Tutorial on IPTV and its latest developments

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Tutorial on IPTV and its Latest Developments

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***Abstract*—This tutorial presents on IPTV technology. Internet Protocol television (IPTV) is a system through which television services are delivered using the architecture and networking methods of the Internet Protocol suite over a packet-switched network infrastructure. IPTV services may be classified into three main groups: live television, time-shifted programming, and video on demand.**

IPTV can be viewed on a display with a set-top box that accesses channels, subscription services, on demand and other interactive multimedia services over a secure, end-to-end operator managed broadband IP data network with desired QoS to the public with a broadband Internet connection.

This tutorial also discusses the IPTV architecture, network technologies, implementation of IPTV, different types of STBs that are being used with in New Zealand, the standards, different business models, hardware and software of IPTV.

I. Introduction

IN 21st century the access with broadband internet and downstream data rates of several Megabit per second (Mbit/s) is making a steady progress. With the increasing number of households are getting used to video streaming and download, using the Internet Protocol (IP) to enable interactive retrieval of video content from the Web. This type of IP based television service is known as WebTV [1]. However, WebTV does not provide a guaranteed quality of service (QoS). Therefore now the telecommunication companies are making an attempt to overcome the deficiencies of WebTV and launched the so-called IPTV.

A. What is IPTV?

Internet Protocol Television (IPTV) is a system where a digital television service is delivered over Internet Protocol network [2]. Werner [1] describes that "IPTV is not a well-defined term and may be a source or ambiguity and sometimes confusion".

IPTV is a television service where content can be displayed on a display with a set-top box that accesses channels, subscription services, on demand and other interactive multimedia services over a secure, end-to-end operator managed broadband IP data network with desired QoS to the public with a broadband Internet connection.

IPTV system may also include Internet services such as Web access and VOIP where it may be called Triple Play and is typically supplied by a broadband operator using the same infrastructure. IPTV is not the Internet Video that simply allows users to watch videos over the Internet in a best effort fashion. IPTV technology offers revenue-generating opportunities for the telecom and cable service providers. For traditional telephone service providers, Triple Play is delivered using a combination of optical fibre and digital subscriber line (DSL) technologies to its residential base. Cable television operators use a similar architecture called hybrid fibre coaxial (HFC) to provide subscriber homes with broadband, but use the available coaxial cable rather than a twisted pair for the last mile transmission standard. Subscriber homes can be in a residential environment, multi-dwelling units, or even in business offices.

From the service provider's perspective, IPTV encompasses the acquisition, processing, and secure delivery of video content over an IP based networking infrastructure. The type of service providers involved in deploying IPTV services range from cable and satellite TV carriers to the large telephone companies and private network operators in different parts of the world.

The Fig. 1 shows us a block diagram of simple IPTV system.

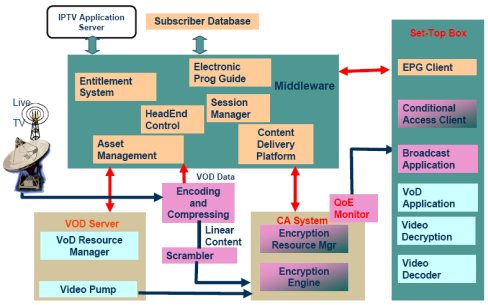

Fig.1: Simplified IPTV system [3]

B. IPTV Features

IPTV has number of features. According to [4], these features are:

(i) Support for interactive TV: The two-way capabilities of IPTV systems allow service providers to deliver a wide range of interactive TV applications such as standard live TV, high definition TV (HDTV), interactive games, and high speed Internet browsing.

(ii) Time shifting: IPTV in combination with a digital video recorder permits the time shifting of programming content.

(iii) Personalization: An end-to-end IPTV system supports bidirectional communications and allows end users personalize their TV viewing habits by allowing them to decide what they want to watch and when they want to watch it.

(iv) Low bandwidth requirements: Instead of delivering

every channel to every end user, IPTV technologies allow service providers to only stream the channel that the end user has requested. This attractive feature allows network operators to conserve bandwidth on their networks.

(v) Accessible on multiple devices: Viewing of IPTV content is not limited to televisions. Consumers often use their PCs and mobile devices to access IPTV services.

C. IPTV Advantages

(i) IPTV signals are 100% digital, so the days of analogue TV are fast becoming a thing of past.

