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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

IPTV multimedia services and applications for IPTV –
IPTV terminal devices

IPTV terminal device: Full-fledged model

Recommendation ITU-T H.722

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Recommendation ITU-T H.722

IPTV terminal device: Full-fledged model

Summary

Recommendation ITU-T H.722 describes the services and key features of the full-fledged Internet Protocol TV terminal device (IPTV TD) defined in Recommendation ITU-T H.720. In comparison with the IPTV TD-basic model defined in Recommendation ITU-T H.721, the full-fledged IPTV TD supports not only such basic services as linear TV and video-on-demand (VoD), but also advanced services such as Internet, medical applications, communications, etc. Based on these services and key features, this Recommendation specifies the architecture of the full-fledged IPTV TD, functional components within its architecture, software architecture for implementation reference and physical interfaces.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T H.722	2014-01-13	16	11.1002/1000/12065-en

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FOREWORD

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1   Scope

This Recommendation describes and specifies the functionalities of the IPTV terminal device (IPTV TD) for the IPTV full-fledged services defined in [ITU-T H.720]. This Recommendation is targeted at IPTV TDs that support more than the basic services supported by the IPTV TD-basic model defined in [ITU-T H.721]. The basic services include receiving linear TV services and video-on-demand services, with additional data content (such as text) using a managed content delivery network. The IPTV TD full-fledged model supports advanced services such as Internet services, medical applications, communication services, etc.

The expected types of IPTV terminal devices are set-top boxes and digital TV sets with embedded IPTV capabilities.

2   References

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

[ITU-T H.622.1]	Recommendation ITU-T H.622.1 (2008), *Architecture and functional requirements for home networks supporting IPTV services*.
[ITU-T H.720]	Recommendation ITU-T H.720 (2008), *Overview of IPTV terminal devices and end systems*.
[ITU-T H.721]	Recommendation ITU-T H.721 (2009), *IPTV terminal devices: Basic model*.
[ITU-T H.730]	Recommendation ITU-T H.730 (2012), *Web-based terminal middleware for IPTV services*.
[ITU-T H.741.0]	Recommendation ITU-T H.741.0 (2012), *IPTV application event handling: Overall aspects of audience measurement for IPTV services*.
[ITU-T H.741.1]	Recommendation ITU-T H. 741.1 (2012), *IPTV application event handling: Audience measurement operations for IPTV services*.
[ITU-T H.741.2]	Recommendation ITU-T H. 741.2 (2012), *IPTV application event handling: Data structures of audience measurement for IPTV services*.
[ITU-T H.741.3]	Recommendation ITU-T H. 741.3 (2012), *IPTV application event handling: Audience measurement for IPTV distributed content services*.
[ITU-T H.741.4]	Recommendation ITU-T H. 741.4 (2012), *IPTV application event handling: Transport mechanisms for audience measurement*.
[ITU-T H.750]	Recommendation ITU-T H.750 (2008), *High-level specification of metadata for IPTV services*.
[ITU-T H.760]	Recommendation ITU-T H.760 (2009), *Overview of multimedia application frameworks for IPTV services*.

[ITU-T H.761]	Recommendation ITU-T H.761 (2011), *Nested context language (NCL) and Ginga-NCL.*
[ITU-T H.762]	Recommendation ITU-T H.762 (2011), *Lightweight interactive multimedia environment (LIME) for IPTV services.*
[ITU-T H.763.1]	Recommendation ITU-T H.763.1 (2010), *Cascading style sheets for IPTV services.*
[ITU-T H.764]	Recommendation ITU-T H.764 (2012), *IPTV services enhanced script language.*
[ITU-T H.770]	Recommendation ITU-T H.770 (2009), *Mechanisms for service discovery and selection for IPTV services.*
[ITU-T X.1191]	Recommendation ITU-T X.1191 (2009), *Functional requirements and architecture for IPTV security aspects.*
[ITU-T Y.1901]	Recommendation ITU-T Y.1901 (2009), *Requirements for the support of IPTV services.*
[ITU-R BT.2052]	Recommendation ITU-R BT.2052 (2005), *Protection of end-users privacy in interactive broadcasting systems.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 client personal video recorder (cPVR) [ITU-T Y.1901]: Same as PVR except that the recording device is located at the end-user's premises.

3.1.2 distributed PVR (dPVR) [ITU-T H.720]: Multiple instances of PVR, where a combination of cPVRs and nPVRs can be used to record and store video, audio, and other associated data for subsequent playback. For example, this usually occurs within a home network containing multiple cPVRs in order to distribute storage of video, audio, and other data.

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

NOTE 1 – The end user consumes the product or service. An end user can optionally be a subscriber.

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

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

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

3.1.7 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.

3.1.8 middleware [ITU-T Y.1901]: A layer of software between applications and resources, which consists of a set of service enablers that allow multiple functionalities running on one or more devices in an IPTV system to interact across a network.

3.1.9   network personal video recorder (nPVR) [ITU-T Y.1901]: Same as PVR except that the recording device is located at the service provider premises.

3.1.10   personal video recorder (PVR) [ITU-T Y.1901]: An end-user controlled device that records, stores and plays back multimedia content. PVR is also known as personal digital recorder (PDR).

3.1.11   picture-in-picture (PIP) [ITU-T Y.1901]: One programme is displayed on the full-sized IPTV TD screen, one or more other programmes are simultaneously displayed in inset windows.

3.1.12   push VoD [ITU-T Y.1901]: A TV service where multimedia content is packaged and delivered at the discretion of the service provider to the end user's storage system.

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

3.1.14   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.

3.1.15   time shifting [ITU-T Y.1901]: A function which allows playback of content after its initial transmission.

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

3.1.17   TV with trick mode [ITU-T Y.1901]: TV service with trick mode functionality.

3.2   Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1   full-fledged IPTV terminal device: A full-fledged IPTV terminal device (IPTV TD) has the capabilities to support advanced IPTV services as well as the basic IPTV services.

3.2.2   full-screen display mode: In this mode, the whole display area of the display device is occupied by the output content of the IPTV terminal function (ITF) inside the full-fledged IPTV terminal device. The output content of other non-IPTV applications is not displayed in the display device of the full-screen display mode. The input devices are all operating instructions delivered to the IPTV software application.

