Subscription-free Pay-TV over IPTV

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ABSTRACT

We propose a novel short-interval charging model for pay-TV over IPTV. To realize this model we develop an approach that relies on the channel switching action of users to trigger the charging process. When a user switches to a paid channel a multicast rekeying procedure is triggered resulting in a new content key for all viewing users of that paid channel. At this time the charging interval for the user who switched to the paid channel is started. In contrast, when a user leaves a paid channel, another multicast rekeying procedure is triggered resulting in a new content key for all viewing users of that paid channel except for the leaving user. At this time the charging interval for the user who left the paid channel is stopped. Obviously, this approach poses tight real-time requirements on the system. We designed and implemented this system based on an in-depth requirement analysis. The system test has shown that the proposed short-interval charging model is feasible without considerable violation of reported requirements regarding channel switching times.

1. Introduction

With the ever-expanding broadband network connectivity, television and Internet are converging and the Internet Protocol Television (IPTV) is gaining in importance increasingly. IPTV is one of altogether four transmission paths for broadcast television alongside cable, satellite and free-to-air transmissions. It differs considerably from web-TV, which has different requirements on the network infrastructure and therefore also uses different protocols. Enabled by its return channel, IPTV is characterized by several developments such as time-, device- and place-shifted viewing. Similarly to conventional television, the IPTV standards support pay-TV. Pay-TV is a business model for funding broadcast transmission of media content, where the subscriber has to pay for the provided content. The market for pay-TV shares more than 40% of the total TV industry worldwide [1].

Currently, there are three major charging models, which are used for pay-TV in broadcast transmissions: subscription-based charging, Video on Demand, and pay-per-view. However, each charging model has several shortcomings with regard to attribution of usage costs, availability of an upper limit for costs, interactivity of entitlement and the adaptability of services. In order to establish a better understanding all charging models are compared in Table 1.

When subscription-based charging is used, users need to take out a monthly or an annual subscription for some channel or channel package, in which they are interested. This subscription-based pricing model offers two main advantages for users regarding convenience and insurance. Specifically, subscribed members, on the one hand, do not need to deliberate upon cost and benefit each time they want to view some content. On the other, the fixed-price subscription model protects users from surprisingly high bills. Nevertheless, subscription-based pay-TV has several drawbacks, which may deter many users from buying this service:

1. Users, who watch TV on occasion or infrequently, often regard long-term subscriptions as too cost-ineffective.
2. Households with a wide interest would wish to subscribe to several channels or channel packages. Such a solution, however, is associated with high expense.
3. The digital TV technology is experiencing a steady sophisticated evolution. Production costs and correspondingly subscription prices for content using such novel techniques is assumed to be extremely high.
4. It is questionable, whether long-term subscriptions are appropriate for viewing IPTV on mobile devices since in this use case subscribers are used to pay for services in time- or volume-based billing units.

Pay-per-view (PPV) is another business model for paid media content, where the user notifies the pay-TV operator in order to be entitled for a single event, for instance a concert or a box match. However, PPV is intended for live events of short duration with many users watching the same event. Since the process of notifying the operator requires a back-channel, which is not available for previous transmission paths such as terrestrial, cable, and satellite transmissions,

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Table 1
Comparison of charging models.

Charging model	Activity-based cost attribution	Cost cap	Interactivity of entitlement	Adaptability of services
Subscription-based Pay-TV	Low	High	Low	Low
Pay-per-view	Medium	Medium	Medium	Medium
Video-on-demand	Medium	Medium	Medium	Medium
Short-interval charging	High	Medium	High	High

methods like automated telephone systems, live phone customer services, and analog modems are used to start the purchase. In any case the user has to inform the operator about the purchase intention a certain period of time before the event starts (latency of the back-channel) and in most cases the entitlement is not possible after the start of some event.

Unlike PPV, VoD is a business model for IPTV, where users can choose among individual pre-recorded movies and are able to consume the content at individual times allowing them even to pause viewing and to continue within a certain period of time. Nevertheless, this model offers low after-sale flexibility: users have to pay for the ordered content entirely, even if they did not consume it completely for any reason.

