IMS based IPTV services - Architecture and Implementation

Eugen Mikoczy
T-Com, Slovak Telekom,a.s.
Jarabinkova 1, 82109 Bratislava
Slovakia
+421 5 5881 2286
eugen.mikoczy@t-com.sk

Dmitry Sivchenko,
Bangnan Xu
T-Systems ES GmbH, Deutsche-Telekom-Allee 7
64295 Darmstadt, Germany
+49 6151 9372512
d.sivchenko@city.ac.uk

Veselin Rakocevic
City University London
Northampton Square
London EC1V 0HB, UK
+44 20 70408136
v.rakocevic@city.ac.uk

ABSTRACT
This paper presents a novel architecture for providing converged IP-based TV (IPTV) services specified by ETSI TISPAN standardisation for IPTV in ongoing NGN release 2 specifications. The described IPTV architecture is based on utilisation of the IP Multimedia Subsystem concept used by NGN architectural framework and its adaptation to provide the IPTV specific functionalities and services. Using the foundation provided by the IMS based architecture, we propose a new functional architecture to enhance the functionalities and features needed for scalable converged networks, flexible media delivery and advanced IPTV service scenarios. The proposed architecture, leveraging on the FMC architecture that operators may deploy to provide IPTV service across different access networks in future deployments (mobile, wireless, fixed) has prototypically been implemented in the ScaleNet* demonstrator testbed. This paper analyses in detail the main principles for such a converged reference architecture. The paper also presents the IPTV service scenario prototype called Click-to-Multimedia which shows some basic features and advantages implemented on top of the presented architecture by prototyping demo applications as proof of concept reference.

Keywords
Next Generation Networks, Fixed-Mobile Convergence, IPTV services, IP multimedia subsystem, Multimedia Delivery Architecture.

1. INTRODUCTION
The digital television has been evolving for several years. What started as digital terrestrial or satellite digital television delivery can now, following the recent technology evolution, be delivered over a broad range of fixed or mobile networks. The deployment of the Internet Protocol based Television (IPTV) over different broadband access networks was made possible because of the Increase in the available bandwidth on new types of access networks together with improving media coding algorithms.

Mobimedia'07, Month 8, 2007, Nafpaktos, Aitolokarnania, Greece

Most of the major European telecom service operators already start or plan to start providing Triple play type of services which include in one service package of video, voice and data services (like IPTV, Voice and high speed internet access). We could clearly recognise a growing demand for multimedia on mobile devices and several technologies like DVB-H also allow receiving mobile TV channels on enhanced mobile terminals. The increasing number of deployments and potential customers enforce the operators and solution vendors to optimise delivery network architecture, control mechanisms, end devices as well as to enable a simplified usage of enhanced services. We are focusing in this article on the description of one possible approach for the delivery of IPTV services over IMS-based network architecture.

The IP multimedia subsystem (IMS) has been introduced by the 3GPP initiative as the architectural subsystem dedicated to control and provide multimedia services over packet based core network within third generation mobile networks [1]. The concept of the Next Generation Networks (NGN) has been evolving for several years and first real standardisation activities have been started by ITU-T NGN focus group and ETSI TISPAN which already employ IMS concept to first standard releases within NGN architecture framework. Ongoing standardisation attempts to use IMS to support IPTV services within NGN release two specifications. This paper explains a new approach to the use of IMS for IPTV application and also shares the experience of the development and evaluation of such IPTV service architecture. In the rest of this paper we describe the details of an IMS based IPTV platform in Section 2 and its prototypical implementation and realisation details in Section 3. A short conclusion and an overview about future work are given in the concluding Section 4.

2. IMS BASED IPTV PLATFORM
If we would like to somehow specify what should be understood by the IMS-based IPTV platform the following definition is possible: IMS based IPTV platform is service platform architecture which is able to provide IPTV services controlled and handled by IMS core subsystem and delivered independently from underlying IP transport networks. There exist at least three different stages of evolution for IPTV architecture:

1. Non-NGN based IPTV solutions (almost all available solutions on market for now). It is possible to make some interworking with NGN but generally a separate service control and

*The project ScaleNet is partly supported by the German Ministry for Education and Research

application layer were developed specially for IPTV services (IPTV middleware).

2. NGN based IPTV architecture. It enables interaction and interworking over specified reference point between IPTV application and some existing common NGN components. These components include transport control elements for resource admission and control subsystem (RACS) or the TISPAN network attachment subsystem (NASS). This approach uses a dedicated IPTV subsystem within NGN to provide all necessary IPTV required functionalities.

