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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

IPTV multimedia services and applications for IPTV –
IPTV terminal devices

IPTV terminal device: Mobile model

Recommendation ITU-T H.723

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Recommendation ITU-T H.723

IPTV terminal device: Mobile model

Summary

Recommendation ITU-T H.723 describes the functionalities of the mobile model Internet protocol television (IPTV) terminal device (TD) for IPTV basic services defined in Recommendation ITU-T H.720. This Recommendation describes the required aspects on requirements, capabilities, architecture, and interfaces of mobile model IPTV TD that can consume IPTV services irrespective of changes of the location or technical environment of mobile device. The meaning of mobile model IPTV TD is that the IPTV terminal function (ITF) is implemented on the mobile device such as a smart phone or smart pad, and is connected to the IPTV service provider through wireless or mobile access networks. The quality of IPTV service depends on such parameters as network conditions and terminal capability, etc. The mobile model IPTV TD can access an IPTV service provider via wireless networks or mobile access network in the home as well as out of home environments.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T H.723	2016-07-14	16	11.1002/1000/12909

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IPTV, IPTV terminal device, mobile IPTV, mobile model.

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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 mobile model Internet protocol television (IPTV) terminal device (TD) for IPTV basic services defined in [ITU-T H.720]. This Recommendation describes the required aspects on requirements, capabilities, architecture, and interfaces of mobile model IPTV TD that can consume IPTV services irrespective of changes of the location or technical environment of the mobile device. In mobile model IPTV TD, the IPTV terminal function (ITF) is implemented on mobile devices such as smart phones or tablets, and is connected to the IPTV service provider through wireless or mobile access networks.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this document 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.701]	Recommendation ITU-T H.701 (2009), *Content delivery error recovery for IPTV services*.
[ITU-T H.720]	Recommendation ITU-T H.720 (2008), *Overview of IPTV terminal devices and end systems*.
[ITU-T H.721]	Recommendation ITU-T H.721 (2015), *IPTV terminal devices: Basic model*.
[ITU-T H.722]	Recommendation ITU-T H.722 (2014), *IPTV terminal device: Full-fledged model*.
[ITU-T H.770]	Recommendation ITU-T H.770 (2015), *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 (2008), *Requirements for the support of IPTV services*.
[ITU-T Y.1903]	Recommendation ITU-T Y.1903 (2014), *Functional requirements of mobile IPTV*.
[ITU-T Y.1910]	Recommendation ITU-T Y.1910 (2008), *IPTV functional architecture*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 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.

3.1.2 **generalized mobility** [b-ITU-T Y.2001]: The ability for the user or other mobile entities to communicate and access services irrespective of changes of the location or technical environment. The degree of service availability may depend on several factors including the Access Network capabilities, service level agreements between the user's home network and the visited network (if applicable), etc. Mobility includes the ability of telecommunication with or without service continuity.

3.1.3 **IPTV end system** [ITU-T Y.1901]: A single or set of consumer devices that support IPTV Services (e.g., delivery network gateway, display).

3.1.4 **IPTV terminal device (TD)** [ITU-T Y.1901]: A terminal device which has ITF functionality, e.g., a STB.

3.1.5 **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.

3.1.6 **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.

3.1.7 **mobile IPTV** [ITU-T Y.1903]: An application of IPTV as specified in [ITU-T Y.1901]. It applies to where the IPTV terminal device is connected to the IPTV Service Provider via an IPTV-enabled mobile network. It must be able to communicate and access services irrespective of changes of the location or technical environment.

NOTE – There are multiple possible levels of mobility, from nomadism, where IPTV service is resumed only after the move is complete, to full mobility, where IPTV service is continuous throughout the movement.

3.1.8 **mobile network** [b-ITU-T Q.1762]: A network that provides wireless access to its services and supports mobility.

3.1.9 **nomadism** [b-ITU-T Q.1761]: Ability of the user to change his network access point after moving; when changing the network access point, the user's service session is completely stopped and then started again, i.e., there is no handover possible. It is assumed that the normal usage pattern is that users shutdown their service session before moving to another access point or changing terminal. This is the mobility alluded to in the case of fixed mobile convergence.

3.1.10 **personal mobility** [b-ITU-T Q.1761]: Ability of a user to access telecommunication services at any terminal on the basis of a personal identifier, and the capability of the network to provide those services according to the user's service profile. Note that personal mobility involves the network capability to locate the terminal associated with the user for the purposes of addressing, routing and charging of the user's calls.

3.1.11 **service mobility** [b-ITU-T H.510]: The ability of a user to use the particular (subscribed) service irrespective of the location of the user and the terminal that is used for that purpose.

3.1.12 **sign language interpretation** [ITU-T Y.1901]: A video service showing an interpreter who uses hand gestures and facial expression to convey the main audio content and dialogue to sign language and lip readers.

NOTE – This service comes in the form of supplementary video content, usually smaller in image size to that the main video content. Ideally the user can control the position, size and background properties (solid or

transparent and the colour, if solid). It is of sufficient temporal and spatial quality to enable sign reading and lip reading.

3.1.13 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.

3.1.14 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 network appliance, a mobile device, a TV set, a monitor, a VoIP terminal or an audio-visual media player.

3.1.15 terminal mobility [b-ITU-T Q.1761]: Ability of a terminal to access telecommunication services from different locations and while in motion, and the capability of the network to identify and locate that terminal.

3.1.16 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.).

3.1.17 wireless network characteristics [ITU-T Y.1901]: The characteristics of a wireless network expressed in terms of the current available bandwidth, packet loss and possibly other wireless network information parameters for a specific wireless link type e.g., WLAN, cellular, WPAN or WMAN.

3.2   Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 link characteristics: Characteristics of the communication path such as bandwidth, delay, latency, error rate, etc.

3.2.2 mobile model IPTV TD: An IPTV terminal device which ITF functionality has been equipped in mobile devices such as smart phone, PDA, PMP, Tablet PC, etc.

4   Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

2G	Second Generation mobile networks
3G	Third Generation mobile networks
4G	Fourth Generation mobile networks
AP	Access Point
BER	Bit Error Ratio
CoD	Content on Demand
DASH	Dynamic Adaptive Streaming over HTTP
DNG	Delivery Network Gateway
DSCQS	Double Stimulus Continuous Quality Scale
DTS	Decode Time Stamp
DVI	Digital Visual Interface
EAN	Emergency Alert Notification

FEC	Forward Error Correction
GOP	Group of Pictures
GPS	Global Positioning System
HEVC	High Efficiency Video Coding
IPTV	Internet Protocol Television
ITF	IPTV Terminal Function
LBA	Location Based Advertising
LBS	Location Based Service
LTE	Long Term Evolution
MBMS	Multimedia Broadcast Multicast Service
MBS	Multicast and Broadcast Service
MMT	MPEG Media Transport
PDA	Personal Digital Assistant
PMP	Portable Multimedia Player
QoE	Quality of Experience
QoS	Quality of Service
SADS	Service and Application Discovery and Selection
SCP	Service and Content Protection
SNR	Signal to Noise Ratio
SSCQE	Single Stimulus Continuous Quality Evaluation
SVC	Scalable Video Coding
TD	Terminal Device
TDES	Terminal Device and End System
UICC	Universal Integrated Circuit Card
USIM	Universal Subscriber Identity Module
VLR	Visitor Location Register
VoD	Video on Demand
WiMAX.	Worldwide interoperability for Microwave Access
WLAN	Wireless Local Area Network

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 document is to be claimed.

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

−   The keywords "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.
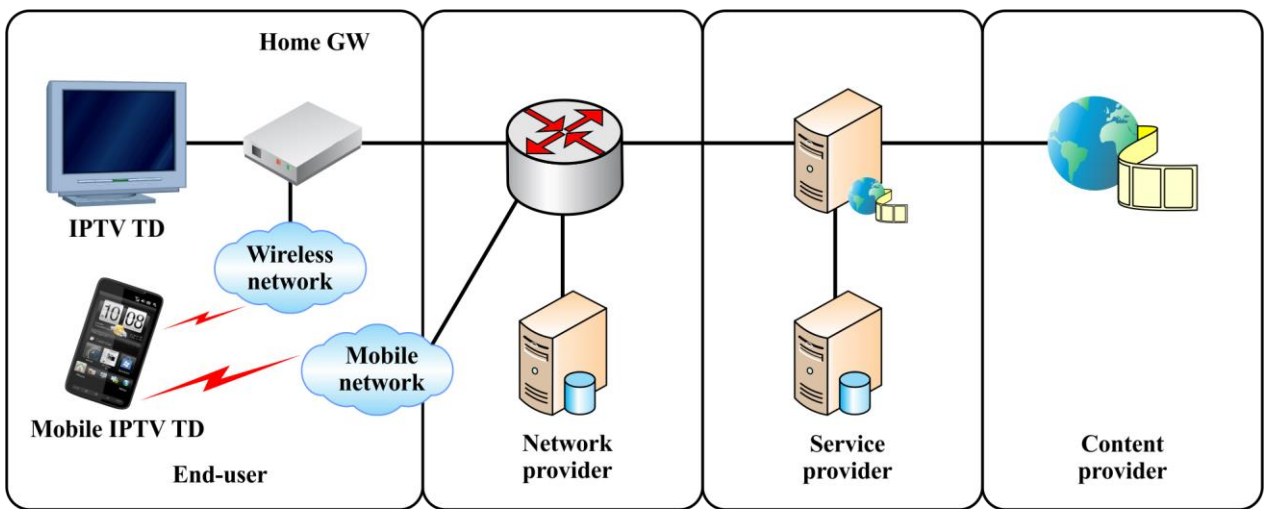
6 Overview

The definition of IPTV is described in [ITU-T Y.1901] as a multimedia services such as television, video, audio, text, graphics, data delivered over IP-based networks managed to support the required level of quality of service/quality of experience (QoS/QoE), security, interactivity and reliability.

