-T H.720 (2008), *Overview of IPTV terminal devices and end systems.*
- [ITU-T H.750] Recommendation ITU-T H.750 (2008), *High-level specification of metadata for IPTV services.*
- [ITU-T H.760] Recommendation ITU-T H.760 (2009), *Overview of multimedia application frameworks for IPTV.*
- [ITU-T H.770] Recommendation ITU-T H.770 (2009), *Mechanisms for service discovery and selection for IPTV services.*
- [ITU-T Y.1901] Recommendation ITU-T Y.1901 (2009), *Requirements for the support of IPTV services.*
- [ITU-T Y.1910] Recommendation ITU-T Y.1910 (2008), *IPTV functional architecture.*
- [ARIB STD-B24] ARIB Standard ARIB STD-B24 Version 5.2 (2008), *Data Coding and Transmission Specification for Digital Broadcasting.*
- [CEA-708] Consumer Electronics Association CEA Standard CEA-708-D (2008), *Digital Television (DTV) Closed Captioning.*
- [ETSI TS 102 366] ETSI TS 102 366 V1.2.1 (2008), *Digital Audio Compression (AC-3, Enhanced AC-3) Standard.*

- [ETSI EN 300 472] ETSI EN 300 472 V1.3.1 (2003), *Digital Video Broadcasting (DVB); Specification for conveying ITU-R System B Teletext in DVB bitstreams.*
- [ETSI EN 300 743] ETSI EN 300 743 V1.3.1 (2006), *Digital Video Broadcasting (DVB); Subtitling systems.*
- [IETF RFC 791] IETF RFC 791 (1981), *Internet Protocol.*
- [IETF RFC 792] IETF RFC 792 (1981), *Internet Control Message Protocol.*
- [IETF RFC 1034] IETF RFC 1034 (1987), *Domain names – concepts and facilities (DNS).*
- [IETF RFC 1035] IETF RFC 1035 (1987), *Domain names – implementation and specification.*
- [IETF RFC 2131] IETF RFC 2131 (1997), *Dynamic Host Configuration Protocol.*
- [IETF RFC 2181] IETF RFC 2181 (1997), *Clarifications to the DNS Specification.*
- [IETF RFC 2236] IETF RFC 2236 (1997), *Internet Group Management Protocol, Version 2.*
- [IETF RFC 2246] IETF RFC 2246 (1999), *The TLS Protocol Version 1.0.*
- [IETF RFC 2250] IETF RFC 2250 (1998), *RTP Payload Format for MPEG1/MPEG2 Video.*
- [IETF RFC 2326] IETF RFC 2326 (1998), *Real Time Streaming Protocol (RTSP).*
- [IETF RFC 2460] IETF RFC 2460 (1998), *Internet Protocol, Version 6 (IPv6) Specification.*
- [IETF RFC 2461] IETF RFC 2461 (1998), *Neighbour Discovery for IP Version 6 (IPv6).*
- [IETF RFC 2462] IETF RFC 2462 (1998), *IPv6 Stateless Address Autoconfiguration.*
- [IETF RFC 2616] IETF RFC 2616 (1999), *Hypertext Transfer Protocol – HTTP/1.1.*
- [IETF RFC 2671] IETF RFC 2671 (1999), *Extension Mechanisms for DNS (EDNS0).*
- [IETF RFC 2818] IETF RFC 2818 (2000), *HTTP over TLS.*
- [IETF RFC 3228] IETF RFC 3228 (2002), *IANA Considerations for IPv4 Internet Group Management Protocol (IGMP).*
- [IETF RFC 3315] IETF RFC 3315 (2003), *Dynamic Host Configuration Protocol for IPv6 (DHCPv6).*
- [IETF RFC 3550] IETF RFC 3550 (2003), *RTP: A Transport Protocol for Real-Time Applications.*
- [IETF RFC 3596] IETF RFC 3596 (2003), *DNS Extensions to Support IP Version 6.*
- [IETF RFC 3646] IETF RFC 3646 (2003), *DNS Configuration options for Dynamic Host Configuration Protocol for IPv6 (DHCPv6).*
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- [IETF RFC 3810] IETF RFC 3810 (2004), *Multicast Listener Discovery Version 2 (MLDv2) for IPv6.*
- [IETF RFC 3986] IETF RFC 3986 (2005), *Uniform Resource Identifier (URI): Generic Syntax.*
- [IETF RFC 4291] IETF RFC 4291 (2006), *IP Version 6 Addressing Architecture.*
- [IETF RFC 4443] IETF RFC 4443 (2006), *Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification.*
- [ISO/IEC 11172-3] ISO/IEC 11172-3:1993, *Information technology – Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s – Part 3: Audio.*

[ISO/IEC 13818-7] ISO/IEC 13818-7:2006, *Information technology – Generic coding of moving pictures and associated audio information – Part 7: Advanced Audio Coding (AAC)*.

[ISO/IEC 14496-3] ISO/IEC 14496-3:2009, *Information technology – Coding of audio-visual objects – Part 3: Audio*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 accessibility feature [ITU-T Y.1901]: An additional content component that is intended to assist people hindered in their ability to perceive an aspect of the main content. Examples: captions for the hard of hearing, subtitles in various languages, sign-language interpretation video and descriptive audio.

3.1.2 acquisition [ITU-T Y.1901]: The process of obtaining content by the end-user.

NOTE – For content with accessibility features, this means that the content will be available in a form that can be used by the end-user.

3.1.3 captions [ITU-T Y.1901]: Captions provide a real-time on-screen transcript of the dialogue as well as any sound effects.

NOTE – This service can be provided by means of either textual or graphical supplementary content. The captions and the dialogue are usually in the same language. The service is primarily to assist users having difficulty hearing the sound. Ideally, users may have some control over the position and size of the presentation. Different speakers are distinguished, usually by different colours.

3.1.4 certificate revocation list (CRL) [b-ITU-T X.509]: A signed list indicating a set of certificates that are no longer considered valid by the certificate issuer. In addition to the generic term CRL, some specific CRL types are defined for CRLs that cover particular scopes.

3.1.5 channel [ITU-T Y.1901]: Content formatted as a selectable set of data and transported as part of a data stream.

3.1.6 content delivery network (CDN) [b-ITU-T F.750]: A network optimized for delivering digital content.

3.1.7 content protection [ITU-T Y.1901]: Ensuring that an end-user can only use the content they have already acquired in accordance with the rights that they have been granted by the rights holder.

3.1.8 content provider [ITU-T Y.1910]: The entity that owns or is licensed to sell content or content assets.

3.1.9 end-user [ITU-T Y.1910]: The actual user of the products or services.

NOTE – An end-user consumes the product or service. An end-user can optionally be a subscriber.

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

3.1.11 IPTV terminal function (ITF) [ITU-T Y.1901]: An end-user function associated with a) receiving and responding to network control channel messages regarding session set-up, maintenance, and tear-down; and b) receiving the content of an IP transport from the network and rendering.

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

3.1.13 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.

3.1.14 metadata [ITU-T Y.1901]: Structured, encoded data that describe characteristics of information-bearing entities to aid in the identification, discovery, assessment, and management of the described entities.

NOTE – EPG metadata has many applications and may vary in depth from merely identifying the content package title or information to populate an EPG to providing a complete index of different scenes in a movie or providing business rules detailing how the content package may be displayed, copied, or sold.