(ii) IPTV works on any existing internet connection. So we just need to install the set-top-box and power it on.

(iii) IPTV doesn't require wires to get its signal. The newest IPTV set-top-boxes work on wireless signals.

(iv) Programs can be stored on servers and ready to view with the click of a button on IPTV remote (in contrast to linear broadcast TV).

D. Video on Demand

The idea of video-on-demand is to allow viewers to watch any programme they desire whenever they want to watch [5]. But as the technology advances and costs come down, video on demand (VOD) becomes more and more attractive to service providers.

The basic concept of VOD is based on video programming that is stored and then delivered to a viewer when it is required. This storage can take the form of a centralised server that is equipped to send programming simultaneously to a hundreds of viewers, or it can take the form of more distributed storage throughout the network. At the limit, individual storage devices for each viewer can be located in individual STBs [5].

Unicast connection is set up between the customers' STB and the delivering streaming server. The signaling for the trick play functionalities (pause, wind, and rewind) is assured by Real Time Streaming Protocol (RTSP). The most common codecs used for VOD are MPEG-2 and MPEG-4.

E. Triple / Quadruple Play

Triple play refers to multiple services being delivered by a single service provider, such as voice (telephony), data (internet access) and television services. Quadruple play adds mobile telephony to the mix [5].

From a service provider perspective, triple play services offer the combined cash flow from three separate services that can be used to pay for a common network that is capable of delivering all of them. Service providers usually offer discounts to customers who buy more than one service, which has proven to be a successful marketing policy.

Triple play focus on a combined business model rather than solving technical issues or a common standard. Quadruple play is often supported by dual-mode GSM plus Wi-Fi cell phones that shift from GSM to Wi-Fi when they come in range of home wired for triple play service.

II. CURRENT IPTV AND ITS EVOLUTION

A. IPTV Deployment

IPTV is a system of delivering television content to consumers over the infrastructure of the Internet. With the proliferation of broadband networks set up by telephone companies to offer broadband Internet to consumers, IPTV has overcome the problem of having limited bandwidth that was once a major barrier to deployment [6].

Currently there are two different ways consumers can get IPTV. They can buy a "set top box" which will convert an IPTV signal and play it on their television. The other option is to watch on a PC. Many IPTV service providers also offer voice and data capabilities with the IPTV service, making it a true "triple play" use of the broadband network. In the market of broadband applications IPTV is a major upset. With the advent of IPTV, many cable television companies are being expelled from the market of providing low cost television, data and voice broadband applications to consumers.

Business applications are also in development. Services such as streaming video are widely available on IPTV due to the scalability of the medium. The categories within IPTV are still evolving, but possibilities are still wide open as to which of the many versions of IPTV will become standard. Companies are in the initial struggle to become leaders of the market, but at this point it is anyone's game. There is no doubt that IPTV is the next generation for television content, but it has yet to be determined which companies will be the benefactors of the innovations that are now taking place [6].

B. Global Growth of IPTV

Worldwide subscriber base for IPTV services is expected to expand more than 26 times from 2005 to 2010 [7]. According to the Al-khatib and Alams' research [7] global IPTV subscribers are expected to grow from 2.4 million in 2005 to over 63 million in 2010. Fig. 2 shows the expected rate of growth of IPTV subscribers.

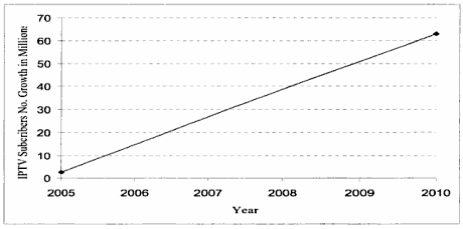

Fig. 2 Expected growth of IPTV subscriber base [7]

The IPTV subscriber base is expected to generate more than $27 billion in revenue for all IPTV services in 2010 [7]. IPTV subscriptions are poised to grow from over 30 million in 2010 to 68 million by the end of 2014, according to forecasts from analyst from Strategy Analytics [7].

III. IPTV Building Blocks

The Fig. 3 shows the basic building blocks that are required for implementing IPTV. The home gateway has to have powerful processing power and enough network bandwidth to provide networking service and to cope with various customers. In order for a system operator to deliver IPTV, it would require encoding, broadcast, and do the appropriate management before the end user can connect their set-top-box.