[ITU-T Y.1903] describes mobile IPTV as application of IPTV as specified in [ITU-T Y.1901] and applies to where the IPTV terminal device is connected to the IPTV service provider via an IPTV-enabled mobile network. It must be able to communicate and access services irrespective of changes of the location or technical environment of mobile device. There are multiple possible levels of mobility, from nomadism, where IPTV service is resumed only after the move is completed, to full mobility, where IPTV service is continuous throughout the movement of IPTV terminal device. With an IPTV-enabled mobile network, it is intended here that a mobile network connecting mobile IPTV TDs provides resource control capabilities to support the QoS required by the end user of mobile IPTV.

This Recommendation describes the required aspects on requirements, capabilities, architecture, and interfaces of mobile model IPTV TD that can consume IPTV services irrespective of changes of the location or technical environment of a mobile device. An IPTV TD can be connected to a non-"IPTV-enabled mobile network" (i.e., a mobile network where the QoS is not managed). The service quality of mobile model IPTV TD depends on the terminal capability and the feature of content delivery function over wireless or mobile access networks. Essentially, mobile model IPTV TDs are assumed to implement an IPTV terminal function (ITF) in devices such as smartphones, smart pads, etc.; a particular feature of mobile model IPTV TDs is that they support mobility in out-of-home environments. It may be considered that a complete model is implemented on higher performance computing devices such as desktop PCs, set top boxes, and digital TV sets with embedded IPTV capabilities to provide deluxe service capabilities.

Figure 1 shows a basic network configuration of mobile model IPTV TD in accordance with the basic network configuration of mobile IPTV TDs with the IPTV domains as described in [ITU-T Y.1903]. Where the mobile device that has ITF functionality (e.g., mobile model IPTV TD) it can be connected to an IPTV service provider via a range of wireless or mobile access networks. The mobile model IPTV TD can be connected to the home gateway (GW) or access point (AP) devices through various wireless local area network (WLAN) connections. Alternatively, the mobile model IPTV TD can be connected to the IPTV service provider through various mobile network technologies provided by mobile network operators. The mobile model IPTV TD can access the IPTV service provider via wireless or mobile access networks in the home as well as out of home environments.

Figure 2 shows the IPTV architectural overview, described in [ITU-T Y.1910].

Figure 1 – Basic network configuration of mobile model IPTV TD with the IPTV domains
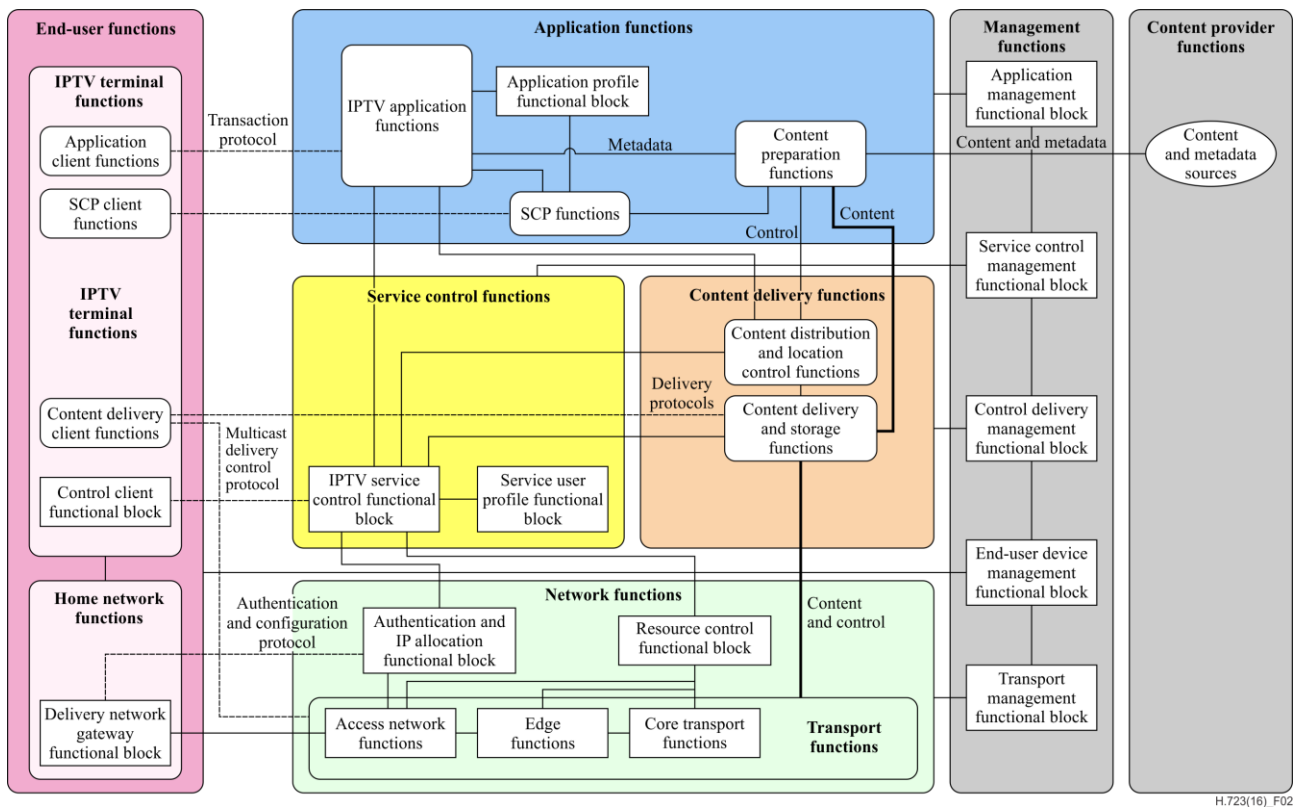
Figure 2 – IPTV architectural overview

For mobile model IPTV TD, IPTV terminal function (ITF) can be directly connected to the Transport Functions of Network Service Provider without Home Network Functions. Figure 3 describes the architectural aspects of mobile model IPTV TD. Here, the ITF is connected to the network functions, which can be a home network function in the home domain or a network function for the out-of-home domain.

This mobile model IPTV TD can be connected to the IPTV service provider through various mobile network technologies such as second generation mobile networks (2G), third generation mobile networks (3G), long term evolution (LTE) and WLAN in the home as well as out-of-home environments.

In a home network environment, the mobile model IPTV TD can be connected to the home GW or AP using wireless access network interface (e.g., WLAN). In other cases, the mobile model IPTV TD can be connected to a mobile network (e.g., 3G, LTE) directly and this TD can obtain IPTV services using the Internet access feature of mobile network. In an out-of-home environment, the mobile model IPTV TD can enjoy IPTV service over the Internet connection over a wireless or mobile access network even if IPTV TD is moving. For the moving IPTV TD, the service quality depends on the capability of mobility support of IPTV TD.

The mobile network should provide the capability to identify and locate the IPTV TD. A mobile model IPTV TD can be any of various types of mobile devices such as a personal digital assistant (PDA), portable multimedia player (PMP), tablet PC, mobile phone or smart phone.
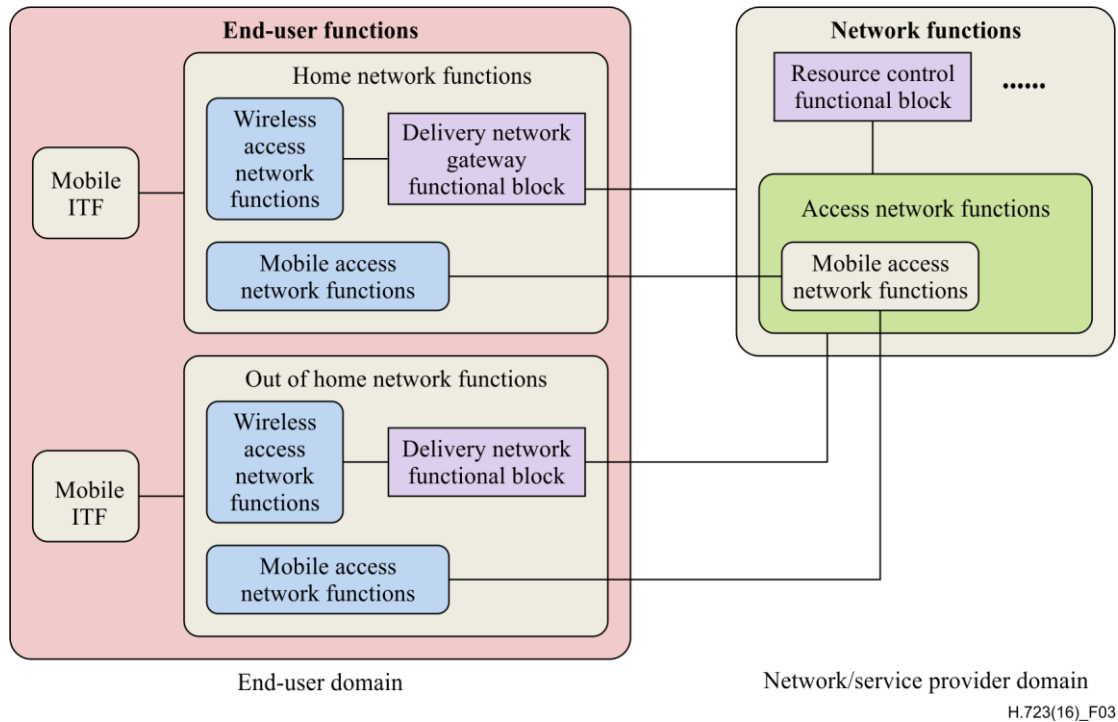
Figure 3 – Architectural aspects of mobile model IPTV TD

7 Services and key features of mobile model IPTV terminal device

The mobile model IPTV TD is required to support basic IPTV services defined in [ITU-T H.720], which are service navigation, linear TV, content on-demand, interactive services, and public interest services (see clause 6.1.1 of [ITU-T H.720]). Most of the basic IPTV services that are supported by the IPTV terminal device's basic model [ITU-T H.721] may be supported by the mobile model IPTV TD. Additionally, enhanced features of basic IPTV services can be provided based on the location information and mobility feature of mobile model IPTV TD. However, due to the lack of service capability of mobile or wireless networks and resource limitations of mobile devices, QoS of mobile model IPTV TD can be degraded compared to the basic model IPTV TD [ITU-T H.721].