3.1.15 multimedia [b-ITU-T J.148]: The combination of multiple forms of media such as audio, video, text, graphics, fax, and telephony in the communication of information.

3.1.16 network provider [ITU-T Y.1910]: The organization that maintains and operates the network components required for IPTV functionality.

NOTE 1 – A network provider can optionally also act as service provider.

NOTE 2 – Although considered as two separate entities, the service provider and the network provider can optionally be one organizational entity.

3.1.17 re-transmission broadcast service [ITU-T Y.1901]: A service in which content is provided from various broadcasting environments including, but not limited to, terrestrial, satellite and cable, and retransmitted into IP network simultaneously or otherwise.

3.1.18 rights [b-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.

3.1.19 service [ITU-T Y.1901]: A set of functionalities enabled by a provider for end-users.

NOTE – Example provisioned functionalities include IP connectivity with managed quality of service, video-on-demand.

3.1.20 service and content protection (SCP) [ITU-T Y.1901]: A combination of service protection and content protection.

3.1.21 service navigation [ITU-T H.720]: The process of presenting information that allows the end-user to discover, select and consume services.

3.1.22 service protection [ITU-T Y.1901]: The process of ensuring that an end-user can only acquire a service, and, by extension, the content contained therein, that he or she is entitled to receive.

3.1.23 service provider [b-ITU-T M.1400]: A general reference to an operator that provides telecommunication services to customers and other users either on a tariff or contract basis. A service provider may or may not operate a network. A service provider may or may not be a customer of another service provider.

NOTE – In the context of IPTV systems, typically, the service provider acquires or licenses content from content providers and packages this into a service that is consumed by the end-user.

3.1.24 subscriber [b-ITU-T M.3050.1]: The subscriber is responsible for concluding contracts for the services subscribed to and for paying for these services.

3.1.25 subscription [b-ITU-T Q.1741.3]: A subscription describes the commercial relationship between the subscriber and the service provider.

3.1.26 subtitles [ITU-T Y.1901]: Subtitles provide a real-time on-screen transcript of dialogue for the purpose of language translation or to clarify speech that is unclear.

NOTE – This service can be provided by means of either textual or graphical supplementary content. The subtitles and the dialogue are usually in different languages. The assumed audience for subtitling is hearing people who do not understand the language of the dialogue.

3.1.27 terminal device (TD) [ITU-T Y.1901]: An end-user device which typically presents and/or processes the content, such as a personal computer, a computer peripheral, a mobile device, a TV set, a monitor, a VoIP terminal or an audio-visual media player.

3.1.28 trick mode functionality [ITU-T Y.1901]: The ability to pause, rewind or forward stored content.

3.1.29 user interface (UI) [b-ITU-T F.902]: Software and hardware components through which a user can interact with a system.

3.1.30 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 – Viewing may occur sometime after the selection of the video content.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 electronic content guide (ECG): A service navigation application used especially for streamed and downloaded content. ECG deals with metadata unlike service information used in terrestrial broadcasting.

3.2.2 electronic program guide (EPG): A service navigation application which is used especially for scheduled linear programs. (This definition is adapted from [ITU-T Y.1901].)

NOTE – In some traditional broadcast services, EPG is defined as an on-screen guide used to display information on scheduled live broadcast television programs, allowing a viewer to navigate, select, and discover programs by time, title, channel, genre. This traditional definition does not cover "catalogues" for on-demand and download services (sometimes called ECG) and bidirectional interactive services (sometimes called IPG) for end-user interaction with a server or head-end. Some EPGs utilize web-pages, or teletext to realize this function.

3.2.3 IPTV TD-basic model: IPTV basic model terminal device as defined in this Recommendation.

3.2.4 portal: A portal presents information from diverse sources in a unified manner and provides a way to attach the communication services.

3.2.5 service navigation application: A user interface (application) which is intended to provide information on available services, including content, which may be accessed by end-users for service navigation.

3.2.6 timestamped transport stream (TTS): A packet format of the transport stream specified in [ARIB STD B24], section 8.1.4, that adds a 32-bit field containing a counter value of a 27 MHz clock synchronized with the MPEG system clock to control a relative time entered into a decoder.

4 Abbreviations

This Recommendation uses the following abbreviations:

AAC	Advanced Audio Coding
AC-3	Audio Compression number 3
AES	Advanced Encryption Standard
API	Application Program Interface
AVC	Advanced Video Coding
BML	Broadcast Markup Language
CDN	Content Delivery Network
CRL	Certificate Revocation List
DEMUX	Demultiplexer
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DVI	Digital Visual Interface
ECG	Electronic Content Guide
ECM	Entitlement Control Message
EPG	Electronic Program Guide
FEC	Forward Error Correction
FIFO	First-in, First-Out
FQDN	Fully Qualified Domain Name
HDCP	High-bandwidth Digital Content Protection system
HDMI	High-Definition Multimedia Interface
ICMP	Internet Control Message Protocol
IGMP	Internet Group Management Protocol
IPTV	Internet Protocol Television
IPTV TD	Internet Protocol Television Terminal Device
MLD	Multicast Listener Discovery protocol
MUX	Multiplexer
NPT	Normal Play Time
NVRAM	Non-Volatile Random Access Memory
PCR	Program Clock Reference
PKI	Public-Key Infrastructure
PLL	Phase-Locked Loop
RTSP	Real-Time Streaming Protocol
RTP	Real-time Transport Protocol
QoE	Quality of Experience
QoS	Quality of Service

SADS	Service and Application Discovery and Selection
SCP	Service and Content Protection
SNA	Service Navigation Application
SSL	Secure Socket Layer
STB	Set-Top Box
TD	Terminal Device
TLS	Transport Layer Security
TS	Transport Stream
TTS	Time-stamped Transport Stream
URI	Universal Resource Indicator
URL	Universal Resource Locator
VGA	Video Graphics Array
VoD	Video-on-Demand
XML	eXtensible Markup Language

5 Conventions

In this Recommendation:

- The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.
- The keywords "is prohibited from" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation 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 not recommended" indicate a requirement which is not recommended but which is not specifically prohibited. Thus, conformance with this Recommendation can still be claimed even if this requirement is present.
- 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 this Recommendation.

6 Introduction

This Recommendation is targeted at IPTV terminal devices capable of receiving linear TV services, including retransmission of conventional broadcasting, and video-on-demand (VoD) service, defined in clause 7, over a content delivery network (CDN), which takes into consideration such conditions on content delivery as QoS.

This Recommendation provides a high-level description of functionalities for common communication, configuration of the receiving environment for a service provider, service navigation, acquisition of linear TV service, acquisition of VoD service, functionalities which constitute the IPTV basic model terminal device (hereafter referred to as IPTV TD-Basic model).

7 Services and key features of an IPTV basic model terminal device

7.1 Services of an IPTV TD-Basic model

7.1.1 Linear TV

Linear TV service envisaged by an IPTV TD-Basic model is a multicast service in which programs are arranged in a temporal order based on the concept of channels. Linear TV service provides the viewing experience comparable to digital terrestrial and satellite broadcasting. In one typical flow of the service, the contents from content providers are delivered through a content delivery network (i.e., a dedicated network to the service provider) to the end-user via multicast. It is also possible that a service provider plays the role of a content provider as well and creates its own content and delivers the content via multicasting.

