A Study on IPTV Standardization

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1. Introduction

IPTV describesa system in which Digital Television (DTV) service is delivered to subscriber through Internet Protocol (IP). A broadband connection such as Digital Subscriber Line (DSL) is needed to deliver IPTV contents. Video on Demand (VoD), Voice over IP (VoIP) and traditional internet services are also delivered in IPTV services. This is also called triple play. Through IPTV service user can have much control over the TV contents that he consumes.

Currently many companies throughout the world provide so called IPTV services to their customers. They do not include all the contents of IPTV services, but provide some of them. Further there is no globalized standard for IPTV service to be globally accepted and interoperable.

IPTV services require the networks which supports high data rate, low latency and a good Quality of Service (QoS)and Quality of Experience (QoE).

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A standardized IPTV service has some requirements to be fulfilled for best content delivery and services support. These include architecture, network, middleware, terminal device, and metadata requirements [1].

1.1 Significance of Standardization

Standards give service providers control over their platform and their offerings. Standards encourage innovation, help

mask complexity of services, guarantee QoS, ensure interoperability and ultimately help players remain competitive.

Next in section 2, we will provide an overview on the standardization bodies involved in the IPTV standardization effort. In section 3we provide the definitions of some basic IPTV services and related entities, section 4 will describe the service requirements of IPTV. In section 5 the functional architecture of IPTV system, its three different approaches and functional domains of IPTV are presented. Next is the section 6, for traffic management part and section 7 present application layer error recovery. In section 8 we provide overview of recommended codec (H.264) for IPTV services and summary is provided in section 9.

2. Standardizing Bodies

IPTV standardization effort is being done in some standardizing bodies like ATIS/IIF, ETSI/TISPAN, DVB, ITU-T.

2.1 ATIS/IIF

Alliance for Telecommunications Industry (ATIS) is United States basedorganization working for rapidly developing and promoting technical and operational standards for communication and related information technology industry worldwide. ATIS set up IPTV Interoperability Forum (IIF) in June 2005 for developing standards and related interoperable activities for IPTV system and services.

2.2 ETSI /TISPAN

European Telecommunications Standards Institute (ETSI) has core competence centre known as Telecoms and Internet converged Services and Protocols for Advanced Network (TISPAN). TISPAN defines many standards relating to broadcasting and telecommunications.

2.3 DVB

Digital Video Broadcasting (DVB) is an industry-led consortium of over 260 broadcasters, manufacturers, network operators, software developers and regulatory bodies in over 35 countries. DVB is committed to design global standards for global delivery of DTV and data services.

2.4 ITU-T

ITU-T is standardization sector of International Telecommunication Union (ITU)which is United Nations based standardizing organization. ITU-T set up Focus Group for IPTV (FG IPTV) in July 2006 to coordinate and promote the development of global IPTV standards taking into account the existing work of the ITU study groups as well as Standards Developing Organizations (SDO). ITU-T leads the standardization process of IPTV and coordinates the work done by different organizations.

The FG IPTV has six working groups, each dedicated to a specific target field.

WG1: IPTV service requirements and architecture.
WG2: IPTV service quality and performance
WG3: service security and content protection.
WG4: network control.
WG5: terminal systems and interoperability.
WG6: middleware applications and content platforms.

The FG IPTVaddresses urgent study issues spanning more than one study group of the ITU-T in a time-limited frame. It builds consensus on matters essential for IPTV standard development from diverse perspectives including architectures, service requirements, and content protection.

The FG IPTV is not authorized to create recommendations; instead the relevant SGs formulate recommendations based on documents output by the FG IPTV.

The Study Groups (SGs) involved in IPTV Standardization work include **SG2, SG3, SG4, SG9, SG11, SG13, SG15, SG16, SG17, and SG19.**

3. Definitions of Basic IPTV Service Entities and Services

3.1 Service Entities

Application provider: The application provider is the entity providing IPTV-related user interface applications.

Content provider: The content provider is the entity owning contents or being licensed to sell content assets. Their role is content production and delivery.

Service provider: The service provider is the entity providing a service to end-user through a procedure of receiving, manipulating, value-added processing and transmitting contents with security and management using an IPTV platform.