3.2.3   supplementary IPTV service: An enhanced IPTV service (e.g., gaming, medical services, video telephony, etc.) which needs more capabilities than provided by the basic service components, including metadata, media management, etc. A supplementary IPTV service may be based on a combination of basic service components, additional service components (e.g., text-to-speech and voice recognition), or even directly OS-based resources.

3.2.4   window display mode: In this mode, the output content of the IPTV terminal function (ITF) inside the full-fledged IPTV terminal device occupies a given display area (which is normally a rectangular area) of the display device. The remaining area is used to display the output content of other non-IPTV software applications based on the operating system (OS).

4   Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

A/V   Audio/Visual

ARQ   Automatic Repeat Query

CPU   Central Processing Unit

cPVR	client Personal Video Recorder
CRL	Copy Right Licence
DASH	Dynamic Adaptive Streaming over HTTP
DVI	Digital Visual Interface
FEC	Forward Error Correction
GUI	Graphic User Interface
HD	High Definition
HDCP	High Definition Content Protection
IM	Instant Messaging
IP	Internet Protocol
IPTV	Internet Protocol Television
IPTV TD	Internet Protocol Television Terminal Device
ITF	IPTV Terminal Function
MAFR	Multimedia Application Framework
NDK	Native Development Kit
NGN	Next Generation Network
nPVR	network Personal Video Recorder
NVRAM	Non-Volatile Random Access Memory
OS	Operating System
OTP	One Time Programming
PAN	Personal Area Network
PIP	Picture-in-Picture
PSTN	Public Switched Telephone Network
PVR	Personal Video Recorder
QoS	Quality of Service
RACF	Resource and Admission Control Function
RAL	Resource Abstraction Layer
RAM	Random Access Memory
RGB	Red Green Blue
RSS	Really Simple Syndication
RTPCP	RTP Control Protocol
RTP	Real-Time Protocol
SCAP	Service, Content and Application Protection
SCP	Service and Content Protection
SD	Standard Definition
SDK	Software Development Kit
STB	Set-Top Box

TD	Terminal Device
TD-PD	Terminal Device Peripheral Device
UI	User Interface
VGA	Video Graphic Array
VoD	Video-on-Demand
VoIP	Voice over Internet Protocol

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 specification 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 the specification.

6   Overview

This Recommendation describes and specifies the functionalities of the IPTV terminal devices for the IPTV full-fledged services defined in [ITU-T H.720]. This Recommendation is targeted at IPTV terminal devices not only supporting basic services supported by basic model IPTV terminal devices defined in [ITU-T H.721], which include receiving linear TV service and video-on-demand services, with additional data content (such as text) using a managed content delivery network, but also supporting advanced services such as Internet services, medical services, communication services, etc.

This Recommendation provides a high-level description of functionalities and software architecture for common communication, configuration of a receiving environment for a service provider, service navigation, acquisition of linear TV service, acquisition of VoD service, acquisition of supplementary IPTV service, functionalities, software architecture and a physical interface which constitute the IPTV full-fledged model terminal device (hereafter referred to as full-fledged IPTV TD).

7 Services and key features of a full-fledged IPTV TD

7.1 Services of a full-fledged IPTV TD

A full-fledged IPTV TD is required to support all the services available to the IPTV TD-basic model. It is further recommended that the full-fledged IPTV TD provide advanced capabilities, features and interfaces with respect to the IPTV TD-basic model defined in [ITU-T H.721], in order to support all the IPTV service use cases defined in [b-ITU-T Y-Sup.5]. A full-fledged IPTV TD will not be limited to the services provided by the IPTV TD-basic model, but will support the following additional services referred to in clauses 7.1.1 to 7.1.10.

7.1.1 Broadcast services

7.1.1.1 Linear TV with trick mode

To support linear TV with trick mode, it is recommended that a full-fledged IPTV TD provide the following capabilities:

– provision of the interface for users to access the contents without time limitation, including pause, rewind, fast forward, etc.;

– provision of the interface for users to enable or disable the service of linear TV with trick mode;

– provision of the interface to set the expiration time;

– provision of format and streaming methods defined in clause 7.1.1 of [ITU-T H.721]. It is also recommended that a full-fledged IPTV TD support HTTP-based streaming, such as dynamic adaptive streaming over HTTP (DASH) [b-ISO/IEC 23009-1].

7.1.1.2 Personal broadcast service

The personal broadcast service provides the end user with a way to advertise personal content (possibly including scheduling information) so that other end users can access such content. This service makes the IPTV end user a content provider.

To support this service, a full-fledged IPTV TD plays a role as content source or for delivery functions. The following capabilities can optionally be provided by a full-fledged IPTV TD:

– provision of A/V capturing/encoding for the end user to generate broadcasted content;

– provision of protocols for transmission of content, such as RTP/RTCP [b-IETF RFC 3550], and/or DASH [b-ISO/IEC 23009-1];

– provision of security aspects associated with broadcasting of customer-generated content.

7.1.1.3 Hybrid: online and off-air TV delivery

An alternative approach for the delivery of linear TV is to enable the end users' IPTV TD to receive the broadcast signal from the broadcaster, e.g., via traditional distribution techniques such as digital satellite TV or terrestrial digital TV.

To support this service, it is recommended that a full-fledged IPTV TD provide the following capability:

– provision for receiving the broadcast signal.

7.1.1.4 Linear TV with multi-view service

Linear TV with multi-view is a service that consists of providing scenes with different camera angles. End users can select one angle from which they would like to watch. For example, when an end user watches a linear broadcast of a baseball game, he/she can choose to see the first base, third base, backfield, etc., and not be restricted to the channel director's preferences.

The linear TV multi-view service might be carried in multiple streams, without being pre-combined into one stream by the broadcasters or the content providers. The end user may therefore watch different scenes from different camera angles at the same time. It is recommended that a full-fledged IPTV TD provide the following capabilities:

– provision of protocols for multiple streaming of linear TV;

– provision of multi-stream decoding.

7.1.2 On-demand services

Content that has been prepared and delivered by the content provider for retrieval is received and stored by the service provider. If necessary, transcoding functions can be performed to accommodate the storage device characteristics. The end user can then select and retrieve such content from storage at any time, according to the constraints provided by the content protection metadata.