The monomedia, multiplex formats and streaming methods used in linear TV services refer to the specifications listed in Table 1.

Table 1 – Specifications used for formats and streaming methods used in linear TV services

Monomedia	Video MPEG-2	[ITU-T H.262] "Information technology – Generic coding of moving pictures and associated audio information: Video"
	Video H.264 (AVC)	[ITU-T H.264] "Advanced video coding for generic audiovisual services"
	Audio MPEG-2 AAC	[ISO/IEC 13818-7] "Information technology – Generic coding of moving pictures and associated audio information – Part 7: Advanced Audio Coding (AAC)"
	Audio MPEG-1 Layer II	[ISO/IEC 11172-3] "Information technology – Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s – Part 3: Audio"
	Audio MPEG-4 HE AAC v1	[ISO/IEC 14496-3] "Information technology – Coding of audio-visual objects – Part 3: Audio"
	Dolby AC-3	[ETSI TS 102 366] "Digital Audio Compression (AC-3, Enhanced AC-3) Standard"
	ARIB Captioning	[ARIB STD-B24] "Data Coding and Transmission Specification for Digital Broadcasting"
	ATSC Closed Captioning	[CEA-708] "Digital Television (DTV) Closed Captioning"
	EBU Teletext Subtitles	[ETSI EN 300 472] "DVB; Specification for conveying ITU-R System B Teletext in DVB bitstreams"
	DVB Subtitling	[ETSI EN 300 743] "DVB; Subtitling systems"

Table 1 – Specifications used for formats and streaming methods used in linear TV services

Multiplex format	MPEG-2 TS	[ITU-T H.222.0] "Information technology – Generic coding of moving pictures and associated audio information: Systems"
	TTS*	[ARIB STD-B24] "Data Coding and Transmission Specification for Digital Broadcasting" *When supported, the use of this solution should be signalled within the service description metadata.
Streaming	RTP	[IETF RFC 3550] "RTP: A Transport Protocol for Real-Time Applications" [IETF RFC 2250] "RTP Payload Format for MPEG1/MPEG2 Video"

NOTE – Compliance of media mentioned in this clause (e.g., preferred, mandatory, optional) is FFS.

7.1.2 Video on-demand

Video-on-demand is capable of offering the consumption of a particular content, from its beginning or from any temporal position of the content, by the end-user's request.

A typical case of the service is that as a result of the end-user's choice of video content from a content list displayed on the IPTV TD, a request to play the video content is transmitted to the content server, to which the content server would return, via unicast streaming, the selected content from its beginning or from the specified position. The IPTV TD is recommended to support trick plays (e.g., variable playback speed control, fast-forward play, rewind play, pause, resume, and chapter jump based on a present chapter information) [ITU-T Y.1901].

The monomedia, multiplex formats and streaming methods used in the VoD services refer to the specifications listed in Table 2.

Table 2 – Specifications used for formats and streaming methods used in VoD services

Monomedia	Video MPEG-2	[ITU-T H.262] "Information technology – Generic coding of moving pictures and associated audio information: Video"
	Video H.264 (AVC)	[ITU-T H.264] "Advanced video coding for generic audiovisual services"
	Audio MPEG-2 AAC	[ISO/IEC 13818-7] "Information technology – Generic coding of moving pictures and associated audio information – Part 7: Advanced Audio Coding (AAC)"
	Audio MPEG-1	[ISO/IEC 11172-3] "Information technology – Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s – Part 3: Audio"
	ARIB Captioning	[ARIB STD-B24] "Data Coding and Transmission Specification for Digital Broadcasting"
	ATSC Closed Captioning	[CEA-708] "Digital Television (DTV) Closed Captioning"

Table 2 – Specifications used for formats and streaming methods used in VoD services

Multiplex Format	MPEG-2 TS	[ITU-T H.222.0] "Information technology – Generic coding of moving pictures and associated audio information: Systems"
	TTS	[ARIB STD-B24] "Data Coding and Transmission Specification for Digital Broadcasting"
Streaming	RTP, RTSP	[IETF RFC 3550] "RTP: A Transport Protocol for Real-Time Applications" [IETF RFC 2250] "RTP Payload Format for MPEG1/MPEG2 Video" [IETF RFC 2326] "Real Time Streaming Protocol (RTSP)"

NOTE – Compliance of media mentioned in this clause (e.g., preferred, mandatory, optional) is FFS.

7.1.3 Service navigation

The IPTV TD-Basic model assumes the following means of service navigation and content selection:

- **Content selection using remote controller:** After linear IPTV service is selected among the service categories (e.g., linear TV, VoD, web service) using the category selection buttons, the end-user can select a desired channel by giving a particular numeral for that channel on the number buttons, or by operating the up-down buttons to navigate the available channels. The remote controller can provide a convenient way to select a channel with a one-touch button presetting channel information.
- **Content selection by EPG:** It is expected that after linear IPTV service is selected among the service categories (e.g., linear TV, VoD, web service) using the category selection buttons, the end-user can view an EPG on the display by operating the EPG related buttons on the remote controller. The end-user can directly view or reserve a desired program or a channel by operations on the displayed EPG.
- **Content selection by ECG:** The IPTV TD-Basic model can optionally display an ECG. ECG on the display of the terminal provides functionalities like EPG (e.g., search and list the available VoD content, and choose and view the desired content) by operating the remote controller.
- **Content selection by portal:** The IPTV TD-Basic model can optionally display a portal by getting access to a particular service provider's portal site. End-users can navigate (i.e., select, acquire, and consume the desired content) through the multimedia portal formatted by the service provider as well as the two methods mentioned above.

7.1.4 Interactive services

It is expected that each service provider will provide its own portal service. The portal service provides the same type of service as the so-called web service on the Internet. It is different from a conventional web-service in the following points:

- It has presentation functions comparable to those on the TV provided by the data broadcasting in a digital broadcasting service;
- It has the control functionalities of a linear TV service and of a VoD service.

Hyperlink functionality between portal sites and within a portal site is provided. Web security is provisioned by server authentication via secure communication such as TLS/SSL.

The unique identifier of an IPTV TD can be associated with a particular end-user. Therefore, the IPTV TD identification may be used as a client identifier for service and content protection (SCP) functionalities. Moreover, a simple authentication function may be executed with an authentication key.

It is also expected that an IPTV TD can control the way content is viewed, e.g., access control by age authentication or password authentication (a.k.a. parental control), by displaying the information on the video screen, limitation of content playback, or displaying thumbnail images.

7.1.5 Public interest services

Some examples of community and accessibility services that may be required by the local customer-base or regulations include the following.

7.1.5.1 Closed caption, subtitles, audio description and sign language interpretation

These features may be provided alongside with all of the above-mentioned basic services with accessibility [b-FSTP-TACL].

7.2 Features of IPTV TD-Basic model

7.2.1 Network attachment and service discovery

This is the process which enables end-users to connect to a particular service and to consume a linear TV service or a VoD service, after connecting their IPTV TD to the network. The details of the service discovery are found in [ITU-T H.770].

By the provisioning operation including network attachment, the IPTV TD automatically obtains the initial information for consumption. When the process is finished, end-users can access to all the IPTV services available. If a promotional linear TV channel is also provided on the network, then such a service is also obtainable.