3.2 IPTV Basic Services

Electronic Programs Guide (EPG): It is on-screen guiding to scheduled service program, scheduled interactive service program, contents and additional descriptive information based on preferring program and content information which user uses frequently. It allows a viewer to navigate, select and discover content by time, title, channel, genre, etc, by using of his remote control, a keyboard, a touchpad or even a phone keyboard.

Linear TV: It isa basic broadcast service of IPTV. This is received, from the existing broadcast transmission from a Content Provider, trans-coded and multicast by the Service Provider. The multicast streams are delivered by the Network Provider, via the Consumer's Network to the End-user's IPTV device.

Linear TV with Trick Modes: It allows end-user to pause live TV, instant replay of interesting scenes, and skip advertising through Personal Video Recorder (PVR) or Digital Video Recorder (DVR) system.

PVR service (network or client-based): The PVR service is consumer based electronic device service that records live program to the hard drive digital storage in standalone set-top boxes or network.

Personal Broadcast Service: Personal IPTV broadcast service provides end-user with a way to advertise personal broadcast schedule and content description so that other end-users can find this information in the same way as other IPTV services. This service allows end-user to find and enjoy another end-user's content, and makes IPTV end-user also be a content provider.

On-demand service: It includes VoD, Music on Demand (MoD) and interactive games.

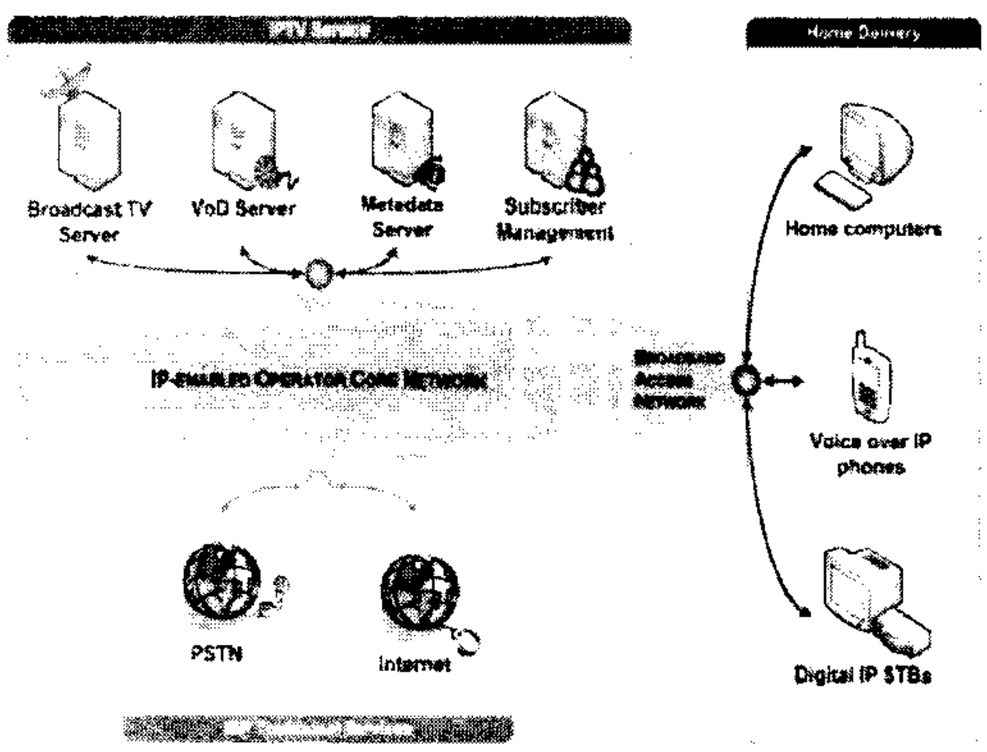
VoD is a service where the end-user selects and watches the video content. MoD serviceallows the end-user to select music or audio contents such as music file, music video and audio book over an IP network as an interactive enhanced selective service like the real VoD.

Interactive games service allowsuser to select video games over an IP network as an interactive enhanced selective service. Interactive games encompass interactive video games on television involving single and multiplayer competitions

IPTV Interactive Communication is a convergence service of telecommunication and broadcasting that compounds phone services (VoIP, video phone, multiple video conference, etc.) and internet-based communication services (instant messaging short-messaging service, email, web, etc.) with classical television services.

