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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 Internet protocol television (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 television (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 quality of service (QoS). The expected types of IPTV terminal devices are set-top boxes and digital TV sets with embedded IPTV capabilities.

The second edition introduced support for high efficiency video coding (HEVC), dynamic adaptive streaming over HTTP (DASH), MPEG-4 audio lossless coding (ALS), MPEG-4 advanced audio coding (AAC), DTS-HD, timed text markup language (TTML), MPEG media transport (MMT) and several corrections and clarifications.

The third edition introduces support for new technologies such as timestamped fragmented time-length-value (TFT).

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1 Scope

This Recommendation describes and specifies the functionalities of the Internet protocol television (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 quality of service (QoS). The expected types of terminal devices are set-top boxes (STBs) and digital television (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 (2021) | ISO/IEC 13818-1:2021, *Information technology – Generic coding of moving pictures and associated audio information: Systems*.

[ITU-T H.262] Recommendation ITU-T H.262 (2012) | ISO/IEC 13818-2:2013, *Information technology – Generic coding of moving pictures and associated audio information: Video*.

[ITU-T H.264] Recommendation ITU-T H.264 (V9) (2021), *Advanced video coding for generic audiovisual services*.

[ITU-T H.265] Recommendation ITU-T H.265 (V2) (2021), *High Efficiency Video Coding*.

[ITU-T H.622.1] Recommendation ITU-T H.622.1 (2008), *Architecture and functional requirements for home networks supporting IPTV services.*

[ITU-T H.701] Recommendation ITU-T H.701 (2009), *Content delivery error recovery for IPTV services*.

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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 type-length-value (TLV) multiplexing scheme [b-ITU-R BT.1869]: A multiplexing scheme that multiplexes variable-length packets without fragmentation, where the type and the length of packet in a TLV container are indicated by the type field and the length field, respectively.

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

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

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 – 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 electronic content guide (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 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.

NOTE – TTS is specified in section 8.1.4 of [ARIB STD-B24].

3.2.7 fragmented TLV packet: The fixed-length packet that consists of the header and the body. The body is a fragmented stream that are made by the type-length-value (TLV) multiplexing scheme. The fragmented TLV packet length is 188 bytes. The header length is 3 or 4 bytes. The first byte of the header is 47_{HEX} [ITU-T J.288]. This TLV multiplexes MMT data, time, etc.

3.2.8 timestamped fragmented TLV (TFT): A packet format of the fragmented type-length-value (TLV) packet 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 as timestamped transport stream (TTS).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAC Advanced Audio Coding

AC-3 Audio Compression number 3

AES Advanced Encryption Standard

ALS Audio Lossless coding

API Application Program Interface

APSK Amplitude Phase-Shift Keying

AV Audio-Visual

AVC Advanced Video Coding

BML	Broadcast Markup Language
CDN	Content Delivery Network
CRID	Content Reference Identifier
CRL	Certificate Revocation List
CSA	Common Scrambling Algorithm
DASH	Dynamic Adaptive Streaming over HTTP
DEMUX	Demultiplexer
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DRM	Digital Rights Management
DTS	Decoding Timestamp
DVI	Digital Visual Interface
EBU	European Broadcasting Union
ECG	Electronic Content Guide
ECM	Entitlement Control Message
EPG	Electronic Program Guide
ERI	Entry Resource Information
ES	Elementary Stream
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
HEVC	High Efficiency Video Coding
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transport Protocol over Secure socket layer
ICMP	Internet Control Message Protocol
IGMP	Internet Group Management Protocol
IPTV	Internet Protocol Television
IPTV TD	Internet Protocol Television Terminal Device
ITF	IPTV Terminal Function
LAN	Local Area Network
LED	Light Emitting Diode
LIME	Lightweight Interactive Multimedia Environment
LLI	Licence Link Information
MAFR	Multimedia Application Framework

MFU	Media Fragment Unit
MLD	Multicast Listener Discovery protocol
MMT	MPEG Media Transport
MMTP	MPEG Media Transport Protocol
MPU	Media Processing Unit
MUX	Multiplexer
NCI	Network Content Control Information
NCL	Nested Context Language
NGN	Next Generation Network
NIT	Network Information Table
NPT	Normal Play Time
NVRAM	Non-volatile Random Access Memory
PCR	Program Clock Reference
PKI	Public-Key Infrastructure
PLL	Phase-Locked Loop
PMT	Program Map Table
PSI	Program Specific Information
PSK	Phase-Shift Keying
PTS	Presentation Timestamp
QoE	Quality of Experience
QoS	Quality of Service
RA	Router Advertisement
RACF	Resource and Admission Control Functions
RAM	Random Access Memory
RF	Radio Frequency
RGB	Red, Green and Blue
ROUTE	Real-time Object delivery over Unidirectional Transport
RTP	Real-time Transport Protocol
RTSP	Real-Time Streaming Protocol
SADS	Service and Application Discovery and Selection
SCP	Service and Content Protection
SDP	Session Description Protocol
SDTV	Standard Definition Television
SI	Service Information
SNA	Service Navigation Application
SNTP	Simple Network Time Protocol
SSL	Secure Socket Layer

STB	Set-Top Box
TCP	Transmission Control Protocol
TD	Terminal Device
TFT	Timestamped Fragmented TLV
TLS	Transport Layer Security
TLV	Type-length-value
TS	Transport Stream
TTML	Timed Text Markup Language
TTS	Timestamped Transport Stream
UDP	User Datagram Protocol
UHD	Ultra High Definition
UI	User Interface
URI	Uniform Resource Identifier
URL	Uniform 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.

– Requirements in "Optionality" column in tables are identified using the following conventions [ITU-T Y.1901]:

  - Mandatory requirement is identified to R;
  - Recommended requirement is identified to RR;
  - Optional requirement is identified to OR.

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. It also supports several recent new technologies to enhance the service capability of basic IPTV terminal device such as high efficiency video coding (HEVC), dynamic adaptive streaming over HTTP (DASH), MPEG media transport (MMT), etc.

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.

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

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

Method	Format	Specification(s)
Monomedia	Video MPEG-2	[ITU-T H.262]
	Video ITU-T H.264 (AVC)	[ITU-T H.264]
	Video ITU-T H.265 (HEVC)	[ITU-T H.265]
	Audio MPEG-2 AAC	[ISO/IEC 13818-7]
	Audio MPEG-1 Layer II	[ISO/IEC 11172-3]
	Audio MPEG-4 AAC	[ISO/IEC 14496-3]
	Audio MPEG-4 HE AAC v1	[ISO/IEC 14496-3]
	Audio MPEG-4 ALS	[ISO/IEC 14496-3]
	Audio Dolby AC-3	[ETSI TS 102 366]
	Audio DTS-HD (Note 1)	[ANSI/SCTE 194-1]
	ARIB captioning	[ARIB STD-B24]
	ARIB TTML captioning	[ARIB STD-B62]
	ATSC closed captioning	[CEA-708]

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

Method	Format	Specification(s)
	EBU teletext subtitles	[ETSI EN 300 472]
	DVB subtitling	[ETSI EN 300 743]
Multiplex format	MPEG-2 TS	[ITU-T H.222.0]
	TTS (Note 2)	[ARIB STD-B24]
	TFT	See Annex A
Streaming	RTP	[IETF RFC 3550] [IETF RFC 2250]
NOTE 1 – Refer to [ANSI/SCTE 194-2] when using MPEG-2 TS for multiplexing. NOTE 2 – When supported, the use of this solution should be signalled within the service description metadata.		

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.

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

Table 2 – Specifications used for formats and streaming methods used in VoD services (see Note 1)

Method	Format	Specification(s)
Monomedia	Video MPEG-2	[ITU-T H.262]
	Video ITU-T H.264 (AVC)	[ITU-T H.264]
	Video ITU-T H.265 (HEVC)	[ITU-T H.265]
	Audio MPEG-2 AAC	[ISO/IEC 13818-7]
	Audio MPEG-1	[ISO/IEC 11172-3]
	Audio MPEG-4 AAC	[ISO/IEC 14496-3]
	Audio MPEG-4 ALS	[ISO/IEC 14496-3]
	Audio DTS-HD (Note 2)	[ANSI/SCTE 194-1]
	ARIB Captioning	[ARIB STD-B24]
	ARIB TTML captioning	[ARIB STD-B62]
	ATSC closed captioning	[CEA-708]
Multiplex format	MPEG-2 TS	[ITU-T H.222.0]
	TTS	[ARIB STD-B24]
	MP4	[ISO/IEC 14496-14]

Table 2 – Specifications used for formats and streaming methods used in VoD services (see Note 1)

Method	Format	Specification(s)
	MMT	[ISO/IEC 23008-1]
Streaming	RTP, RTSP	[IETF RFC 3550] [IETF RFC 2250] [IETF RFC 2326]
	DASH (Note 1)	[ISO/IEC 23009-1]
NOTE 1 – Compliance of mentioned media (e.g., preferred, mandatory, optional) is for further study. NOTE 2– Refer to [ANSI/SCTE 194-2] when using MPEG-2 TS for multiplexing.		

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 may be provided. Web security can be 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 (also known as 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	Specifications
IP, ICMP	[IETF RFC 791] [IETF RFC 792]
IPv6, ICMPv6	[IETF RFC 2460] [IETF RFC 2461] [IETF RFC 2462] [IETF RFC 4291] [IETF RFC 4443]
DHCP	[IETF RFC 2131] [IETF RFC 3315] [IETF RFC 3646] [IETF RFC 3736]
DNS	[IETF RFC 1034] [IETF RFC 1035] [IETF RFC 2181] [IETF RFC 2671] [IETF RFC 3596]

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 uniform resource identifier (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

Method	Format	Specification(s)
Multiplex format	MPEG-2 TS	[ITU-T H.222.0]
	TTS	[ARIB STD-B24]
	MMT	[ISO/IEC 23008-1]
Streaming	RTP, RTSP	[IETF RFC 3550] [IETF RFC 2250] [IETF RFC 2326]
Multicast	IGMPv2	[IETF RFC 2236] [IETF RFC 3228]
	IGMPv3	[IETF RFC 3376]
	MLDv2	[IETF RFC 4604]
Unicast	HTTP	[IETF RFC 2616]

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 entitlement control message (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

Security element	Method	Specification(s)
Secure communication	SSL/TLS	[IETF RFC 2246] [IETF RFC 2818]
Encryption algorithm	AES	[b-FIPS-197]
	CSA	[b-DVB-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 non-volatile random access memory (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].

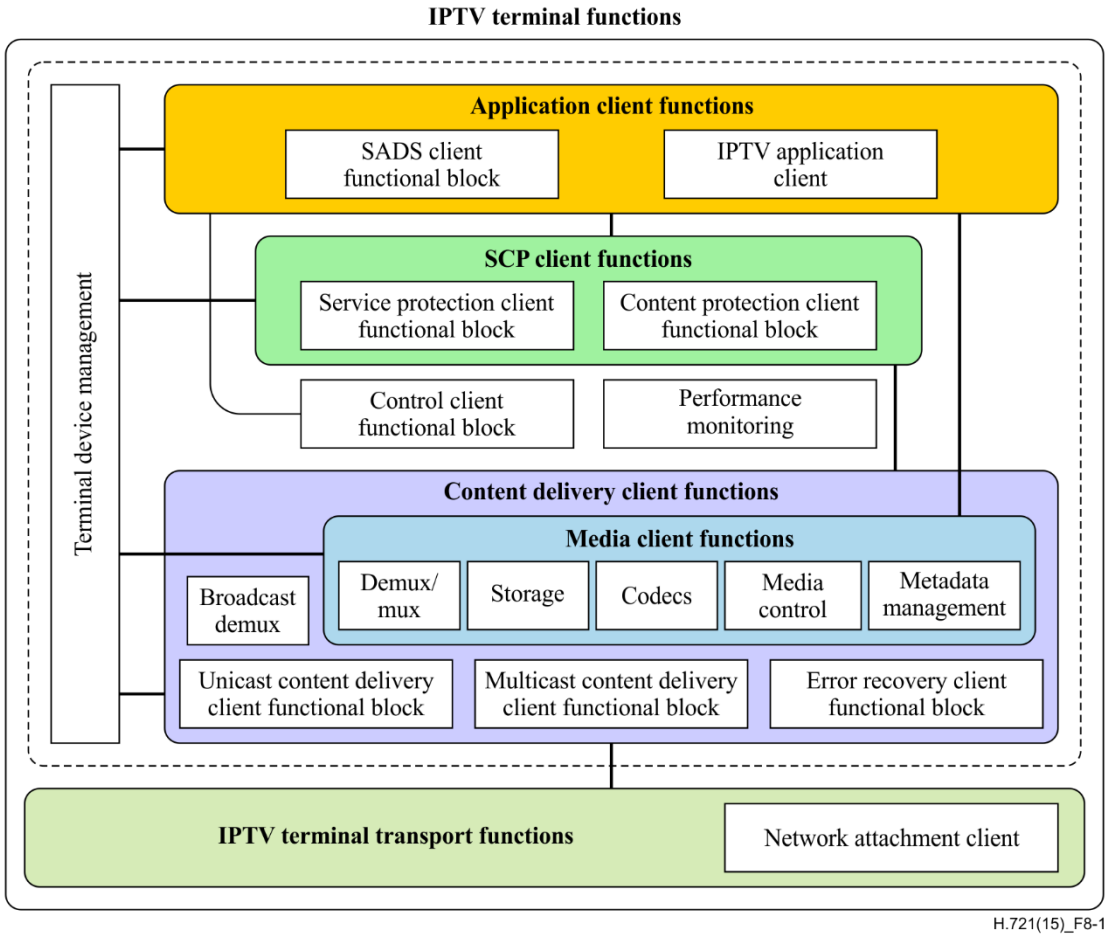


Figure 8-1 – Functional architecture block diagram of a basic model IPTV terminal device