For A/V-related on-demand services, it is recommended that a full-fledged IPTV TD support the formats and streaming methods defined in clause 7.1.2 of [ITU-T H.721]. It is also recommended that a full-fledged IPTV TD support HTTP-based streaming, such as DASH [b-ISO/IEC 23009-1].

7.1.2.1 Reserved delivery service

The reserved delivery service can be used in several cases:

– in VoD when video delivery cannot be carried out immediately following the end user request but will be triggered at a later stage by a wake-up mechanism;

– when an end user has subscribed to a reserved-video delivery service based on certain criteria (e.g., the end user has subscribed for the delivery of new movies from a specific director or with a specific actor, etc.);

– when the service provider offers a network personal video recorder (nPVR) functionality. After an end user record request, the nPVR waits for the event to be recorded. When the content is available in the nPVR, the content can be delivered in some cases to the end user's equipment without waiting for the end user request;

– when the service provider, on the basis of known user preferences, decides to download content that is likely to be requested by the end user to a TD having recording features, in order to avoid later network congestion;

– when the service provider decides to download commercials for insertion at content replay time.

To support the reserved-content delivery service, it is recommended that a full-fledged IPTV TD provide the following capabilities:

– provision of remote wake-up/notification mechanisms for content delivery;

– provision of background content downloading/recording mechanisms;

– provision of local or external storage.

7.1.2.2 On-demand with multi-view service

The on-demand with multi-view service provides various camera angles in addition to the one station view provided by the video-on-demand service. End users may select a camera angle from which they would like to watch. For example, when the end user watches a baseball game, he/she can choose to see the first base, third base, backfield, etc., and not only what is predefined by the channel.

In this service, multiple VoD streams might be delivered to the IPTV TD while the on-demand video is playing via unicast protocols, as described in clause 7.1.1.4 for the linear TV with a multi-view service. It is recommended that a full-fledged IPTV TD provide the following capabilities:

– provision of protocols for multi-streams of VoD;

– provision of multi-stream decoding.

7.1.3 Advertising service

The traditional advertising service consists of broadcasting commercial advertising or public promotion of goods, services and companies. End users located in a certain region receive the same advertisements, which are usually inserted in A/V programmes.

It is recommended that a full-fledged IPTV TD support the following additional advertising services.

7.1.3.1 Targeted advertising

Targeted advertising can be defined as automatically matching and delivering relevant content to end users according to certain campaign objectives, the end user can only watch the advertisement without interaction. Targeted advertising usually takes advantage of the end user's profile including user preferences, residence, usage history, personal characteristics (e.g., accessibility) and usage environments (e.g., TDs, networks and natural environmental characteristics, etc.). The details concerning the end user's profile should be consulted in [ITU-T H.750].

7.1.3.2 On-demand advertising

On-demand advertising delivers business directory information so that the end user can select and navigate through additional information or get additional services and benefits such as a coupon. The end user may press a button (or click on an icon) on the IPTV TD's remote in order to initiate a free A/V call to discuss or purchase a certain product. This type of advertisement is also called an interactive advertisement.

To support this service, it is recommended that a full-fledged IPTV TD support the following capabilities:

– provision of end user's preference setting, such as category, location, brand, etc.;

– provision of periodic advertisement delivering service once it has been requested by the end user;

– provision of PVR capability supported for selected advertisement;

– provision of telephony and video communication service.

7.1.4 Interactive services

Interactive services enable end users to send various types of requests and receive feedback with interactivity. According to different security requirements on user privacy, such as home address, credit card information, personal health condition and so on, interactive services may be classified into two types:

1. Of no security concern. Interactive services for information collecting without user information, like reading newspapers, resident games, etc.

2. Security required. Interactive services that require personal user's information for the service capability, like online shopping, e-health, online games, etc. The details concerning the end user's profile may be consulted in [ITU-T H.750].

Because of the service complexity, the services listed hereafter cover both services with no security concern and aspects in certain service types that have security requirements. Instructions will be given in the service description.

7.1.4.1 Commercial service

The commercial service enables the end user to purchase goods and use financial services, such as banking, stocks, shopping, ticketing, auctions, etc. For example, a personal banking service enables

the end user to view account balances, review past account activity, pay bills and transfer money between accounts via the IPTV TD.

Since the commercial service is finance-related, it is recommended that a full-fledged IPTV TD provide high security with the following capabilities:

– provision for protection of end user's privacy;

– provision for protection of end user's financial information, such as bank account, credit card, debit card, etc.;

– support of security software plug-in and multiple cryptographic algorithms;

– support of hardware-related protection such as one-time programming (OTP);

– provision for protection of end user's personal information.

NOTE – If the commercial service provides browsing of general financial information on the stock market, currency exchange rate, etc., there is no security concern.

7.1.4.2 Entertainment service

The entertainment service is designed to provide content such as games, karaoke, lottery, blogs and photo albums for the end user's amusement. Games can be subdivided into single player and multi-player games, depending on the number of players. Moreover, games can be classified into network games and non-network games, depending on the level of interaction. In the case of a photo album, the end users can view pictures they uploaded or transfer them to other people's IPTV TDs, mobile phones, etc.

To support these services, it is recommended that a full-fledged IPTV TD support the following capabilities:

– provision of input interfaces for joysticks, microphone, etc.;

– provision of output interfaces for A/V enhancement devices such as an amplifier;

– provision of A/V capturing.

NOTE – If the entertainment service is only a non-network game, landscape photos, etc., and there is no personal user information such as details concerning the user's account, password and personal photos, etc., there is no security concern.

7.1.4.3 Learning service

The learning service is instructional services for delivering educational content, e.g., languages, financial skills, etc., to students who are physically located in different geographic areas. Teachers and students can communicate in real time (i.e., both present at the same time) and/or non-real time (i.e., at a time of their own decision using a messaging capability) through video, audio, pictures and text, etc.