Place-shifting service: It is an IPTV service in which subscribers can access IPTV contents without place limitation. That is, this service makes subscriber see his or her subscribed IPTV contents anywhere. The place-shifting basically is to support users who move to the other place from the place where he or she originally subscribed for. This service is assuming that a user's terminal can even be a mobile phone [2].

3.3 A simplified Modal of IPTV



(Figure 1) A simplified modal of IPTV System

In simplified modal, IPTV services are provided through broadcast TV server, VoD server, metadata server and subscription management server. The traditional ISP services are provided by traditional PSTN network.

These are connected to broadband access network which may be ADSL through IP enabled operator's core network. The IPTV services are consumed by user through PC, IP Phones and on traditional TV with Set Top Box (STB).

4. Services requirements

IPTV services have some architecture, network, middleware, terminal device and metadata requirements which must be followed [1].

4.1 Architecture requirements

The IPTV architecture is required to support various content resolutions, content aspect ratios e.g. 4:3, 16:9, various encapsulation types such as MPEG-2 TS. It is also required to support IPTV services charging through various payment methods, mechanisms for accounting and charging purposes related to IPTV services usage.

The IPTV architecture is required to, allow for two-ways communication between end-user network and the service provider, and allow for the utilization of Internet protocols and standards. It also required support the capability to deliver Linear TV content in both High Definition (HD) and Standard Definition (SD).

The IPTV architecture required to provide mechanisms to support on-demand services, interactive services such as educational and entertainment applications (e.g. games), communications services (such as mail, chat, and messaging), and information services (such as stock and weather services).

The IPTV architecture is required to support mechanisms for the IPTV services provider to Operate, Administer, Maintain, and Provision (OAMP) IPTV equipments.

The IPTV architecture is also required to support for the provision of securitymeasures to be taken to block illegal or unwanted traffic, support the ability to search for available content, have the capability to support information about the content available to the end user.

4.2 Network requirements

Networks that support IPTV arerequired to support the IP QoS class and associated performance requirements specified in Y.1541 [ITU-T Y.1541], which recommends the selection of the specific QoS class based on application requirements.

4.3 Middleware requirements

IPTV middleware is required to, be capable of performing self-diagnostics information such as power status, boot status, memory allocation, software version, middleware version, network address, and network status.

Middleware also needs to support terminal device start-up and initialization function, server-side device start-up and initialization function, and to be able to decompress and decode multimedia contents.

4.4 Terminal device requirements

The IPTV terminal device is required to support play, pause, stop, system start-up and initialization function. It also requires the ability to select and receive multiples audio sources.

The IPTV terminal user interface is required to not rely on color alone to convey information. When no relevant national regulations apply, the IPTV terminal device can optionally support the ability of presenting emergency messages in text, alert, videoand audio over normal program media streams, and also the ability of interrupting any audio stream, including the supplementary audio.

For multi-channel audio transmissions, the IPTV terminal device is required to implement the transcoding feature, e.g. from HE-AAC to DTS Surround or Dolby Digital Plus to Dolby Digital, if it is a multi-channel capable terminal; such multichannel terminals are required to have a S/PDIF interface.

IPTV terminal device without multi-channel audio capabilities is required to implement multi-channel decoders and downmix from multi-channel to stereo.

4.5 Metadata requirements

The IPTV metadata is required to, support the indication of which accessibility features are available for a TV program, i.e. captions, subtitles in various languages, supplementary video and descriptive audio, description of accessibility features, including language etc.