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 such as RTP, UDP, HTTP/TLS, RTSP, TCP, IP and 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 domain name system (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

Method	Format	Specification(s)
Multicast	IGMPv2	[IETF RFC 2236] [IETF RFC 3228]
	IGMPv3	[IETF RFC 3376]
	MLDv2	[IETF RFC 4604]

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 following are the requirements of the unicast content delivery client functional block (Table 7 contains a list of applicable specifications):

– The unicast content delivery client functional block is required to support RTP and RTSP for receiving and controlling of the unicast stream.
– The unicast content delivery client functional block is required to support HTTP for the selection of VoD contents and retrieving non-streaming content.
– If HTTP is used for streaming, the unicast content delivery client functional block is recommended to support DASH.

Table 7 – Specifications used for unicast content delivery

Control element	Format	Specification(s)
Control of the unicast stream	RTP, RTSP	[IETF RFC 3550] [IETF RFC 2250] [IETF RFC 2326]
	DASH	[ISO/IEC 23009-1]
Control of the portal content	HTTP	[IETF RFC 2616]

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 of [ITU-T H.701] may be supported.

Note that even if the error recovery functional block supports the FEC according to Annex A of [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 of 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 the 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 timestamped transport stream (TTS) format.

The Demux/Mux functional block can optionally support MP4 format.

The Demux/Mux functional block can optionally support MMT 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.

9.3.3.1 Video decoding

The codec functional block is required to support one or more video codecs and resolutions. Table 8 defines the list of combination of video codecs and resolutions.

Table 8 – Specifications used for video decoding

Category	Implementation	Reference	Optionality
0	ITU-T H.262	9.3.3.1.1	R
	ITU-T H.264	9.3.3.1.2	R
1	ITU-T H.262	9.3.3.1.1	RR
	ITU-T H.264	9.3.3.1.2	R
	ITU-T H.265 with spatial resolution 1 920 × 1080 or less.	9.3.3.1.3	R
2	ITU-T H.262	9.3.3.1.1	RR
	ITU-T H.264	9.3.3.1.2	R
	ITU-T H.265 with spatial resolution 3840 × 2160 or less.	9.3.3.1.3	OR
3	ITU-T H.262	9.3.3.1.1	RR
	ITU-T H.264	9.3.3.1.2	R
	ITU-T H.265 with spatial resolution 3 840 × 2160 or less.	9.3.3.1.3	R

Category 0 of the codec functional block is required to support [ITU-T H.262] (9.3.3.1.1) and [ITU-T H.264] (9.3.3.1.2).

Category 1 of the codec functional block is recommended to support [ITU-T H.262] (9.3.3.1.1).

Category 1 of the codec functional block is required to support [ITU-T H.264] (9.3.3.1.2) and [ITU-T H.265] (9.3.3.1.3) with spatial resolution 1920×1080 or less.

Category 2 of the codec functional block is recommended to support [ITU-T H.262] (9.3.3.1.1).

Category 2 of the codec functional block is required to support [ITU-T H.264] (9.3.3.1.2).

Category 2 of the codec functional block can optionally support [ITU-T H.265] (9.3.3.1.3) with spatial resolution 3840 × 2160 or less.

Category 3 of the codec functional block is recommended to support [ITU-T H.262] (9.3.3.1.1).

Category 3 of the codec functional block is required to support [ITU-T H.264] (9.3.3.1.2) and [ITU-T H.265] (9.3.3.1.3) with spatial resolution 3840 × 2160 or less.

9.3.3.1.1 ITU-T H.262

Table 9 contains the list of [ITU-T H.262] video coding specifications. If IPTV TD supports [ITU-T H.262], one of the resolutions and its frame frequency is required to be implemented.

Table 9 – Specifications used for ITU-T H.262 video decoding

Spatial resolution	Frame frequency	Profile	Level (minimum)
1920 × 1080	50, 60/1.001, 60 Hz (progressive)	Main	High
	24/1.001, 24, 25, 30/1.001, 30 Hz (progressive, interlace or segmented-frame)	Main	High
1440 × 1080 (Note)	50, 60/1.001, 60 Hz (progressive)	Main	High 1440
	24/1.001, 24, 25, 30/1.001, 30 Hz (progressive, interlace or segmented-frame)	Main	High 1440
1280 × 720	50, 60/1.001, 60 Hz (progressive)	Main	High 1440
720 × 576	50Hz (progressive)	Main	High 1440
	25 Hz (interlace)	Main	Main
720 × 480	60/1.001 Hz (progressive)	Main	High 1440
	30/1.001 Hz (interlace)	Main	Main
NOTE – The spatial resolution of 1440 × 1080 is not a HDTV production standard. Horizontal resolution 1440, which is three-fourths of 1920, is used to reduce bit rate.			

9.3.3.1.2 ITU-T H.264

Table 10 contains the list of ITU-T H.264 video decoding specifications. If IPTV TD supports [ITU-T H.264], one of the resolutions and its frame frequency is required to be implemented.

Table 10 – Specifications used for ITU-T H.264 video decoding

Spatial resolution	Frame frequency	Profile	Level (minimum)
1920 × 1080	50, 60/1.001, 60 Hz (progressive)	High 422, High 10, High or Main	4.2
	24/1.001, 24, 25, 30/1.001, 30 Hz (progressive, interlace or segmented-frame)	High 422, High 10, High or Main	4.0
1440 × 1080	50, 60/1.001, 60 Hz (progressive)	High 422, High 10, High or Main	4.2
	24/1.001, 24, 25, 30/1.001, 30 Hz (progressive, interlace or segmented-frame)	High 422, High 10, High or Main	3.2
1280 × 720	50, 60/1.001, 60 Hz (progressive)	High 422, High 10, High or Main	3.2
720 × 576	50 Hz (progressive)	High 422, High 10, High or Main	3.1
	25 Hz (interlace)	High 422, High 10, High or Main	3.0

Table 10 – Specifications used for ITU-T H.264 video decoding

Spatial resolution	Frame frequency	Profile	Level (minimum)
720 × 480	60/1.001 Hz (progressive)	High 422, High 10, High or Main	3.1
	30/1.001 Hz (interlace)	High 422, High 10, High or Main	3.0

9.3.3.1.3 ITU-T H.265

Table 11 contains the list of ITU-T H.265 video decoding specifications. If IPTV TD supports [ITU-T H.265], one of the resolutions (for 3840 × 2160 or less) and its frame frequency is required to implement.

Table 11 – Specifications used for ITU-T H.265 video decoding

Spatial resolution	Frame frequency	Bit depth	Profile	Level (minimum)
7680 × 4 320	100, 120/1.001, 120 Hz (progressive)	8 bit	Main 10 or Main	6.2
		10 bit	Main 10	
	24/1.001, 24, 25, 30/1.001, 30, 50, 60/1.001, 60 Hz (progressive)	8 bit	Main 10 or Main	6.1
		10 bit	Main 10	
3840 × 2 160	100, 120/1.001, 120 Hz (progressive)	8 bit	Main 10 or Main	5.2
		10 bit	Main 10	
	24/1.001, 24, 25, 30/1.001, 30, 50, 60/1.001, 60 Hz (progressive)	8 bit	Main 10 or Main	5.1
		10 bit	Main 10	
1920 × 1 080	50, 60/1.001, 60 Hz (progressive)	8 bit	Main 10 or Main	4.1
		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
		10 bit	Main 10	
1280 × 720	50, 60/1.001, 60 Hz (progressive)	8 bit	Main 10 or Main	4
		10 bit	Main 10	
720 × 576	50 Hz (progressive)	8 bit	Main 10 or Main	3.1
		10 bit	Main 10	
	25 Hz (interlace)	8 bit	Main 10 or Main	3
		10 bit	Main 10	
720 × 480	60/1.001 Hz (progressive)	8 bit	Main 10 or Main	3.1
		10 bit	Main 10	
	30/1.001 Hz (interlace)	8 bit	Main 10 or Main	3
		10 bit	Main 10	

9.3.3.2 Audio decoding

The codec functional block contains the audio codecs listed in Table 12. See [b-HSTP-MCTB] for other codecs.

Table 12 – Specifications used for audio decoding

Format	Specification(s)
MPEG-2 AAC	[ISO/IEC 13818-7]
MPEG-1 Layer II	[ISO/IEC 11172-3]
MPEG-4 AAC	[ISO/IEC 14496-3]
MPEG-4 HE AAC v1	[ISO/IEC 14496-3]
MPEG-4 ALS	[ISO/IEC 14496-3]
Dolby AC-3	[ETSI TS 102 366]
DTS-HD	[ANSI/SCTE 194-1]

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 at least the following buffers and temporary data if IPTV TD supports relevant functions. These temporary data are usually stored in the random access memory (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 a SCP server

A method to establish an authenticated encrypted communication channel is required to be based on the mutual authentication using public-key infrastructure (PKI). A 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 the 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 the IPTV services. See [ITU-T H.760] for other recommended formats.

9.5.2 SADS client functions

The service and application discovery and selection (SADS) client functions support the process of service provider discovery, service discovery and service selection. The functions intimately cooperate with the storage functional block and the 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 resource and admission control functions (RACF). For details, refer to [ITU-T Y.1910] and [ITU-T Y.2012].

9.7 Terminal device management

Remote management is closely related to this functional block. For details of remote management, see [ITU-T H.622.1].

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 digital visual interface (DVI) or high-definition multimedia interface (HDMI), and when it outputs content with copy control or protection, it is required to provide appropriate protection according to the high-bandwidth digital content protection system (HDCP) specification. The details of copy control and output control are for further study.

10.2.1 RGB analogue interface

The IPTV TD can optionally support a red, green and blue (RGB) analogue interface (e.g., D, RCA, S or S2 connectors). The IPTV TD can optionally support a video graphics array (VGA) interface and a DVI interface with analogue 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 a HDMI interface.

Annex A

Timestamped fragmented TLV (TFT)

(This annex forms an integral part of this Recommendation.)

A.1 General structure of MMT-based IPTV system

Figure A.1 shows the protocol stack of MMT-based IPTV systems. This protocol stack consists of the Contents layer and the Communication layer. The Contents layer is derived from part of the general structure of the MMT-based broadcasting system [ITU-R BT.2074-1]. TLV in the Contents layer is a multiplexing method defined in [ITU-R BT.1869]. The Communication layer transports the Content layer by using fixed-length packets. To do so, the fragmented TLV (see [ITU-T J.288]) is introduced.