To support these services, it is recommended that a full-fledged IPTV TD support the following capabilities:

– provision of interfaces for input devices, such as keyboard, mouse, etc.;

– provision of A/V capturing/encoding;

– provision of protocols for transmission of A/V, such as RTP/RTCP [b-IETF RFC 3550] and/or DASH [b-ISO/IEC 23009-1];

– provision of protocols for multi-stream of linear TV with trick mode;

– provision of multi-stream decoding;

– provision of content protection for copyright.

NOTE – If no personal information and educational content copyright are concerned, there is no security concern.

7.1.4.4 Medical service

The medical service provides connection between doctors and patients who are in different geographic areas. Doctors can perform health monitoring, remote diagnosis, remote consultation, remote medical examination, remote medical education, etc.

Since the medical service is in relation with the end users' private information, it is recommended that a full-fledged IPTV TD provide high-level security with the following capabilities:

– provision of A/V capturing/encoding for remote video diagnosis;

– provision of peripheral devices for medical diagnosis, like electronic blood pressure meter;

– provision of convenient peripheral devices for message input, such as keyboard, mouse, etc.

NOTE – If the medical service is restricted to giving only medical instruction and does not enter into the user's personal health status, there is no security concern.

7.1.5 Communication service

Communication is the process of transferring information from one source to another. The communication service enables the end user to exchange information such as voice, video and data with other end users. It is a key example of the converged services of telecommunication and broadcasting that compound phone services (VoIP, videophone, multiple videoconference, etc.) and Internet-based communication services (instant messaging (IM), short messaging service, e-mail, the web, etc.) with television services.

Communication services which require high capabilities of a full-fledged IPTV TD, e.g., video conferencing, may not be supported sufficiently by other kinds of IPTV TDs such as an STB or the mobile phone.

7.1.5.1 Messaging service

The messaging service is one of the communication services that offers telecommunication between individual users. The messaging service may be immediate (e.g., IM) or of a store-and-forward type (e.g., e-mail and voicemail).

To support the messaging service, it is recommended that the following capabilities be provided by a full-fledged IPTV TD:

– provision of convenient peripheral devices for message input, such as keyboard, mouse, etc.;

– provision of audio capture/encoding for voicemail;

– provision of speech recognition to simplify text input.

7.1.5.2 Telephony service

The telephony service is a general telephone call service using IPTV TD. One example is VoIP which uses the Internet to transmit digitized voice data packets. With this service, the end user may select another end user from the address book listed by the IPTV TD or dial a direct phone number with the remote controller to create an IP-based communication session to transmit and receive sound only (most commonly the human voice), without knowing if the called party is via PSTN, mobile or the IP network.

To support the telephony service, it is recommended that a full-fledged IPTV TD provide the following capabilities:

– provision of TD-PD interface to support a peripheral device to transfer the sound information through a non-IP-based connection;

– provision of audio digitalization for IP-based transmission.

7.1.5.3 Video communication service

The video communication service provides bidirectional symmetric real-time transfer of motion video and voice. These services may include video telephony (a kind of telephony with the video stream data), the multi-party conference call (a telephone call in which more than two users take part) and the videoconference (a service providing real-time transmission of motion video, text and voice between end users in two or more locations).

To support the video communication service, it is recommended that a full-fledged IPTV TD provide the following capabilities:

– provision of convenient peripheral devices for message input, such as keyboard, mouse, etc.;

– provision of A/V capturing/encoding;

– audio-video synchronization with best effort delivery;

– provision of multi-channel decoding for video conferencing.

7.1.6 Personal video recorder (PVR) service

It is recommended that the IPTV TD be capable of supporting the PVR service so that end users can retrieve a recording and play it back later. PVR services may include the following capabilities:

– scheduling recordings;

– displaying a list of stored programmes/content and a list of upcoming recordings;

– ranking recordings according to priority;

– playing back/erasing stored programmes/content;

– copying stored programmes/content to removable or external local storage devices.

Such services are required to ensure that copyright enforcement mechanisms are preserved. Relevant security issues may be consulted in [ITU-T H.622.1] and [ITU-T X.1191].

An advanced PVR will be able to support the personal channel service at the PVR. In such a service, the PVR generates the end user's own preview schedule customized according to his/her preferences or lifestyle.

7.1.6.1 Client PVR (cPVR)

In the case of cPVR, the IPTV TD contains (or is directly connected to) some sort of storage buffer or memory, such as a hard disk drive, removable media, or solid state memory (e.g., flash, RAM, etc.). The end user can interact with the graphic user interface (GUI) in order to schedule, modify, playback and erase local recordings.

To support the cPVR service, it is recommended that the following capabilities be supported by a full-fledged IPTV TD:

– provision of programmes/content recorded to removable or external local storage devices;

– provision to play back stored programmes/content with trick mode functionality and programme/content erasing;

– provision of copyright enforcement mechanisms.

7.1.6.2 Network PVR (nPVR)

There might be some cases in which it is not appropriate to save the content locally. For example, if the IPTV TD has a hard drive of limited size, the nPVR is more appropriate.

The end user will not be able to recognize any difference between using cPVR or nPVR. The PVR service should function identically, the only difference being the location of the storage device.

To support the nPVR service, it is recommended that the following capabilities be supported by a full-fledged IPTV TD:

–   provision of local storage occupation reports to the nPVR server;

–   that preference be given to the storage file format of the end user side as a file of directly captured raw data are transmitted as data;

–   automatic retrieval of the network-recorded video once the local storage space is free, with user permission.

7.1.6.3   Distributed PVR (dPVR)

In the case of the distributed PVR, all content is stored within the home network on multiple cPVR services or within a combination of multiple nPVR and cPVR services, with interaction for scheduling, modifying, playback, erasing and recording.

To support the dPVR service, it is recommended that the following capabilities be supported by IPTV TD:

–   that preference be given to the storage file format of the end user side as a file of directly captured raw data are transmitted as data;

–   that preference be given to the network access methods in the case of the dPVR, refer to [ITU-T H.770].

7.1.7   Audience measurement information

Audience measurement information is used for the end user's convenience when watching IPTV content. For example, advertisement services can refer to this information to provide appropriate advertising. The information consists of the channel numbers before and after a channel change, time of the change and user information (e.g., a unique identifier). With the end user's permission, information can be collected by the IPTV TD and the IPTV network can be used to upload the collected information to the relevant server-side applications.

