User Generated Content for an IMS-Based IPTV

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***Abstract*— Offering an IPTV service is one possible tactic for a Telco to stay relevant in the ever changing market. However, unless there is something to differentiate the offer from the competition, users will question why they need to subscribe. There has to be a unique selling point (USP), something that represents a compelling emotional reason to sign up for the service. This can be done by adding an extra service that has the potential to attract more users to the service. One such service is user-generated content (UGC). With the high success of UGC websites in terms of generating revenue through advertisements, the success can be shared with IPTV if the UGC service is offered with other IPTV services. The IP Multimedia Subsystem (IMS) provides the platform that can integrate different services together hence this is why it was used in this paper. This paper will propose and investigate a framework for IMS-based IPTV that include UGC services that have an advertising system. The implementation is based on the University of Cape Town (UCT) Advanced IPTV server, which is deployed in the UCT IMS test-bed.**

Keywords-UGC, IPTV, EPG, IMS

I. INTRODUCTION

Many telecommunications service providers worldwide are moving towards triple play offerings by combining voice, video and high speed data services. Majority of service providers are using IP-based technology to support such video services, commonly known as IPTV (Internet Protocol Television) services.

Internet Protocol television (IPTV) is a system whereby digital television content is delivered over an IP network infrastructure instead of being delivered through traditional radio frequency broadcast, satellite signal and cable television (CATV) formats. It is important to differentiate between IPTV and Internet TV [1]. IPTV is a video service supplied by a telecom service provider that owns the network infrastructure and controls content ingestion and distribution over the broadband network for reliable delivery to the consumer, generally using an IP set-top box. This is essentially a private network controlled by the service provider. Internet TV, which is rapidly emerging in parallel, consists of content sourced from anywhere on the Internet that can be streamed and/or downloaded by the user, generally on a PC [2] [1]. Secondly IPTV video is of high quality which is maintained throughout the network whereas Internet TV quality of video is driven by the speed of internet connection i.e. best effort. Furthermore IPTV is a subscription service while Internet TV is typically free or charged per video.

The period between the first quarter of 2009 to the first quarter of 2010 saw a global growth of 46% in IPTV subscriptions, equating to 11.4 million new IPTV subscribers [3]. In the first quarter of 2010 alone the world-wide IPTV market grew by 7.8% leading to an overall 36.3 million IPTV subscribers as of March 31st 2010. IPTV penetration is around 7.7% of total broadband lines which significant given the established position of cable, Digital Terrestrial Television and satellite alternatives in many mature markets [3].

Offering an IPTV service is one possible tactic for a Telco. However, unless there is something to differentiate the offer from the competition, users will question why they need to subscribe. After all, they already receive national broadcast channels and may well subscribe to cable TV or satellite services. Why would they want to pay more money for a duplicate service that uses new technology and an extra set-top box? There has to be a unique selling point (USP), something that represents a compelling emotional reason to sign up for the service [4]. This led to IPTV providers to offer services in a more competitive way. Social TV is one of the ways the service providers are trying to set apart their offerings and provide the USP for the end-user. A number of different implementation of Social TV are available [5][6][7][8][9][4], each with its unique attributes. All these variations have the potential to draw in consumers but they lack a clear way in which the service provider can generate revenue out of it.

This paper proposes to offer user-generated content to IPTV users as one of the services to offer the USP. UGC sites like YouTube, Break.com, Metacafe and Daily motion amongst others generated more than 230 billion domestic US views in 2010, a 146.9% year-to-year increase [10]. By the end of 2011, UGC sites were expected to earn $4.3 billion in ad revenue in the US [11]. These huge audiences attract investments from advertisers. YouTube generated an estimated $213 Million (Net) in pre-roll advertising in 2010[10]. This shows the potential of investing in such a business. IPTV service providers can offer such a service on their network as it has the potential of attracting users because of the social aspect of sharing and attract advertisers because of the number of users. This paper aims to overcome the problems of IPTV service providers not generating a lot of revenue, TV operators potentially losing users to streaming services [12] and

incentivise IMS-based IPTV roll out. In particular, it will answer the following research questions:

- Can adding UGC services which also has an advertising system as an extra service to IPTV be a feasible business model that can increase revenue and subscribers for Telco's and also act as an incentive for others to invest in IMS-based IPTV?
- IPTV is usually offered on subscription; therefore users have an expected Quality of Experience (QoE) which can be measured using service latency, service features and service quality. So, how will the adding of UGC services to IPTV service affect user's QoE of the IPTV service?