7.2.1.1 Terminal device attachment and initialization

Network layer protocols to be used are IPv4 specified by [IETF RFC 791] and/or IPv6 specified by [IETF RFC 2460]. When end-users obtain an IPTV TD-Basic model, they need to connect the IPTV TD to the network terminal device via a physical connection (e.g., an Ethernet cable, wireless LAN, see Table 3 for applicable protocols).

Table 3 – Protocols for terminal device attachment and initialization

Protocol	IP, ICMP	[IETF RFC 791] "Internet Protocol" [IETF RFC 792] "Internet Control Message Protocol"
	IPv6, ICMPv6	[IETF RFC 2460] "Internet Protocol, Version 6 (IPv6) Specification" [IETF RFC 2461] "Neighbour Discovery for IP Version 6 (IPv6)" [IETF RFC 2462] "IPv6 Stateless Address Autoconfiguration" [IETF RFC 4443] "Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification" [IETF RFC 4291] "IP Version 6 Addressing Architecture"
	DHCP	[IETF RFC 2131] "Dynamic Host Configuration Protocol" [IETF RFC 3315] "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)" [IETF RFC 3646] "DNS Configuration options for Dynamic Host Configuration Protocol for IPv6 (DHCPv6)" [IETF RFC 3736] "Stateless Dynamic Host Configuration Protocol (DHCP) Service for IPv6"
	DNS	[IETF RFC 1034] "Domain names – concepts and facilities" [IETF RFC 1035] "Domain names – implementation and specification" [IETF RFC 3596] "DNS Extensions to Support IP Version 6" [IETF RFC 2181] "Clarifications to the DNS Specification" [IETF RFC 2671] "Extension Mechanisms for DNS (EDNS0)"

7.2.1.2 Service provider description entry points

When the IPTV TD attaches to the network, it has to know where to get the description of the IPTV service providers available to access. This description is called service provider discovery information. It is recommended that an IPTV TD be provisioned with an entry point to access the service provider discovery information server. The entry point (i.e., the server location) can be a multicast or unicast address.

It is expected that the IPTV TD-Basic model connects to such a server by referring to the entry point which is acquired by the terminal device by a specific method, which is outside the scope of this Recommendation.

7.2.1.3 Service provider discovery and service attachment

Service provider discovery information provides the IPTV TD with the information concerning the service platforms available on the network. It is required that a service provider discovery information server provides XML-encoded service provider discovery information.

After obtaining the server location such as the IP address and accessing a service provider discovery information server, the IPTV TD acquires the service provider discovery information file. One of the typical acquisition methods is HTTP by using the uniquely specified URI. The IPTV TD in turn acquires service provider information, which includes the location of services to attach in the file. The IPTV TD then selects a particular IPTV service to attach, based on the information provided therein. In case of a linear TV service, the service provider information provides necessary information for obtaining the metadata for EPG, etc. The details and description of the discovery procedures and data formats mentioned in this clause are included in [ITU-T H.770].

At this stage, IPTV TD is also required to support mechanisms of selection of programs and channels (e.g., displaying EPG, getting access to the portal, obtaining metadata for VoD). In case of getting access to the portal, promotional VoD content may be available to the IPTV TD.

Table 4 contains a list of applicable specifications.

Table 4 – Specifications used for service provider discovery and service attachment

Multiplex Format	MPEG-2 TS	[ITU-T H.222.0] "Information technology – Generic coding of moving pictures and associated audio information: Systems"
	TTS	[ARIB STD-B24] "Data Coding and Transmission Specifications for Digital Broadcasting"
Streaming	RTP, RTSP	[IETF RFC 3550] "RTP: A Transport Protocol for Real-Time Applications" [IETF RFC 2250] "RTP Payload Format for MPEG1/MPEG2 Video" [IETF RFC 2326] "Real Time Streaming Protocol (RTSP)"
Multicast	IGMPv2	[IETF RFC 2236] "Internet Group Management Protocol, Version 2" [IETF RFC 3228] "IANA Considerations for IPv4 Internet Group Management Protocol (IGMP)"
	MLDv2	[IETF RFC 3810] "Multicast Listener Discovery Version 2 (MLDv2) for IPv6"
HTTP	HTTP	[IETF RFC 2616] "Hypertext Transfer Protocol – HTTP/1.1"

7.2.2 Security

The IPTV TD-Basic model is required to support the following two categorized security items after establishing the network layer connections to receive IPTV services.

– **Service security items**

Service security functionalities mainly authenticate whether the terminal is a legitimate IPTV TD and authorizes the usage of services. SCP functions of IPTV TD realize the following items:

- Establishment of the secure communication channel by the mutual authentication with server-side SCP functionalities.
- Communicate with the certificate revocation list (CRL) server for update and management of the CRL.

– **Content protection items**

Content protection functionalities are integral to IPTV services and handle the content usage conditions and decryption keys necessary for the consumption of contents.

- Management and acquisition of rights and keys from the server side SCP functionalities.
- For linear TV service, extraction of the descrambling key from ECM and its provisioning to the renderer.

Connections between IPTV TD and the security-related application servers are required to use TLS/SSL as the protocol for communicating security-related information, including privacy. As always-on connections are conceivable, it is recommended to consider security threats on IPTV TD through the network.

Table 5 contains a list of applicable security specifications.

Table 5 – Specifications used for IPTV TD-Basic model service security

Secure Communication	SSL/TLS	[IETF RFC 2246] "The TLS Protocol Version 1.0" [IETF RFC 2818] "HTTP over TLS"
Encryption Algorithm	AES	[b-FIPS-197] FIPS publication 197 "Advanced Encryption Standard (AES)"
	CSA	[b-DVB-CSA] DVB Common Scrambling Algorithm (CSA)

These security modules can allow various implementations. IPTV TD can include the security modules as its internal functionalities. IPTV TD can also optionally implement the mechanism to download the security modules so that the module update is facilitated [ITU-T Y.1901].

7.2.3 Privacy

To take into account the cases where the ownership of IPTV TD is transferred to a different end-user or it is discarded, IPTV TD is required to have the capability to initialize and delete the private information stored in the NVRAM such as flash memory.

Moreover, IPTV TD is required to have the capability to delete the configuration involving private information set-up by the end-user and to initialize to the factory setting.

It is recommended to ensure that this capability be not mistakenly operated and unintentionally activated (e.g., the limitation for remote operation by the end-user).

7.2.4 Quality of service (QoS)

7.2.4.1 Streaming

In streaming delivery of the content, packet losses and clock mismatch due to asynchronous communication may cause video and audio quality degradation. Service providers and IPTV TD are recommended to implement the following measures in order to make prolonged and stable playback possible.

7.2.4.2 Forward error correction (FEC)

IPTV TD, as well as the content delivery server, can implement what is recommended in [ITU-T H.701], with an appropriate consideration of the quality of communication network, to ensure a sustainable and stable delivery of streamed content.

7.2.4.3 Clock synchronization and jitter removal

IP transmission is based on asynchronous communication, and therefore the transmission of explicit clock information is difficult. In order to realize a sustained and stable playback, a mechanism for clock synchronization between the sender and the receiver is important. The solutions for this purpose are described in Appendix I.

8 IPTV terminal device functional architecture

The functional architecture of IPTV TD-Basic model is shown in Figure 8-1. The expected types of IPTV terminal devices are set-top boxes and digital TV sets with embedded IPTV capabilities [ITU-T H.720].