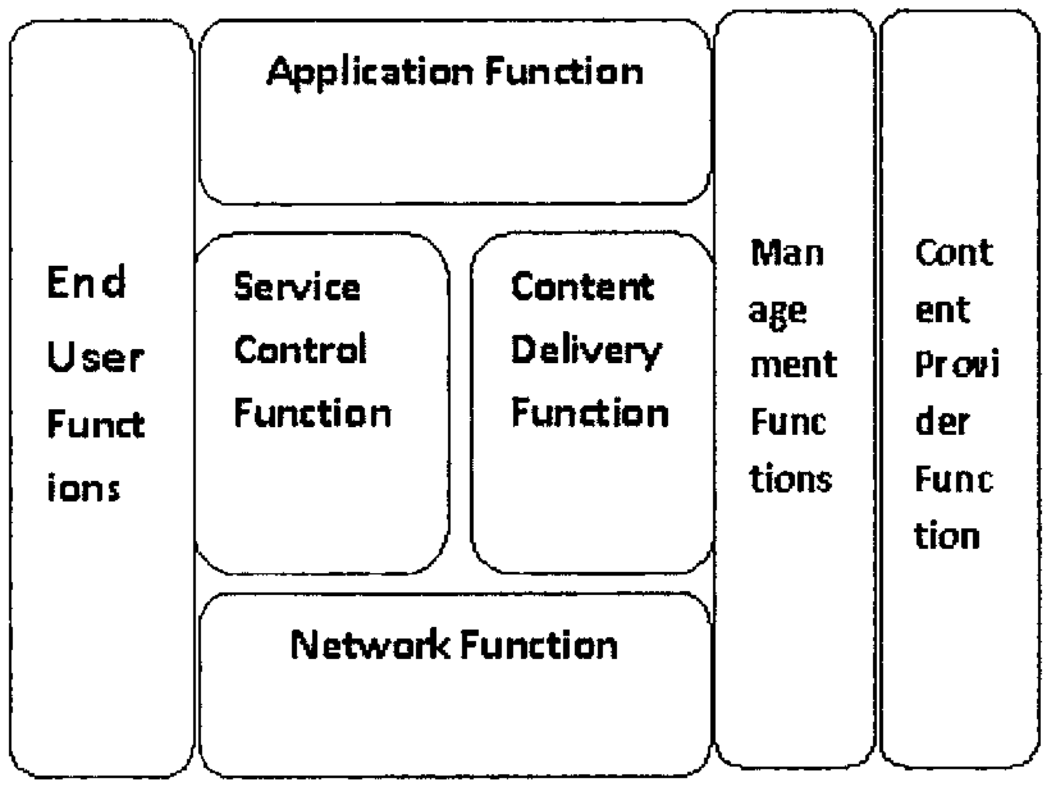
The IPTV metadata is required to provide general information about a piece of content that does not change regardless of how the content is published or broadcast, such as title, synopsis, parental control, rating, encrypted or not, price and conditions of availability like the number of plays in duration, as well as an access to a pricing server, credit list, actors, characters, key talent, key characters, writer, composer, conductor, review, critic's review, identification of the original content provider, etc.

5. Functional Architecture of IPTV

5.1 Functional Architecture

The functional architectural overview for IPTV shows the principal functional groups for IPTV.

These functional groups provide a more detailed breakdown of the IPTV functions. The layers in the architecture are derived by grouping related functions, how these layers are allocated across operational and organizational boundaries will vary between implementations [3].



(Figure 2) Functional Architecture of IPTV

5.1.1 End-User Functions

The end-user functions include those functions normally provided by the IPTV terminal and the end-user network.

The terminal functions are responsible for collecting control commands from the user, and interacting with the application functions to get service information (e.g. EPG), content licenses, and keys for decryption.

The end-user network functions provide the connectivity between the external network and each IPTV terminal.

5.1.2 Application Functions

The application functions provide the end-user functions for IPTV services, enable the end-user functions to select, and purchase if necessary, an item of content.

5.1.3 Content Delivery Functions

Content which is prepared in the application functions are delivered to the end-user via the network transport functions by the content delivery functions.

5.1.4 Service Control Functions

Service control functions provide the functions to request and release the network and service resources required to support the IPTV services.

5.1.5 Management Functions

The IPTV system management & monitoring functions manages overall system status monitoring and configuration. This set of functions may be deployed in a centralized or distributed manner.

5.1.6 Content Provider Functions

The functions provided by the entity that owns or is licensed to sell content or content assets. These are normally the sourcing of content, metadata and usage rights.

5.1.7 Network Transport Functions

The network transport functions are the combination of network transport and control functions.

The network control functions control the network transport layer to provide the required QoS for the successful operation of the IPTV service.

The network transport functions provide the IP layer connectivity between the IPTV service components and the end-user functions. These components are normally shared across all services delivered by IP to an end-user.

5.2 IPTV Architectural Approaches

There are three architecturalapproaches identified by ITU-T which are as follows:

1) Non-NGN IPTV functional architecture (Non-NGN IPTV)

The Non-NGN IPTV architecture is based on using existing IPTV network components and protocols/ interfaces the technology components and protocol interfaces used in this IPTV architecture are already in widespread use and hence this model is a representation of typical existing IPTV networks and services.