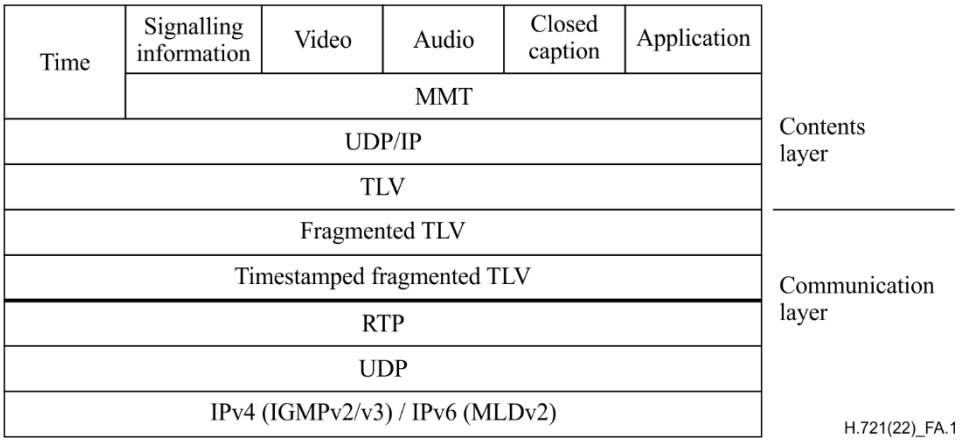


Figure A.1 – Protocol stack of MMT-based IPTV systems

A.2 Contents layer

A.2.1 MMT and time

In these systems, media components, such as video, audio and closed captions, constituting contents (e.g., drama, movie) are encapsulated into media fragment units (MFUs)/media processing units (MPUs). They are carried as MMT protocol (MMTP) payloads of MMTP packets and delivered in IP packets. Data applications that are related to contents are also encapsulated into MFUs/MPUs, carried in MMTP packets, and delivered in IP packets.

IP packets generated like this are multiplexed over broadcasting channels with an IP multiplexing scheme, TLV in [ITU-R BT.1869]. The systems also have MMT signalling information (MMT-SI). MMT-SI is signalling information on the structure of contents and associated information on IPTV services like EPG. MMT-SI is carried in MMTP packets and delivered in IP packets.

In order to provide UTC in broadcasting systems for receiver terminals to synchronize with broadcast station, time information is also delivered in IP packets.

A.2.2 UDP and IP multiplexing scheme TLV

The type-length-value (TLV) multiplexing scheme can multiplex variable-length packets of any format unless packet filtering and fragmentation are needed. The type of packet is indicated by the packet type field in its header, and the length of the packet is indicated by the length field. Header compressed IP packets and transmission control signals can also be encapsulated into TLV containers. This scheme enables multiplexing a maximum UDP packet, 65 535-byte-long packet, without fragmentation. The transmission overhead is small and the TLV multiplexing scheme efficiently uses transmission capacity.

A.3 Communication layer

TLV packets are fragmented and encapsulated into the fixed-length packet called the fragmented TLV packet [ITU-T J.288]. Each fragmented TLV packet is 188 bytes in length and its first byte has the value of 47_{HEX}. As these two features are the same as MPEG-2 TS [ITU-T H.222.0], the lower layers of the fragmented TLV, such as "Timestamped fragmented TLV", "RTP", etc. may be used without any enhancements for MMT transmission. Timestamps for timestamped fragmented TLV packets are generated as in TTS. FEC defined in [ITU-T H.701] is required in this IPTV system. It is recommended that RTP payload types are as follows:

− 110 – Fragmented TLV for AV media stream.

− 111 – Fragmented TLV for SI stream.

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 four bytes of 27 MHz-based timestamp in front of each transport stream (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 the sender and the receiver. The sender and the 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.

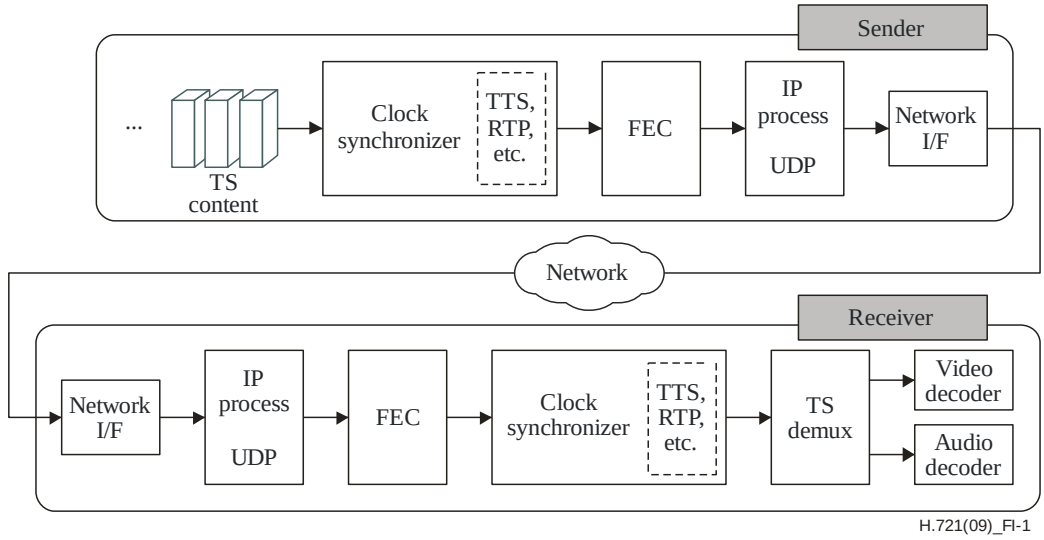


Figure I.1 – System overview of the clock synchronization

I.2 Timestamped 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 phase-locked loop (PLL) that is synchronizing with the timestamp embedded in the TTS.

In addition, each TTS packet is temporarily stored in the first in, first out (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 wireless (i.e., radio frequency (RF)). The conventional TS decoding processes, which is used in typical digital television sets, is applicable to IPTV reception.

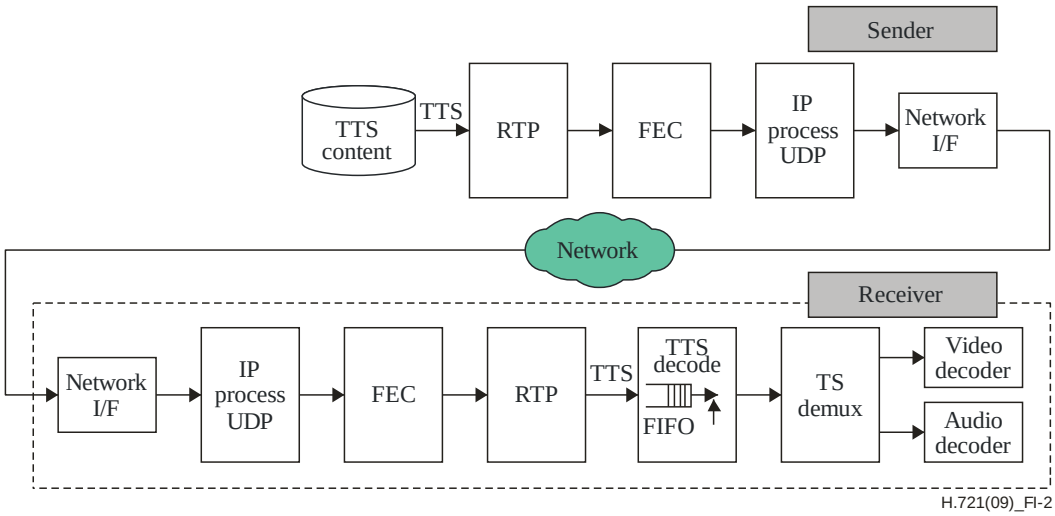


Figure I.2 – System overview of timestamped TS clock synchronization

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.

Appendix II

Terminal device implementation example

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

This appendix provides implementation examples of ITU-T H.721 terminal device (TD) specifications supporting linear TV, video on-demand and interactive services.

II.1 IPTV terminal device functional overview

II.1.1 TD reference model

Figure 8-1 depicts the functional architecture of the IPTV TD-Basic model according to this Recommendation. Figure II.1 illustrates details of an example implementation of an IPTV TD-Basic model using the functional elements in Table II.1.

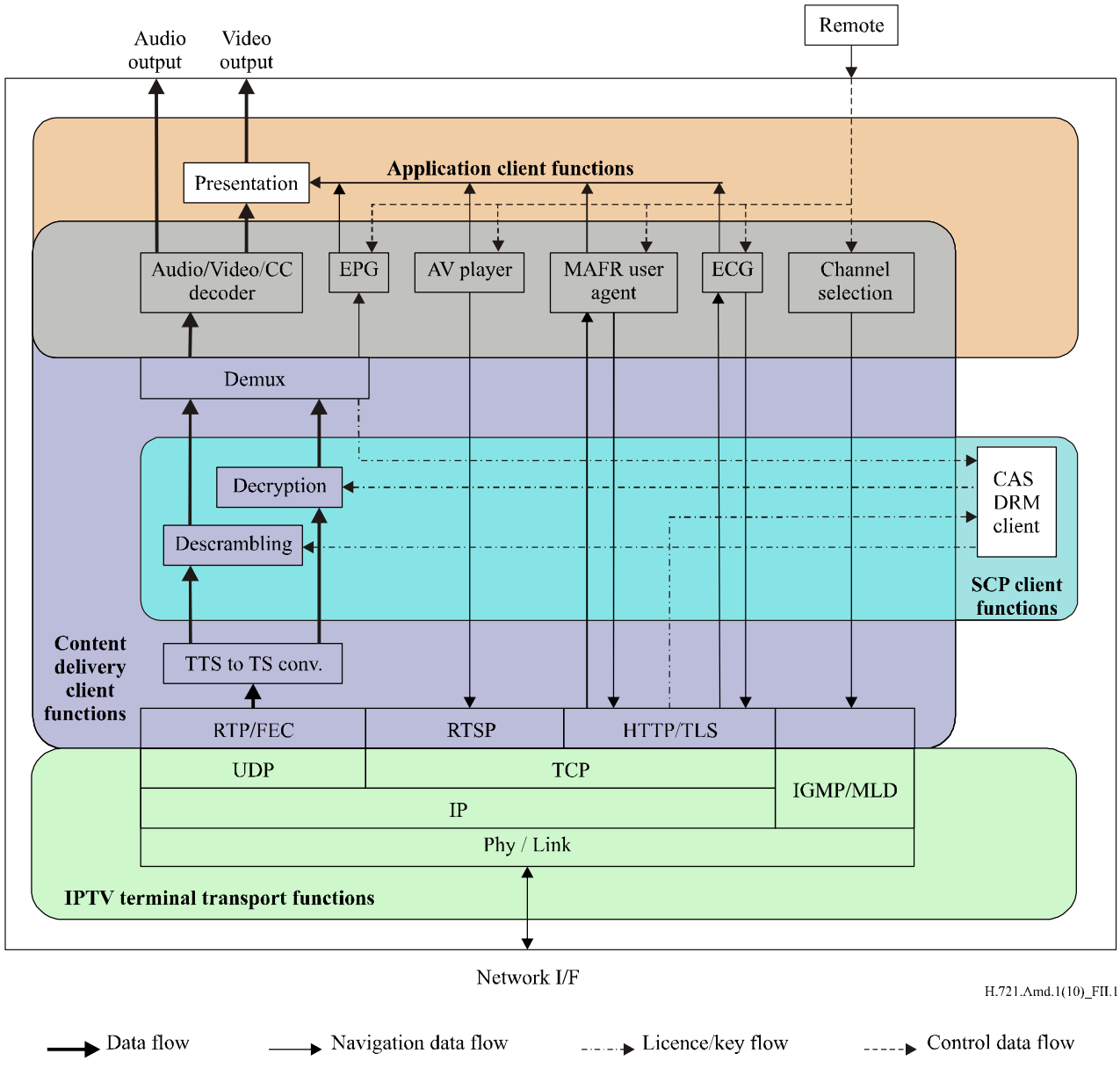


Figure II.1 – Implementation example of the IPTV terminal functions

Table II.1 – Functional elements

Functional element	Description
Communication interface	A communication interface is an interface used to transmit/receive signals from/to the communication networks.
Communication processing	The communication processing block processes communication protocols such as RTP, UDP, HTTP/TLS, RTSP, TCP, IP and IGMP/MLD. Network jitter absorption and FEC processing are performed for the streaming data that is sent using UDP. Refer to clause 7.2.4.
TTS/TS conversion	Clock synchronization and jitter removal based on TTS/TS conversion is an optional function. In the TTS/TS conversion process, TTS that is output from the communication process is buffered (FIFO), and the MPEG-2 TS stream that is synchronized with a 27-MHz clock on the transmitter side is output using the TTS timestamp and 27-MHz terminal automated clock. Refer to Appendix I.
Descrambler	A descrambler decodes scrambled MPEG-2-TS streams using a scramble key that is obtained from a SCP client.
Decrypter	A decrypter decodes encrypted MPEG-2-TS streams using a content key that is obtained from a SCP client.
Demultiplexer	A demultiplexer splits multiplexed MPEG-2 TS streams into video streams, audio streams, subtitle, PSI/SI, ECM packets, etc.
Video decoder	The video decoder decodes video data.
Audio decoder	The audio decoder decodes audio data.
Subtitle decoder	The subtitle decoder decodes subtitle data.
Channel selection process	An application used to select linear TV services.
AV player	An AV player is an application that provides transport control for VoD content.
Presentation process	In the presentation process, data such as stream data from video decoders, browsers, EPG and ECG are merged to create data that are presented to users.
Video output	A video output is an interface used to output video signals to displays.
Audio output	An audio output is an interface used to output audio signals to speakers.
MAFR user agent for IPTV	A MAFR user agent for IPTV is an application that provides the playback function for MAFR documents obtained from portal servers. For more information on MAFR user agent for IPTV, see [b-ITU-T H.761] and [b-ITU-T H.762]
EPG	An EPG extracts service information (SI) provided in linear TV services and provides navigation functions including functions to display IP broadcast program lists, program details, etc.
ECG (option)	An ECG provides navigation functions using metadata that is obtained from an ECG metadata server, including functions to display lists of contents provided in VoD services, purchased content lists and content detail information.
Remote controller	A remote controller is used to operate a terminal.
SCP client	A SCP client obtains a licence from a SCP server. When using linear TV services, a SCP client extracts a scramble key from ECM that is obtained by demultiplexing IP broadcast streams using the licence and provides the scramble key to a descrambler. When using VoD services, a SCP client provides the content key that is extracted from the licence to a decrypter.