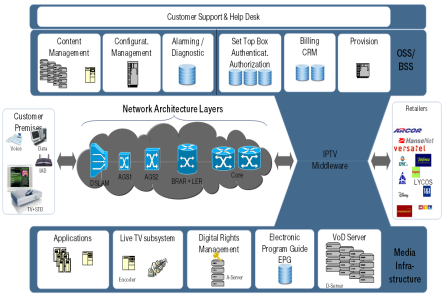

Fig. 3 IPTV Basic Building Blocks [8]

IV. IPTV Architecture

A typical IPTV architecture is comprised of the following functional blocks:

(i) Super head-end: Where most of the IPTV channels enter the network from national broadcasters.

(ii) Core network: Usually an IP/MPLS network transporting traffic to the access network.

(iii) Access network: Distributes the IPTV streams to the DSLAMs.

(iv) Regional head-end: Where local content is added to the network.

(v) Customer premises: Where the IPTV stream is terminated and viewed.

For a very large IPTV delivery system, there is often a hierarchy of facilities constructed to deliver video signals across a large extent of territory. One Super Head-end can serve millions of customers by processing the video channels that are common to all subscribers across the serving area. A Video Serving Office is located in each region as required to handle local programming and channels specific to a single city or geographic area. The Remote Terminal can serve as a Regional Head-end that contains the equipment needed to actually deliver the programming to customers in local area.

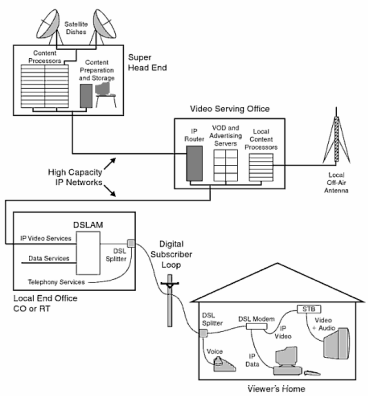

Fig. 4 Typical IPTV System Architecture [5]

Broadcast information coming from an antenna or a satellite dish at the Super Head-end is mainly distributed using MPEG-2 multi-program transport stream (MPTS) to the video service node. The distribution of the actual SDTV or HDTV channel content is performed using various devices on the access network, such as digital subscriber line access multiplexers (DSLAM) and other technologies like fibre-to-the-home (FTTH) can be used to interface with the user's STB. For IPTV, each channel is distributed using a multicast IP address.

V. IPTV Networking Technologies

IPTV technology is part of a new breed of services designed to facilitate access to video entertainment. It provides access to digital TV over the IP transport medium from a head-end device to the end user's TV set-top box (STB). Most service providers use a dedicated transport network to support IPTV.

A. IP Distribution to the STB via DVB IPI

DVB has had a technical ad-hoc committee (TM-IPI) dedicated to IP distribution to the STB since 2000. It has a responsibility to provide a standard for the IP interface connected to the STB. The special feature about this technology in contract to the other standard bodies and traditional broadcast methodology is that it starts at the STB and then works to outwards [9]. The standards bodies of TM-IPI are shown in Fig. 5.

(i) DLNA (Digital Living Network Alliance) for the home network.

(ii) HGI (The Home Gateway Initiative) for the standards surrounding the residential gateway between the broadband connection and the in-home network.

(iii) ISMA (The Internet Streaming Media Alliance) for the transmission of AVC video over IP.

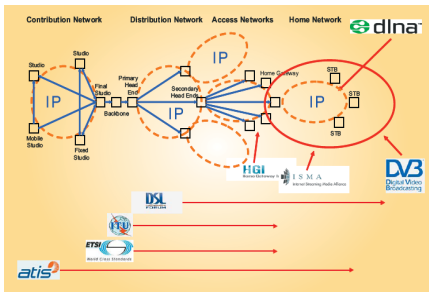

Fig. 5 IPTV related activities of selected standardisation bodies [9]

(iv) DSL Forum for the standards surrounding DSL and remote management of in-home devices including STBs and residential gateways.
(v) ITU which, via the IPTV Focus Group, is standardizing the distribution and access network architecture.
(vi) ETSI which, via the NGN initiative, is standardizing the IP network carrying the IPTV.
(vii) ATIS which, via the ATIS IPTV Interoperability Forum (ATIS-IIF), is standardizing the end-to-end IPTV architecture including contribution and distribution.