We proposed and explored the architecture that will offer UGC to IPTV viewers. We utilized the European Telecommunications Standards Institute (ETSI) Telecoms and Internet Converged Services and Protocols for Advanced Networks (TISPAN) IMS-Based IPTV architecture. The University of Cape Town (UCT) IMS client and the UCT Advanced IPTV system were modified for implementation purposes. These modifications are detailed in section IV. The rest of the paper is structured as follows: section II will give the Literature Review, section III presents the proposed architecture, section V presents the tests and results and section VI will conclude the paper.

II. LITERATURE REVIEW

Table 1 shows the different systems that offer UGC video service on TV. It also shows the different features that each one has compared to the others and shows how the proposed system is better than available systems.

Table 1 UGC video service on TV

Features					
	Colurful TV [4]	**TV Blog [13]**	**Living@room [9]**	**Tribler [14]**	**Proposed System**
Server Storage	☆	☆			☆
Streaming capability	☆		☆	☆	☆
Publically shared content	☆	☆		☆	☆
Instant watching with no communication between users	☆	☆		☆	☆
Way to generate revenue					☆

Colorful TV is a system developed by Telekom Austria [4] which offered standard channels and pay-per-view Hollywood movies and also programs and channels featuring content created locally. As shown in table 1, it lacks a way in which the service provider can generate revenue out of it and this is true for all the systems. Mantzari and Vrechopoulos [13] introduced TV Blog which allows users to upload videos on the blog and other users download the content to their recorders to watch. The drawbacks of this system are that the only way the user can view a video is by downloading the content so that it is locally available on their system meaning the user has to wait for the video to download before they can watch it. Furthermore, this system requires the user to have storage on their side to be able to enjoy the content hence this forces the user to have storage to use the system. G. Andrea et al. [9] proposed a system called Living@room which enables the remote enjoyment of multimedia content (photo, video, documents, etc.) The problem of this system is that it requires the users to communicate first before the session starts. Once the streaming session is over and the user who had initiated the session is gone, the other users cannot access the content. J. Fokker et al [14] created Tribler. This allows users to be connected in a network where they can view other users' content which they can watch through downloading, live streaming and VoD. The drawbacks of this system are that the service provider has no control of the system, meaning they cannot make money out of it. There is also the problem of some content not being available when the user is offline since it is not server based.

III. PROPOSED SYSTEM ARCHITECTURE

Figure 1 below shows the proposed system architecture which is based on the ETSI TISPAN IMS-based IPTV architecture. It introduces the IPTV Application Server (AS) with UGC services.

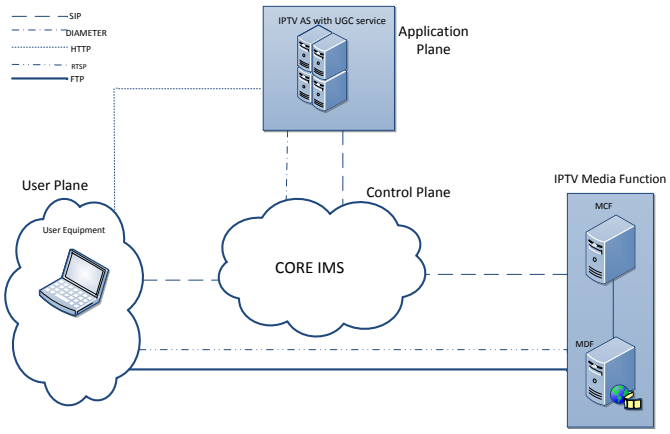

Figure 1: Proposed Architecture

There are two procedures that will be considered in this architecture:

- **Creation of the user-generated content:** this allows the user to declare UGC with its metadata and upload to the network. This will include an option to select who will be able to view the content once it is on the network.
- **Watching of user-generated content:** this allows the user to select and watch the content that is already on the network.

A. *Creation of user-generated content*

Figure 2 depicts the 3 main steps that occur during UGC creation and these are as follows:

Step 1: Declaration and Publication of UGC by User Equipment (UE)

- 1A) The UE sends a UGC creation Request through the Core IMS to the IPTV AS.