II.1.2 Other TD functions

Other terminal functions not included in clause II.1.1 are described in Table II.2.

Table II.2 – Other terminal functions

Function	Description
Service discovery	A process to obtain configuration information which enables end users to connect to a particular service. The TD is able to initially obtain configuration information of CDN operators, platform operators and service providers as initial connection information. It is also possible that a service provider plays multiple roles such as CDN operator, and/or platform operator. Refer to [ITU-T H.770].
Portal selection	A function to enable users to select a portal of a service provider to display portal documents of the service provider in a MAFR user agent for IPTV.
Registration verification entry	A function to enable users to specify a service provider to obtain the registration verification MAFR document of the specified service provider and display it in a MAFR user agent for IPTV.

II.1.3 Data handled by the TD

Data items handled by a typical IPTV TD-Basic model are described in Table II.3.

Table II.3 – Data handled by TDs

Data	Outline
Content	Video data, audio data, subtitle data, etc. for viewing. Provided by VoD services and linear TV services.
MAFR document	A document produced using a MAFR language (e.g., LIME, NCL, etc.) that contains information required to implement portal services such as a navigation tool to use contents, basic registration and licence acquisition.
ECG metadata	Contains information of VoD content used for implementing the electronic content guide.
SI data	Service information data contain the linear TV programming information that is used for implementing EPG.
Licence	Data containing the rights management and protection information for target contents and a decryption key used to decrypt encrypted contents.
URI of CDN configuration information	URI that is used to obtain the CDN configuration information. In this implementation, this URI represents the service discovery entry point defined in [ITU-T H.770]. The use of a pre-configured URI is a common method to assign the entry point required for service discovery.
CDN configuration information	Information necessary to obtain the platform configuration information corresponding to platform operators which are available on the particular network being used.
Platform configuration information	Information related to platform operators and their respective services. Information such as portal server addresses (for VoD service) and SI stream addresses (for IPTV broadcasting) of service provided by the platform operator are some examples.
Logo ID management information	Information that is used to manage the correspondence of logo ID with service ID, service provider ID and network ID.
Logo data	Contains information for a logo mark that is defined for each channel and service provider and is used to display channel selection banners, EPG, etc.

Table II.3 – Data handled by TDs

Data	Outline
Licence renewal notification information	Provides information on whether there is a licence renewal or not to facilitate prompt licence renewal.
Purchased package information	Provides information on purchased packages to display content contract information in ECG.
Content playback control information	Information that is required for VoD content playback control.
User residence information	Information in regard to location of residence and postcode of the users.
Parental control information	Information including the parental level (minimum age for viewing) and parental password (code number) that are set by users to implement parental control.
Network setting information	Setting information such as IP address that terminals need to connect to communication networks and receive various services.
Basic registration information	Information from service providers with whom basic registration has been completed, including service provider ID, information on authentication key and SCP server URI.

II.1.4 Data flows for IPTV TD-Basic model

This clause presents typical data flow examples for terminal devices supporting linear TV, video on-demand and interactive services.

II.1.4.1 Linear TV data flow

This clause illustrates an example of the sequential data flow inside the IPTV TD for linear TV service. See Figure II.2.

(1) When a user performs the selection operation for a linear TV channel using the remote controller, a request to join the multicast group which provides linear TV using the IGMP/MLD protocol is transmitted, reception of the linear TV stream starts.

(2) The linear TV stream is subjected to communication processing and TTS/TS conversion processing.

(3) The demultiplexer extracts the ECM, which is transmitted to the SCP client.

(4) The SCP client uses the multicast licence obtained from the SCP server to take out the scramble key from the ECM and inputs the key to the descrambler.

(5) The descrambler uses the scramble key input from the SCP client to descramble the linear TV stream.

(6) The demultiplexer separates the stream into video, audio and subtitle data.

(7) The video, audio and subtitle decoders decode the above data and output video and audio signals.

For navigation of the linear TV service, an EPG (9) that implements the SI data separated by the demultiplexer or the portal (8) reproduced by the MAFR user agent is used.

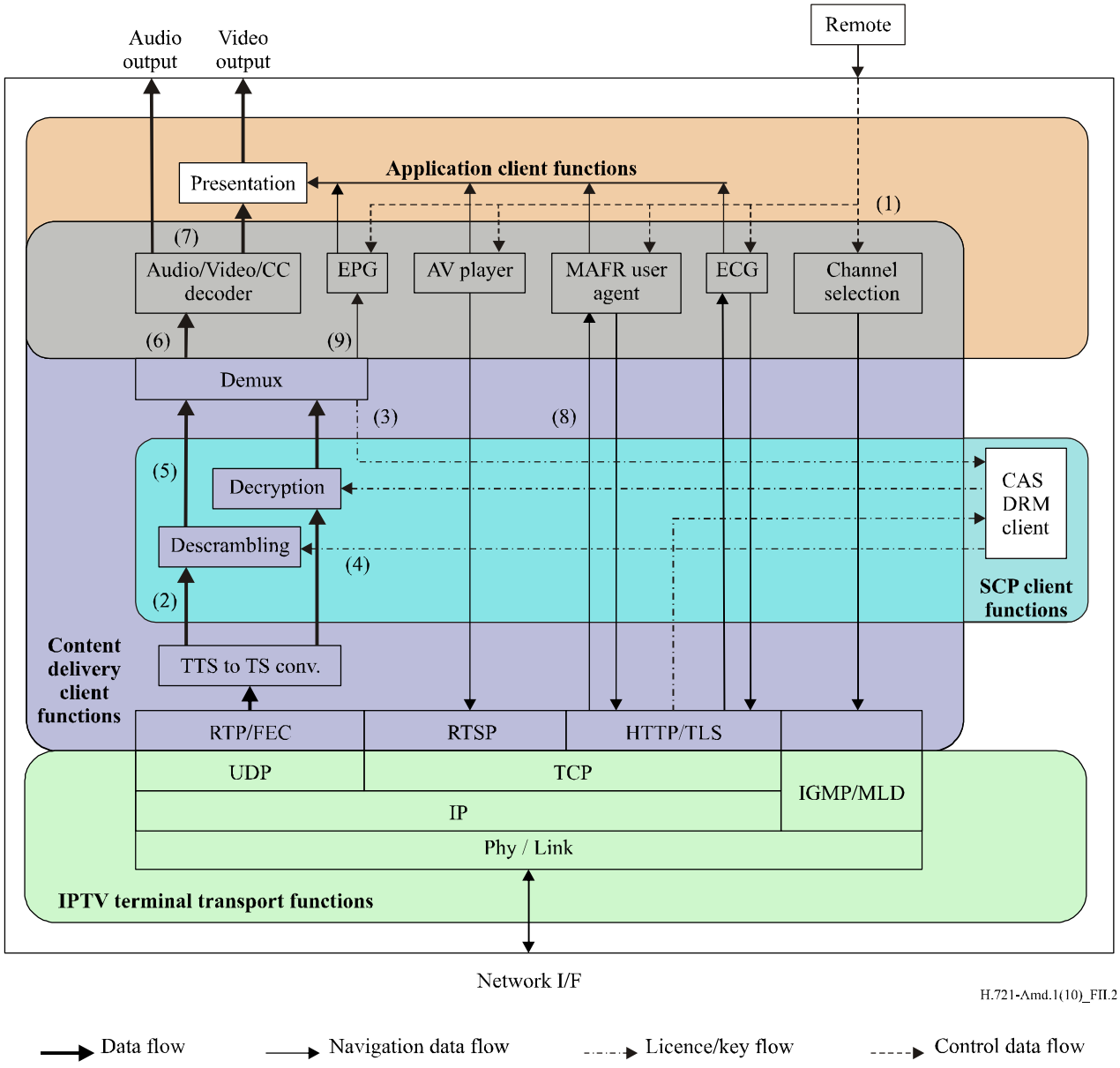


Figure II.2 – Linear TV service

II.1.4.2 Video on-demand data flow

The following illustrates an example of data flow inside the receiver for video on-demand service. See Figure II.3.

1) Content is selected by the browser or ECG.
2) The browser or ECG notifies the information related to the content playback control metafile of the selected content to the VoD playback control component.
3) The VoD playback control component obtains and analyses the content playback control metafile from the playback control information server.
4) When the VoD playback control component detects that the selected content has been encrypted, it notifies the SCP client to obtain a VoD licence.
5) The SCP client obtains the VoD licence from the SCP server.
6) The SCP client sets the content key contained in the VoD licence in the decrypter.
7) The VoD playback control component uses the communications protocol (HTTP or RTSP) to issue a request for playback to the video content server.

8) The video content that is received is subjected to communication processing, TTS/TS conversion processing and processing by the decrypter, demultiplexer, video decoder, audio decoder and subtitle decoder so that the video and audio signals can be output.

In the sequence described above, if the response from any of the servers results in an error or timeout, an appropriate message shall be displayed.

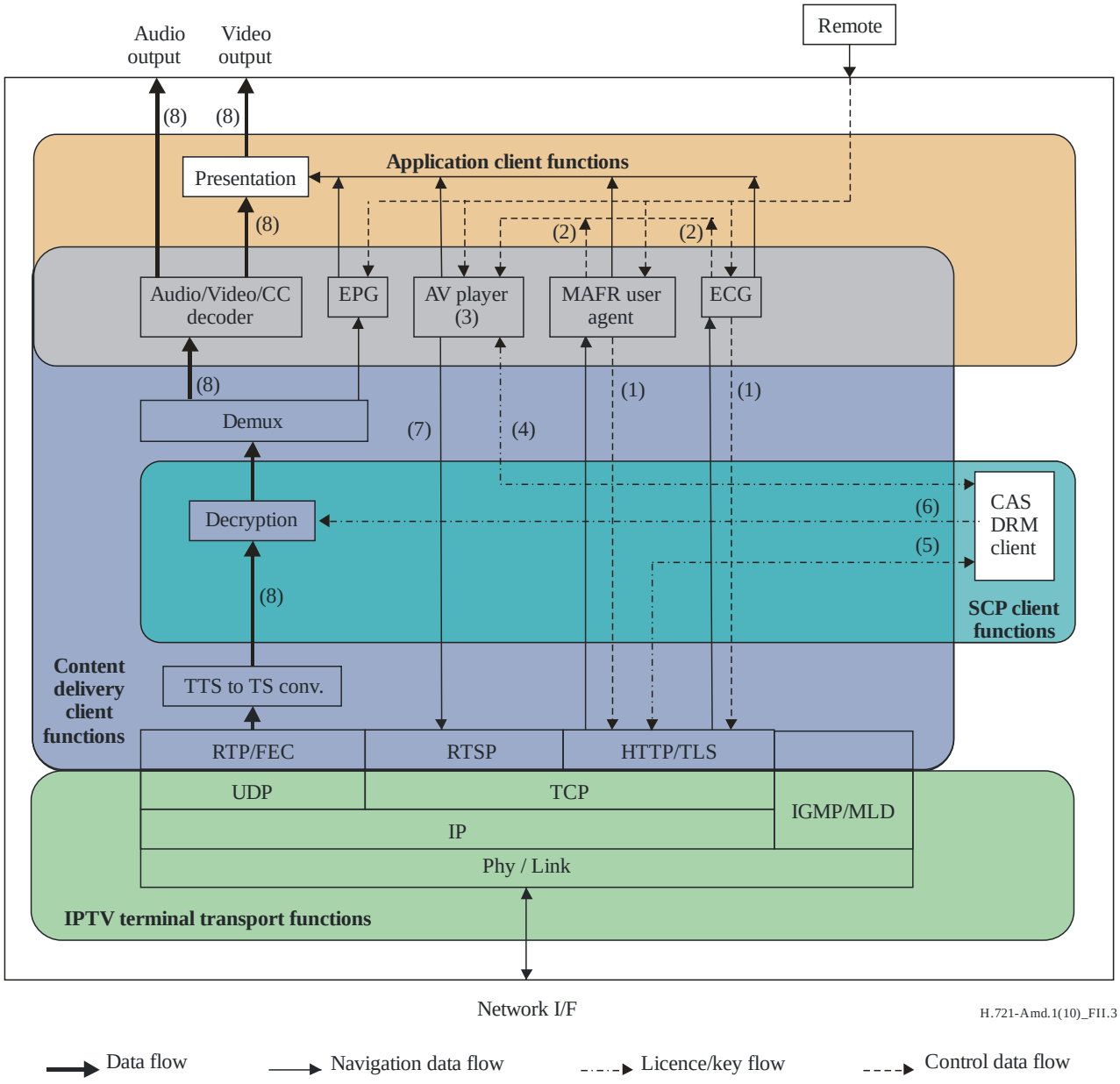


Figure II.3 – VoD service

II.1.4.3 Portal interactive service data flow

The following illustrates an example of data flow inside the receiver for portal services. See Figure II.4.