B. IPTV over DSL versus DVB over satellite and cable

In contrast to other technologies, the difference in IPTV over DSL is that the client-server architecture used for IPTV sit between the provider backbone and the IPTV home. The difference here is that not a single programme goes automatically into the IPTV home. A simplified comparison of IPTV over DSL with the DVB-S and DVB-C is shown in Fig. 6.

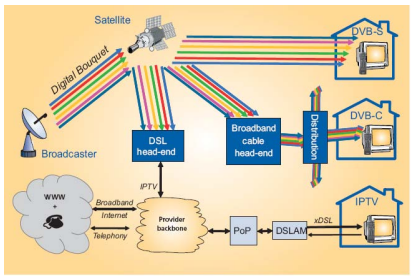

Fig. 6 Comparison between IPTV over DSL with the DVB-S and DVB-C [1]

The coloured (if printed in black and white, the different grey lines) lines represent the different television programmes of a digital bouquet that are bundled together in one or more multiplexes. Each of these carries a multi-programme transport stream (MPTS) [1]. Similar to Broadband cable head-end, the DSL head-end picks up the satellite signals and converts them to IPTV signals. But the difference is that when we press the button of an IPTV remote control, it is communicate back via the return channel to the service provider. Then the server routes the requested programme as a single programme transport stream (SPTS), over the backbone to the point of presence (PoP) at the DSL access multiplex (DSLAM). The technical challenge for IPTV is the short time delay during channel hopping [1].

VI. IPTV Standards and Solutions

Setting standards for IPTV would be difficult at best. There are multiple areas to cover, as IPTV is very broad subject, and the medium was not intended to transport audio and video when it was created. Moreover, some specific features of this medium allow some services while outdating some of the former schemes based on broadcast [10].

Standardization is important in the telecommunications industry. Especially when talking about such a complex and large system as IPTV. So it requires many standards for the user's vote to be securely recorded when pressing the red button on the remote control. The main standards body for IPTV has emerged to be ETSI (European Telecommunications Standardization Institute), through the branch that develops standards for the "next generation networks", which many telecom operators are deploying. Table 1 shows the organisations that are working to develop standards for IPTV.

TABLE 1: THE STANDARDS ORGANISATIONS DRIVING IPTV [11]

Name	Focus	Type of organization	Primary industry
Open IPTV Forum	End-to-end IPTV service, including interaction and quality of service	Industry consortium	Telecom
ITU-T	IPTV Focus Group	Formal standards organization	Telecom
ETSI TISPAN	IPTV based on IMS, and referencing relevant standards for the transport layer	Formal standards organization	Telecom
ATIS	IPTV for cable TV providers	Membership organization	Cable-TV
SCTE (Society of Telecommunications Engineers)	Technologies related to digital cable television	Industry association	Cable-TV
DVB Forum	IPTV and interactive television, primarily for broadcasters	Industry consortium	Broadcasting

VII. Set-top Boxes

An IP set-top box is a dedicated computing device that serves as an interface between a television set and a broadband network. In addition to decoding and rendering broadcast live TV signals, a set-top box provides functionality that includes video-on-demand (VOD), electronic program guide (EPG), digital rights management (DRM), and a variety of interactive and multimedia services. Set-top boxes can support additional features such

as Web browsing, e-mail and viewing e-mail attachments, advanced multimedia codecs, home networking and PC connectivity including playback and rendering of content stored on the PC (photos, music, and personal videos), gateway functionality, instant messaging (IM), and real-time voice over IP (VoIP). These types of advanced functionalities are in demand by end-users, enable incremental network operator service opportunities, and allow set-top box manufacturers to easily offer a large range of differentiated devices [12].

Also to provide secure delivery of satellite data in IPTV systems, service providers charge subscribing fee by scrambling the program in conditional access system using control words. At the receiver end, smart card is used to decrypt the control words and transfer them back to set-top box to descramble the scrambled program. Therefore, secure communication between set-top box and smart card is closely related with the benefit of service providers and the legal rights of users [13].

Current set-top box development is driven by service provider requirements and customer demand for new features. Priorities for service providers include the capacity to deploy, using minimal capital expenditures, new revenue-generating services and multimedia and entertainment-oriented applications on a set-top box to meet changing customer requirements over time. Service providers also need to ensure that copyrighted content is protected from unauthorized distribution. To accommodate these expectations, the set-top box operating system platform must be extensible and remotely upgradeable, and include both rich multimedia technologies and fundamental security features, such as access control.