Refer to [ITU-T X.1191] and [ITU-R BT.2052] for discussions of privacy issues relating to audience measurement information.

Refer to the [ITU-T H.741.X]-series for the overview and specifications for audience measurement.

7.1.8   Internet service

The Internet service is a service in which the end user can access the Internet with a web-browsing agent installed in the IPTV TD. The web-browsing agent may include e-mail, web browser, instant messaging, really simple syndication (RSS) news, etc.

To support the Internet service, it is recommended that a full-fledged IPTV TD provide the following capabilities:

–   provision of convenient peripheral devices for message input, such as keyboard, mouse, etc.;

–   provision of Internet software and applications such as IM, mail client, etc.

7.1.9   Application store service

The application store service is an online digital application distribution service that allows end users to browse and download applications onto the terminal device. Depending on the application, they are available either for free or at a cost. The applications, which may be IPTV widgets implemented with [b-ITU-T H.IPTV-Widget], can be downloaded directly to a target device, or downloaded onto a personal computer. The application may be provided by a service provider or third-party developers with the software development kit/native development kit (SDK/NDK) supported by the TD, according to its application framework, see clause 7.2.1.

To support the application store service, it is recommended that the following capabilities be supported by a full-fledged IPTV TD:

– provision of SDK/NDK for application development, see clause 7.2.1;

– provision of application download, installation, execution and uninstallation.

7.1.10 Multi-device interactive service

The multi-device interactive service provides the user with a different IPTV service-consuming experience over one or more other TDs. Typically, the multi-device interactive service may include content sharing, content transferring, coupled content playing, etc. Moreover, some devices may control media playing on the other device, or transfer inputted text to the other device. In a multi-device environment, the roles defined for the device determine which capability the device should support.

To support the multi-device service, it is recommended that the following capabilities be supported by a full-fledged IPTV TD:

– provision of the ability to send announcements to all connected terminal devices for claiming its functional roles;

– provision of devices discovery and inter-connection set-up;

– interworking with different types of TDs, e.g., performing services defined in [b-H.IPTV-TDES.5].

7.2 Features of full-fledged IPTV TD

7.2.1 Application framework

The application framework is the functionality to support the end user in installing, un-installing, running and closing the applications sanctioned (signed) by the service providers. For a possible implementation of the application framework, refer to [ITU-T H.730].

Value-added IPTV services can be provided by supporting various supplementary IPTV services from third-party application providers or a full-fledged IPTV TD. Through SDK/NDK based on an application framework, a full-fledged IPTV TD enables IPTV users to use an application store service with various supplementary IPTV services effectively. It is recommended that the device support the following features:

– supplementary IPTV service using, e.g., [b-ITU-T H.IPTV-Widget], etc.;

– application installation, un-installation, running and stop;

– application life-cycle management;

– web-based applications using [ITU-T H.761], [ITU-T H.762], [ITU-T H.763.1] and [ITU-T H.764].

7.2.2 Audience measurement

The audience measurement of the IPTV TD is used to collect information while the end user's TV-watching behaviour is monitored with user permission. The IPTV network can be used to upload the collected information to the relevant server-side applications. A detailed description on audience measurement is found in the [ITU-T H.741]-series.

It is recommended that a full-fledged IPTV TD support an audience measurement function (end-user measurement function) to acquire the following audience measurement information:

– end-user permission information;

– the configuration information of the measurement object configuration function;

– the delivery mechanism information;

–   end-user measurement function update information.

It is recommended that a full-fledged IPTV TD support an audience measurement function (end-user measurement function) to acquire the following metadata information:

–   in the linear TV service, audience measurement information consisting of the channel numbers before and after a channel change, time of the change, and user information (e.g., a unique Identifier);

–   in the push VoD service, audience measurement information which may consist of the content identifier, start time, end time, times of replay, etc.;

–   in the PVR service, audience measurement information which may consist of the content identifier, start time, end time, times of replay, etc.

In the personal broadcast service, audience measurement information consists of the content identifier, start time, end time, etc.

7.2.3   Codec and display

7.2.3.1   Codec

The codecs functional entity is responsible for:

–   decoding the compressed video and audio streams;

–   decoding the multiple video and audio streams, e.g., for linear TV and on-demand with multiple-view service or PIP mode;

–   decoding textual data, e.g., closed caption;

–   decoding other multimedia content, e.g., graphics;

–   encoding textual data, audio/video streams, and other multimedia content.

It is recommended that full-fledged IPTV TD have capabilities to encode and process IPTV multimedia contents using high-capacity storage, high-performance processor, and easy-to-use peripheral devices. For example, IPTV contents may be encoded by a personal computer to provide a personal IPTV broadcast service, one of the advanced IPTV services or to be made suitable for other IPTV TDs such as the mobile phone. However, encoding and distribution of IPTV contents are required to follow a contents protection policy.

7.2.3.2   Picture-in-picture (PIP) display

A full-fledged IPTV TD supports not only common video display but also picture-in-picture (PIP) display. In PIP mode, the display screen, which is composed of two or more screens windows, provides the capability to display different media content in separate screens:

–   a full-screen display mode is recommended for the main screen; and a window display mode is recommended for the secondary screen(s);

–   it is recommended that the main screen and secondary screen be able to present two different output contents of ITF inside a full-fledged IPTV TD and to switch between each other. It is recommended that the secondary screen(s) be able to be shifted, resized and switched off by the end user within the main screen display area;

–   it is recommended that the main screen support HD/SD video decoding and audio decoding. It is recommended that the secondary screen support SD video decoding.

7.2.4   Local storage

It is recommended that a full-fledged IPTV TD support local storage. The end user may view the multimedia content downloaded from the network, such as a movie, cPVR, dPVR, music, picture, applications, etc. For A/V content, it is also recommended that a full-fledged IPTV TD support the trick mode such as pause, fast forward, fast rewind, etc.

7.2.5 Accessories

To support interactive services, it is recommended that a full-fledged IPTV TD support peripheral devices to transfer the sound information through a non-IP-based connection.

7.2.6 Network attachment and service discovery

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

Via the provisioning operation including network attachment, the IPTV TD automatically obtains the initial information for consumption. When the process is finished, end users can have 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.