7.1 Services for the IPTV TD mobile model

7.1.1 Linear TV

Linear TV is a broadcast TV service that is the same as the classic form of television services that are provided by terrestrial, cable, and direct-to-the-home satellite broadcasting operators, where the programme content is transmitted according to a defined schedule and is intended for real-time consumption by the end-user.

Broadcast and multicast mechanisms are typically used for efficient contents delivery for providing linear IPTV service. It is especially helpful to support mobile IPTV TD if the mobile network supports broadcast/multicast mechanisms directly. However, there may be some limitations to provide broadcast/multicast mechanisms from specific mobile network technologies.

Due to the resource limitations of mobile model IPTV TD in general, the quality of video and audio for linear TV service can have a different level of requirements from the quality of fixed IPTV TD. Appropriate media format to support mobile model PTV TD can be selected by the IPTV service provider or user.

Table 1 of [ITU-T H.721] includes specifications used for formats and streaming methods used in linear TV services, and they can be applied to the mobile model IPTV TD. However, the specific media types (e.g., ITU-T H.265 high efficiency video coding (HEVC), audio decoding time stamp-high definition (DTS-HD) and multiplex formats (e.g., MPEG multimedia transport (MMT)) of this table may not be available due to the limited resources of the mobile model IPTV TD. Considering rapid enhancement of mobile device capability and the quality of network conditions, the most of audio and video codecs should be supported in the near future.

7.1.2 Video on-demand

The video on-demand service (VoD) enables an end-user to select, acquire, and consume from a library of content stored on a remote or local server. Video on-demand is used as the same term with content on demand (CoD) in this Recommendation.

Due to the resource limitations of mobile model IPTV TD, the quality of video and audio for VoD service can have a different level of requirement than the quality of fixed IPTV TD. Appropriate media format to support mobile model IPTV TD can be specified.

Table 2 of [ITU-T H.721] includes specifications used for formats and streaming methods used in VoD services that can be applied to mobile model IPTV TD. However, the specific media types and multiplex formats of this table may not be available due to the same reason as that of the linear TV case.

7.1.3 Interactive services

The IPTV TD is recommended to have the ability to communicate with a remote interactive content server via means such as HTTP or HTTPS protocols. Examples of interactive services are information services and entertainment services.

Information services are, for example, news, stock and weather services. Entertainment services are, for example, games, karaoke and lottery services. Some types of information services, including weather and traffic information services, can be provided based on the location information of mobile model IPTV TD.

7.1.4 Public interest services

The IPTV TD is required to be compliant with regulatory requirements for accessibility services. Examples of these accessibility services are closed caption and subtitles, audio description, and sign language interpretation.

The mobile model IPTV TD is also required to be compliant with emergency telecommunications and regulatory information services. The TD notifies the user of an incoming emergency alert notification (EAN) message both visually and audibly or according to the user's preferences and capabilities if specified.

7.1.5 Advertising services

Location-based advertising (LBA) is a form of marketing communication that uses location-tracking technology in mobile networks to target consumers with location-specific advertising on their mobile devices. Location-based advertising, e.g., the advertisement of local restaurants, can be

provided to the IPTV service user when the mobile model IPTV TD determines its location and sends the location information to the IPTV service provider.

7.2 Features of the IPTV TD mobile model

7.2.1 Network attachment and service discovery

This process 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. A mobile device that has IPTV TD mobile model functions has to be connected to the IPTV service provider through wireless or mobile access networks. For details of the service discovery, refer to [ITU-T H.770].

Through the provisioning operation, including network attachment, the IPTV TD automatically obtains the initial information for consumption. When this process is completed, end-users have access to all available IPTV services. Except for the establishment of wireless or mobile network connectivity, the detailed information on "network attachment and service discovery" is the same as in [ITU-T H.721].

7.2.1.1 Terminal device attachment and initialization

The detailed information is the same as clause 7.2.1.1 "Terminal device attachment and initialization" of [ITU-T H.721].

7.2.1.2 Service provider description entry points

The detailed information is the same as clause 7.2.1.2 "Service provider description entry points" of [ITU-T H.721].

7.2.1.3 Service provider discovery and service attachment

The detailed information is the same as clause 7.2.1.3 "Service provider discovery and service attachment" of [ITU-T H.721].

7.2.2 Security

A mobile model IPTV TD is required to support the "Service security items" and "Content protection items" described in clause 7.2.2 of [ITU-T H.721] after establishing the network layer connections to receive IPTV services. Specifications used for IPTV TD-basic model service security described in Table 5 of [ITU-T H.721] are also applied to mobile model IPTV TD.

A mobile model IPTV TD can include the security modules as its internal functionalities or it 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

The detailed information about privacy is the same as clause 7.2.3 "Privacy" of [ITU-T H.721].

7.2.4 Quality of service

The quality of IPTV service of mobile model IPTV TD depends on various situations such as conditions of wireless or mobile networks and the capability of a mobile device with embedded ITF functions. As described in Recommendation [ITU-T Y.1903], when a mobile model IPTV TD is connected to IPTV service provider through an IPTV-enabled mobile network, the QoS of mobile model IPTV TD can be managed in accordance with the QoS capabilities of the mobile network. The level of QoS depends on the service and resource control mechanisms of the mobile network.

When an IPTV TD is connected to a non-IPTV-enabled wireless or mobile access networks, the QoS cannot be managed. The service quality of mobile model IPTV TD depends on the terminal capability and the content delivery function feature over wireless or mobile access networks.

The appropriate service and resource control capabilities in the wireless or mobile networks where the mobile IPTV TD is connected are recommended to support the QoS required by the end user of mobile IPTV TD. The details of QoS control mechanisms are out of scope of this Recommendation.

Appendix I provides a description of QoS-related issues.

7.2.5 Codecs

7.2.5.1 Video decoding

The detailed information is the same as clause 9.3.3.1 "Video decoding" in [ITU-T H.721]. However, high quality video codecs would not supported due to the limited resources of the mobile model IPTV TD. Appropriate video codec for the mobile model IPTV TD can be selected by the IPTV service provider or user.

Support of one of the categories in Table 8 of [ITU-T H.721] is required.

7.2.5.2 Audio decoding

The detailed information is the same as clause 9.3.3.2 "Audio decoding" in [ITU-T H.721]. However, high quality audio codecs would not be supported due to the limited resources of the mobile model IPTV TD. Appropriate audio codec for the mobile model IPTV TD can be selected by the IPTV service provider or user.

Support of one of the audio codecs in Table 12 of [ITU-T H.721] is required.

7.2.6 Location determination

Location information indicates the location of the mobile user as accurately as possible with the available information. This could be, for example, cell ID, location area ID, visitor location register (VLR) address, or some type of geographical information [b-ITU-T Q.1721]. Location information of mobile IPTV terminal device can usually be acquired by the network operator. Location information, however, acquired by the mobile TD using global positioning system (GPS) can be more accurate than the location information acquired by the network provider. The IPTV service user can be provided with location-based IPTV services by transferring the location information acquired by the mobile model IPTV TD to the IPTV service provider.

For providing advanced IPTV services based on location information, it is recommended to provide location information acquired by the mobile model IPTV TD to the IPTV service provider if the mobile model IPTV TD has the location detection capability.

7.2.7 Multi-device interworking

Multi-device service provides the user a different IPTV service consuming experience over one or more other terminal devices. Typically, the multi-device service may include content sharing, e.g., content transferring and coupled content playing. Moreover, some devices can control media playing on the other devices. In a multi-device environment, the roles defined for the device determines which capability the device should support.

To support the multi-device service, support of the following capabilities by a mobile model IPTV TD is recommended:

– provide send announcement to all connected terminal devices for claiming its functional roles;

– provide devices discovery and inter-connection setup.

The details of multi-device services are out of scope of this Recommendation. These will be studied within the context of an interworking-enabled model of multiple devices.

Mobile model IPTV TD will have more portable capabilities to act as remote media controller and portable player device. It will play the client functional roles when it is working under terminal device interworking mode. The following functional roles are recommended:

–   media controller: provide the capability of remote media control, remote user interface (UI) for control panel;

–   media player: provide the capability of media playing;

–   optional media renderer: optionally provide media playing capability or media rendering capability for other displays;

–   optional media server: optionally provide media server capability to be the media centre device.

7.2.8   Mobility

Mobility is the ability for the user or other mobile entities to communicate and access services irrespective of changes of the location or technical environment of the mobile device. There are three different aspects of mobility: personal mobility, terminal mobility, and service mobility. Based on the different aspects of mobility, different mobility feature of mobile model IPTV TD can be taken into account. These mobility-related issues are standardized by the relevant standardization bodies.

7.2.8.1   Personal mobility

Personal mobility implies a guarantee that a user can get the service anywhere with any device. It also means the mobility of a network itself, and providing the mobility without connecting to different kinds of networks. For example, if someone watching IPTV content wants to move and continue watching it with a different terminal device, then the IPTV network should support personal mobility so that the user can be guaranteed to continue to get the IPTV service according to the user's service profile.

