The Emergence of Internet Protocol Television as Next Generation Broadcast Network

P.L. Srinivasa Murthy and T. Venu Gopal

Abstract Due to the emergence of innovative technologies over Internet, the traditional broadcasting of TV is changed to use IPTV for next generation networks. IPTV is the delivery of multimedia content to multiple subscribers through multicasting over well known IP. The IPTV depends on the Internet and telecommunications. Therefore, the inherent issues are to be identified and resolved for the success of IPTV. In this paper, we review the IPTV concept and its related aspects. The paper throws light into the issues of IPTV, integration of different communication media and approaches like P2P (unicast model) and IPTV (multicast model), and the need for QoS requirements and evaluation of QoS in the context of IPTV networks. Moreover, the paper provides user behaviour that can have impact on the content distribution infrastructure and the underlying strategies for content delivery and reduction of zapping time. We also present a hybrid approach that combines the features of delay insensitive and delay sensitive approaches to strike balance between highly popular and least popular IPTV channels. The insights of the paper are useful in further research in the area of IPTV which is going to be the next generation network for high quality and complex content delivery.

Keywords IPTV · Multicasting · Interactive video streaming · User behaviour modelling · QoE

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1 Introduction

In the wake of technological advancements Internet Protocol (IP) is being used for delivering multimedia content over Internet. In fact, leveraging IP for global communications became a cheaper alternative for reliable and instant communication over global communication medium such as information super highway. It is a wise idea to utilize already established public network such as the Internet for public communications. With IP v6 and security considerations, IP became a viable alternative for cost effective global communications. Many technologies such as Voice over IP (VoIP) are already in place to exploit delivery of voice communications and multimedia content over Internet Protocol. This has motivated broadcasting networks like Television to adapt IP based content delivery as its next generation broadcasting method. The phenomenon which facilitates deliverance of multimedia services of Television via Internet Protocol is known as Internet Protocol Television (IPTV). Thus, the TV network can leverage the advantages of well established public network (Internet) and its underlying protocols for broadcasting content. IPTV when realized fully can bestow plethora of advantages like interactive TV, personalization, low bandwidth requirement, and accessibility on multiple devices besides a low-cost service.

Traditionally, TV is a telecommunications medium for delivering broadcasting content like text and moving images. Right from the inception TV had undergone many changes such as mechanical television, electronic television, colour television, digital television, smart television, and 3D television. With respect to broadcasting medium TV is categorized into terrestrial television, cable television, satellite television, and Internet television [24]. With the emergence of IPTV, there will be revolutionary changes in the way TV works as next generation mass communication medium with many benefits as said before. However, IPTV can throw many challenges as it is based on the public network Internet and over IP which is considered an untrusted public network. The challenges are pertaining to security, service quality, privacy and content quality. Reducing risk of unauthorized access to digital services rendered via IPTV is the major concern that needs to be addressed for taking the TV services to the next generation network IPTV successfully.

This paper throws light on the IPTV and its present state-of-the-art. Our contribution in this paper is to review IPTV as next generation broadcasting network and related aspects with valuable insights. The remainder of the paper is structured as follows. Section 2 provides integration of WiMAX and GEPON for seamless integration of underling wireless and wired counterparts. Section 3 throws light on the need for QoS and its evaluation in IPTV. Section 4 reviews interactive usage dynamics in IPTV. Section 5 focuses user behaviour modelling for reducing zapping. The Sect. 6 hybrid approaches for IPTV. Section 7 provides conclusions and recommendations for future work.

2 Integration Of WiMAX and GEPON

According to Obele et al. [1] bandwidth–hungry applications like IPTV and high-definition television (HDTV) have been around for some time and they keep on driving even for higher bandwidth in the networks. To overcome this problem it is possible to integrate both wired and wireless networks Gigabit Ethernet Passive Optical Network (GEPON) and Worldwide Interoperability for Microwave Access (WiMAX) respectively for improving Quality of Service (QoS). Obele et al. reviewed a convergence architecture that makes use of QoS and queuing concept to provide highly reliable treatment to traffic based on different classes of traffic such as long-range-dependent and self-similar. The performance was evaluated under realistic load conditions.