- 1B) The UE also sends a UGC Description Request which contains a description of the UGC (name, category, textual description, special group users).
- 1C) The IPTV AS records the UGC information and sends a UGC creation Response which includes the UGC content ID through the Core IMS to the UE.
- 1D) The IPTV AS records the UGC description and sends a UGC Description response through the Core IMS to the UE.

Step 2: Creation of user-generated content

- 2) The UE initiates a UGC creation session according to the category provided by the user in step one and the Media Function (MF) will provide the location where the content is going to be stored. The content is then transferred to the location from the UE using file transfer protocol (FTP).

Step 3: Publication of user-generated content information

- 3) The Service Control Function (SCF) establishes the relationship between UGC ID, description and location and publishes this information in a database used for the EPG.

B. Watching of the User Generated Content

The UGC watching procedure comprises two major steps illustrated by Figure 3:

Step 1 Selection of UGC

- The user will select the content from an EPG. The EPG will have the name of the content and textual description. This information is from the MySQL database which is updated every time new content is added in step 3 of the creation of UGC.

Step 2 Watching of UGC

- When the user selects the content a Session Initiation Protocol (SIP) INVITE message is sent which requests the channel for the UGC content.
- The INVITE is the then forwarded to the IPTV AS by the Core IMS.
- The IPTV AS runs the categorising algorithm using the category of the requested video.
- IPTV AS performs a hash table lookup to select the relevant advertisement for the media.
- The Real Time Streaming Protocol (RSTP) addresses of the requested media and advertisement are forwarded to UE which then requests the media from the Media Function
- The Media Function will stream the advertisement first and once it has ended it streams the selected content.

IV. TESTBED SETUP

The University of Cape Town (UCT) IMS test-bed was used to evaluate the framework and was taken through some modification to meet the requirements. Figure 4 shows the architecture of the test-bed.

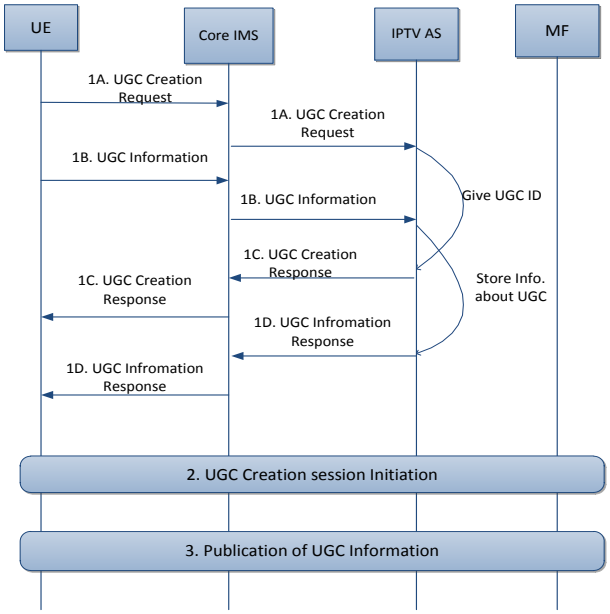

Figure 2: UGC Upload Procedure

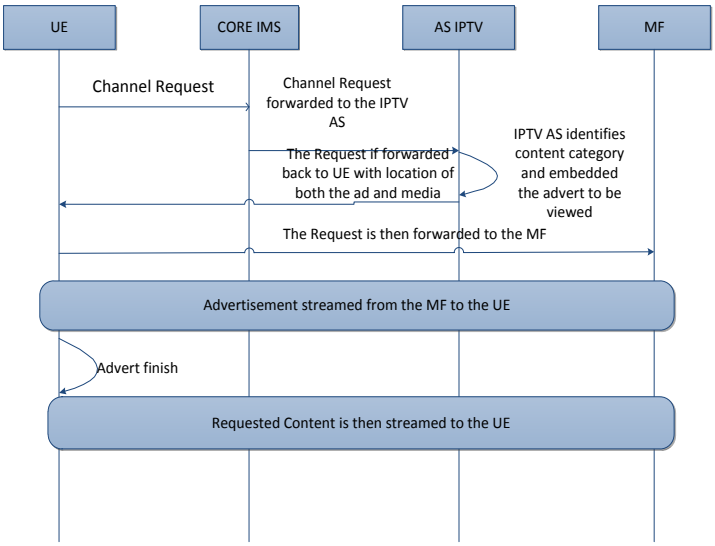

Figure 3: UGC Watching Procedure

The UCT IMS Client [15] was used to provide the user with the required client functionality for IPTV services. These include IMS registration, IPTV service selection, viewing IPTV media and allowing trick play functions. The UCT IMS Client was modified to allow users to access the UGC service. This enabled the user to select UGC services by clicking the UGC Listing button added in the IPTV advanced tab. This will show the UGC Electronic program guides (EPG) with all the videos that are available on the server. The EPG GUI also has the upload button that will allow the user to upload videos.