To provide personal mobility, IPTV should consider the following aspect:

–   when a user moves to a location where the network connection point is different or the network provider is different from what the has been connecting to, the IPTV TD is required to connect to IP network per the user's service profile to continue accessing the IPTV service.

7.2.8.2   Terminal mobility

Terminal mobility implies a guarantee of providing seamless IPTV service when the IPTV terminal device is moving or used at different locations.

To provide terminal mobility, the network is required to provide a roaming and routing service including handover and automatic routing setup for the IPTV TD.

The IPTV TD can receive the IPTV services seamlessly without changing its IP address despite a location change. The IPTV TD may have mobility functions at the IP layer.

7.2.8.3   Service mobility

Service mobility provides seamless IPTV service irrespective of the location of the user and the IPTV TD. For providing seamless IPTV service, it is required to support seamless handover capability.

8   Functional architecture of IPTV terminal device (mobile model)

[ITU-T H.720] describes a functional architecture block diagram of IPTV TD based on [ITU-T Y.1910], "IPTV Functional Architecture" as shown in Figure 4 below. See [ITU-T H.720].

Some considerations for mobile model IPTV TD are described here for relevant functions of the terminal device.

IPTV terminal functions
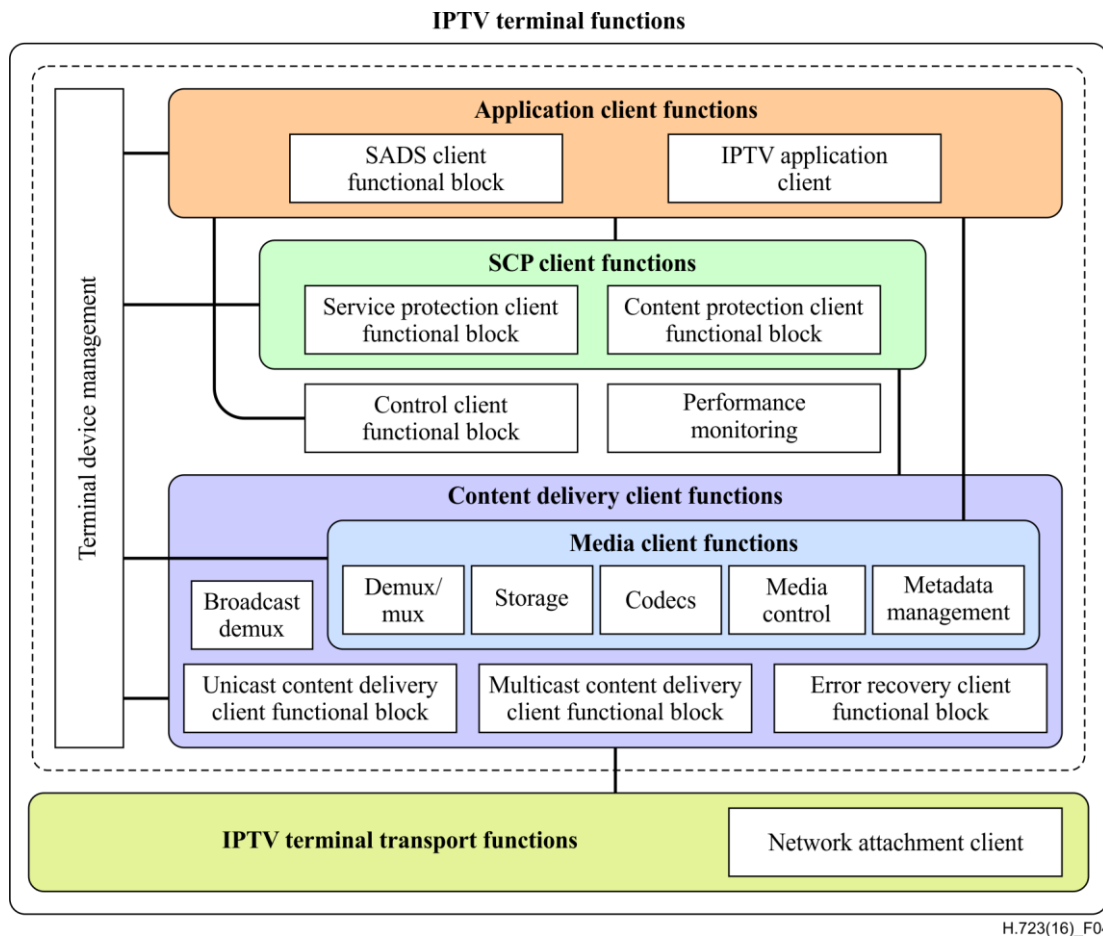
Figure 4 – Functional architecture block diagram of an IPTV terminal device

– **IPTV terminal transport functions**

These functions are responsible for handling IP-based connection between an IPTV TD and the mobile network. These functions are responsible for mobility management to provide personal mobility and terminal mobility if such a mobility feature is required. Network attachment clients provide connectivity to the mobile networks through various mobile access network technologies such as 2G, 3G, LTE, and WLAN, etc.

- **Content delivery client functions**

  These functions receive and control the delivery of the content from the content delivery and storage functions. The unicast content delivery client functional block and multicast content delivery client functional block could have responsibilities for content reception and control of real time streaming, etc. These functional blocks will interact with the IPTV terminal transport function that is connected to mobile networks. The error recovery client functional block is responsible for improving the QoS/QoE provided by the mobile network. Retransmission, forward error correction (FEC), and hybrid combinations of both are known mechanisms for error recovery. Due to the link characteristics of mobile networks, efficient error recovery is a very important capability for mobile model IPTV TD. FEC is known as an appropriate mechanism to support mobile model IPTV TD. Refer to [ITU-T H.701] for recommended details regarding error recovery.

- **Media client functions**

  These functions are responsible for content processing functionalities such as storage, metadata processing, and decoding of audio/video contents. A mobile model IPTV TD may require different codec characteristics compared to another IPTV TD that is connected to a fixed network.

- **SCP client functions**

  These functions are responsible for service and content protection (SCP) aspects of the IPTV TD.

- **Application client functions**

  These functions are responsible for the basic functions, management functions, and service supporting functions for IPTV TD. The individual functional blocks of the application client functions defined in [ITU-T Y.1910] are divided roughly into two groups based on their nature, as shown in Figure 3. The IPTV application client function consists of service specific functional blocks such as on-demand client functional block, linear TV client functional block and other client functional blocks. Other client functional blocks interact with the other server-side relevant ones for the delivery and presentation of additional IPTV services and their content, e.g., games and distant learning. The service and application discovery and selection (SADS) client functional block provides for the end user's discovery and selection of IPTV services and applications. Power management that is one of the important capabilities of mobile model IPTV TD, which belongs to management function of application client function.

- **Terminal device management function**

  This functional entity provides configuration management and remote management of IPTV TD. This functional entity also provides the functions for monitor and control of the mobile model IPTV TD functionality.

- **Control client functional block**

  The control client functional block allows the terminal device to initiate service requests to the IPTV service control functional block, in order to prepare for the connection to the content delivery functions. Terminal capability information will be managed to establish and control content delivery over mobile network environments.

- **Performance monitoring**

  This function is responsible for monitoring of performance aspects of IPTV TD.

9   Specific requirements for mobile model IPTV TD

This clause provides additional functional requirements to the general requirements that are described in Appendix I.

9.1 Functional requirements of terminal transport functions

Various mobile or wireless networks to which mobile model IPTV TDs can connect have their own access network characteristics. A mobile model IPTV TD needs to detect and use these wireless network characteristics to manage QoS/QoE of mobile or wireless network connections. In addition, the mobile model IPTV terminal device may have several different mobile or wireless network interfaces, such as WLAN, 3G and forth generation mobile networks (4G). In this case, signal interference that may be caused by the electromagnetic characteristics of the different interfaces should not be allowed.

Handover refers to the process that enables a mobile terminal to change network access areas/points within a network or to another network, while maintaining call(s) and/or signalling relationship(s). When the vertical handover occurs to provide seamless IPTV service, transport features such as bandwidth and codec information can be changed due to the link characteristics of the mobile/wireless network. A terminal device needs to take into account these cases. The following functional requirements of terminal transport functions of mobile model IPTV TD take into consideration various transport-related issues:

–   mobile model IPTV TD supporting mobile communications technology is recommended to support horizontal handover;

–   mobile model IPTV TD can optionally support vertical handover;

–   mobile model IPTV TD is recommended not to allow signal interference among the different mobile/wireless network interfaces;

–   mobile model IPTV TD is recommended to support the capability to detect mobile network characteristics;

–   mobile model IPTV TD is recommended to support functions to change its transport capabilities such as bandwidth based on the network conditions.

> NOTE – This can take place where the handover occurs to provide seamless mobile IPTV service when the terminal device is moving.

A mobile model IPTV TD may have multiple network interfaces to enable handover. The following functional requirements can be considered to manage multiple network interfaces of mobile model IPTV TD:

–   mobile model IPTV TD is recommended to have the ability to determine the appropriate interface to be used considering the condition of each network interface when the mobile terminal provides multiple network interfaces;

–   mobile model IPTV TD with multiple network interfaces is recommended to have the ability to let the user select the interface to be used;

–   mobile model IPTV TD with multiple network interfaces is recommended to efficiently manage its interfaces (e.g., considering power management), whose status are on, off, sleep, etc.