3 Need for QoS and Its Evaluation in IPTV Networks

Habib [2] proposed a method to evaluate QoS evaluation in IPTV networks. The research was carried out on the QoS evaluation of bandwidth scheduling. Traffic policing and call admission control (CAC) were applied to evaluate the QoS performance of IPTV networks. As Markov chain based models are widely used for QoS analysis, Habib used a model known as Markov Fluid Flow,model (MFFM) to evaluate QoS pertaining to bandwidth scheduling. With the proposed model the waiting time and probability of loss were reduced in video content delivery. This model was found good for evaluation of IPTV performance with experiments on five movie traces. QoS differentiation is explored in [3] for having diversified traffic handling mechanism to accommodate service classes that need different quality. There must be different approaches for traffic classes like delay-sensitive and delay-insensitive traffic. The economic analysis pertaining to QoS differentiation was performed in presence of different traffic classes expecting varying quality requirements. The real time applications like IPTV and VoIP need to have well defined strategies to ensure that the quality is not lost. Caching strategies as explored in [4] can help commercial IPTV to have high quality content delivery. For improving quality of services for IPTV, Ethernet networks have built in broadcasting capabilities [5].

IPTV is one of the transport layer protocols that needs high bandwidth besides quality of service networks [6]. Real Time Transport Protocol (RTP) is the underlying protocol for various bandwidth intensive applications like IPTV. Link functioning under such applications were explored in [7]. For high QoS delay-oriented analysis of networks that demand high bandwidth is essential. This is explored in [8] with respect to the design and implementation of optimal scheduling algorithms. This will help in improving quality of applications like IPTV for broadcasting multimedia content. Therefore, delay is an essential metric to measure the performance of IPTV. Not only IPTV there are many delay-sensitive

applications in the real world. They include YouTube, UStream, Video on Demand, Goggle Hangouts, Google Voice, FaceTime, Line, Skype, and so on. Distortion and Error Propagation modelling are explored by Chakareski [9] in the presence of predictive video coding. Loss of packets leads to distortion of video generally. However, the research revealed that distorting is caused not only by data loss but also patio-temporal distribution of multimedia content. These are all capable of affecting quality communications in IPTV. Similar kind of research was carried out in [10].

Adaptive video streaming is one of the approaches to increase quality of video content delivery for IPTV. Video streaming is characterized by delivery of video to multiple users at a time with initial buffering. Adaptive streaming will help IPTV to enhance quality of content deliverance. Markov chains are generally used to represents different states in the content delivery process of IPTV. The underlying Hidden Markov Process can take into account bandwidth variations at run time and the application layer encoding constraints and strikes balance between then for improving quality of services [11].

4 Interactive Usage Dynamics of IPTV in Large Scale

Video on demand (VoD) is one of the means in which consumers like to have access to video content. The consumers wanted to have interactivity to watch videos selectively. Gopalakrishnan et al. [12] explored the behaviour of consumers with respect to interactive viewing of videos in the context of IPTV. They investigated how users make use of advanced streaming features and controls and how the user behaviour causes overhead on the content distribution systems. Thus, their research provides useful insights pertaining to user behaviour and the impact of the same on the distribution infrastructure. They also proposed a comprehensive model in which a large number of subscribers watch videos on demand interactively. Towards this end, they used two components known as arrival process model and stream control usage models, respectively. They are meant for determination of arrival process and interactive usage of videos. the model includes many control features to end users such as stop, no action, pause, replay, skip, rewind, fast forward, play, exit and start. The two models hey presented have their strengths based on the application.