3. IMS based IPTV architecture. It specifies IPTV functions supported by the IMS subsystem and employs these functions to allow reused IMS functions and also make service initiation and control based on SIP (Session Initiation Protocol). This paper presents one solution achieved with this concept.

IPTV services can be divided in three main groups of services (but not limited just for those in future):

- Broadcast services (BC): live TV and radio channel feeds broadcasted or multicasted over network
- Content on demand (CoD): generally unicast services provided on subscriber demand to deliver required content (e.g. movie, song, etc.)
- Personal video recorder services (PVR) include services which allows recording, pause or time shift capabilities for live content (can be provided by network or by UE).

2.1 The advantages of IMS based IPTV concept

Deploying IMS functionalities to support IPTV services enables more interesting IPTV features as follows:

- Integrated user registration and authentication (single sign-on)
- User subscription management
- Session management, routing, service trigger, numbering
- Interaction with existing NGN service enablers (presence, messaging, group management, etc.)
- Roam and nomadic support
- QoS and bearer control
- Unified charging and billing

The IMS based IPTV can also bring additional advantages such as support for mobility, enabling interaction with existing NGN service enablers, service personalisation and media adaptation as well as provide converged applications integrated voice, data, video and mobile services to flexible quadruple play service concept (in the future proof of concept called sometimes also multi-play services).

2.2 IMS based functional architecture for IPTV services

The functional architecture of IMS based IPTV presented in this section contains main functions and reference points defined in TISPAN IMS IPTV concept. The following sections describe the main functions, including the service control function, the media control function and the media delivery function. We enhance the short description from original TISPAN drafts [2] (originally described in TISPAN Work item 2048) and include our extensions presented in TISPAN draft WG2TD11 [3] but more as just additional functions descriptions in line with our IMS IPTV concept implemented in ScaleNet demonstrator as shown in Figure 1.

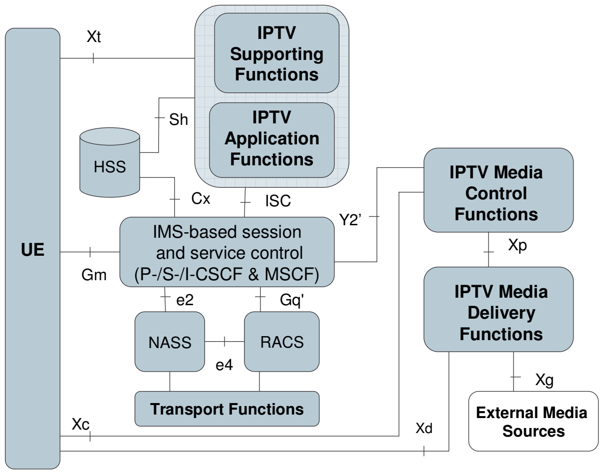

Figure 1. Simplified and adapted IMS IPTV functional architecture for ScaleNet

In this paper we define functional entities for the presented functional architecture and propose new concept of service control for IMS based IPTV. Several enhancements for distributed IPTV media delivery functional elements and new reference points are introduced. All these enhancements are necessary in more realistic environments. In following section we would like to explain main principles of this IPTV functional architecture

The User Equipment communicates with the IPTV Service Control Functions via the Core IMS for the purpose of session management, and may use the Xt (enhanced Ut interface) reference point for the purpose of service profile configuration or interaction with IPTV application server (in our realisation it is also used for service discovery and selection functionalities). IPTV application server functions (IASF) use the ISC interface to communicate with the IMS based NGN service control. We propose to introduce Multimedia Service Control Function (MSCF) which should be used as reusable service control element for any multimedia services not just for IPTV services. This additional functional element extend IMS core without special needs to change IMS core functionality or interfaces. MSCF is used for control tasks across distributed media control and delivery architecture. Each UE has at least four interfaces for media control over Xc (originally Xc') and media delivery over Xd (originally Xc'') as well as Gm interface to IMS and Xt interface to IASF. Media Control Functions (MCF) can control Media Delivery Functions (MDF) over Xp reference point that also allows building a really scalable and distributed media delivery infrastructure. External content can be imported from external media sources (e.g. content providers) via Xg external interface for MDF.

2.3 Multimedia Service Control Functions (MSCF)

This function handles IPTV related request and play a role of the service and session control element for all IPTV services. This component is also responsible for interworking with IMS core on the service control layer. The service control function should include all functions required for each IPTV service and therefore should be reusable as specific IPTV application server functions or as separated functional elements depending on implementations (we therefore use separated functional entity called Multimedia Service Control Function - MSCF).