9.2 Functional requirements of content delivery client functions

Unicast and multicast content delivery client functional block need to interact with relevant transport functions that provide connectivity to mobile network such as 2G, 3G, LTE, WLAN, etc. Relevant technologies such as evolved multimedia broadcast multicast service (MBMS) of 3GPP and enhanced multicast and broadcast service (MBS) of IEEE to support multicast/broadcasting applications should be taken into account. Additionally, the error recovery function is very important to deliver contents to the mobile model IPTV terminal device. The applicable functional requirements are:

–   mobile model IPTV TD is recommended to support FEC error recovery mechanisms;

–   mobile model IPTV TD is recommended to use multicast delivery mechanisms (e.g., MBMS, MBS) if wireless or mobile network provides those capability.

Specifications used for IP level multicast content delivery is the same as clause 9.2.2 "Multicast content delivery client function block" of [ITU-T H.721].

Specifications used for IP level unicast content delivery is the same as clause 9.2.3 "Unicast content delivery client functional block" of [ITU-T H.721].

9.3   Functional requirements of media client functions

It is desirable that the quality provided by mobile model IPTV TD can be degraded, but that it can be maintained without disconnection of the IPTV service. When the IPTV TD is moving, the wireless network characteristics can change. If the quality of the wireless network is degraded due to mobility, it may not be possible to continue to receive the IPTV service of mobile mode IPTV TD with the same quality. If the quality of the media can be adjusted, the IPTV service can be provided by mobile model IPTV TD without service discontinuity. The applicable functional requirement is:

–   mobile model IPTV TD is recommended to support functions to request the IPTV service provider to adjust codec characteristics when wireless network characteristics have been changed.

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

Specifications used for video decoding are the same as clause 9.3.3.1 "Video decoding" of [ITU-T H.721]. However, there are some limitations to support high quality video codec due to the lower mobile model IPTV TD computing capability. At least Category 0 of Table 8 in clause 9.3.3.1 of [ITU-T H.721] is required to be supported as a basic mode of video decoding.

Specifications used for audio decoding are the same as clause 9.3.3.2 "Audio decoding" of [ITU-T H.721]. However, there are some limitations to support high quality audio codec due to the lower terminal capability of mobile model IPTV TD.

9.4   Functional requirements of control client functional block

The mobile model IPTV TD capability should be managed for efficient content delivery over mobile/wireless network environments. This TD capability information needs to be exchanged between TD and the IPTV network to control content delivery. Also, the TD capability information may need to be modified for the same session for providing seamless mobility service.

–   mobile model IPTV TD is recommended to support the capability to provide the following TD capability information:

•   type of network interface and its features;

•   capability information of display device.

–   mobile model IPTV TD is recommended to support the capability to provide characteristics information (e.g., available bandwidth, SNR, BER) of the link to which the IPTV TD is connected.

9.5   Functional requirements of SCP client functions

Requirements for SCP client function of mobile model IPTV terminal device need to be aligned with the relevant detailed security requirements, described in [ITU-T X. 1191]. Detailed security requirements may be described for service security, content protection, device security, and user security.

9.6 Functional requirements of performance monitoring functions

There are no specific requirements for performance and monitoring functions of mobile model IPTV TD.

9.7 Functional requirements of terminal device management functions

– mobile model IPTV TD can optionally have environmental adaptation abilities, e.g., making the sound louder with street noise or making the display dimmer as evening approaches;

– mobile model IPTV TD can optionally determine its location and send the location information to the IPTV service provider.

9.8 Functional requirements of application client functions

No additional functional requirement is needed for the application client function to support mobile model IPTV TD. Requirements specified in [ITU-T Y.1901] are generally applied to mobile model IPTV TD.

10 Interfaces for mobile model IPTV terminal device

This clause provides an abstract description of mobile model IPTV TD interfaces. Since the realization of physical interfaces may be varied, the diagram of IPTV TD interfaces, as shown in Figure 5, describes possible external TD interfaces and is not meant to indicate required interfaces.
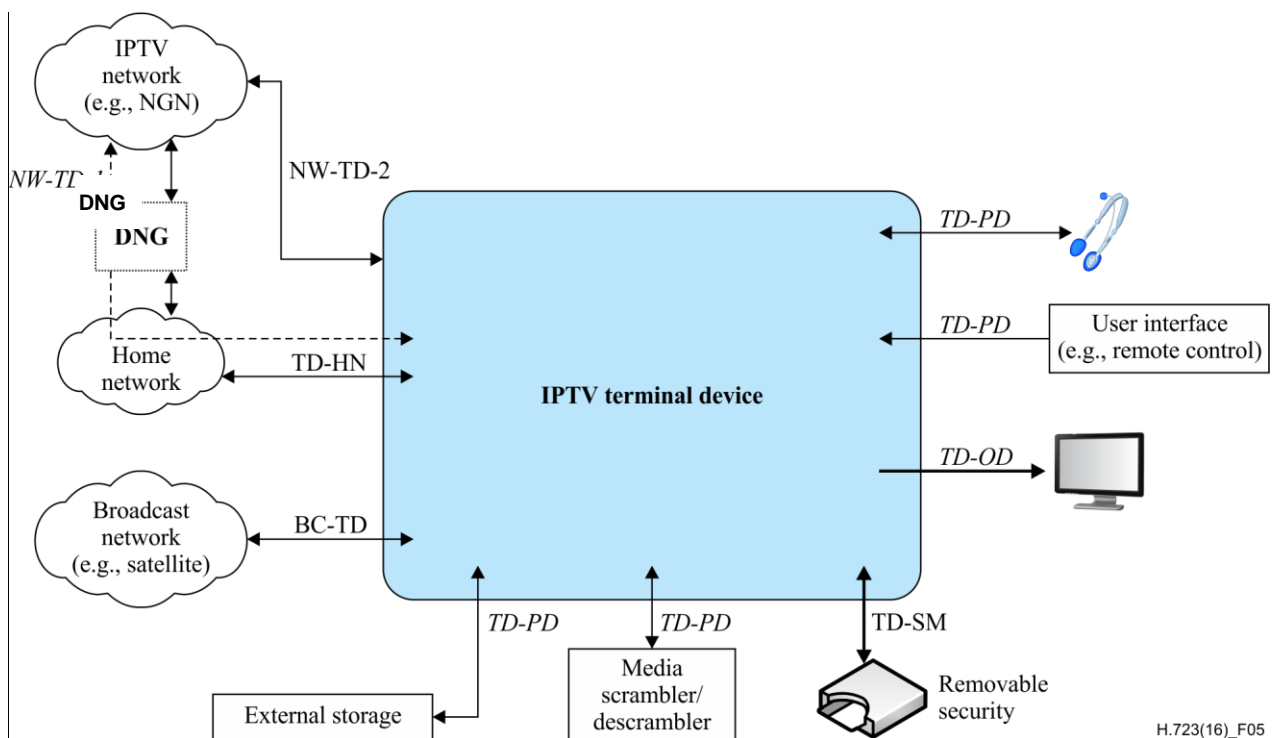

Figure 5 – Examples of IPTV terminal device interfaces

10.1 Network interface

10.1.1 Mobile/wireless network interface

There are various mobile or wireless access networks for providing IPTV services over mobile model IPTV TD. It will be very useful for users if mobile model IPTV TD supports as many mobile or wireless access network technologies as possible (e.g., 2G, 3G, LTE, WLAN). However, there

will be limitations to the support of several interfaces simultaneously due to the lack of terminal capability.

– mobile model IPTV TD is required to equip at least one mobile or wireless interface for providing IPTV service.

10.1.2 Fixed network interface

It will be helpful in the home and enterprise network environments if mobile model IPTV TD provides fixed network interface such as 10BASE-T, 100BASE-T, Gigabit Ethernet LAN.

– mobile model IPTV TD can optionally support LAN interface.

10.2 User input interface

This interface allows user input to handle mobile model IPTV TD. It can be a hardware or software component such as a microphone, remote control device, keyboard or touch screen.

– mobile model IPTV TD is required to support at least one input interface;

– mobile model IPTV TD can optionally support touchscreen and other various sensors such as accelerometer or position sensor.

10.3 Output interface

This interface is between mobile model IPTV TD and output devices such as a speaker, headphone, display, home theatre system or external personal video recorder (PVR). It facilitates transfer of audio and video signals from IPTV terminal device to the output device.

– mobile model IPTV TD is required to support an audio output interface;

– mobile model IPTV TD can optionally support a video output interface;

– mobile model IPTV TD can optionally support a red, green, blue (RGB) analogue interface (e.g., D, RCA, S or S2 connectors);

– mobile model IPTV TD can optionally support a digital video interface (DVI) interface;

– mobile model IPTV TD can optionally support a high-definition multimedia interface (HDMI) interface;

– mobile model IPTV TD can optionally support a video graphics array (VGA) interface and a DVI interface with analog output;

– mobile model IPTV TD can optionally support vibration.

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

10.4 Peripheral device interface

This interface is between mobile model IPTV TD and peripheral device such as a universal serial bus (USB) flash drive or Bluetooth device. Bluetooth and other ad hoc network technologies can be used for IPTV content delivery between mobile model IPTV TD and other Bluetooth devices. Contents protection aspects need to be considered regarding to the content delivery, but it is not dealt with in this clause.

– mobile model IPTV TD can optionally support USB interface;

– mobile model IPTV TD can optionally support Bluetooth interface.

10.5 Security module interface

This interface is between mobile model IPTV TD and a removable security module such as universal integrated circuit card (UICC).

– mobile model IPTV TD is recommended to support removable security module interface.

Annex A

General requirements for mobile IPTV services

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

[ITU-T Y.1901] describes various aspects of IPTV service requirements. Some of these requirements of [ITU-T Y.1901] are related to mobile IPTV service and it may need to be applied to specify detailed functional requirements and capabilities of mobile IPTV TDs.

The followings are general requirements for mobile IPTV services, described in [ITU-T Y.1901]. These requirements should be taken into account for mobile IPTV TD as appropriate.