When a portal is started using a remote controller, a browser accesses a portal server using the HTTP/TLS protocol to obtain a MAFR document. The obtained MAFR document is reproduced in the browser, and video/audio signals are output.

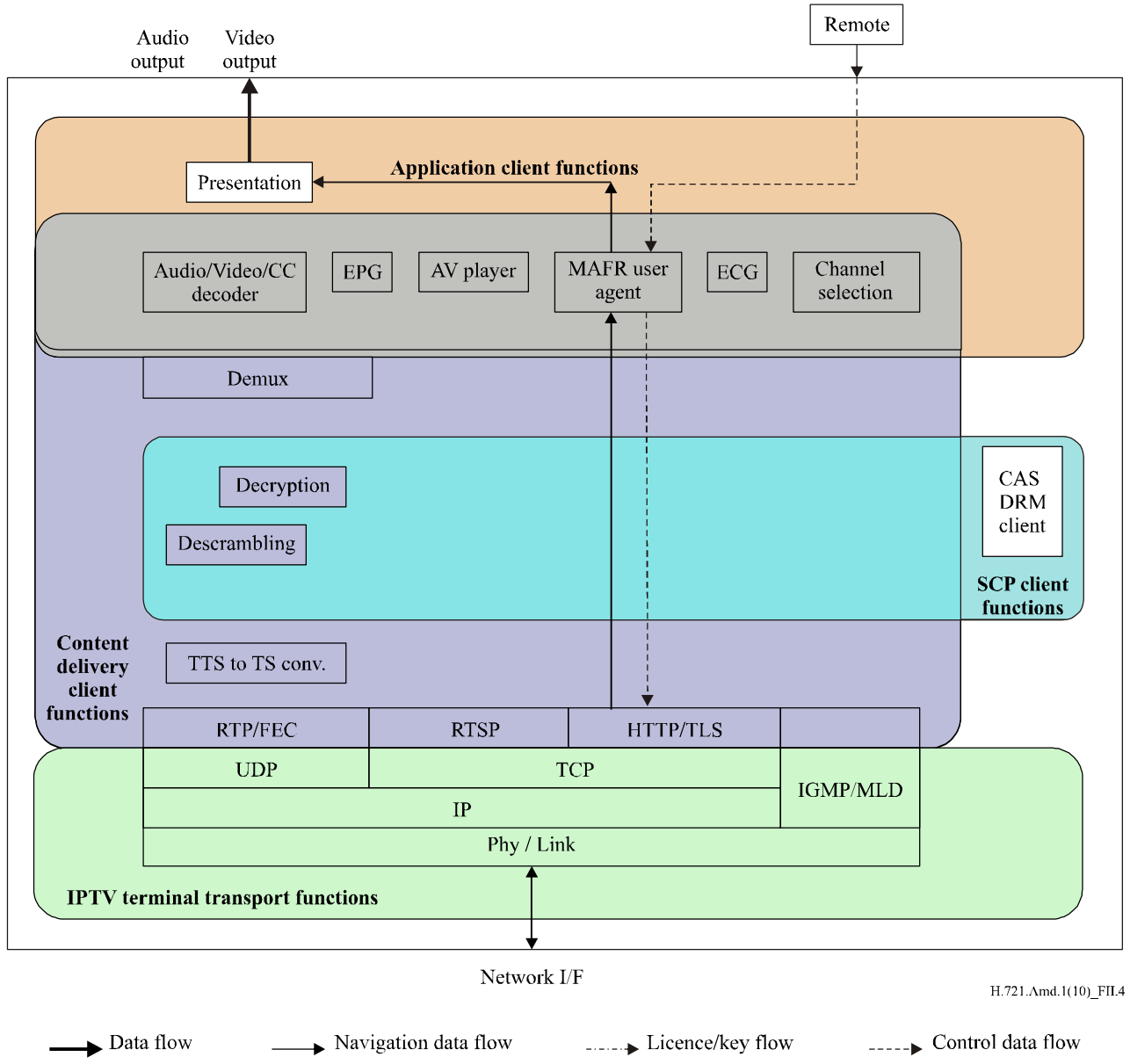


Figure II.4 – Portal service

II.2 Summary of IPTV TD-Basic model functions

This Recommendation provides a high-level description of functionalities of IPTV TD-Basic model. The Recommendation also specifies required, recommended and optional requirements. Table II.4 summarizes IPTV TD features and functions providing the appendix clause number to find the corresponding examples.

Table II.4 – IPTV TD functions

IPTV TD functions described in Appendix II		Requirement level	Related ITU-T H.721 clause
Network attachment and service discovery			
II.3	Network settings	Required	7.2.1.1
II.4	Initial setting overview	Required	7.2.1.2
II.5	Initial settings	Required	7.2.1.3
II.6	Portal selection	Required	7.2.1.3
Privacy			
II.7	Function to clear user configuration information	Required	7.2.3
Media client functions			
II.8	Playback of VoD content	Required	9.3.1.1
II.9	Electronic Content Guide	Recommended	9.3.1.1
II.10	Parental control settings	Recommended	9.3.5.4
II.11	Residence location configuration	Required	9.3.4.2
II.12	Terminal preset information	Required	9.3.4.2
II.13	Basic registration information management	Required	9.3.4.2
SCP client functions			
II.14	SCP client identification	Required	9.3.4.2 9.4
Application client functions			
II.15	MAFR user agent requirements for IPTV	Required	9.5.1
Input interface			
II.16	Remote controller	Recommended	10.1.2
NOTE – Detailed implementation information of the functions can be found in [b-IPTVFJ-0002], [b-IPTVFJ-0004] and [b-IPTVFJ-0006].			

II.3 Network settings

Table II.5 lists the items that require settings in a screen among the settings required by a a terminal to connect to communication networks and receive various services.

Table II.5 – Required network settings

Classification	Category	Sub-category	Requirement level	Remarks
IPv4/IPv6 operation switching	Dual/operation specification (IPv4/IPv6)		Optional	
IPv6	Network address setting		Required	Default: Automatic acquisition
		Automatic acquisition (Router advertisement (RA))		
		IP address Subnet mask Default gateway		
		Manual setting		
		IP address Subnet mask Default gateway		
	DNS		Required	Default: Automatic setting
		Automatic setting		
		Manual setting		
IPv4	Network address setting		Required	Default: Automatic acquisition
		Automatic setting（DHCP）		
		IP address Subnet mask Default gateway		
		Manual setting		
		IP address Subnet mask Default gateway		
	DNS		Required	Default: Automatic setting
		Automatic setting		
		Manual setting		

II.3.1 Supplementary information

It is desirable that information that can be obtained through DHCP and DHCPv6 not be stored on the terminals.

The assumed default IPv4/v6 switching mode is dual operation. Considering cases in which user operability is reduced (e.g., in terminal operations, etc.) depending on the network environment, it is desirable to enable independent operation settings.

II.4 Initial setting overview

A terminal that acquired an IP address obtains the CDN configuration information via HTTP, based on a uniquely determined URI. Additionally, the terminal obtains the platform configuration information (e.g., the pf_url) included in the CDN configuration information, and determines whether linear TV services are provided by the platform based on the presence of relevant elements (e.g., ip_broadcast_service) in the platform configuration information. When linear TV services are provided, information such as multicast addresses for receiving SI information is available for reference in the platform configuration information. To actually receive it, a terminal transmits the participation notification (JOIN) for the SI information multicast stream multicast group and obtains network information table (NIT) for the platform and other SI information. At this point, features such as channel selection, EPG display, portal connection and ECG metadata acquisition become possible.

II.5 Initial settings

In order to receive linear TV/VoD services, etc., various types of information should be obtained by a terminal.

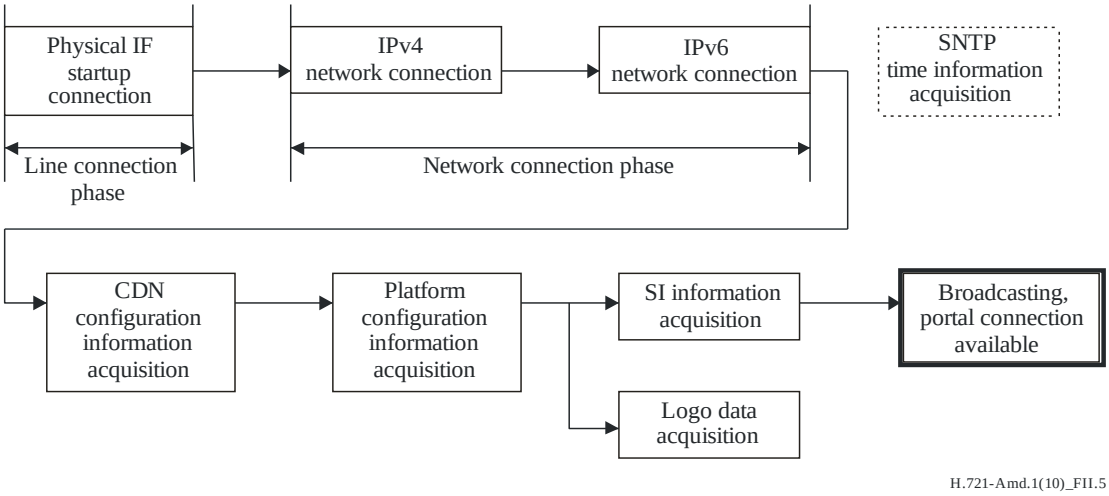


Figure II.5 – Setting process

Figure II.5 illustrates a process flow from the moment the power is turned on for the first time to the initial acquisition of various types of information (this flow does not necessarily define the processing order):

1) Line connection phase

   After the power is turned on, the terminal detects a linkup when it is connected to a physical line. It is desirable to provide an indication of the link status (e.g., using a LED).

2) Network connection phase

   After the physical line is connected and the link layer connectivity is detected, if the terminal is set to address automatic configuration of an IP (recommended default setting), the terminal attempts both IPv4 and IPv6 address acquisition since it may be connected to either or both networks. The above process is not required if the terminal is set to fixed IP address mode.

3) CDN configuration information acquisition

   After the network connection phase is completed, the terminal obtains the CDN configuration information that enables the terminal to access information for obtaining time information and other information in regard to connection to a platform configuration information server

that is operated by a platform operator providing services in the CDN. The terminal is connected to a server by referencing the connection destination information in the preset CDN configuration information. It is assumed that the terminal is connected to one CDN, which is associated with one CDN configuration information server. After the initial acquisition, the update process should be performed once per day.

The CDN configuration information mainly contains the following information:

– A server address to connect via simple network time protocol (SNTP) to implement time management, and various parameters that are used for summer time operation, etc.

– Information for individual platforms:

  • Identification information to distinguish amongst platforms.

  • Connection destination information to obtain a platform configuration information file.

  • Serial information to distinguish CDN configuration information updates, etc.