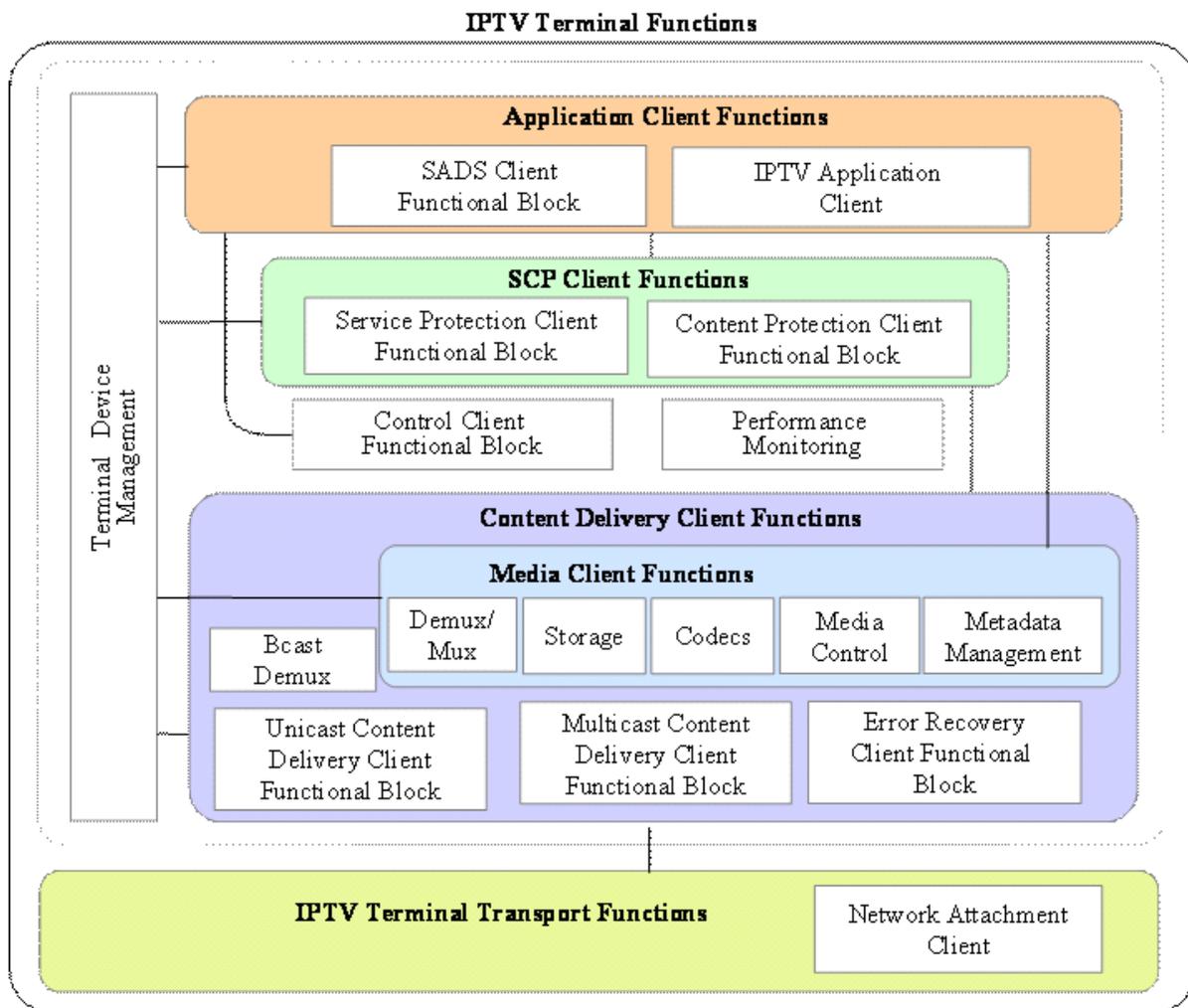


Figure 8-1 – Functional architecture block diagram of a basic model IPTV terminal device

9 Functional components of a basic model IPTV terminal device

9.1 Terminal transport functions

The terminal transport functions are a logical block that takes in data such as video and audio data transmitted via IP packets. This comprises the following functionalities:

- **Communication interface:** The interface to the network through which signals are received and sent.
- **Communication processing:** This component processes communication protocols as RTP, UDP, HTTP/TLS, RTSP, TCP, IP, IGMP/MLD. The jitter absorption processing and FEC processing of streaming data in physical layer is also done by these functions.
- **Network attachment processing:** This functionality initiates IP connectivity and manages a configuration for communication interface such as IP address acquiring.

When the unicast protocol is used to connect to the service provider's server, IPTV TD is required to use an URI as specified in [IETF RFC 3986].

URIs can be used in the following form:

`<scheme>://<authority><path>?<query>`

where:

- **<scheme>**: the protocol name;
- **<authority>**: the URI of the service provider's server that provides the IPTV services in request;
- **<path>**: the relative path of the target information from the base URI;
- **<query>**: the information to be processed by the queried server.

Service providers can optionally use a fully qualified domain name (FQDN) rather than an IP address when specifying the URI of a server. When FQDN rather than an IP address is given, IPTV TD makes a query to a DNS server, via the DNS sequence, and tries to connect to the server by resolving the FQDN to an IP address. When accessing information delivered from a server using a multicast protocol, IPTV TD is expected to use a multicast address rather than a URI.

9.2 Content delivery client functions

The content delivery client functions receive and control the delivery of the content from the content delivery and storage functions. After receiving the content, the content delivery client functions can optionally use the SCP client functions to decrypt and decode the content, and can also optionally support playback control [ITU-T Y.1910].

9.2.1 Broadcast demux functional block

Hybrid IPTV TDs, which include the broadcast demux functional block for terrestrial and satellite broadcast service, are beyond the scope of this Recommendation, even though such hybrid IPTV TDs can be assumed.

9.2.2 Multicast content delivery client function block

The multicast content delivery client functional block receives the content from the multicast delivery functional block within the content delivery and storage functions. This functional block communicates with the multicast control point functional block for the selection of the multicast stream [ITU-T Y.1910].

It is required that the multicast content delivery client functional block support IGMPv2, MLDv2, or both of them for the selection of the multicast stream. Table 6 contains a list of applicable specifications.

Table 6 – Specifications used for multicast content delivery

Multicast	IGMPv2	[IETF RFC 2236] "Internet Group Management Protocol, Version 2" [IETF RFC 3228] "IANA Considerations for IPv4 Internet Group Management Protocol (IGMP)"
	MLDv2	[IETF RFC 3810] "Multicast Listener Discovery Version 2 (MLDv2) for IPv6"

9.2.3 Unicast content delivery client functional block

The unicast content delivery client functional block receives the content from the unicast delivery functional block within the content delivery and storage functions. This functional block communicates with the content delivery control functional block within the content delivery and storage functions for the control of the unicast stream [ITU-T Y.1910].

The unicast content delivery client functional block is required to support RTP and RTSP for receiving and controlling of the unicast stream. Also, the unicast content delivery client functional block is required to support HTTP for the selection of VoD contents and retrieving non-streaming content. Table 7 contains a list of applicable specifications.