– R 6.4.3-01: The IPTV architecture is required to support mechanisms for exchanging subscriber-related information between the visited network (where the end-user accesses the IPTV services) and the home IPTV service provider (where the end-user has its subscription to the IPTV services) in case mobility is supported.

– R 6.4.3-02: The IPTV architecture is required to support mechanisms for discovering and selecting the end-user's service profile from the IPTV TD or the home service provider that will be used by the end-user whenever accesses such IPTV services from a visited network in case mobility is supported.

– R 6.4.3-03: The IPTV architecture is required to support mechanisms for discovering and selecting IPTV services provided by the home IPTV service provider for roaming users in case mobility is supported.

– R 6.4.3-04: The IPTV architecture is required to support capturing relevant control context information from the originating terminal device, and transferring them to the target terminal device in case mobility is supported.

– R 6.4.3-05: IPTV architecture is required to support nomadism for both personal mobility and terminal mobility.

  Note: further information concerning nomadism, personal mobility and terminal mobility can be found in [ITU-T Y.2201].

– RR 6.1.1-01: The IPTV architecture is recommended to allow seamless IPTV service provision and operation across different networks supporting IPTV services.

– RR 6.1.4-03: The IPTV architecture is recommended to support capabilities for the end-user mobility allowing access to IPTV services by the end-user either in motion or not.

– RR 6.4-03: The IPTV architecture is recommended to support the ability to identify wireless network characteristics information sent by the IPTV terminal device.

– RR 6.4.1-02: The IPTV architecture is recommended to allow the delivery of IPTV services over different access networks (e.g., cable, optical, xDSL, wireless).

– RR 6.4.3-01: Where support for terminal mobility with service continuity exists, such support is also recommended for IPTV.

Appendix I

QoS and performance

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

I.1 Quality of service

Various QoS parameter sets have significant impact on the perceptual quality of transmitted video. These can be related to the duration of the impairment in the video signal, or to the network impairment parameters. They are indispensable for equipment specifications, as well as daily system performance measurement, improvement and monitoring.

Group of pictures (GOP) length has impacts on transmitted video quality over error-prone networks. It has direct relationship with the error propagation (the error length), the severity of loss (which conceptually refers to the difficulty in lost frame concealment, and can be measured, for example, by the peak signal-to-noise ratio (PSNR) drop following a loss), the loss position (measured by the time to the end of sequence, known as the "forgiveness effect"), the number of loss in a sequence and the loss pattern (random or impulsive).

From the network provider's point of view, the transmitted compressed video quality can be monitored indirectly by network parameters including:

– packet arrival time;
– packet delay and jitter;
– network bandwidth;
– impairment duration;
– packet loss (or drop), duplication or out of sequence.

Other parameters above the IP level can help getting better estimation of the effect of network QoS parameters on video quality. These include:

– PSI data presence rate;
– payload compression schemes (MPEG-2 video [b-ITU-T H.262], [b-ITU-T H.264], etc.);
– GOP;
– encapsulation schemes (Ethernet/IP/UDP/MPEG-2 TS, Ethernet/IP/UDP/RTP/MPEG-2 TS, Ethernet/MPLS/IP/UDP/RTP/MPEG-2 TS, etc.).

These network and high-level parameters can be monitored to provide cost-effective indications of the contribution of network behaviour to video quality.

Optional parameters for diagnostic purposes can be found in the (non-exhaustive) list below:

– jitter buffer size;
– bit rate (audio and video);
– packet-loss ratio (audio and video);
– packet-discard ratio (audio and video);
– averaged burst packet loss length (audio and video);
– burst packet loss variation range;
– mean packet size;
– delay;
– delay variation range;
– FEC, automatic repeat request (ARQ) and de-jitter buffer.

I.2 Quality and performance assessment

I.2.1 Video quality assessment

I.2.1.1 Subjective assessment

There are a number of subjective video quality measurement methods suggested in [b-ITU-R BT.500-13]. Depending on the impairment being evaluated, the selection of a method requires careful considerations of sequence duration, transmission condition, ecological environment and other factors. The output of the subjective tests is often an average of the quality ratings called mean opinion score (MOS). [b-ITU-R BT.500-13] recommends a five-grade impairment scale:

5 – imperceptible;

4 – perceptible, but not annoying;

3 – slightly annoying;

2 – annoying;

1 – very annoying.

The grading of video quality can also be expressed as a percentage from 0 to 100, with 0 indicating no distortion. The higher the value is, the greater the distortion occurs.

[b-ITU-R BT.500-13] includes specifications on how to perform different types of subjective test. The double stimulus continuous quality scale (DSCQS) and double stimulus comparison scale (DSCS) are both double stimulus where viewers rate the quality or change in quality of two video streams (reference and impaired). The single stimulus continuous quality evaluation (SSCQE) assesses only one impaired video stream. The DSCQS is claimed to be less sensitive to the context, while SSCQE is claimed to produce more representative estimates for quality monitoring.

In addition, [b-ITU-T P.910] includes specifications on how to perform a type of subjective test for video. The absolute category rating with hidden reference removal (ACR-HRR) is a single stimulus continuous quality evaluation.

I.2.1.2 Objective assessment

Due to the complexity and time consuming nature of subjective video monitoring, there has been significant development of perceptual video quality measurement (PVQM) algorithms in recent years in an attempt to replicate the scores given by subjects in an objective tool. Objective quality monitoring can be classified into the following categories:

– techniques based on models of human video perception;
– techniques based on video signal parameters.

Human video perception models attempt to emulate the characteristics of the human visual system to obtain video quality scores. A good model should yield high correlation to the ratings the actual viewers would provide. Three popular approaches can be used:

1) Full reference (FR) – both the original transmitted and received video are available to determine the video quality;

2) Reduced reference (RR) – partial information about transmitted video and full information about received video are available to determine the video quality;

3) No reference (NR) – only the received video is available to determine the video quality.

I.3 Quality and performance monitoring

I.3.1 Adaptability

I.3.1.1 Video/audio adaptation

Scalable video coding (SVC) as specified in Annex G of [b-ITU-T H.264] allows the combinations of different video resolutions being supported within the mobile IPTV application platforms. There exist mainly three video scalability modes in SVC: temporal, spatial and quality. Spatial and temporal scalabilities describe respectively the capability of representing the source video using a reduced picture size (spatial resolution) and frame rate (temporal resolution). The quality scalability, also referred to as signal-to-noise ratio scalability, represents the source video with a lower fidelity one (lower SNR) while keeping the spatial-temporal resolution unchanged. Scalable video coding is the key to adapt the content distribution for resource optimization of access networks. It provides efficient means for achieving better video end user QoS/QoE.

The scalable video is generally coded into one base layer, which represents the minimum quality, and enhanced layers for higher qualities. It is recommended to pre-encode the video in a base layer and multiple enhanced layers, corresponding to multiple network bandwidths. So the server can stream the suitable layer(s) based on the monitored QoS. The video player on the mobile model IPTV TD is recommended to seamlessly switch between different qualities without interrupting the video playback.

I.3.1.2 Environmental adaptation

Environmental adaptation of mobile model IPTV terminal device may improve the service quality by making the sound louder, the display brighter, etc., since service provision environment such as brightness and street noise may change when the IPTV terminal device moves.

I.3.1.3 Media distribution adaptation

Content distribution to a mobile model IPTV TD needs to adapt to the changing of network conditions and terminal devices for better quality of experience. The adaptation may take different forms, such as connection speed, video format, etc.

Dynamic adaptive streaming over HTTP (DASH) [b-ISO23009-1] defines a way to advertise a range of different streams to a player together with the information it needs to pick which ones to stream. It also defines media file formats suitable for adaptive streaming. The file formats enable efficient and seamless switching between streams, enabling a player to adapt to changing network conditions without pausing playback for re-buffering. The standard considers the differing needs of both on-demand and live services, and it is all based on the use of industry standard HTTP servers. DASH provides flexible deployments of adaptive media distribution for mobile model IPTV TD.

Appendix II

Example use cases and service scenarios

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

II.1 Linear TV service with terminal mobility (horizontal handover)

Linear TV service is a television service in which a continuous stream flows in real time from the service provider to the terminal device. As one of IPTV basic services, linear TV service can be provided to mobile IPTV service users. This service scenario, as shown in Figure II.1, describes a use case of linear TV service while the service user moves with the mobile IPTV terminal.
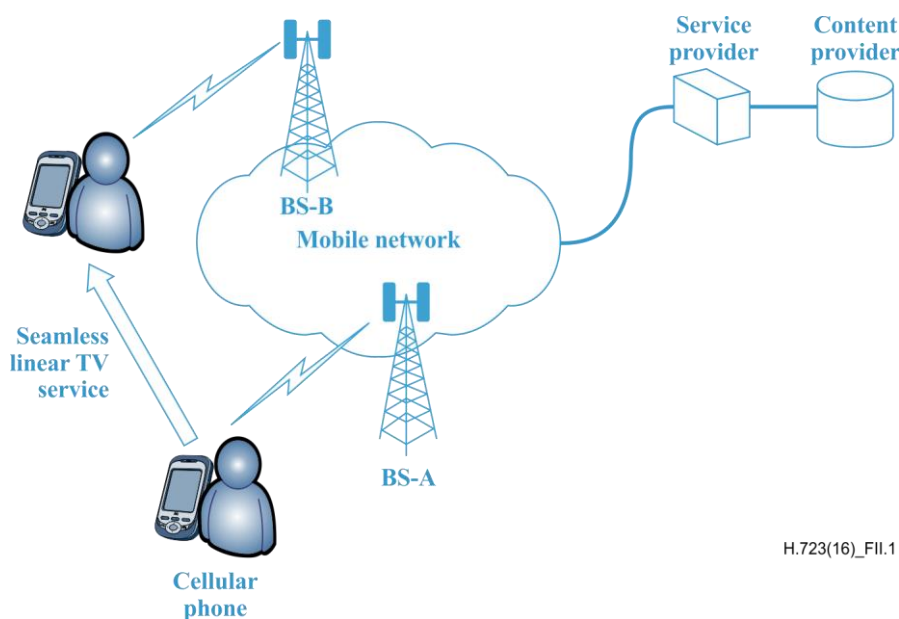

Figure II.1 – IPTV linear TV service with horizontal handover

In this scenario, an IPTV user watches news, one of linear TV program, while she moves on foot. While she moves, horizontal handover takes place and the content is provided seamlessly. The service scenario of IPTV linear TV service with horizontal handover is as follows;

1)   The cellular phone of IPTV service subscriber Carol accesses the mobile network through base station (BS)-A, the nearest one, while she moves on foot;

2)   Carol reaches a linear TV service and selects the news content she would like to watch after IPTV service provider discovery and IPTV service discovery procedures;

3)   The selected news stream starts to deliver to her cellular phone, and she keeps watching the news while she walks;

4)   After a few minutes, her cellular phone loses the coverage of BS-A and the connected base station is changed from BS-A to BS-B, the one most adjacent to BS-A. Carol keeps watching the news seamlessly.