2) NGN-based non-IMS IPTV functional architecture (NGN-non-IMS IPTV)

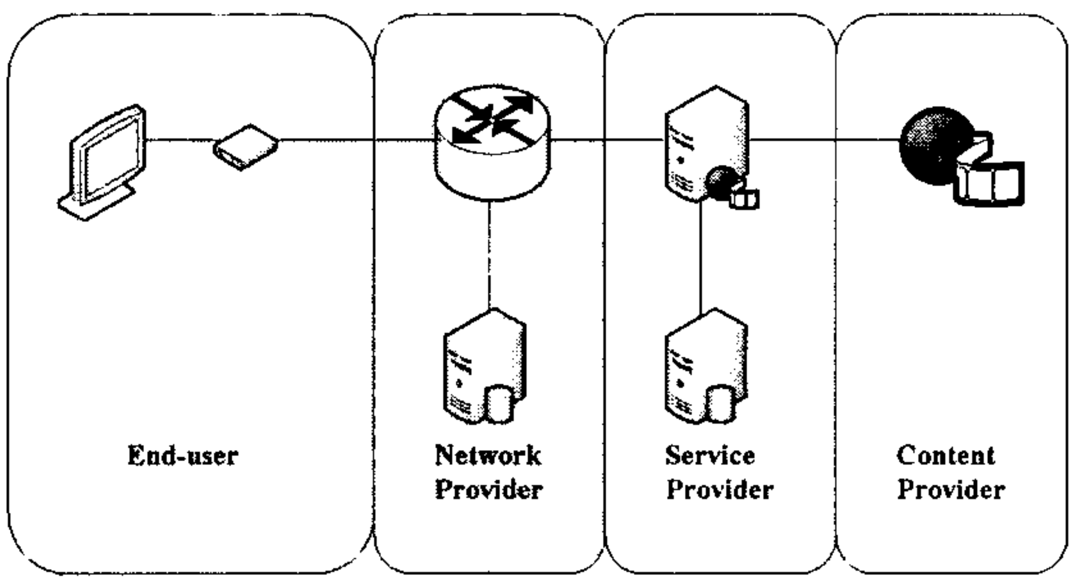
The NGN non-IMS IPTV functional architecture utilizes the components of the NGN framework reference architecture as identified in ITUT's recommendation Y.2012 to support the provision of IPTV services, in conjunction with other NGN services if required.

3) NGN IMS-based IPTV functional architecture (NGN-IMS-IPTV)

The NGN-IMS based IPTV functional architecture utilizes the IMS component to support the provision of IPTV services, in conjunction with other IMS services if required.

5.3 Functional Domain of IPTV

The functional domain involved in provision of IPTV services are shown in figure 3.



(Figure 3) Functional domain

Content Provider: The entity that owns or is licensed to sell content or content assets.

Service Provider: The entity that provides the IPTV services to the end-user.