General tasks of MSCF:

- Session initiation and service control for IPTV applications
- Interaction with IMS core and S-CSCF to perform IPTV requests (receive, validate and perform IPTV service requests from user)
- Service authorisation and validation of user request for selected content based on user profile information
- Select the relevant IPTV media control/delivery functions
- Perform Credit control

The MSCF could use the IPTV profile in order to customise the user experience. For instance, the list of subscribed channels could be used to filter the list of channels presented to subscriber.

2.4 IPTV Media Control Function (IMCF)

The purpose of this function is to:

- Selection of MDFs
- Propagate content to the distribution network.
- Manage the distribution of assets between media delivery functions and also to the user equipment (whether by streaming them or any other means)
- Content protection control function (Control licensing policy across IMDF, validate user license for specific content)
- Apply policy (e.g. according to specific spatial or temporal restriction) of distribution management;
- Storage management in the distribution and delivery system
- Mapping content ID and content location in specific IMDF
- Manage interaction with the UE (e.g. handling of video-recorder commands or IGMP commands)
- Manage the capture of live events (network PVR and network time shift TV)
- Collect information of service using statistics collecting and submission
- Generate billing information

2.5 IPTV Media Delivery Function (IMDF)

Originally MDF was responsible just for delivery of media to the user equipment (in IPTV domain, media may be video, voice as well as data). We propose to extend media delivery functionalities to the three following functional elements:

- ***Interconnection - IPTV Media Delivery Function (I-IMDF)*** these functions handles the media import and ingress importation of CoD content and all metadata and service provider as well as receives live streams from IPTV Headend or directly from content provider sources.
- ***Serving - IPTV Media Delivery Function (S-IMDF)*** - function handles the processing of content (encoding, content protection processing, transcoding to different formats) and is also responsible for storage of contend and metadata together with propagation content information within IPTV IMS.
- ***Primary - IPTV Media Delivery Function (P-IMDF)*** - function is primary contact point which provide also the streaming functionalities for all IPTV services in required quality, format and with specified casting (multi-/uni-/broad-casting).

Media delivery function can be distributed depending either on the service type (BC, CoD, PVR) or on the mentioned specialised sub-functions. Hence, this function is composed of the following sub-content:

- ***Metadata:*** used to provide user information about asset describing metadata such as SD&S data, EPG, or VoD catalogue. It may provide any type of metadata, given that it is properly standardised.
- ***Assets***: the CoD-MDF is designed to deliver assets to the user equipments. Those assets were previously propagated by the IMCF to P-/S-IMDFs, according to the availability, popularity and regionalisation of the content they compose.

2.6 IMS core

The IMS core is used to forward the complete SIP signalling used in the IMS for session management. The media flows of established sessions like IPTV streams, instead, do not traverse the IMS core. A number of Call Session Control Functions (CSCF) are introduced to establish a multimedia session between subscribers and to prepare delivery of the demanded services according to the session characteristics required by users. Some of CSCFs have interfaces to the ***Home Subscriber Server*** (HSS) where the complete information about particular subscribers is stored, like their profiles, policies, subscriptions, preferences, etc. Three types of CSCFs are defined:

- ***Proxy-CSCF*** (P-CSCF) is the first point of contact for the IMS users. The main goal of the P-CSCF are the guarantee of signalling messages between the network and subscriber and resource allocation for media flows by the interaction with TISPAN defined Resource and Admission Control Subsystem (RACS)
- ***Serving-CSCF*** (S-CSCF) is the main control entity within the IMS. It processes registrations from subscribers and stores their current location, is responsible for subscriber authentication and call management. Subscriber policies stored in the HSS control the operations performed by the S-CSCF for a particular subscriber.
- ***Interrogating-CSCF*** (I-CSCF) queries the HSS to find out the appropriate S-CSCF for the subscriber. It can also be used to hide operator's network topology from other networks.

2.7 Converged access aggregation network architecture

The main aim of the described IMS based IPTV functional architecture is to provide various IPTV services with personalisation and adaptation of service and media independently for any user terminal connected over underlying converged access aggregation network infrastructure. Figure 2 shows the network architecture developed in the ScaleNet project [4,5] as a basic building block of the Next Generation

Network that realises Fixed & Mobile Convergence (FMC). The main element of the proposed network architecture is the Converged Access Aggregation Network (CAAN). All available access technologies are integrated within a single converged access network domain. Both wired (e.g. optical, DSL) and wireless (e.g. 3G and beyond, WiFi, WiMAX, Mesh) access networks are connected together via a jointly managed transport network. The Access Border Controller (ABC) is the main logical entity of the CAAN. It deploys overarching functions needed to provide mobility, AAA and QoS support within the CAAN.