IP network traffic management is essential for VoD purposes. Mirtchev et al. [13] reviews different models for managing IP traffic in the context of IPTV. They focused on experimenting on the traffic measures on different traffic types like VoIP flows, TV, Point-to-Point (P2P), and HTTP transfer. The parameters considered for measuring traffic include priority of packets, distribution of packets, and distribution of session duration, mean inter-arrival time, mean packet size, and packet intensity for the four kinds of network traffic. Thus, they explored the possible optimization of different traffic flows based on traffic analysis. There were many video traffic models that can be explored for IPTV. According to Tawnier and

Perros [14], the VBR video traffic models [15] can be classified into autoregressive models, and models that are based on Markov process. Auto regressive models were explored by them in terms of video coding, level, scene changes, residual error, sources, and publication date. They also investigated markovian models in terms of video coding, level, scene changes, sources and publication date. There are other models such as Wavelet based models that decompose signals for traffic analysis. Their experiments reveal that wavelet-based model was found good for having SRD and LRD co-existed.

Hossfeld [16] focused on how Internet applications and users behave in future. The investigation was made on emerging user behaviour in the context of next generation Internet applications. Quality of Experience (QoE) was used as a measure to know how users are satisfied with the content delivery. QoE largely depends on the jitter, packet reordering, packet loss and degradation of QoS. The quality of content distribution networks are determined by certain characteristics such as ability to handle flash crowds, handle churn, mobility and true participation in the network. There is a relation between selfishness of users and the robustness exhibited by the system.

5 User Behavior Based Model for Minimizing Channel Zapping Time in IPTV

Channel zapping is one of the concerns in IPTV. The content delivery quality gets reduced and this leads to the reduction in QoE of end users. Lee et al. [17] proposed a predictive tuning method that can reduce channel zapping time. This model is based on user behaviour. They used semi Markov process to model the channel zapping time based on user behavioural dynamics. User behaviour patterns are used as inputs to have tuning with pre-defined knowledge that can cater to the improved quality of services. This will lead to high QoE due to the fact that the model reduces channel zapping. This kind of model is very useful even when bandwidth availability is less and there needs to be high quality output in the content delivery. When channel preferences are considered for tuning, it will be useful in achieving the reduction in channel zapping time. In the process both channel preference and button preference are exploited.

6 P2P Approach for IPTV Streaming Over Internet

P2P approach for IPTV has been a very interesting research area. It is possible to combine IPTV and P2P where multicast and unicast are utilized, respectively. Both multicast and unicast channels work together for IPTV. The hybrid approach is shown in Fig. 1.

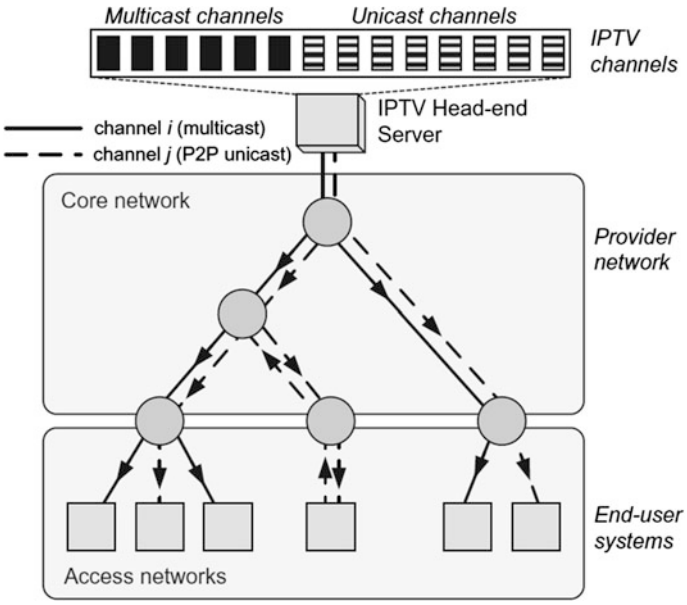

Fig. 1 Hybrid approach for IPTV [18]

As can be seen in Fig. 1, it is evident that there are unicast and multicast channels combined to form IPTV channels. For unpopular TV channels unicast approach is sufficient while the popular channels need to utilize multicast. Therefore, it is possible to achieve both the benefits using the hybrid approach. When the TV channels are not much popular, the content delivery is made using P2P networks while the TV channels with high popularity are given multicasting capabilities. Thus, it is possible to optimize bandwidth besides improving QoE [18]. Other contributions towards IPTV include modelling multiplexed traffic [19], exploring challenges in future Internet applications [20], P2P streaming in distributed fashion [21], Push-to-Peer VoD systems [22], VoIP [23] and quality of service management approaches in IPTV content delivery.