Table 7 – Specifications used for unicast content delivery

Control of the unicast stream	RTP, RTSP	[IETF RFC 3550] "RTP: A Transport Protocol for Real-Time Applications" [IETF RFC 2250] "RTP Payload Format for MPEG1/MPEG2 Video" [IETF RFC 2326] "Real Time Streaming Protocol (RTSP)"
HTTP	HTTP	[IETF RFC 2616] "Hypertext Transfer Protocol – HTTP/1.1"

9.2.4 Error recovery client functional block

The content delivery client functions can optionally include an error recovery client functional block. This functional block performs error recovery on the content streams in conjunction with the error recovery functional block within the content delivery functions [ITU-T Y.1910].

The support of content delivery error recovery mechanisms is not required for all networks, in particular for networks that can fulfil the desired IPTV service requirements. In the case that a network cannot fulfil the packet loss requirements necessary to achieve the IPTV service requirements, the use of a content delivery error recovery solution is recommended.

9.2.4.1 FEC-based error recovery mechanism

When a packet loss occurs in the network, it may cause some impact to the quality of video and audio content. The FEC-based error recovery mechanism can be used to prevent such deterioration.

The error recovery client functional block can optionally support the FEC-based error recovery mechanism whether the error recovery functional block supports it or not. However, the FEC-based error recovery mechanism is effective only when both of the error recovery client functional block and the error recovery functional block support the same mechanism.

If the FEC-based error recovery mechanism is supported, the error recovery client functional block is required to support receiving the base layer of the FEC according to [ITU-T H.701]. In addition, receiving of enhancement layer packets of FEC according to Annex A in [ITU-T H.701] may be supported.

Note that even if the error recovery functional block supports the FEC according to Annex A in [ITU-T H.701] and the error recovery client functional block does not, the IPTV TD can process contents normally by receiving only media packets and ignoring FEC packets.

Guidelines on the support of FEC in general and different FEC layers are provided in [ITU-T H.701] and references therein.

9.3 Media client functions

Media client functions receive contents from the content delivery client functions and process contents to the appropriate data formats so as to provide it to the output interface. Media client functions also achieve playback and trick mode functionalities (e.g., fast-forward playback and rewind playback with various speed, pause, resume, and chapter jump to the pre-configured point of each content).

9.3.1 Media control functional block

Media control functional block controls the following playback and trick mode functionalities.

9.3.1.1 Playback and trick mode functionalities for VoD

9.3.1.1.1 Playback functionality for VoD

Media control functional block is required to support playback of VoD contents with the resident capabilities concerning ECG or a portal web site access.

9.3.1.1.2 Fast-forward and rewind functionalities for VoD

Media control functional block is required to support fast-forwarding and rewinding of VoD contents. These functionalities are triggered by user interfaces (e.g., a remote controller).

There are two possible ways to achieve these functionalities.

9.3.1.1.2.1 Fast-forward and rewind functionalities for VoD using specialized content

These functionalities handle specialized VoD contents, which are previously encoded with predetermined speeds for fast-forwarding and/or rewinding. The contents are pre-stored in the content delivery and storage functions and sent to the media client functions through the content delivery client functions [ITU-T Y.1910].

Hence, if this method is supported, the IPTV TD is required to support a mechanism to choose an appropriate content being specialized for the end-user's control of fast-forwarding or rewinding. Relevant requirements and mechanisms as to the content delivery and storage functions are out of scope in this Recommendation.

9.3.1.1.2.2 Fast-forward and rewind functionality for VoD using usual content

These functionalities treat usual VoD contents, which are encoded one at a time. The codec functional block extracts I-frames which are used for fast-forwarding or rewinding of a video content at the requested speed.

Hence, if this method is supported, IPTV TD is required to support a mechanism to control the process of the above-mentioned extraction, and playback a content at the requested speed.

9.3.1.1.3 Skip forward and skip backward functionalities for VoD

These functionalities mean that the VoD playback position can be moved forward or backward to any point. These functionalities are triggered by the user interfaces (e.g., a remote controller).

Media control functional block can optionally support the skip forward and skip backward functionalities for VoD.

9.3.1.1.4 Chapter playback functionality for VoD

This functionality means that end-users can select a playback position from a pre-configured list of playback points, e.g., a chapter. This functionality is triggered by the user interfaces (e.g., a remote controller).

Media control functional block can optionally support the chapter playback functionality for VoD.

9.3.1.1.5 Stop/pause functionality for VoD

Media control functional block is required to support stopping and pausing of VoD content during playback. This functionality is triggered by the user interfaces (e.g., a remote controller).

Media control functional block is required to send heartbeats to the content delivery and storage functions through the content delivery client functions during pausing so as to keep connections alive. The interval of these heartbeats is required to be less than the timeout value in the session

header of the RTSP SETUP response. However, the media control functional block can stop the functionality, if pausing time becomes too long.

If an IPTV TD uses normal play time (NPT) according to [IETF RFC 2326], the media control functional block is recommended to store the NPT values in the Range header of the RTSP PAUSE response and use these values as the next playback positions.

9.3.1.1.6 Resume functionality for VoD by the resident capabilities of the IPTV TD

When an IPTV TD selects a VoD service which has not been completed to be watched, IPTV TD can automatically playback at a previous point with the resume functionality. This functionality for VoD can be achieved by the network side capabilities or by the resident capabilities of the IPTV TD. The media control functional block, if the resume functionality for VoD by the resident capabilities of the IPTV TD is supported, is required to store the last position of a VoD content and resume playback from that position.

9.3.2 Demux/mux functional block

The Demux/Mux functional block receives contents from the content delivery client functions and de-multiplexes and multiplexes them. The Demux/Mux functional block also processes the clock synchronization functionality.

NOTE – Further information on clock synchronization can be found in Appendix I.

The Demux/Mux functional block is required to support at least the MPEG-2 TS format. The Demux/Mux functional block can optionally support the time-stamped transport stream (TTS) format.

9.3.3 Codec functional block

The codec functional block receives de-multiplexed stream data from the Demux/Mux functional block and decodes it to the appropriate data formats so as to render or provide it to the output interface. The codec functional block also receives a decrypt key from the SCP client functions and decrypts streamed data before decoding, if the content is encrypted.

The codec functional block decodes video data, audio data, caption data, graphics and image data, textual data, and other multimedia data.

Profiles for codecs are discussed in [b-ITU-T H.IPTV-ProComp].

9.3.3.1 Video decoding

The codec functional block is required to support the following video codecs and their resolutions.

9.3.3.1.1 ITU-T H.262

- 1920x1080i MP@HL
- 1440x1080i MP@HL
- 1280x720p MP@HL
- 720, 544, 480x480i MP@ML

9.3.3.1.2 ITU-T H.264

- 1920x1080i HPorMP@Level4.0
- 1440x1080i HPorMP@Level4.0
- 1280x720p HPorMP@Level4.0
- 720x480i HPorMP@Level3.0/3.1/3.2
- 720x576i (the format used in Europe)

9.3.3.2 Audio decoding

The codec functional block contains the audio codecs listed in Table 8. See [b-HSTP-MCTB] for other codecs.