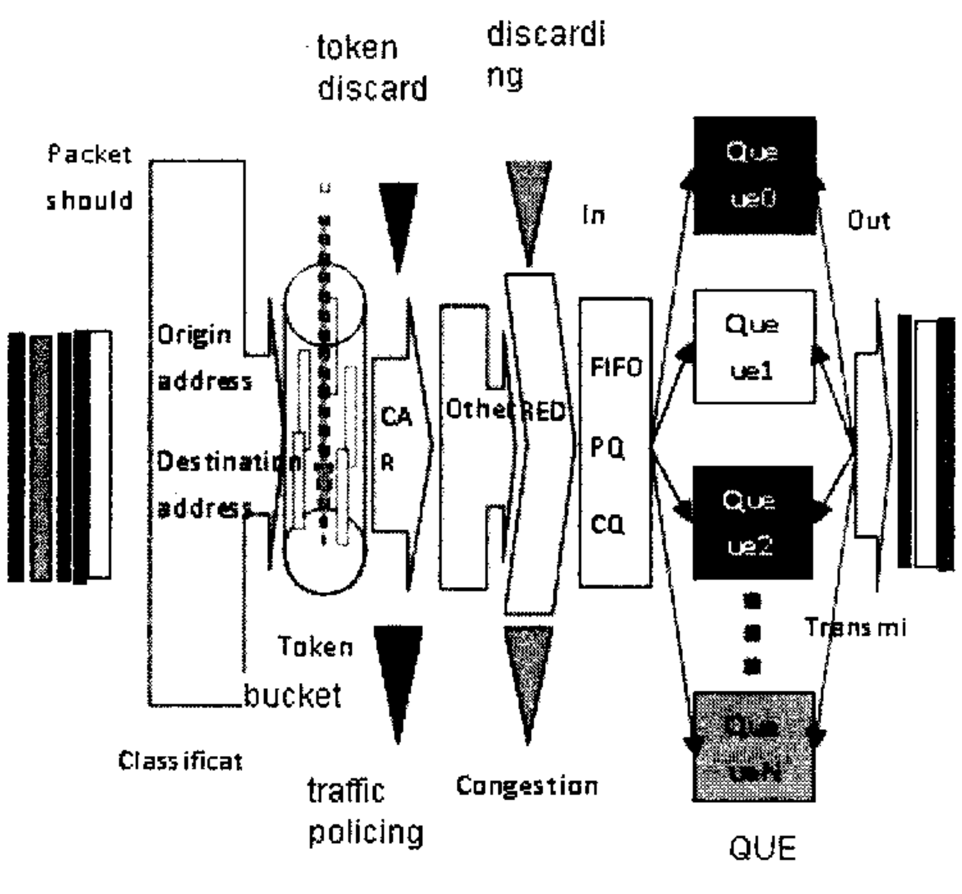
Network Provider: The entity that connects the end-users and the service providers.

End-user: The end-user consumes the IPTV services.

6. Traffic management

Traffic management is a set of generic network mechanisms for controlling the network service response to a service request. This request can be specific to a network element, or for signaling between network elements, or for controlling and administering traffic across a network, which may include bandwidth allocation, admission control, packet classification/ marking, congestion management, congestion avoidance traffic policing ,traffic shaping and line rate constraint, etc. [4].

The basic processing sequence of traffic management is shown in figure 4.



(Figure 4) The basic processing sequence of traffic management

7. Application layer error recovery mechanisms

Application layer reliability is an important aspect for IPTV service. Data being delivered over IP networks may suffer from packet losses. In case of the delivery of video and audio data errors such as packet losses or bit errors being exposed to the media decoder generally degrade the IPTV service quality [5].

7.1 Techniques of Error recovery

The mechanisms of error recovery may be retransmission, Forward Error Correction (FEC) and hybrid combinations of both. When an error recovery scheme and the associated protocol are selected, at least the following aspects should be taken into account:

1) Type of IPTV service, e.g., real time streaming video, EPG, application data.
2) Type of data delivery mechanisms, e.g., broadcast, multicast, unicast, overlay multicast, and P2P.
3) Protocol or processing overhead at senders and receivers.
4) Network bandwidth overhead aspects.

7.1.1 Retransmission

Real Time Protocol (RTP) retransmission is one viable packet loss recovery technique for real time applications. retransmitted RTP packets can be sent in a separate stream from the original RTP stream. Like TCP retransmissions, it is assumed that feedback from receivers to senders is available, but, unlike TCP, RTP/UDP does not mandate congestion control by reducing the packet transmission rate, thereby making RTP more appropriate for broadcast - grade video. The companion protocol of RTP is Real Time Control Protocol (RTCP).

7.1.2 FEC

Forward Error Correction (FEC) at the application / transport layers generally refers to packet erasure correction techniques. In these techniques, an amount of data is sent which is in total greater than the stream or the object to be communicated, with the property that the stream or the object can be reconstructed from any sufficiently large subset of the transmitted data. The stream or object is thus resilient to a certain amount of loss (at most the difference between the transmitted and the original data size).

7.1.3 Recommendations

The support of an application layer error recovery mechanism is not required for all networks, in particular for networks that can fulfill the desired IPTV service requirements.

In the case that a network cannot fulfill the packet loss requirements necessary to achieve the IPTV service requirements, the use of an application layer error recovery mechanism is recommended.

For an application layer error recovery mechanism based on FEC, the DVB IP AL FEC is recommended.