User Behaviour Analysis of IPTV Usage of VOD

As explored in [12] the IP based video distribution traces provided valuable insights on interactive usage of the IPTV. The experiments were done on both weekends and week days. The user activities considered for analysis include play, fast forward, rewind, pause, skip, and replay. Average count and average duration were considered in both time periods. The difference between the weekend and week day behaviour can provide useful information to estimate general user behaviour with respect to video distribution over IPTV.

As can be shown in Figs. 2 and 3, it is evident that there is clear difference between the user behaviour with respect to the viewing of videos of VOD fashion in terms of the difference count of different events aforementioned and the duration of

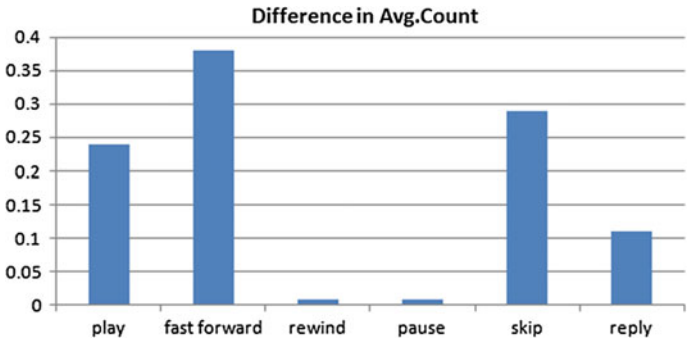

Fig. 2 Shows the difference in average count of events between weekend and week day

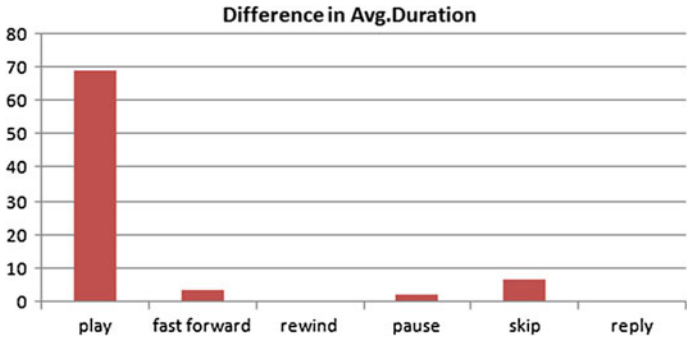

Fig. 3 Shows the difference in average duration of events between weekend and week day

each event. The usage patterns reveal that in weekend the count of events and the duration are more when compared to week days. This behaviour paves way for formalizing policies and planning for VOD content distribution through IPTV.

7 Conclusions and Future Work

In this paper we studied the concept of IPTV and its present state-of-the-art in the real world. It has been understood that many bandwidth-hunger applications like VoIP and IPTV demand high bandwidth. Therefore, there should be cost-effective strategies to ensure that the IPTV is a reality and successful phenomenon. Towards this end, this paper focuses on the IPTV and its related issues and solutions. This paper also throws light into the combination of P2P and IPTV, integration of wireless and wired communication protocols, need for QoS and evaluation of IPTV networks as next generation content delivery networks. User behaviour with respect to interactive behaviour, reduction of zapping and modelling of IPTV with

provision for handling different QoE and QoS requirements. It is achieved in terms of implementing delay sensitive and delay insensitive approaches that can cater to the needs of the modern IPTV network. This research can be extended further to explore Markov model to effective user behaviour analysis. Such analysis can lead to a holistic approach for ensuring quality of services.

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