II.2 IPTV broadcast service with personal mobility

IPTV broadcast service is expected to be available on various kinds of mobile IPTV TDs such as cellular phones and PDAs as one of basic IPTV services.
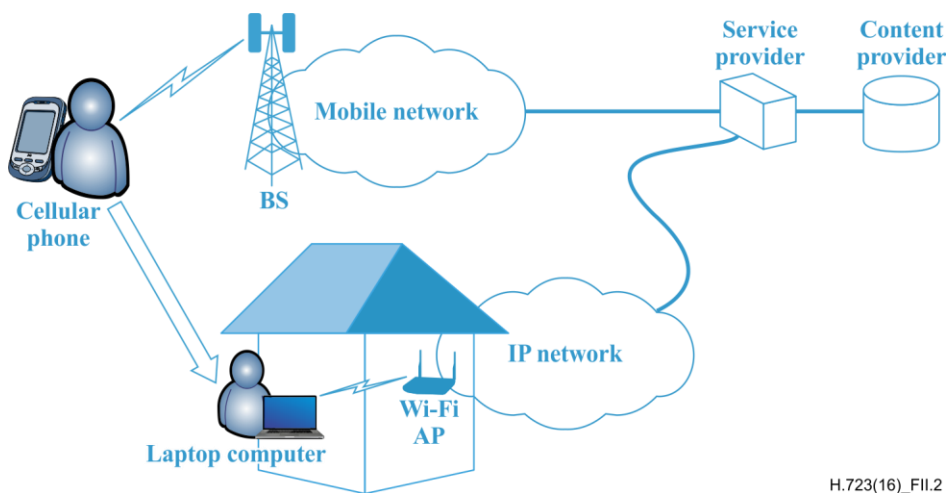
**Figure II.2 – IPTV broadcast service with personal mobility**

One service scenario of IPTV broadcast service with personal mobility, shown in Figure II.2, is as follows:

1)   The cellular phone of IPTV service subscriber Alice connects to the mobile network;

2)   Alice accesses an IPTV broadcast service provided by an IPTV service provider with her cellular phone. The IPTV service provider authenticates the subscriber based on the personal identity of Alice to provide the IPTV broadcast service;

3)   Alice watches TV programs on her cellular phone for some period of time, and then closes the IPTV broadcast service on the cellular phone. The session between the cellular phone and the IPTV service provider is disconnected;

4)   Alice enters her house and attempts to use an IPTV service with her laptop computer. The laptop computer connects to a Wi-Fi AP and accesses the same IPTV broadcast service that she previously accessed on her cellular phone outside her home. Alice also can consume other IPTV services to which she subscribes. For session establishment between the laptop computer and the IPTV service provider, in the case, Alice is authenticated based on her personal identity, just like the use case of her cellular phone.

While Alice uses the IPTV broadcast service on various IPTV TDs, personal mobility, the mobility for those scenarios where the user changes the terminal used for network access at different locations, is provided.

II.3   VoD with terminal mobility (vertical handover)

VoD is a service in which the end-user can, on demand, select and watch video content and where the end-user can control the temporal order in which the video content is viewed. VoD is also expected to be available on various kinds of mobile IPTV TDs as one of basic IPTV services.
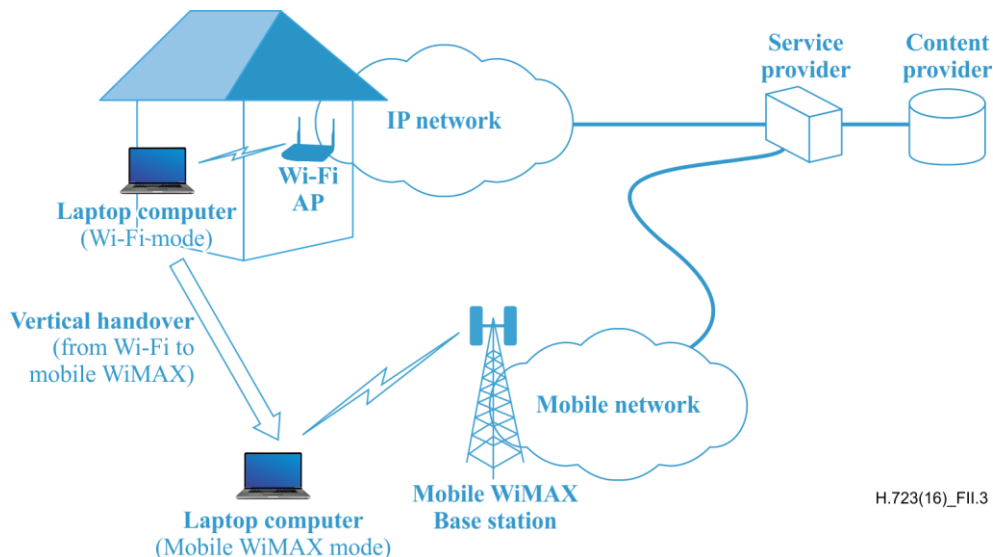
Figure II.3 – VoD with terminal mobility

Service scenario of VoD with terminal mobility, shown in Figure II.3, is as follows:

1) A laptop computer of IPTV service subscriber Bob, connects to a Wi-Fi AP at home.

2) Bob accesses a VoD service provided via the IPTV service provider to which he has subscribed.

3) While Bob watches VoD content, he starts to ride in a car to move to another location. After a few seconds from departing his house, Bob's laptop computer moves out of the coverage range of the Wi-Fi AP to which the laptop computer was initially connected.

4) The laptop computer then searches for another signal it can use to get IP connectivity. It finds a signal from a mobile worldwide interoperability for microwave access (WiMAX) base station and connects to this base station.

5) The network access mode of the laptop computer is changed from Wi-Fi mode to mobile WiMAX mode. Bob continuously uses the VoD service on the laptop computer.

While Bob uses a VoD service on his laptop computer with movement, terminal mobility, the mobility for those scenarios where the same terminal equipment is moving or is used at different locations, is provided. To be more concrete, vertical handover, handover between different networks, is supported by the laptop computer.

Since the network access service which Bob uses changes from Wi-Fi to mobile WiMAX, audio/video (A/V) quality adaptation may be supported by the IPTV service provider considering bandwidth of each network access technology, etc. Service mobility may or may not be provided according to the network access technologies used before and after the vertical handover.

II.4   Three-screen service with contents sharing

Three-screen service allows an IPTV service subscriber consume IPTV service contents on TV, PC, and wireless screens. The basic type of three-screen service is sharing the same IPTV service contents on more than one screen among the three types of screens.
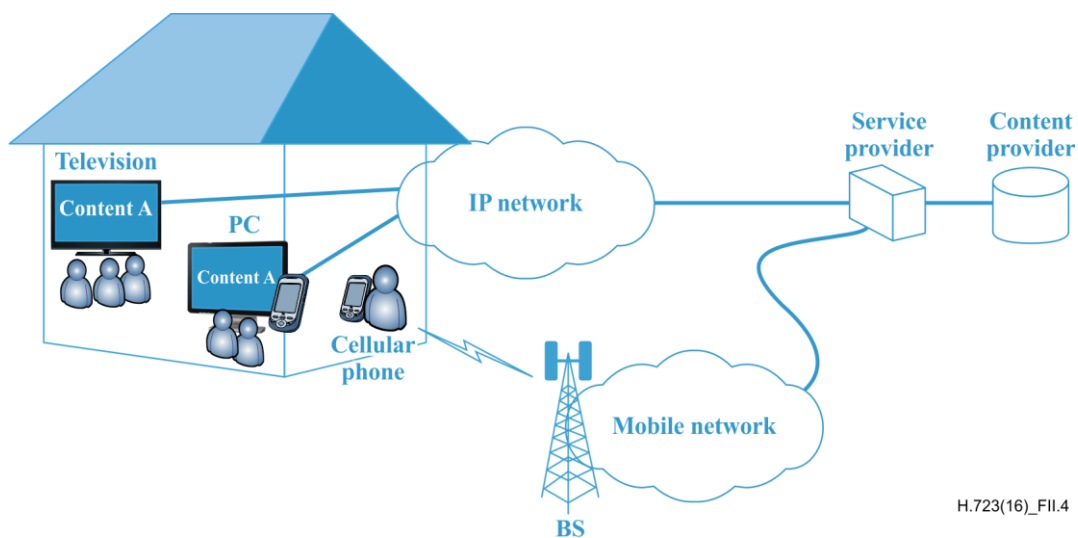
Figure II.4 – Three-screen service with contents sharing

An IPTV service scenario in which many IPTV service users share the same IPTV content, as shown in Figure II.4, is as follows;

1) Eve, an IPTV service subscriber, and her friends want to watch a movie at Eve's home. Eve wants to watch the movie on her cellular phone, and others want to watch the movie on a television and a PC.