A. Basic Functions

The main job of the STB is to receive the incoming IPTV signal and convert it to a video signal that can be displayed on the viewers' television. This also provides the user interface that allows viewers to select the video programming to be viewed. To do these tasks STB has the following functional elements [5]:

(i) Network Interface, to receive the IPTV signals and transmit user commands.
(ii) Video and audio outputs, which are connected to the viewers' video display and speaker system.
(iii) User interface, both on the front panel of the STB and by way of an on-screen display and remote control.
(iv) Conditional access hardware/software, to support secure viewing of valuable content.
(v) Hard disk drive, for recording video programs.

B. TiVO Set-top-box

Telecom New Zealand and Hybrid TV has the exclusive rights of TiVo products and only its broadband customers can have the access to TiVo internet features [14].

A TiVo box acts like a digital tuner, giving the access to Freeview HD channels and the ability to record them. It will also provide internet access to pay-per-view movies and TV shows. Fig. 7 shows TiVo set-top box, remote controller and Wi-Fi wireless access device.

Fig. 7 TiVo Set-top-Box, wireless adopter and remote controller [15]

Some of the TiVo STB features are summarised below.
(i) Vital statistics: The TiVo box is 42cm long, 32cm wide and 7.5cm tall.
(ii) Hard disk: 320 GB (up to 250 hours Standard Definition or 120 hours of High Definition, dependent on station broadcast formats recorded).
(iii) Composite video and stereo out, HDMI output.

TiVo features for Telecom customers [16] are;
(i) The HD DVR allows viewer to play, pause or rewind live TV and record two programmes at once.
(ii) The 14-day on-screen TV Guide makes it easy to schedule the recording of free-to-air programmes and see what's coming up on the box. The Now Playing list shows all the programmes that viewer have already recorded.
(iii) The Season Pass Manager automatically records every episode of the favourite series for the whole season.
(iv) The WishList search finds and records programmes that feature viewers' favourite actor, director, team or topic.
(v) Viewer can restrict programmes, lock channels or set ratings to shows that are unsuitable for children with TiVo KidZone.
(vi) Using the remote scheduling tool via the internet, viewer can set their TiVo to record when they are away from home.

C. My Sky HDI Set-top-box

The MySky HDi is a Personal Video Recorder (PVR), just like the original MySky box. The "i" in MySky HDi refers to interactive offerings; ie: the box is allowed to receive internet-delivered television (IPTV) from Sky [17]. Another feature that differs from the old Sky box is that the stunning High Definition output delivers to HDMI-capable TV sets.

The new box has twice the theoretical capacity of the original MySky (320 Giga Bytes vs 160 Giga Bytes). However, in practice, consumers can only access 160GB to store recorded programmes and the remainder is for operating system software and to store pay-per-view programming downloaded to the box.

The MySky HDi comes with four tuners, but only two are enabled in the first release. So initially you'll be able to record two Sky channels at once, just as the existing box offers [17].

The My Sky HDI Set-top-Box shown in Fig. 8 has the resolution of 1080i and Sound of 5.1 Dolby [18].

Fig. 8 My Sky HDI Set-top-Box and the remote controller [18]

D. *TelstraClear Set top box*

According to [19] TelstraClear STB has the following features.

(i) 3 Tuners - This allows viewer to record 2 HD (High Definition) channels whilst watching another HD channel OR to watch a pre-recorded programme while recording 2 others.

(ii) 300GB of hard drive space - To record up to 180hrs of SD (Standard Definition) and 50hrs of HD TV.

(iii) Up to 1080P HD playout through HDMI 1.

(iv) TV Guide with picture-in-picture functionality.

(v) MPEG2, MPEG4, Windows Media, Flash Video and H264 compliant.

(vi) Dolby AC3, MP2, MP3 and AAC audio compliant – The best options to cover all the best audio formats.

(vii) Supports future internet video delivery.

VIII. CONCLUSION

IPTV is an evolving technology platform to provide television broadcasting services based on wide range of rapidly advancing technologies. There are little information about implementation and services in operation for newcomers to observe. Caution and careful planning would mitigate the risk of failures.

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