The detailed information on "terminal device attachment and initialization", "service provider description entry points" and "service provider discovery and service attachment" is the same as in clause 7.2.1 in [ITU-T H.721] on network attachment and service discovery.

7.2.7 Security

A full-fledged IPTV TD is required to support the "service security items" and "content protection items", which are fully described in clause 7.2.2 in [ITU-T H.721] on security, after establishing the network layer connections to receive IPTV services.

7.2.8 Privacy

To take into account the cases where the ownership of IPTV TD is transferred to a different end user or is discarded, the 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 and local storage.

Moreover, a full-fledged 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 cannot be mistakenly operated and unintentionally activated (e.g., by a limitation for remote operation by the end user).

7.2.9 Quality of service (QoS)

It is recommended that a full-fledged IPTV TD support not only the QoS guarantee as described in clause 7.2.4 in [ITU-T H.721] but also support automatic repeat query (ARQ) and forward error correction (FEC) with an appropriate consideration of the quality of the communication network, to ensure a sustainable and stable delivery of streamed content.

7.2.10 SDK/NDK

Public SDK and/or NDK for applications, which may refer to [ITU-T H.730], are provided by a full-fledged IPTV TD so that third-party developers can develop applications.

7.2.11 Multi-device interactive function

It is recommended that a full-fledged IPTV TD be powerful enough to act as a media centric device. It will play the full functional role when it supports multi-device interactive services. The following functions are recommended:

– media server: provides the media server and service aggregation capability. For example, this TD may provide the function of media detection, media management, media streaming (push or pull), and media synchronization, etc. It may also provide the function of device management, content protection, security, and user interface (UI) for remote access;

- media player: provides the capability of media playing for other displayers;
- media renderer: provides the capability of media rendering for other displayers;
- media controller: provides the capability of media control and UI for the control panel.

8 Full-fledged IPTV TD functional architecture

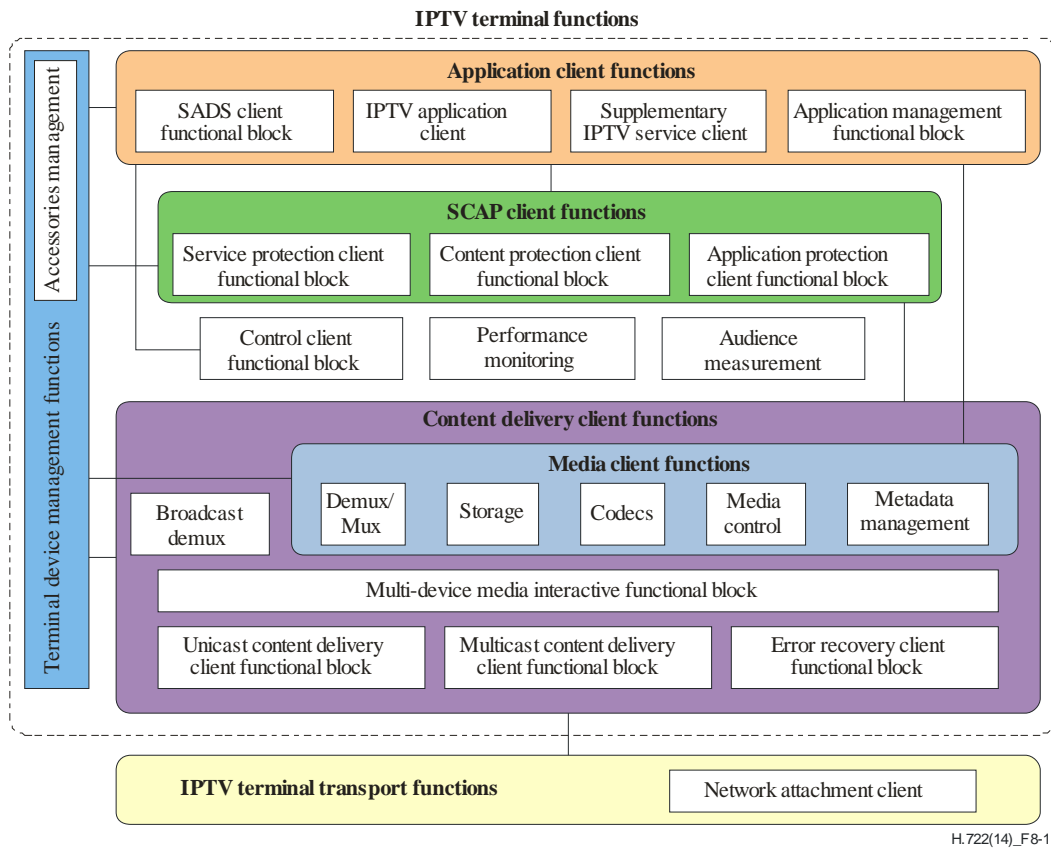The full-fledged IPTV TD functional architecture is shown in Figure 8-1.

Figure 8-1 – Full-fledged IPTV TD functional architecture

9 Functional components of IPTV full-fledged terminal device

9.1 Terminal transport functions

The terminal transport functions are logical blocks that take in data such as video and audio data transmitted via IP packets. The communication interface, communication process, network attachment processing and service discovery procedure of a full-fledged IPTV TD are the same as the functions which are already defined in clause 9.1 "Terminal transport functions" of [ITU-T H.721].

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.

The broadcast demux, multicast content delivery client, unicast content delivery client and error recovery functional blocks of a full-fledged IPTV TD are the same as the functions which are already defined in clause 9.2 "Content delivery client functions" of [ITU-T H.721]. However, when acting as a media-centric device, it is recommended that the full-fledged IPTV TD include a multi-device media interactive function.

9.2.1 Multi-device media interactive functional block

The multi-device media interactive functional block provides the media server and service aggregation capability such as media detection, management, rendering, streaming (push or pull), and synchronization and control functions. A full-fledged IPTV TD may act like a streamer but with more strict connection authentication and less connections.

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 them to the output interface. The media control, demux/mux, codec, storage and metadata management functional blocks of full-fledged IPTV TD are the same as the functions which are already defined in clause 9.3 "Media client functions" of [ITU-T H.721].