Table 8 – Specifications used for unicast content delivery

MPEG-2 AAC	[ISO/IEC 13818-7] "Information technology – Generic coding of moving pictures and associated audio information – Part 7: Advanced Audio Coding (AAC)"
MPEG-1 Layer II	[ISO/IEC 11172-3] "Information Technology – Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s – Part 3: Audio"
Audio MPEG-4 HE AAC v1	[ISO/IEC 14496-3] "Information technology – Coding of audio-visual objects – Part 3: Audio"
Dolby AC-3	[ETSI TS 102 366] "Digital Audio Compression (AC-3, Enhanced AC-3) Standard"

9.3.4 Storage functional block

The storage functional block stores temporary data and permanent data used on IPTV TD restart.

9.3.4.1 Temporary data stored in the storage functional block

The storage functional block is required to handle the following buffers and temporary data if IPTV TD supports relevant functions. These temporary data are usually stored in RAM.

- Jitter buffer so that the media client functions can continuously receive stream data from the content delivery client functions, even if there is jitter due to network conditions.
- Buffer to process FEC-based error recovery mechanism. The size of this buffer depends on which FEC algorithm is chosen.
- Portal contents displayed on the IPTV TD.
- Application data for the resident capabilities of the IPTV TD (e.g., EPG and ECG).

9.3.4.2 Permanent data stored in the storage functional block

The storage functional block is required to store the following permanent data if these are required to be used even after the IPTV TD restart. These permanent data are usually stored in NVRAM.

- Parental control information, including enable/disable of the parental control, parental guidance level, and password for parental control.
- Network information which is manually configured by the end user, or pre-configured before shipping.
- Service provider information. For details, refer to [ITU-T H.770].
 - ID of each service provider to which the end user subscribed
 - Registration key, expiration date
 - URI of SCP server of each registered service provider
 - Entitlements of subscribed contents
 - Information of subscribed packages
 - Service provider discovery and service attachment information
 - Logotype data of each service provider

9.3.5 Metadata management

9.3.5.1 Metadata for service navigation

The metadata, as described in [ITU-T H.750], is to be handled.

9.3.5.2 Caching metadata

It is recommended that the IPTV TD have capabilities to retrieve metadata and to temporarily store it as cache. The exact implementation of the cache mechanism depends on commercial issues (e.g., RAM as temporary memory, hard-disk drive as permanent memory or as large-size memory). Its envisaged storing capacity is variable from the minimum value (which is just the metadata related with current displayed content) to the maximum value (which is all the metadata provided by all the service providers). For better quality of experience (QoE), it is recommended that the IPTV TD construct a local metadata database for service navigation application (SNA) and provide its management.

It is recommended that the cache management of metadata comply with the following:

- The received metadata from the service provider can be managed to display a service list for the end-users.
- The structure between contents described as metadata is to be maintained (e.g., relation among group of contents as package and individual contents).
- Consistency between the metadata on the service provider's server and that cached in the IPTV TD is to be maintained within a reasonable period (e.g., less than a day).
- The IPTV TD is to always get the newest metadata when it is available, and to update the locally cached metadata accordingly.
- The IPTV TD is to respect the expiration date of metadata (e.g., not display the metadata exceeding that date), if specified.

9.3.5.3 Searching with metadata

It is recommended that the SNA on the IPTV TD be able to interact with the service provider side applications (e.g., metadata server), so that it can provide the user with the content searching based on metadata (e.g., by title, genre, cast, keyword, popularity, or review).

9.3.5.4 Parental control

This functionality restricts the viewing of certain content and the associated information according to the parental guidance information described in the metadata for that content. For any content, IPTV TD compares the parental rating information with the parental guidance level (e.g., minimum age requirement for viewing) that the end-user has set in the IPTV TD. If the former violates the latter, then IPTV TD requires a password authentication and makes the content available for consumption only when the viewer is authenticated.

It is recommended that the IPTV TD provide the parental control functionality based on metadata for content listing as well as for content consumption.

9.4 SCP client functions

The SCP client functional entity is an entity that receives and manages rights and keys and that provides content keys and descrambling keys for content consumption. It has the following functions:

- Establishment of a secure communication channel by mutual authentication with the SCP server.
- Management and acquisition of rights and keys from the SCP server.
- Provisioning of usage conditions and content keys to the renderer, for VoD streaming service.
- Extraction of the descrambling key from ECM and its provisioning to the renderer, for linear IPTV service.
- CRL update and management by communication with the CRL server.

9.4.1 Service protection client functions

9.4.1.1 Establishment of a secure communication channel by mutual authentication with an SCP server

A method to establish an authenticated encrypted communication channel is required to be based on the mutual authentication using PKI. An SCP client is required to have the client certificate and root certificate. After mutually authenticating the SCP server and the SCP client, the SCP client shares the key for encryption of the messages for requesting and delivering rights and keys.

9.4.1.2 CRL update and management by communication with CRL server

It is recommended that the SCP client have the newest CRL so that an appropriate server authentication may be possible in establishing a secure communication channel. It is therefore recommended that the SCP client acquire the most recent CRL from the CRL server, in accordance with a specified rule and to make appropriate updates.

9.4.2 Content protection client functions

9.4.2.1 Management and acquisition of rights and keys from SCP server

The SCP client requests a licence by transmitting to the SCP server a message which includes the ID concerning the rights and keys that identify the targeted rights and keys. Robust security is required for this communication channel. For security reasons, it is necessary that an encrypted communication channel be established.

9.4.2.2 Provisioning of usage conditions and content keys to the renderer for VoD streaming service

During the playback of VoD streaming service content, an individual set of rights and keys is delivered, at the request of the SCP client, from the SCP server side to the SCP client. The SCP client then sets the content key onto the decryptor of the renderer, while at the same time it transmits the usage condition information to the renderer. The IPTV TD then accesses the content server, and receives the encrypted content stream. The encrypted content is decrypted by the renderer using the content key, generating the decoded audio and video data; thereby, a playback signal is output according to the usage conditions (mainly the output control information).

9.4.2.3 Extraction of the descrambling key from ECM and its provisioning to the renderer, for linear IPTV services

At the request of the SCP client, the SCP server side transmits the rights and keys to the SCP client. The SCP client stores the acquired rights and keys. (On the SCP server side, the scrambling key is generated, which along with the usage condition information is made into an ECM packet as a sub rights and keys. The content server scrambles the content stream using the scrambling key, multiplexes it with ECM packets, and delivers to the terminal.) IPTV TD receives the content stream, extracts the ECM packets, and sends them to SCP client. The SCP client decrypts the ECM using the work key, matches the usage condition information with each other, and, if the usage conditions are met, extracts the scrambling key and sets it onto the descrambler of the renderer. The renderer descrambles the content stream and decodes the audio and video data, and then plays the content applying the usage conditions.

9.5 Application client functions

9.5.1 IPTV application client functions

This functional block interacts with its server-side counterpart to perform session management, service authorization, presentation of the content metadata, and execution of the service logic for service consumption [ITU-T Y.1910]. IPTV TD-Basic model includes at least both linear TV application client functional block and VoD application client functional block. Both client

functional blocks can handle HTML/BML contents, metadata to replay control, and EPG/ECG based on IPTV services. See [ITU-T H.760] for other recommended formats.

9.5.2 SADS client functions

The SADS client functions support the process of service provider discovery, service discovery and service selection. The functions intimately cooperate with storage functional block and metadata management functional block. After service selection, IPTV application client functional blocks take over the process. The functions are compliant with [ITU-T H.770].