8. Recommended Standard: H.264

H.264 is enhancement to the original MPEG-4 and is also known as MPEG-4AVC.It is developed by Joint Video Team (JVT) of ISO and ITU-T. H.264 is recommended codec for IPTV services. It reduces bandwidth requirements up to half to any other standard for same quality of service.

MPEG-4 is interoperable, transport independent, has high compression ability of rich media,scalable and has interactivity support. MPEG4 is designed for low and mid bit rate compression of rich media.

Several enhancements set out by JVT were:

- To simplify the design.
- To improve compression performance and save 50% bit rate
- Support a flexible application that is appropriate to a variety of services, including low delay for real-time conversational services and higher delay appropriate for storage or server-based streaming applications.
- Ensure network friendliness through ease of packetization, information priority control and application to video streaming services.
- Performance improvements at higher bitrates.
- File storage support which includessimple stream exchange, http streaming service and multiple streams with transitions.

MPEG-4 has different profiles for different applications. In this way it allows service providers to use only subset that suits their needs.

8.1 H.264 Video Profiles

(Table 1) Video Profiles of H.264

Profile	Target Application	Decoder Complexity over MPEG-2	Estimated Improved Efficiency over MPEG-2
Baseline Profile	Low delay, video phone	2.5 times more complex	1.5 times better
Extended Profile	Mobile, streaming	3.5 time more complex	1.75 times better
Main Profile	Interlaced video applications, broadcast, packaged media	4times more complex	2.0 times better

8.2 Audio Profile

MPEG-4 uses a compression format Advanced Audio Coding (AAC) which can produce near CD quality at 64 kbps channel?

Recent Extension in AAC called Spectral Bandwidth Replication (SBR) improves bandwidth savings for applications like internet audio and digital broadcast.

AAC with SBR (High Efficiency AAC) can deliver high quality stereo audio at 48kbps.

8.2.1 AAC Features are

Multichannel Support: In addition to mono and stereo, AAC supports various surround sound configurations up to 48 audio channels.

Low Computational Complexity: Most of the AAC encoder implementations are real-time capable.

Wide Application Range: AAC supports a large set of audio sample rates, ranging from 8 kHz to 96 kHz, making it ideal for high quality audio in many applications with limited channel or memory capacities [6].

9. Summary

The IPTV Standardization work being done by the ITU-T in collaboration with other SDOs and telecommunication companies. Currently IPTV services are provided with no global standards and interoperability. ITU-T leads the process of IPTV standardization. We used the ITU-Ts working documents which were publically available to investigate the direction of IPTV standardization process. Many things including architecture, services, service requirements, codec and error correction mechanisms etc already defined through recommendations. But still there is effort going on to standardize the complete IPTV system.

Acknowledgements

This work is supported by a BcN project hosted by Hanaro Telecomm in 2007.

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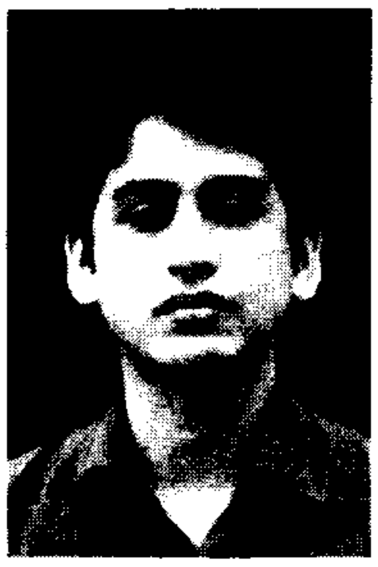

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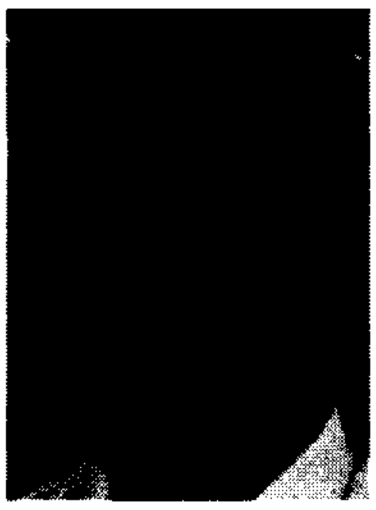

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The photograph and profile were not available at the time of publication.