9.4 Service, content and application protection (SCAP) client functions

The SCAP client functional entity is an entity that receives and manages rights and keys and that provides content keys and descrambling keys for content consumption.

The service protection client and content protection client functions of a full-fledged IPTV TD are the same as the functions which are already defined in clause 9.4 of [ITU-T H.721] on SCP client functions. In order to support application store service, it is recommended that the full-fledged IPTV TD provide application protection.

9.4.1 Application protection client functional block

The application protection client with the newest CRL is required to establish a secure communication channel by mutual authentication with an SCAP server during the application downloading procedure.

The application protection client is required to provide robust and mutual encryption to the application downloaded, e.g., a digital signature. Once the application is installed in an individual IPTV TD, a copy of this application cannot run on another IPTV TD.

9.5 Application client functions

The application client functions of a full-fledged IPTV TD are the same as the functions which are already defined in clause 9.5 of [ITU-T H.721] on application client functions. In order to support the application store service, it is recommended that the supplementary IPTV service client functions be provided.

9.5.1 Supplementary IPTV service client functions

The supplementary IPTV service client functions interact with the application store, which is a supplementary service for a full-fledged IPTV TD, to perform session management, service authorization and presentation of the application metadata. It is recommended that a full-fledged IPTV TD support not only the presentation of the application store but also the downloading, installation, execution and un-installation of the applications which are programmed with the SDK/NDK of the TD.

9.6 Control client functions

In the case of next generation network (NGN) IPTV, the control client functional block can optionally support sessions for resource management with the resource and admission control function (RACF). The requirements of the control client functions are the same as for the functions which are already defined in clause 9.6 of [ITU-T H.721] on control client functions.

9.7 Performance monitory client functions

The performance monitory client functions monitor the status of a full-fledged IPTV TD, such as the occupancy rate of the central processing unit (CPU), RAM and flash, network speed, package loss, jitter, etc.

9.8 Audience measurement client functions

The audience measurement client functions collect information during viewing of the end user's TV-watching behaviour, with the user's permission, and upload the collected information to the relevant server-side applications. For details, refer to the ITU-T H.741.x-series.

9.9 Terminal device management

Remote management is closely related to this functional block. Since a full-fledged IPTV TD supports accessories such as the mobile telephone headset and microphone, it is recommended that the terminal device management support accessory management.

10 Software architecture

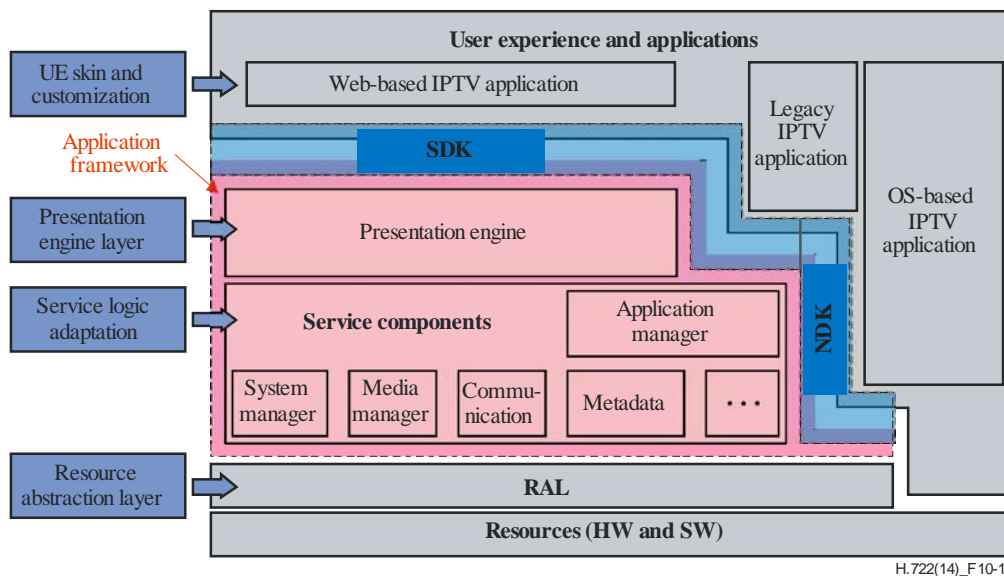The diagram in Figure 10-1 presents the software architecture of a full-fledged IPTV TD.

Figure 10-1 – Full-fledged IPTV TD software architecture

10.1 Resource abstraction layer (RAL)

The IPTV terminal middleware is hardware-agnostic. A specific RAL exists for each specific hardware and operating system – this provides the necessary interface to the lower layers (e.g., RAM, network access, hard drive, etc.). The RAL interface is designed so that device drivers can be written irrespective of the service logic adaptation layer.

In general, some basic functionalities to support the IPTV service logic adaption layer are implemented by hardware in the IPTV TD-basic model, but these functional entities can optionally be implemented by software in a full-fledged IPTV TD. Therefore, a full-fledged IPTV TD has to implement these functionalities through software.

10.1.1 Media decoder

The media decoder of a full-fledged IPTV TD can optionally be implemented through software to support the A/V decoding functionality. It can support all the decoders that are required for IPTV

services and can install, uninstall, or combine any of them if necessary. It may provide the APIs to the media management component for trick mode implementation.

10.1.2 Output display

In a full-fledged IPTV TD, the display graphical device may be implemented by software and a device driver which may be called an "output display component". This component receives the output display signal from the media decoder and may implement multiple-layer control including overlap, blending, position and scaling.

10.1.3 Input device control

Since it is recommended that a full-fledged IPTV TD support multiple input devices, it is recommended that the software input device control component in this layer be implemented to support the IPTV services requirements from the upper layers.

10.2 Service logic adaptation layer

The service logic adaptation layer is made of service components. The service components are pure native components that offer functionalities common to all middleware implementations (e.g., service selection and presentation, service information management, PVR, and security system). They are used and enriched by the application services in order to simplify the development of the service components and applications above it.

The definition and the scope of services depend on the concrete functionalities deployed in the IPTV service system.

Nevertheless, some service components can be defined that are generic in nature:
–   system and resource management component;
–   media management component;
–   communication component;
–   security component;
–   metadata access component;
–   user interaction component.