9.6 Control client functions

In the case of NGN IPTV, control client functional block can optionally support sessions for resource management with RACF. For details, refer to [ITU-T Y.1910] and [b-ITU-T NGN-FRA-rev1].

9.7 Terminal device management

Remote management is closely related to this functional block. For details of remote management, see [b-ITU-T H.IPTV-RM].

10 Physical interface

10.1 Input interface

The input interface of IPTV TD-Basic model is used to support user interactions.

10.1.1 Reset button

It is recommended that the IPTV TD support a reset button to manually resolve its hang-up status.

10.1.2 Remote controller

It is recommended that the IPTV TD support a remote controller. The details are outside the scope of this Recommendation.

10.2 Output interface

If the IPTV TD has DVI or HDMI, and when it outputs content with copy control or protection, it is required to provide appropriate protection according to the HDCP specification. The details of copy control and output control are for further study.

10.2.1 RGB analog interface

The IPTV TD can optionally support a RGB analog interface (e.g., D, RCA, S or S2 connectors). The IPTV TD can optionally support a VGA interface and a DVI interface with analog output.

10.2.2 Digital video interface

The IPTV TD can optionally support a DVI interface.

10.2.3 Digital audio interface

This item is for further study.

10.2.4 High-definition multimedia interface

The IPTV TD can optionally support an HDMI interface.

Appendix I

Clock synchronization and jitter removal

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

I.1 Overview

IP transmission is based on asynchronous communication, and therefore the transmission of explicit clock information is difficult. In order to realize a sustained and stable playback, however, a mechanism for clock synchronization between the sender and the receiver is important.

Taking into account features such as the performance, accuracy, and interoperability with other standards, the technique to support an offer of 27 MHz-based network timestamps should be considered.

For this purpose, there are various implementation technologies for this clock synchronization requirement. One example is the method using TTS, which adds 4 bytes of 27 MHz-based time stamp in front of each TS packet (188 bytes) [ARIB STD-B24]; another example is the method of adding 27 MHz-based timestamp for each TS packet to RTP's extension header.

Figure I.1 gives the system overview of clock synchronization between sender and receiver. The sender and receiver in an IPTV system include each a clock synchronizer.

The role of this functionality module is to provide clock synchronization with the 27 MHz timestamp, synchronized with program clock reference (PCR) of the corresponding TS.

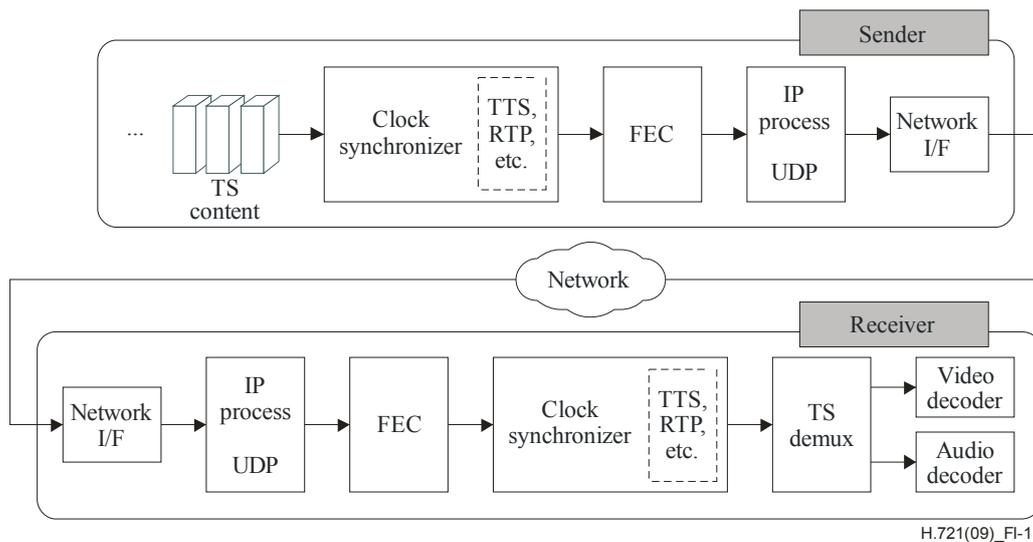


Figure I.1 – System overview of the clock synchronization

I.2 Time-stamped TS (TTS) clock reconstruction

As described in clause 7.2.4.3, the TTS clock synchronization method is introduced in the IPTV terminal device defined in this Recommendation to facilitate clock reconstruction at the receiver. This method works as follows.

Each TS packet embeds a 27 MHz timestamp in front of the packet synchronizing with the sender's clock reference.

At the receiver, 27 MHz reference clock is generated by a PLL that is synchronizing with the timestamp embedded in the TTS.

In addition, each TTS packet is temporarily stored in the FIFO buffer, and the packet is extracted from the buffer according to the exact timing specified by the timestamp embedded in the packet. Then, the timestamp is removed from the TTS. Since this gating process is controlled by the reference clock reconstructed by the previous step, the extraction timing of each TS is exactly synchronized with the sender's clock reference. Transport jitters are also removed in this process. See also Figure I.2.

In the subsequent processes, there is no need to distinguish how the TS packets are conveyed, whether over IP or RF. The conventional TS decoding processes, which is used in typical digital television sets, is applicable to IPTV reception.

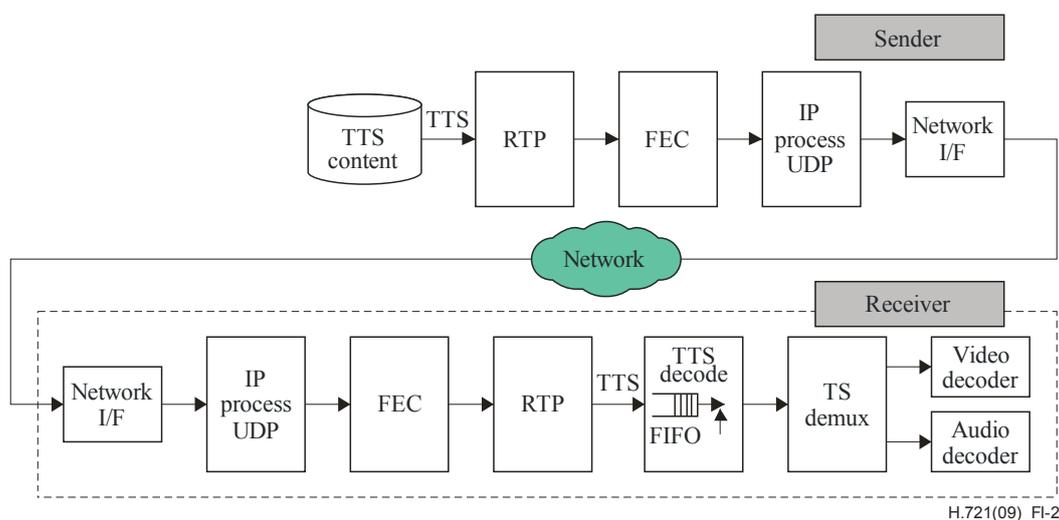


Figure I.2 – System overview of time-stamped TS clock synchronization

I.3 IETF RFC 2250-based mechanism (DVB)

This is for further study.

I.4 IETF RFC 2250-based mechanism (ATIS)

This is for further study.

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