4) Platform configuration information acquisition

The terminal refers to the connection destination of the platform configuration information written in the CDN configuration information and obtains information such as portal server connection destination and multicast address for SI reception. This information is in a server that is built for each platform operator who provides services in the CDN. If the platform provides linear TV service, the configuration information includes relevant information (e.g., the element ip_broadcast_service) required to receive broadcasts. After the initial acquisition, the platform's serial information is confirmed when CDN configuration information is referenced, and platform configuration information can be obtained and updated when there is a change. The platform configuration information mainly contains the following information:

i) Platform identification information to distinguish amongst platforms.

ii) Connection destination information to obtain logo data.

iii) Various elements that are required to receive SI-dedicated streams:

  • multicast address for SI transmission;

  • transmission port information;

  • SI transmission server address, etc.

iv) Various elements for each service provider:

  • identification to distinguish service providers;

  • connection destination information to connect to portals;

  • connection information to connect to a meta server that is used by the ECG, etc.

5) SI information acquisition

When ipbroadcast_service is included in the platform configuration information, the terminal acknowledges that broadcasting services are provided in the platform and receives SI information by referencing information such as the multicast address required for receiving SI dedicated streams in the platform configuration information. This data is transmitted using multicast communication. Therefore, JOIN should be transmitted to an edge router to receive data streams, LEAVE should be transmitted after receiving the required data, and the stopping process should be performed.

6) Logo data acquisition

Terminals can display logo data on the EPG display and selection screens of multiple operators. Logo data can be obtained for each platform operator, service provider and channel.

Platform operators maintain logo data servers and create logo data that is used in the linear TV services.

The URI of a logo data server is indicated by the logo_url of a platform configuration information file, and the file that associates logo id and channels or operators (logo id management file) and other logo files are allocated in a logo server. It is desirable to perform update processing when platform configuration information is referenced after initial acquisition. Also, since the information element of the logo id management file name described in the logo server connection destination contains serial information, the information can be updated if there is a change.

7) Time information acquisition

Terminals can obtain time information using SNTP or other methods.

When terminals obtain time information, they can adjust the time e.g., by referring to server connection destinations and offset values in the CDN configuration information.

II.6 Portal selection

The terminal must provide a function to display and select links to all service provider portals who provide services in the network environment to which the terminal is connected.

Also, when basic registration is completed with one or more service providers, it is desirable that the service providers with whom basic registration has been completed are given priority when service providers are displayed/selected.

II.7 Function to clear user configuration information

In order to support handover and disposal of terminals, terminals should provide an initialization function to clear personal information that is stored in the NVRAM of terminals. In addition, terminals should provide a function to clear personal information that users have set (such as user setting information and company-specific area information) and a function to restore factory settings. In order to prevent operation mistakes by users, it is desirable to take measures to prevent erroneous operation, for example by placing this function in a deeper layer of the operation menu.

II.8 Playback of VoD content

VoD content items may be selected either from a resident function such as ECG, or from a portal. This clause describes the operational specifications that are specific to CDN scope services.

II.8.1 Starting VoD content

Terminals should start streaming according to the following procedures:

1) Terminals access a video content server on a communication network using the sequence that is described in clause II.8.1.1 according to the ProgramURL description of OnDemandProgram in the instance description metadata (ProgramLocationTable) that corresponds to the content reference identifier (CRID). When streaming is started from a portal, the information is listed in content_uri of launchIPTVContent() function that is described in [b-ITU-T H.764]. When the streaming is started from ECG, the CRID of the content is selected from the ECG.

2) When streaming is started from the ECG, authentication is performed between terminals and a video content server so that the terminals can access the server on the communication network and obtain content playback control metafiles of the contents.

3) Terminals obtain content playback control metafiles of the content to be streamed from a video content server on a communication network:

   – Entry resource information (ERI): Information for identifying the entry resources of per-use content.

   – Licence link information (LLI): Information used to refer to a licence of per-use content.

   – Network content control information (NCI): Information related to the use of streaming services.

4) Terminals analyse NCI and obtain information in regard to content streaming control.

5) Terminals analyse LLI and obtain a licence from a SCP server by specifying a licence ID to identify the licence that is required to playback the contents. When there are multiple licences that can playback the contents, the licence that was selected in advance from the ECG is used.

6) Terminals input the licence into a SCP client and obtain the rights management and protection information and a content key.

7) Based on the content URL obtained by analysing ERI, terminals access a video content server and receive and playback streaming data via RTP using RTSP streaming control.

8) When playback is resumed using a resident function, terminals search the playback start point in the stream resources based on the information related to resume that was stored in the terminals when the content playback was previously stopped. To start from a portal, terminals obtain a playback start position that is specified in a MAFR document.

II.8.1.1 Protocol for reproduction control metafile acquisition

1) Terminals request acquisition using the HTTP or hypertext transport protocol over secure socket layer (HTTPS) Get method. HTTPS is used when LLI is included.

2) Transmission/reception of reproduction control metafile.

   A video content server returns a HTTP response, including the module format data. Figure II.6 shows an example of the reproduction control metafile acquisition sequence.

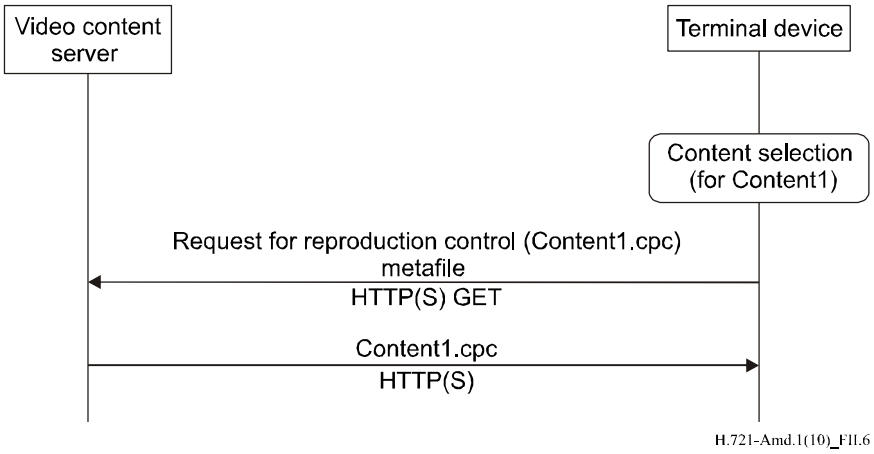


Figure II.6 – Sequence to acquire control metafile

II.8.2 Content reproduction control

Terminals should implement the following processes in regard to playback control for stream resources:

– Terminals should operate according to clause II.8.2.1 in regard to trick playback during the playback of stream resources.

– For clock synchronization, terminals should perform processes in accordance with Appendix I.

– Terminals that implement FEC should perform processes in accordance with [ITU-T H.701].

II.8.2.1 Trick playback

In order to implement a trick playback function using a user interface function such as a remote controller, terminals must perform the following processes:

– Two types of fast-forward playback/fast-rewind playback methods are assumed: a method to use stream resources that are dedicated to fast-forwarding and fast-rewinding and a method to use stream resources composed only of the TS packets related to I-frames that are extracted from 1x-speed stream resources. The former method is called the "normal TS method", and the latter method is called the "I-frame TS method".

  • Terminals distinguish between the normal TS method and the I-frame TS method based on the speed value listed in the NCI of the contents.

  • The speed value listed in the NCI should be used to specify the fast-forwarding/fast-rewinding speed.

  • For the normal TS method, terminals should perform playback processes that correspond to the timestamp value of TTS, PCR, presentation timestamp (PTS) and decoding timestamp (DTS) as with 1x-speed playback. Packets other than video packets (audio packets and subtitle packets) should be discarded without being played.

  • For the I-frame TS method, terminals should ignore the timestamp value of TTS, PCR, PTS and DTS, and perform playback processes. In the I-frame TS method, it is assumed that correct clock synchronization information and presentation synchronization information are lost. Therefore, free-run sequential playback, which does not use the clock synchronization feature of terminals, is acceptable. Also, packets other than video packets (audio packets and subtitle packets) should be discarded without being played.

  • When terminals reach the end position of contents during fast-forwarding or the start position of contents during fast-rewinding, the terminals should distinguish the status based on an instruction notified from a video content server (ANNOUNCE method) and perform appropriate processes such as stopping or resuming playback.

– In regard to jump playback, it is desirable to implement a jump playback function that enables jumping to a playback point (or an interval) in the contents. Implementation methods vary depending on terminals, including methods to specify jumping intervals and positions to jump to.

– It is desired that terminals implement a chapter playback function. Implementation methods vary depending on terminals:

  • Terminals analyse ERI of the contents to be reproduced and obtain chapter start points and chapter titles that are described.

  • Using a user interface function such as a remote controller, terminals jump to a chapter start point. The procedures for jumping are the same as the procedures for jump playback.

  • Chapter information display methods to display chapter information are implementation-defined. When chapter jump is performed using remote controller buttons, it is desirable that the corresponding chapter title be displayed immediately after the chapter jump.

II.8.2.2 Pause/stop

In order to pause or stop playback of contents using a user interface function such as a remote controller, terminals should implement the following processes:

– Terminals should avoid disconnection by transmitting a method or heartbeat in an interval that is smaller than the timeout value in the Session header of the SETUP response. However, terminals should perform stop processing to continue the PAUSE status for more than a defined period of time to reduce the server load.

– In order to perform stop processing, terminals should use the NPT value listed in the Range header of the RTSP PAUSE response as a playback stop position of the contents, associate it with the content, and record/store the information.

II.8.2.3 Resume

When terminals support resume operation using a resident function, terminals should implement the following processes. The resume function provided by a resident function is different from the resume function provided by a portal service in that it is provided differently depending on terminals based on the following processing:

– As described in clause II.8.2.2, when content playback is interrupted by a resident function such as stop, terminals should associate and store the playback stop position of the interrupted content and the identification information of the target streaming content. For the playback stop position, the NPT value described in the Range header of the RTSP PAUSE response should be used.

II.8.2.4 Playback termination

The following two cases are assumed as transition destinations when content playback ends:

– When playback of contents that are started from a resident function such as ECG ends, it is desirable that the display of the terminal returns to a resident graphical UI such as ECG, by which contents playback were started.

– When playback of contents that are started from a portal ends, the streamstatus attribute is automatically changed to "stop".

Completion of content playback is detected using an instruction that indicates completion of content playback from a video content server (ANNOUNCE method). When the notice header indicates reception of the Event_Code for playback termination, terminals should display appropriate messages describing the reason for termination.

There are two independent processes in playback termination:

1) termination processing using a user interface function through remote controller operations such as stop, and

2) termination processing for communication servers such as transmission of RTSP TEARDOWN and disconnection of sessions due to timeout.

II.8.2.5 Information display during viewing

Audio-visual (AV) players are capable of displaying the following information during stream resource playback (note that information display methods are implementation-defined):

– Banners related to contents that are being reproduced: content titles and content outlines can be displayed according to the information described in ERI of the contents.

– A user interface function to switch elementary stream (ES) for contents that are being reproduced: audio ES and subtitle ES should be switched using the information described in program map table (PMT) that is multiplexed to the stream resource of the contents. For audio ES switching labelling, "Audio 1, Audio 2" suffices. For subtitle ES switching labelling, a format in which no subtitle or one of the languages in the subtitle ES is selectable, can be used. The default subtitle setting is no subtitle.
– A progress bar indicating the streaming playback position: the current playback position on the length of the content that is described per the session description protocol (SDP) can roughly be determined by combining the value of the Range header indicated in the Response message of the RTSP PAUSE method, clock value in a terminal, or PTS value of the stream, etc. For example, when the mode changes from trick playback to normal playback, the PAUSE method is always used for transmission/reception. By this, the playback start time position is located, and time elapsed that is measured by the terminal's clock is added during the following normal playback. During high-speed playback, the product of the measured playback time and the speed value can be added.
– Graphical UI that is used to specify a time code for jump playback: for example, terminals can provide a graphical UI that provides a sub-menu enabling entry or selection of a playback time position for the content being reproduced using a user interface function such as a remote controller.

II.9 Electronic content guide

This clause describes an example of the electronic content guide (ECG) function that is implemented by terminals using ECG metadata provided by the service providers. The ECG function is an optional function, and whether it is implemented or not, depends on the terminal.

The ECG uses the metadata that is provided by content delivery service providers in advance and provides users with the means to search contents, display information, reproduce, purchase contents and work with portals using a terminal resident function. Especially, the ECG enables searching across service providers since it is implemented as a resident function.

II.9.1 Functions provided by ECG

An ECG provides the following functions:

– A function to specify the entire ECG metadata, or a search condition for each service provider and obtain metadata.
– A function to obtain ECG metadata from multiple service providers.
– A function to display lists and details of obtained ECG metadata to users.
– A function to move from displayed ECG metadata to contents and procedures to purchase packages.
– A function to display contents and packages that are purchased by users.
– A function to reproduce purchased contents.