2) The cellular phone of Eve accesses the mobile network. She reaches the IPTV service to which she is subscribed and reaches a VoD service after IPTV service completion of the discovery procedure. She selects the movie she and her friends plan to watch.

3) She requests the IPTV service provider that she wants to use the three-screen service with the selected VoD content, which means that Eve's TV, PC, and cellular phone show the same VoD content simultaneously.

4) The IPTV service provider receives capability information of each IPTV terminal, adapt audio and video of the content for these screens, considering these capabilities, and then delivers the content to these IPTV TDs. Eve and her friends watch the same movie on these three screens.

For the provision of three-screen service in this scenario, capability information of each terminal device needs to be delivered to the IPTV service provider. Then, the IPTV service provider adapts the IPTV contents to the screens considering the capabilities of each terminal device.

II.5 Three-screen service with service mobility

Three-screen service allows an IPTV service subscriber to consume IPTV service content on TV, PC, and wireless screens seamlessly. It is considered as one of the representative IPTV services supporting service mobility among three types of screens.
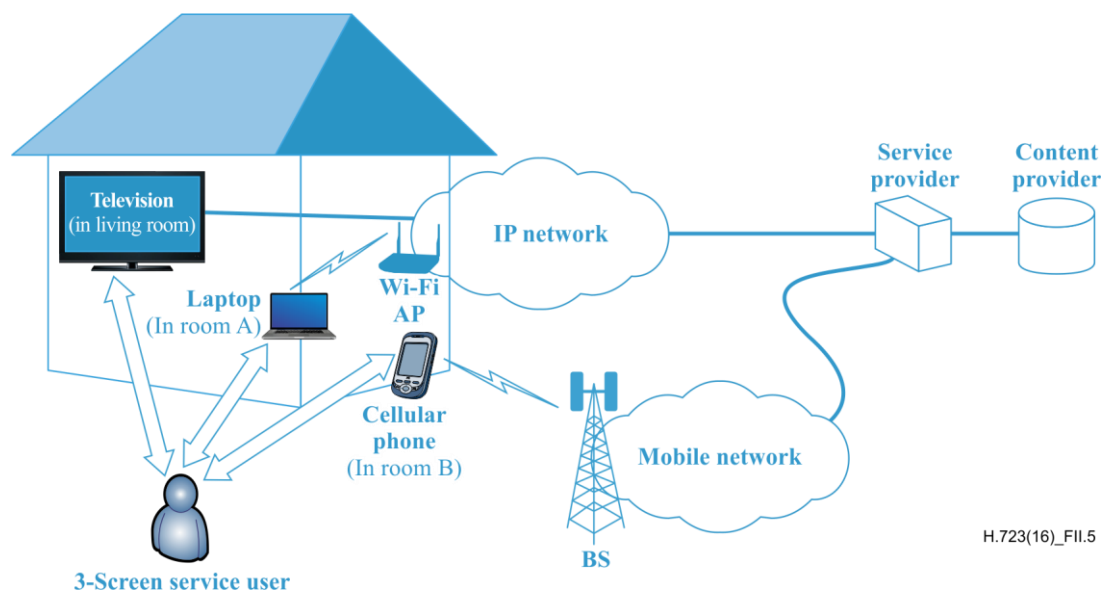
**Figure II.5 – Three-screen service with service mobility**

Service scenario of three-screen service with service mobility, as shown in Figure II.5, is as follows:

1) IPTV service subscriber Charlie, watches a VoD content on a television in his living room.

2) After a few minutes, Charlie moves to room A to watch the same VoD content on his laptop computer:

    2-1) Charlie turns on a laptop in room A and requests the laptop to show the same VoD content continuously which the television in the living room showed;

    2-2) the laptop connects to Wi-Fi AP;

    2-3) the laptop is authenticated as part of a three-screen service, and requests the IPTV service provider to send the same VoD content;

    2-4) the IPTV service provider verifies the information about Charlie and the VoD service which Charlie uses and sends the same content to the laptop computer;

    2-5) Charlie watches the VoD content seamlessly on the laptop computer. During this process, A/V quality adaptation may be supported by the IPTV service provider considering the capabilities of IPTV TDs and bandwidth of network access technologies.

3) After some period of time, Charlie moves to room B and uses his cellular phone to watch the same VoD content continuously. The cellular phone connects to a mobile network and shows the same VoD content through the same process as described above. A/V quality adaptation may also be supported considering the capabilities of the cellular phone and bandwidth of the mobile network.

While Charlie uses the the IPTV VoD service on a television, a laptop computer and a cellular phone seamlessly, service mobility, which provides seamless IPTV service irrespective of the location of the user and the IPTV terminal device, is provided. Content protection related issues should be taken into consideration when sharing IPTV contents on several IPTV TDs.

II.6 Location based information service

A location-based service (LBS) is an information and entertainment service, accessible with mobile devices through the mobile network and utilizing the ability to make use of the geographical position of the mobile device. LBS can be provided to mobile IPTV service users since mobile IPTV terminal device has mobility.
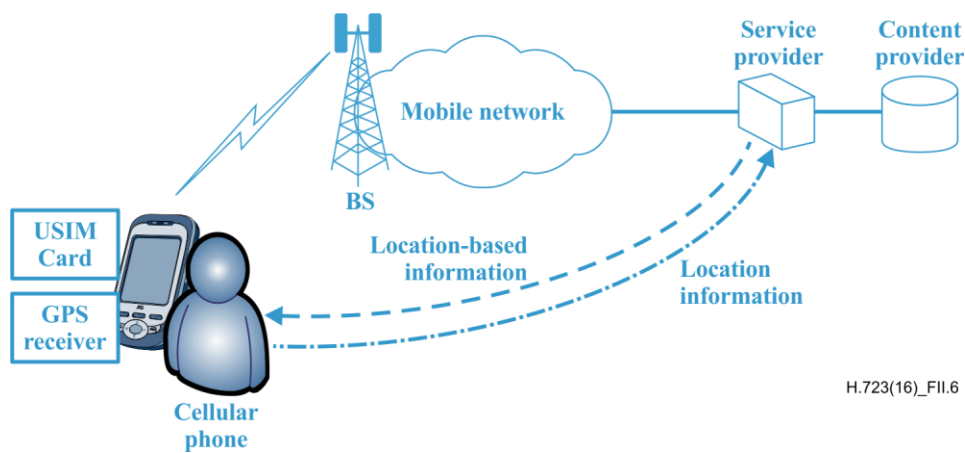
Figure II.6 – Location-based information service

A user wants to receive information about restaurants in an unfamiliar area in which he is staying through a mobile IPTV service. A service scenario of location based information service, as shown in Figure II.6, a is as follows:

1)   Frank rents a mobile IPTV TD with GPS receiver from a rental shop and put his universal subscriber identity module (USIM) into the terminal.

2)   The mobile IPTV TD accesses the mobile network and Frank is authenticated by the IPTV service provider to which he has subscribed.

3)   Frank reaches a location-based information service on the terminal after the IPTV service discovery procedure has completed.

4)   The mobile IPTV TD determines its location using GPS and sends the location information to the IPTV service provider.

5)   When Frank select "restaurant" in location-based information service, information about restaurants in the area where Frank is currently located is delivered to him. If he agrees, the Ddelivery of advertisements of some of these restaurants is also possible.

6)   After Frank receives the information about his favourite restaurant, including exact location and telephone number, the LBS is terminated.

In the provision of the abovementioned IPTV service, the user is authenticated by the USIM. For the provision of location-based IPTV service, location of the terminal is determined using GPS. Although location information determined by the network operator can also be available, the location information determined by GPS is usually more accurate.

Bibliography

[b-ITU-T H.262]   Recommendation ITU-T H.262 (2012), *Information technology - Generic coding of moving pictures and associated audio information: Video.*

[b-ITU-T H.264]   Recommendation ITU-T H.264 (2016), *Advanced video coding for generic audiovisual services.*

[b-ITU-T H.510]   Recommendation ITU-T H.510 (2002), *Mobility for H.323 multimedia systems and services.*

[b‑ITU-T P.910]   Recommendation ITU-T P.910 (2008), *Subjective video quality assessment methods for multimedia applications.*

[b-ITU-T Q.1221]   Recommendation ITU-T Q.1221 (1997), *Introduction to Intelligent Network Capability Set 2.*

[b-ITU-T Q.1706]   Recommendation ITU-T Q.1706/Y.2801 (2006), *Mobility management requirements for NGN.*

[b-ITU-T Q.1721]   Recommendation ITU-T Q.1721 (2000), *Information flows for IMT-2000 capability set 1.*

[b-ITU-T Q.1761]   Recommendation ITU-T Q.1761 (2004), *Principles and requirements for convergence of fixed and existing IMT-2000 systems.*

[b-ITU-T Q.1762]   Recommendation ITU-T Q.1762/Y.2802 (2007), *Fixed-mobile convergence general requirements.*

[b-ITU-T Y.2001]   Recommendation ITU-T Y.2001 (2004), *General overview of NGN.*

[b-ITU-T Y.2201]   *Recommendation ITU-T Y.2201 (2007), NGN release 1 requirements.*

[b-ITU-R BT.500-13] Recommendation ITU-R BT.500-13 (2012), *Methodology for the subjective assessment of the quality of television pictures.*

[b-ISO23009-1]   ISO/IEC 23009-1:2014, *Information technology – Dynamic adaptive streaming over HTTP (DASH) Part 1: Media presentation description and segment formats.*

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