Figure 5 shows the GUI for the user to upload videos and provide metadata.

FOKUS Open IMS Core [16] was used to provide all the necessary functionalities of the control plane in an NGN network.

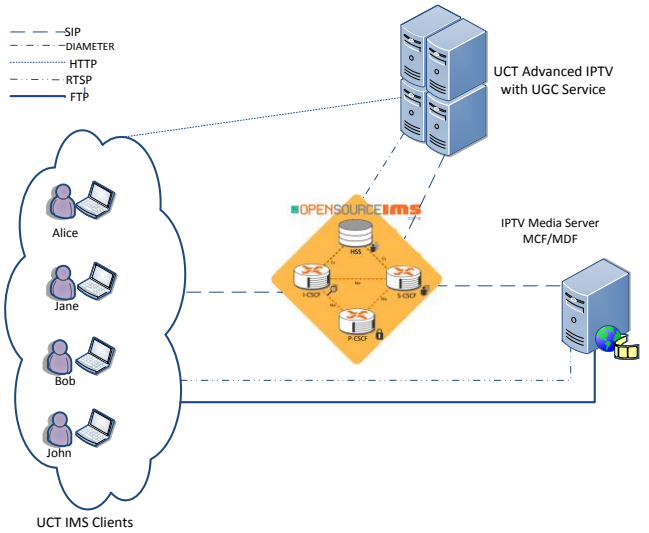

Figure 4: Modified UCT IMS test-bed with UCG Service

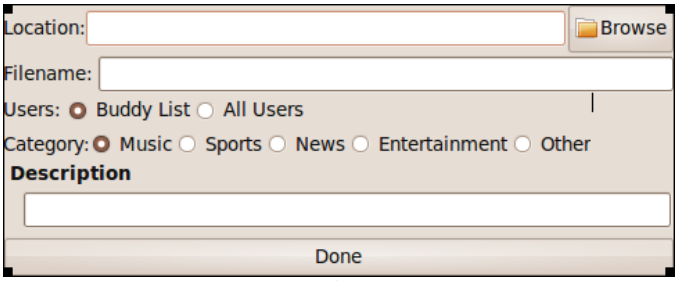

Figure 5: GUI for video upload

The UCT Advanced IPTV system [17] was used to provide the required IPTV AS functionalities. This AS was modified to offer UGC services. These modifications included the ability for the server to service one of the two procedures that occur during UGC services which could either be creation procedure or watching procedure. It was also modified so that it would be able to determine which advert would be played according to the category of the requested video. The AS still offered VoD and live TV services. IPTV AS hosts the advertisement database. The IPTV AS was implemented as a SIP indirection server rather than a SIP proxy server since the SIP session invitation was redirected to an external domain, i.e., the media plane where the IPTV media is stored. The UCT advanced IPTV system required a third party Real Time Streaming Protocol (RTSP) server to act as the Media Server, i.e. to store the media files and deliver the media stream to the IMS Client running on the UE. VLC streaming server was used.

The Media Server was implemented as a hybrid of the two modules Media Delivery Function (MDF) and Media Control Function (MCF). The MDF module stores and streams media files to the UE while the MCF module controls the streaming of media through the MDF and allows for trick play functions. In ETSI TISPAN's IMS-based IPTV, the MCF is responsible for identifying the relevant media file according to the channel request received from the Serving Call Session Control Function (S-CSCF) on behalf of the UE. It then controls the delivery of the media stream from the MDF to the UE. However, since there are no real MCF functionalities implemented, the IPTV AS performs a hash table look-up to identify the relevant media file. This was done when the IPTV AS receives the service request from the S-CSCF on behalf of the UE. This information containing the identified media file was sent back to the UE which contacts the Media Server directly to retrieve the requested media [18].