1.1. Contribution

We propose a short-interval charging model (SIC) for pay-TV over IPTV. For the technical implementation of this model we introduce an approach called channel-switch triggered charging (CSTC). CSTC provides means for managing the charging process based on channel changing actions of users while ensuring that a payment obligation arises for all users who gain access to the content of a specific channel. Another contribution of this work relates to the integration of CSTC into established IPTV architectures. Modifications on existing architectural components and new components are proposed as far as necessary. The proposed system was implemented considering all discussed design aspects. A test environment was established for the measurement of channel switching times in order to predict the performance of an IPTV system implementing CSTC under real world conditions.

1.2. Related work

Pay-TV business models were addressed in several academic research work and patents. The authors in [2] introduced an Internet-based pay-as-you-watch system, which allows on-demand streaming for mobile broadband-enabled devices such as cell phones and PDAs. A pay-TV business model called flexible-pay-per-channel (FPPC) is presented in [3]. In this model users are able to subscribe to an arbitrary combination of channels and to change their subscription at any time during the subscription period. As technical implementation this work considers unidirectional broadcasting technology, especially Digital Video Broadcasting (DVB). Flexible-pay-per-group (FPPG) introduced in [4] is a model which is an enhancement of FPPC regarding security and scalability. However, the model seems to support limited user dynamics since the authors consider an additional PPV functionality. An approach is presented in [5] that combines the advantages of PPV and VoD by using delay-dependent charging: The allocation of server-streams is driven by the delay tolerance of the users, which also affects the purchase cost of the desired content. In [6] the authors propose an Impulse PPV system for one- or two-way communication analog cable networks by using addressable cable TV set-top boxes (STB). In the system described in [7], the customer communicates the impulse purchase by using the STB. As a main innovation the necessary codes are transmitted upon authorization only to STBs which are used to make the purchase. An IPTV

system which is able to employ a live broadcast of a PPV event is introduced in [8]. Information about available events are delivered by the electronic program guide (EPG), a call center, or a subscriber management center. The service request is made in-band by using the return channel of IPTV. Upon authorization, a page confirming the actual request and necessary entitlement information is generated by the head-end. Subsequently channel list is updated according to the purchase. Once the STB has obtained the authorization information, the validity of entitlement is checked on every channel switch. When the purchased event begins, a timer is started that instructs the STB to exit the channel after the purchased event has ended. A scheme for accurate billing using unidirectional broadcasting technology (DVB) is briefly presented in [9]. The channel watched as well as the start and stop times of watching a particular channel is determined by using DVB service information (SI). The view-time is charged by using a prepaid account on the smartcard or by contacting the payment gateway of the service provider over the Internet.

This paper is organized as follows. In Section 2, we specify the requirements of our system and discuss its design aspects. Section 3 details the system components. A system test environment for the measurement of channel switching times in addition to test results are given in Section 4. Finally, Section 5 concludes this paper and gives outlook to future work.

2. System requirements and specification

For the specification and design of a short-interval charging system (SIC system), we started with identifying the high-level requirements on this system from the perspective of consumers, service providers, and conditional access solution providers. Three system-level requirements were identified which are:

1. Retaining the procedure of TV watching
2. Maintenance of quality of experience
3. Compliance with available standards and architectures.

These requirements are given at the top of Fig. 1, which shows how these requirements are used to make methodological as well as architectural design decisions. The numbers in the figure refer to following sections where the respective aspects are addressed.

In order to provide seamless charging without altering established user habits, we introduce the channel-switch triggered charging (CSTC), which is detailed in Section 2.1. To implement CSTC we use multicast encryption schemes described in Section 2.2. Multicast encryption schemes on the one hand require the presence of a return channel. On the other, these schemes have to achieve high performance so that the quality of user experience is not deteriorated. The performance aspect of multicast encryption schemes is investigated in Section 2.2.1. Apart from other optimizations, the use of batch processing is emphasized in order to increase performance. However, a careful synchronization between the batch interval and the structure of the broadcast data is required so that quality of experience can be maintained. This aspect is covered in Section 2.2.2.

For the implementation of the discussed methods we re-use existing architectures defined in established standards: Instead of introducing new components, we try to identify appropriate functional components and related interfaces in available standard architectures