All these components can optionally use the functions available on the network.

10.3 Presentation engine layer

The presentation engine layer may include various engines along with a set of high-level services. This layer is built on top of the service logic adaptation layer.

10.4 User experience skin and customization

The applications are either downloaded or resident. In particular, an application is powered by a presentation engine, such as multimedia application framework (MAFR). An application can either have full or restricted access to the presentation engine layer features. Moreover, some applications may directly access the service logic adaptation layer without using a presentation engine.

11 Physical interfaces

The physical interfaces of a full-fledged IPTV TD are described in this clause to meet the requirement of services and features listed in clause 7.2. Figure 11-1 illustrates the physical interfaces of the full-fledged IPTV TD.
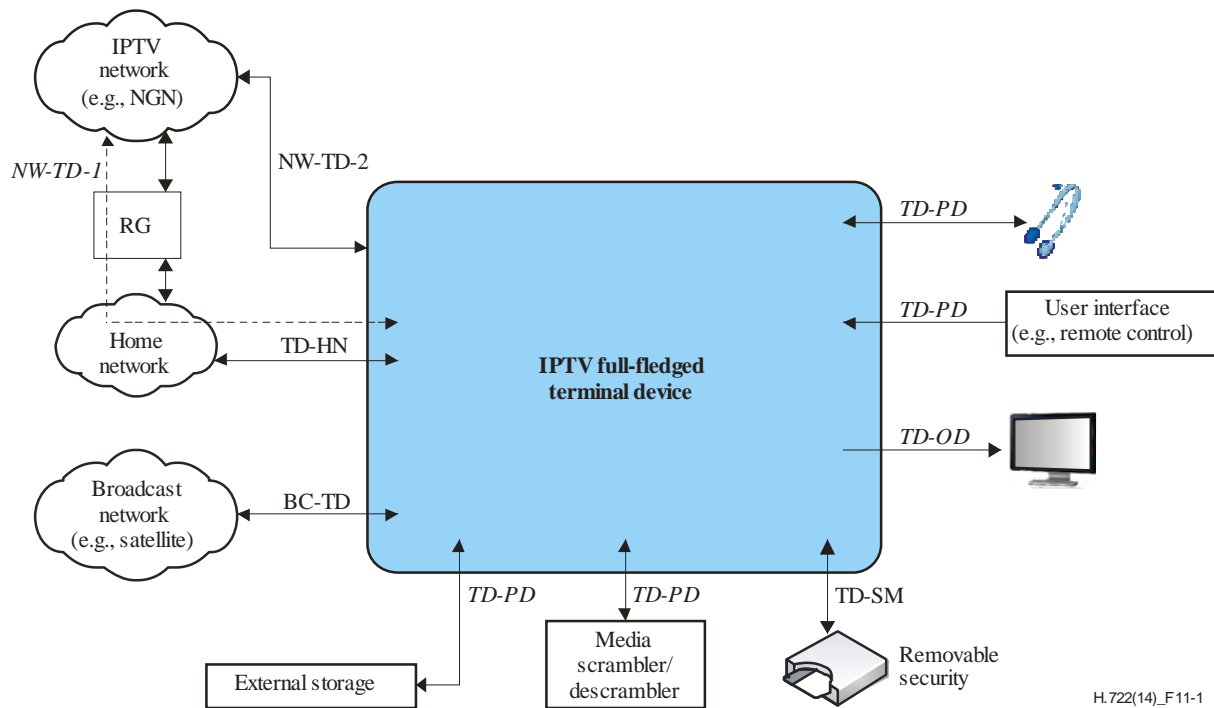
Figure 11-1 – Full-fledged IPTV TD interfaces

11.1 Input interface

The input interface of the full-fledged IPTV TD is to support user interaction. It is recommended that the interfaces support not only peripheral devices such as the keyboard, mouse, etc., via actual physical interfaces, but also via a virtual control software application running in a tablet or smart phone. An example is found in [b-H.IPTV-TDES.5].

11.1.1 Reset button

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

11.1.2 Remote controller

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

11.1.3 Keyboard and mouse

It is recommended that the full-fledged IPTV TD support a keyboard and mouse for convenient text input and control. The details are outside the scope of this Recommendation.

11.1.4 Microphone

It is recommended that the full-fledged IPTV TD support a microphone for voice input. The details are outside the scope of this Recommendation.

11.1.5 Camera

It is recommended that the full-fledged IPTV TD support a camera for video communication and other necessary services. The details are outside the scope of this Recommendation.

11.1.6 Multi-screen interaction devices

It is recommended that the full-fledged IPTV TD support an IP-based connection from other devices like a smart phone or tablet with a virtual control software application for text input or

controller simulation. The details are outside the scope of this Recommendation; examples can be found in [b-H.IPTV-TDES.5].

11.2 Output interface

If the full-fledged IPTV TD has a digital visual interface (DVI) or a high-definition multimedia interface, and when it outputs content with copy control or protection, it is required to provide appropriate protection according to the high-definition content protection (HDCP) specification. The details of copy control and output control are outside the scope of this Recommendation.

11.2.1 RGB analogue interface

The full-fledged IPTV TD can optionally support an RGB analogue interface.

The full-fledged IPTV TD can optionally support a video graphic array (VGA) interface and a digital visual interface (DVI) interface with analogue out.

11.2.2 Digital video interface

The full-fledged IPTV TD can optionally support a DVI interface.

11.2.3 Digital audio interface

The full-fledged IPTV TD can optionally support a digital audio interface.

11.2.4 High-definition multimedia interface

It is recommended that the full-fledged IPTV TD support a high-definition multimedia interface.

11.2.5 Headset output interface

The full-fledged IPTV TD can optionally support a headset audio output interface.

11.3 External data access interface

It is recommended that the full-fledged IPTV TD support removable external storage devices. If the contents in the removable storage require copy control or protection, it is required to provide appropriate protection according to the HDCP specification. The details of copy control and output control are outside the scope of this Recommendation.

11.4 Network access interface

It is recommended that the full-fledged IPTV TD support wired or wireless data connection for IP-based data transmission.

It is recommended that the full-fledged IPTV TD support a personal area network (PAN) interface, refer to [b-ITU-T H.810].

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