V. TESTBED VALIDATION AND RESULTS

To validate the evaluation platform as an accurate testing environment for the proposed framework proof of concept tests needs to be carried out. This ensures further results obtained from the proposed framework are meaningful. Proof of concept tests are performed for three scenarios, each with expected outcomes. The observed results are then compared to the expected results, which are based on the theoretical framework. Obtaining the expected results in all three scenarios will help to consider if the evaluation platform a suitable and accurate testing environment to evaluate the proposed framework.

In scenario 1, a user, *Alice*, will request for the UGC service. She will upload two videos to the server. One of the videos is a public video while the other is a private video and she will provide the metadata for both files. From the metadata provided by *Alice* for the first video, the video will be in entertainment category. The file will be stored on the server in the entertainment category and will be visible to anyone on the network. *Alice* will also upload the second video that she took at a party with her friends and only wants people in her buddy list to view this video. She will upload the video as a private video and the video will be stored on the server on her private collection that will be viewed by her friends. The video is also stored in a category specified in the metadata.

In scenario 2, a user, *Bob*, will request for the UGC service by requesting the UGC electronic program guide. The UGC EPG will show all the public videos shared by all the people on the network. He will be able to view the public video that was uploaded by *Alice* when he selects this video an advert in the entertainment category will play first before the desired video is played. Whilst the advert is playing the trick play functions are disabled to ensure advertisements cannot be skipped or fast forwarded. *Bob* is not friends with *Alice* so he would not be able to view the second private video uploaded by *Alice*. When *Bob* request for private videos by selecting the private button on the UGC EPG, the server will look for the private videos he and his friends on his buddy list have uploaded. In this scenario *Bob* does not have friends who have uploaded private videos and he has not uploaded any videos also. So the EPG will display nothing.

In scenario 3, a user, *Jane*, will also request for UGC service just like *Bob* in scenario 2. *Jane* will be able to view everything that *Bob* was able to view but the only difference is that Jane is friends with *Alice* so she will be able to view the private video that *Alice* uploaded. When *Jane* requests for the private videos, the server will check the private collections of all the people in her buddy list and check if they have uploaded some videos. In this case *Alice* has uploaded a video so it will show this video to *Jane*. When *Jane* selects this video an advert will play first which is determined by the category in which *Alice* specified when she uploaded the video. Just like in scenario 2 when the advert is being played the trick play functions are disabled so the user does not skip the advertisement.

The outcome observed for all three scenarios corresponds to what is expected based on the theoretical framework. As a result, the proof of concept tests may be considered successful therefore, the evaluation platform may be considered a suitable and accurate testing environment for the proposed framework. Below details the QoE tests performed to analyse the effect of the UGC framework on the user's QoE of the IPTV service.

A. Evaluation of the Proposed Framework

Quality of Experience is determined by a number of factors which are objective and subjective factors. The objective factors include service factors, transport factors and application factors. *Service latency* is used to measure the service factors and application factors thus it will measure QoE objectively. Transport factors are beyond the scope of this paper so it will not be measured. The subjective factors are human related relating to user emotions, billing and user experience. *Service features* and *service quality* are the metrics used to measure QoE subjectively by comparing them to those offered in similar services.

a) Service Latency

To measure service latency, session setup delay for the VoD session was used. From the time when the video is uploaded to the media server requesting the video will be similar to a VoD session. This delay include, the delays experienced in the network, at the AS and in the UE. Scenario 4 was created to compare service latency with scenarios 2 and 3. In scenario 4, user John, uses the classic IPTV system, before the proposed framework was added to the IPTV service, i.e., before the UGC services are added to the AS and the UE. Table 2 shows the standard typical latencies expected for the VoD service in particular [19]. The VoD access delay refers to session setup and it can be noted that it should be less than 5 seconds.

Table 2: Timing measurements for typical VoD functionalities. [19]

Functionality	**Elapsed time (seconds)**
UE Registration	0.8
IPTV Service Subscription	1.3
VoD access	<5
Channel Changing	0.4

Each scenario was run a total of 26 times, and the session setup delay was recorded for each instance. Table 3 shows the averaged latency results and the standard deviations for the three scenarios. It is clear that the proposed framework adds to session setup delay, as expected. The extra delay experienced by Bob and Jane is due to the fact that the AS has to search for the advert that is relevant to the selected video. However, it only adds delays between 83-92 milliseconds which are not noticeable with human eye. It can also be noted from table 3 that Jane had a larger delay than Bob and this was because the server had to do extra processing to find the private videos.

a) Service Features

IPTV is a paid service meaning that users will be expecting a service that will have features that will attract them away from live television and PVR services.