II.9.2 Information comprising ECG and management

II.9.2.1 ECG metadata management using terminals

It is assumed that obtained metadata is temporarily stored in cache for ECG. Implementation of cache depends on individual terminals. It is assumed that cache capacity ranges from the minimum of a content search result screen to the maximum of all ECG metadata from all service providers. Also, the assumed storage methods range from saving temporarily in RAM as storage media to saving on a hard-disk drive.

ECG compatible terminals build and manage a metadata database based on obtained ECG metadata to reduce stress on users to use functions such as search. However, the methods to manage ECG metadata in terminals are implementation-defined.

The following points in regard to ECG metadata cache management should be noted:

– Metadata should be obtained from an ECG metadata server of a service provider and managed so that it is available for use as lists, etc.

– Metadata for individual content and package metadata comprising a content group should be correctly associated.

– Effort should be made so that the difference between ECG metadata in a service provider server and cache in the terminal becomes less than one day.

– Terminals should always keep the metadata database up-to-date based on the latest ECG metadata that is obtained.

– When an expiration date is specified, expired ECG metadata should not be presented to users. Expiration dates may be shortened, so metadata should be updated in an appropriate manner.

II.9.2.2 Management of viewing availability information for individual packages

Terminals should save PurchaseID, usage start date, and usage end date of packages, or the licence ID and the expiration date of licence usage and the date on which the select option is reset for select packages, in NVRAM, at least until the usage end date or the date on which the select option is reset.

II.9.2.3 Other information managed by terminals

It is desirable that terminals can manage viewing status of contents that are available for viewing, such as information on whether they are viewed or not, and content playback stop positions for the resume function, etc.

II.9.3 ECG metadata acquisition

The following points in regard to metadata acquisition by ECG should be noted:

1) Cache capacity of ECG varies depending on the terminals. Exceeding the cache capacity may result in lost data when obtaining ECG metadata.

2) Terminals connect to an ECG metadata server, as described in <meta_url> in the platform configuration information of a service provider with whom basic registration has been completed and obtain metadata.

3) When obtaining ECG metadata, terminals should obtain metadata partially, for example by specifying the size (taking into consideration their cache capacity).

4) When the obtained ECG metadata has the same ProgramInformation/@programID as the cached metadata, and @fragmentVersion of the obtained ECG metadata is new, the cached metadata should be replaced by the obtained metadata.

5) Scheduling to obtain ECG metadata is implementation-defined, but effort should be made so that the difference between the cached metadata and the server metadata is less than one day.

6) Implementation in which terminals of a manufacturer obtain ECG metadata concurrently should be avoided. When the error code 503 (Service Unavailable) is returned from a server, terminals should connect to the server after an appropriate interval.

7) When there are multiple service providers with whom basic registration has been completed, terminals should obtain metadata evenly from the multiple service providers, associate the obtained metadata with respective service providers and manage the metadata in their metadata database.

II.9.4 Content information and package information display

ECG should provide at least a function to display content and package lists and detail screens. The following points in regard to each display function should be noted:

1) ECG should be able to display content and package lists using obtained metadata. There are two assumed types of lists to be displayed: content lists and package lists. Also, group lists can be displayed using group information elements such as series.

2) Other list display methods are implementation-defined, but as the number of contents may become large, consideration should be given to paging, scrolling, hierarchical displays, etc.

3) It is assumed that package name, package type, price, new arrival, recommended package and status (such as viewing period) are displayed when packages are displayed in a list. It is assumed that content name, new arrival, recommended contents and status (such as viewing availability and viewing period) are displayed when contents are displayed in a list. Also, it is assumed that group name, new arrival, recommended group and status (such as viewing period) are displayed when groups (e.g., series) are displayed.

4) The display order in lists is implementation-defined, but consideration should be given to avoid unfair display opportunity among service providers, for example, by ordering items using search keys.

5) A purchase button can be displayed for the contents and packages in the content list screen and package list screen.

6) Users should be able to move to a detail screen that displays information such as details of contents and packages and purchase conditions by selecting individual contents and packages displayed in lists.

7) Detailed information of obtained contents and packages should be viewable. A purchase button should be displayed for each content and package in the detail information screen so that users can proceed to purchase procedures.

8) When multiple data is defined with the same tag in ECG metadata, the data should be displayed in the order that follows the described order.

9) In regard to licence information related to contents and packages such as viewing period, licence reference information should be obtained and displayed.

10) It is desirable that contents and packages that have already been purchased be differentiated in the contents list screen and package list screen as well as in the detail screen.

11) If there is a provider logo, it is desirable that the logo be displayed.

12) The items that should be displayed in list screens and detail screens are implementation-dependent.

II.9.5 Search using ECG metadata

The ECG function should provide users with a metadata search function in cooperation with an ECG metadata server. The following points should be noted in regard to searching:

1) Terminals should accept metadata search conditions from users, send the search condition to ECG metadata servers and obtain ECG metadata. When ECG metadata is obtained, terminals can cache the metadata according to their cache capacity.

2) ECG metadata display for search results should conform to the display method described in clause II.9.4 above.

3) Obtained ECG metadata should be compared to cached metadata, and cached metadata should always be up-to-date.

4) When a user presents the same search condition as cached ECG metadata, and it has been more than one day since the ECG metadata was cached, the search should include the ECG metadata server of the service provider.

5) Search by genre may be performed according to implementation-dependent classification schemes.

6) Consideration should be given to avoid unfair metadata searches among service providers.

II.9.6 Purchase of packages

Using the ECG function, users should be able to move from list and detail screens to the package purchase screen to purchase packages.

1) By selecting a button to start the purchase procedure in the content list, package list and detail screens, users should be able to start a MAFR user agent for IPTV using the URI indicated in PurchaseInformation/Purchase/PricingServerURL of the purchase information element corresponding to the contents and packages, move to a portal server of a service provider and proceed with the purchase procedure.

2) When multiple packages contain the selected content, users should be able to select a package.

3) When a package is purchased in a portal server, viewing availability information should be saved in the terminal at least until the viewing period ends. The storage period after expiration of the viewing period is implementation-defined.

4) When users return to the ECG function after purchasing packages, it is recommended that the transition to the purchased package detail screen be carried out using the ECG button or startResidentApp() in the MAFR document after the purchase.

5) When contents and packages are displayed, they should be displayed in a way that users can find out what items have been purchased and what are for purchase.

6) In regard to contents included in the subscriber's plan, the CRID of the contents should be added to the above URI as an argument, and users should be able to move to a portal server and proceed with the selection procedure.

II.9.7 Purchased content and package lists

Using the ECG function, users should be able to display contents and packages that are available for viewing and reproduce them by selecting a content.

1) Users should be able to display a list of contents and packages that are available for viewing using viewing availability information that is saved on terminals. A dedicated screen can be prepared, or it can be included in the list screen. When the purchased content and package list is included in the list screen or detail screen, the available for viewing status should be displayed.

2) When users display the list of contents and packages that are available for viewing, it is desirable that a play button, viewing status (previous viewing position), viewing period of the contents and links to portal servers be displayed.

3) When multiple contents become available for viewing by purchasing one package such as pack and all-you-can-view packages, only package information should be displayed. Displaying all contents is not needed.

4) Since it is assumed that package purchase and cancellation of package purchase take place off-line, it is desirable that terminals provide a button that starts a function to synchronize viewing availability information with a service provider server, or other means to execute an equivalent function such as a menu item.

The following methods can be used for synchronization:

a) Terminals access a portal server of a service provider and specify the user using a method such as user authentication with DRM_ID by executing the obtained MAFR document. Then terminals perform update processing for the MAFR document that is customized for a specified user using setContentPackageInfo() (when the information on packages for which purchase application has been made is added individually) or updatePackageLicenceInfo() (when the information is updated collectively).

b) Using ECG, users connect to the contract package information URI of the platform configuration information using HTTPS and obtain a contract package information file. If the error code 503 (Service Unavailable) is returned from the server, terminals should connect to the server after an appropriate interval. In regard to acquisition timing, it is assumed that terminals can perform automatic updates using the above protocol at any time, e.g., when the power is turned on. Allowing terminals to access a server concurrently should be avoided.

II.9.8 Linkage with portal

It is desirable that links to the corresponding service provider portals be displayed in content lists and package lists.

A MAFR user agent for IPTV is started using <portal_url> in the platform configuration information when a user moves to a portal of a service provider.

II.10 Parental control settings

Parental control settings vary depending on local regulations. This clause describes an example of parental controls.

The following three functions should be configurable in the menu screen of terminals.

– Parental level (minimum age for viewing): The minimum age is set according to local policies (e.g., between four and 20). Programs, contents, etc., with a parental rating exceeding the set value are not displayed.

– Parental password (code number).

– Parental control ON/OFF.

It is desirable that the initial setting does not display R-20 programs (equivalent to parental control = ON, parental level = 19).

II.10.1 Function overview

This function is used to compare the parental rate that is described in PSI/SI and ECG metadata with the parental level (minimum age for viewing) that is set on a terminal by a user. When the parental rate exceeds the parental level (minimum age for viewing), users are asked to enter a password (code number) for the parental control target program/contents, which can be viewed only when the entered password matches the password that is preset in the terminal by the user.

This function is used for programs provided by conditional access services and contents provided by conditional playback services.

Terminals should be equipped with a function to set the parental level to ON/OFF, and when the parental level is OFF, terminals should not display the parental level/password entry screen until the parental level is set to ON.

When a password and/or parental level are not set, terminals should not present any services including restricted programs and should display a screen to ask users to set a password and/or parental level. It is desirable to allow users to set the above-mentioned "parental function ON/OFF" function in the password and parental level setting screens.

II.10.2 Initial setting

In the factory setting of terminals, it is desirable that the parental function is set to ON and the parental level is set to 19 or an equivalent value. However, actual parental level setting and password setting are implementation-defined.

When the parental level is set to 19, users are not asked to enter a password to view programs and contents that are under R-19. If a password is not set in the factory setting, users should set a password when they change the parental level setting.

II.10.3 Parental level (minimum age for viewing)

Examples of parental levels: The parental rate of a program should be (rating + 3). The rating takes a value between 0x01 and 0x11. The parental rate for content takes a value between R-4 and R-20.

An exceptional process is applied when a value between 0x12 and 0xFF is specified for rating (age restriction rate), where all become restricted regardless of the parental level setting, except when the parental level (minimum age for viewing) of the terminal is set to "no restriction (unconditional)" or when the setting is made not to use the above-mentioned parental control.

Adult-themed video services with 0x11 rating and R-20 adult themed contents should not be displayed even when the restriction is temporarily removed. However, the above-mentioned restriction does not apply to digital TV services that have 0x11 rating.

This restriction does not apply to programs that do not have a rating (age restriction rate).

Values that are set in terminals should fall between four and 20, and should be specifiable in years.

II.10.4 Password (code number)

1) Password digit number: the password should be a decimal four-digit number.
2) Deletion of password: Deletion of password is optional, depending on the terminal.

II.10.5 Restriction removal status

After a password and the parental level are set and when the restriction is removed temporarily (after password authentication), it is desirable that the restriction be removed at least until the power is turned off (including when the power is turned off using a remote controller).

II.11 Residence location configuration

Examples of location settings include:

– Administrative region (e.g., prefecture) code: In order to provide services that correspond to a user's residence location, administrative region codes should be configurable.
– Postal code (seven-digit): In order to provide services that correspond to a user's residence area, postal codes should be configurable.

II.12 Terminal preset information

The terminal preset information includes items that are preset in terminals and that terminals require to receive various services. For example, the information on the URL from which the CDN configuration information is obtained.

II.13 Basic registration information management

During basic registration with a service provider, a terminal saves the information to identify the contracted service provider (ip_service_provider_id) in NVRAM using the basic registration completion process document in a portal. Terminals use this information to give priority to the providers with whom basic registration has been completed when, for example, displaying the EPG. Authentication key information and the SCP server URI are also saved and managed in NVRAM. Upon expiry, the relevant basic registration information is nullified.

II.14 SCP client identification

It is assumed that SCP client identifiers (e.g., DRM_ID) are registered with subscriber management servers of the operators as a means to identify devices and users of these devices. SCP client identifiers are used as needed when the terminal browser, etc. processes authentication, and users do not usually need to know the values. However, users may need to report the values by phone or by other means when, for example, a service is cancelled due to device failure. Therefore, terminal manufacturers need to consider the way by which DRM_IDs can be notified to users.

Examples of DRM_ID

The DRM_ID is called the "DRM number" and can be displayed as a hexadecimal (0 to F) 16-digit string divided into groups of four characters connected with "-" (hyphens) in the following display format:

```
XXXX-XXXX-XXXX-XXXX
```

where "X" is a hexadecimal number or a character between 0-9, A-F (letters in upper case).