Table 3: Average latency results and the standard deviation

	User	Description	Average latency (milliseconds)	Standard deviation
Scenario 2	Bob	Accessing a public UGC video	823.1153	120.723
Scenario 3	Jane	Accessing a private UGC video	831.5385	119.090
Scenario 4	John	Classic VoD service	739.3076	104.519

Therefore, IMS-based IPTV should have features that will be at least on par or even better than live television, PVR services and other UGC service. Having these features is expected to help to boost user's QoE. A Graphical User Interface (GUI) is required to make it easy for the users to register to the IMS and makes it easy to find the IPTV services. The UCT IMS Client [16] offers an easy to use UI to do all this. Figure 5 shows how easy it is to provide all the metadata when the user is uploading a video. Triple play functions are the key features of PVR services and this is what set it apart from live television. As a result, IPTV has to have these functions. The trick play functions are available for the UGC service and disabled when the pre-roll ad is playing. It can be seen that IPTV services offer service features that are up to par and better than those offered by live television, PVR and UGC service because it can offer the best of each of these services. Users are able to perform trick play functions on UGC media and can easily upload and provide information for their uploaded videos. These features contribute positively to user QoE.

b) Service quality

Service quality will affect the user's QoE. Even though the videos uploaded by the user will differ from user to user, users will still expect good quality adverts being played just like the ones played on competing services like live TV. To ensure the user will not have to wait long the pre-roll advert is limited to 30 seconds or less. With the size of the adverts being that small it will be easy to keep high quality files. In addition, the fact that the adverts are stored in categories will help in the relevance of the advert shown in the video since it will be related to the video requested. Having relevant or targeted adverts shown to users improves the quality of the service because the user will be viewing adverts that are useful to them.

VI. CONCLUSIONS AND FUTURE WORK

The paper proposed and evaluated a platform for UGC for an IMS-Based IPTV, to provide IPTV subscribers with UGC

services i.e. the ability for the user to upload and share a video with everyone or just a group of people. It integrates UGC with the ETSI TISPAN's IMS-based IPTV. It streamed pre-roll adverts before the requested media, the adverts and the media were stored in categories and these categories were used to determine which advert to play.

Telcos around the world are looking for ways to extend their businesses and many are looking to offer IPTV. For IPTV to be competitive and take in more market share it should have a unique selling point compared to the competition like live TV, online streaming, PVR services. It should be able to do this but at the same time bring in revenue for Telcos so that they can justify the investment. This paper proposed user-generated content system for an IMS-Based IPTV with advertising in the hopes to solve this problem. UGC is one of the most popular services on the internet companies that offer it enjoy and large number of traffic. Hence offering it on IPTV can help attract users to it. As noted before UGC sites in the US generated more 230 billion domestic views in 2010. With these views comes investment from advertisers because they want to advertise where there is a large audience. YouTube alone generated an estimated $213 Million (Net) in Pre Roll Advertising in 2010. This is a clear sign for Telcos that investing in UGC for IMS-Based IPTV is worth it.

An evaluation platform was used to test the effect of the proposed framework on the user's QoE of the IPTV service. QoE can be divided into two components namely, an objective component and a subjective component. Thus to test these components the following parameters were tested: service latency, service features and service quality. Service latency tested the objective component of QoE, while service features and service quality tested the subjective component. It was found that the service latency of the modified system was slightly more but this was expected due to the additional processing functions, required at the IPTV AS and UE. However, the service delays were below those recommended for VoD service which is 5 seconds. Live TV, PVR services and other UGC services were used to compare the service features and service quality of the system. They were found to meet user expectations due to the functions available to the user, the ease of use of the features and the relevant adverts limited to 30 seconds all contributed in passing the QoE tests. It is therefore concluded that the addition of the UGC service does not negatively affect user's QoE of the IPTV service.

Future work includes improving the system to offer more features. Creation of contain will not only be uploading of videos but the user can broadcast video. In this scenario the user can have webcam connected to the STB and so the user can make a movie which will be streamed and recorded on the network. The other user can view this recorded stream at a later time. In addition, add more to the social aspects of the UGC services, having the ability for the users to comment on the videos. So this should be added in so that the users will be able to view and post their comments on the videos they like. The advertising system can be improved by using a more targeted approach. Rather than just using the categories of the videos use the information about the user like gender, age and preference to determine which adverts are relevant to the user.

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