II.15 MAFR user agent requirements for IPTV

In order to implement a MAFR user agent for IPTV (e.g., [b-ITU-T H.761] or [b-ITU-T H.762]), terminals need to satisfy corresponding functions and specifications, implementation of additional functions for linear TV/VoD services, as well as SCP related features.

Also, a resident application should start and terminate the MAFR user agent for IPTV under the following conditions:

– Starting a MAFR user agent for IPTV:
  - When access to a portal is instructed by a portal selection method.
  - When displaying simulated data broadcasts using the data broadcasting button of a remote controller (e.g., *d button in some regions*) during linear TV reception.
  - When displaying a portal page specified at start-up to return to upon termination of VoD that is started from the portal.
  - When displaying a registration verification document for a portal of the corresponding service provider.
  - When displaying a purchase processing document in PurchaseInformation/Purchase/ PricingServerURL through the purchase operation by a user in the package purchase screen of ECG.

– Terminating a MAFR user agent for IPTV:
  - When linear TV channel selection is performed, or when the network is switched.
  - When selecting an IP broadcast specified by executing epgTune() function in a portal document.
  - When an AV player is started by executing launchIPTVContent() function in a portal document.

- When a resident application such as the initial setting, EPC, ECG and the portal selection screen is started by user operation.
- When restarting ECG by executing startResidentApp() function in the portal document for purchase processing that is started from ECG with pricingServerURL.

II.16 Remote controller

It is desirable that the main functions of terminals can be controlled by remote controller operations. For convenience of users, it is desirable to standardize buttons to match regional specifications.

Appendix III

Examples for the lossless high quality audio service

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

III.1 Examples for the lossless high quality audio service

There are following two audio service types specified for the 8K/4K UHDTV broadcasting:

– General and multi-channel surround audio service (up to 22.2 channels)

– Lossless high quality audio service (up to 5.1 channels)

As for the lossless high quality audio service, MPEG-4 audio lossless coding (ALS) has approved to be used in Japanese broadcasting services [b-ARIB STD-B32]. As for the general and multi-channel surround audio service, MPEG-2 AAC and MPEG-4 AAC are used. Detailed examples for those services are shown in clauses III.1.1 and III.1.2. For further details, see [b-ARIB STD-B32].

III.1.1 Examples for 8K/4K UHDTV service (34.5 MHz BAND - BS, 110 East Longitude CS)

Figure III.1 shows an example configuration enables two 4K+ lossless streams and one HD+5.1 MPEG-4 AAC stream. Detailed configuration parameters are shown in Tables III.1, III.2 and III.3.

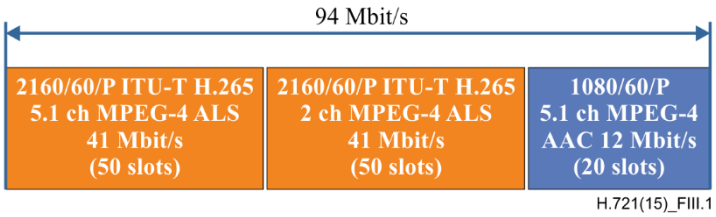


Figure III.1 – Example configuration for two 4K with lossless streams and one HD stream with MPEG-4 AAC

Table III.1 – Example configuration for 4K (60P) + 48kHz/24bit/5.1ch lossless

Data type	Specifications	Bandwidth
Video	Number of active lines: 2 160 Frame frequency: 60 Hz Scanning system: Progressive Codec: ITU-T H.265	30 Mbit/s
Audio	Sampling rate: 48 kHz Bit depth: 24 bit Number of channels: 5.1 channels Codec: MPEG-4 ALS	Average 4.8 Mbit/s (Max. 7.2 Mbit/s)
Other data	Still picture, caption, EPG, et.al.	Average 6.2 Mbit/s (Min. 3.8 Mbit/s)
Transportation	Frame structure: 50 slots Digital modulation method: 16 APSK 7/9	41 Mbit/s

Table III.2 – Example configuration for 4K (60P) + 48kHz/24bit/2ch lossless

Data type	Specifications	Bandwidth
Video	Number of active lines: 2 160 Frame frequency: 60 Hz Scanning system: Progressive Codec: ITU-T H.265	34 Mbit/s
Audio	Sampling rate: 48 kHz Bit depth: 24 bits Number of channels: 2 channels Codec: MPEG-4 ALS	Avg. 1.6 Mbit/s (Max. 2.4 Mbit/s)
Other data	Still picture, caption, EPG, et.al.	Avg. 5.4 Mbit/s (Min. 4.6 Mbit/s)
Transportation	Frame structure: 50 slots Digital modulation method:16 APSK 7/9	41 Mbit/s

Table III.3 – Example configuration for HD (60P) + 48kHz/16bit/5.1ch MPEG-4 AAC

Data type	Specifications	Bandwidth
Video	Number of active lines: 1 080 Frame frequency: 60 Hz Scanning system: Progressive Codec: ITU-T H.265	10 Mbit/s
Audio	Sampling rate: 48 kHz Bit depth: 16 bits Number of channels: 5.1 channels Codec: MPEG-4 AAC	0.3 Mbit/s
Other Data	Still picture, caption, EPG, et.al.	1.7 Mbit/s
Transportation	Frame structure: 20 slots Digital modulation method:8 PSK 3/4	12 Mbit/s

III.1.2 Examples for 4K UHDTV service (27 MHz BAND - 124/128 East Longitude CS)

Figure III.2 shows an example configuration which enables a 4K+48kHz/24bit/5.1 channel or a 2 channel lossless stream. Detailed configuration parameters are shown in Tables III.3 and III.4.

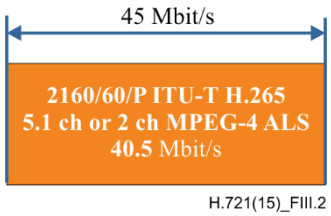


Figure III.2 – Example configuration for a 4K UHDTV with lossless stream

Table III.3 – Example configuration for 4K (60P) + 48kHz/16bit/5.1ch lossless

Data type	Specifications	Bandwidth
Video	Number of active lines: 2 160 Frame frequency: 60 Hz Scanning system: Progressive Codec: ITU-T H.265	32 Mbit/s
Audio	Sampling rate: 48 kHz Bit depth: 16 bit Number of channels: 5.1ch Codec: MPEG-4 ALS	Avg. 3.2 Mbit/s (Max. 4.9 Mbit/s)
Other data	Still picture, caption, EPG, et.al.	Avg. 5.3 Mbit/s (Min. 3.6 Mbit/s)
Total	Digital modulation method: 8 PSK 3/5	40.5 Mbit/s

Table III.4 – Example configuration for 4K (60P) + 48kHz/24bit/2ch lossless

Data type	Specifications	Bandwidth
Video	Number of active lines: 2 160 Frame frequency: 60 Hz Scanning system: Progressive Codec: ITU-T H.265	33.5 Mbit/s
Audio	Sampling rate: 48 kHz Bit depth: 24 bit Number of channels: 2ch Codec: MPEG-4 ALS	Avg. 1.6 Mbit/s (Max. 2.4 Mbit/s)
Other data	Still picture, caption, EPG, et.al.	Avg. 5.4 Mbit/s (Min. 4.6 Mbit/s)
Total	Digital modulation method: 8 PSK 3/5	40.5 Mbit/s

Appendix IV

Examples for the bandwidth of digital broadcasting

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

The delivery of UHDTV images via various delivery formats for the digital broadcasting has begun and is accelerating in the near future utilizing ITU-T H.265 codec. Table IV.1 indicates the formats that are most likely to be used for broadcasting.

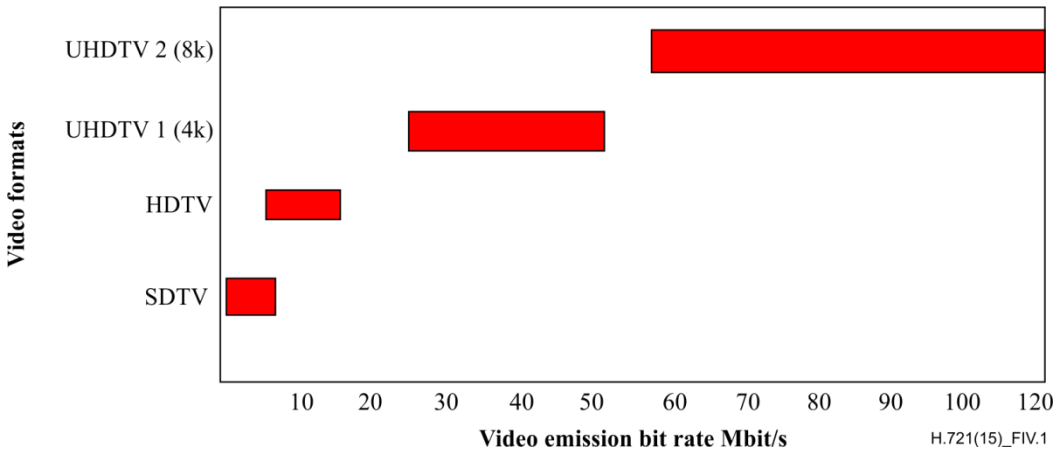
Table IV.1 – Basic parameters for UHDTV and HDTV broadcasting using ITU-T H.265

Video format		Level	Profile	Tier	Bit rate for broadcasting emission required for broadcasting (Mbit/s)
Spatial resolution	Frame frequency (Hz)				
7 680 × 4 320	120 (Note 1), 100	6.2	Main 10	Main	90-120
	60 (Note 1), 50	6.1	Main 10	Main	80-100
3 840 × 2 160	120 (Note 1), 100	5.2	Main 10	Main	35-50
	60 (Note 1), 50	5.1	Main 10	Main	30-40
1 920 × 1 080	60 (Note 1), 50	4.1	Main 10 or Main	Main	10-15
	30 (Note 1), 25 (interlaced)	4.1 (Note 2)	Main 10 or Main	Main	10-15
NOTE 1 – Those divided by 1.001 are also included. NOTE 2 – To allow coding at a sufficient bit rate as needed, level 4.1 (the maximum bit rate is 20 Mbit/s) is preferred to level 4 (the maximum bit rate is 12 Mbit/s).					

These suggested bit rates are for the video only. Audio and other related data require additional bit rate. Table VI.1 does not include other permissible frame rates such as 24, 25 and 30 that are allowed by [b-ITU-R BT.2020-1].

Figure IV.1provides a generalization of expected delivery bit rates that includes all the possible frame rates from 24 Hz to 100 Hz and 120 Hz frame rates.

The above is not optionality information for IPTV services for HDTV and UHDTV but the information only for digital broadcasting.



NOTE 1 – The numbers in this chart should only be used as a guideline.

NOTE 2 – The range of bit rates reflects compression settings of:

- Pixel matrix
- Bit depth
- Sampling strategy
- Permitted frame rate
- Desired quality
- Compression engine, e.g., HEVC, MPEG 2

Figure IV.1 – Video emission bit rate for broadcasting

Appendix V

Candidate technologies for future support in ITU-T H.271 profiles

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

V.1 Linear TV technology candidates

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

Table V.2 shows combinations between multiplexing format and streaming protocol.

Table V.1 – Specifications for linear TV services

Monomedia	–	–
Multiplex format	MMT	[ISO/IEC 23008-1] "Information technology – High efficiency coding and media delivery in heterogeneous environments – Part 1: MPEG media transport (MMT)"
	MP4	[ISO/IEC 14496-14] "Information technology – Coding of audio-visual objects – Part 14: MP4 file format"
Streaming	MMTP*1	[ISO/IEC 23008-1] "Information technology – High efficiency coding and media delivery in heterogeneous environments – Part 1: MPEG media transport (MMT)"
	ROUTE/DASH *2	[b-IEEE TOB V62I1 RD] "ROUTE/DASH IP Streaming-Based System for Delivery of Broadcast, Broadband, and Hybrid Services"
NOTE 1 – MMTP is an abbreviation of "MPEG Media Transport Protocol". NOTE 2 – ROUTE is an abbreviation for "Real-time object delivery over unidirectional transport". ROUTE/DASH [b-IEEE TOB RD V62I1 RD] has been incorporated into the advanced television systems committee (ATSC) 3.0 design.		

Table V.2 – Combinations between multiplexing format and streaming protocol

No.	Multiplex format	Streaming protocol
1	MMT	MMTP
2	MP4	ROUTE/DASH

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