A new functional block placed on every access node, Universal Access Node Function (UANF), is an interface integrating every access technology into the common Ethernet based CAAN core. It supports interaction with the ABC and adapts its mechanisms like QoS reservation to the appropriate access technology of the access node whereon the UANF is installed. An Edge Router builds a single IP domain for all nodes connected to a CAAN and connects it to the IP backbone.

Using the CAAN in the transport layer and the IMS in the control layer any type of multimedia services available in the application layer may be provided to mobile users connected to the CAAN.

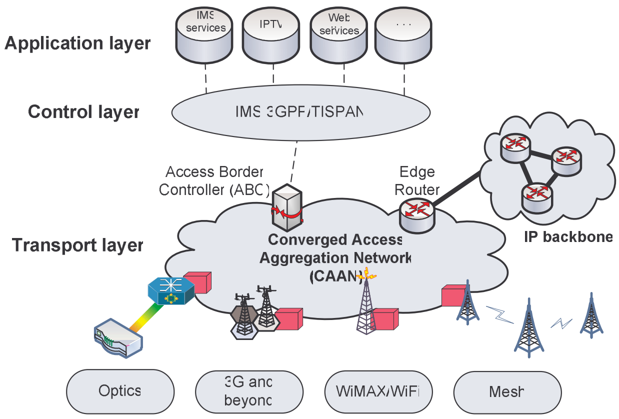

Figure 2. Converged access aggregation network architecture realising FMC.

That avails convergence of fixed and mobile access networks since the multimedia services which can be delivered to network subscribers are independent from the terminal and access technology used by the subscriber. In the next section we describe how the IPTV functionalities reusing IMS signalling can be implemented in the CAAN.

3. PROTOTYPICAL REALISATION OF IMS BASED IPTV PLATFORM

3.1 Overview

To proof the concept of the integration of IPTV and IMS platforms on the example of the advanced network architecture presented in Figure 2 we have prototypically elaborated the "Click to Multimedia Service" to evaluate and demonstrate advantages of the defined IMS based IPTV functionalities. The main particularities of the developed system are as follows:

- Session management performed in the IMS core and IPTV IMS capable application server
- Personalisation of available services based on IMS user identities
- Support for both terminal and session mobility of IMS users maintaining IPTV service
- Accommodation of IPTV QoS parameters to the terminal device used to access IPTV service
- Personalisation of IPTV services

The prototypically implemented IMS based IPTV service enables a high level of efficiency and flexibility of service discovery and selection for IMS users. In a typical usage scenario an IMS user authenticates on a web portal using a secure https connection. Multimedia services including IPTV services available for the user according to its preferences and subscriptions are shown on a user-friendly graphical web interface adapted to user preference and capabilities of the terminal display. The logged on user is able to search for a specific service or media, modify its group of interest etc. After selection of the desired service a simple click on the appropriate icon or link is sufficient to initiate the establishment of the multimedia session.

During session establishment based on basic IMS mechanisms the QoS parameters of the selected multimedia service are adapted to the current user terminal in terms of audio and video bitrate and video resolution. During session handovers the QoS parameters are adapted to the new terminal device of the user. This is because a typical MDA with a small display and a not very powerful processor is not able to play back an incoming stream with HDTV quality. The flexible QoS adaptation is very important in the FMC environment where access networks of various access technologies with highly differing constraints are used by a number of terminals with different capabilities.

Using implemented "Click to Multimedia Service" a single click on the selected service is enough to establish the desired multimedia session. Thereby users can access multimedia services using any terminal devices they have on hand. The best possible IPTV service quality in every access network with any terminal device is guaranteed. The possibility of session and terminal handovers enables the highest level of flexibility for mobile users maintaining multimedia services everywhere.

3.2 Implementation details

Generally, an IMS user needs to know the SIP identifier of the corresponding peer to be able to establish a multimedia session to it. Information about SIP identifiers which can be used to generate SIP INVITE messages during session initiation is usually stored in the buddy lists of IMS users. New entries in the list are created either manually or using some automatic mechanisms to exchange contact data between IMS users, like the well known contact sharing in Microsoft Outlook Express. A manual creation of the contact assumes that the user must know the exact SIP identifier of another network user or server that can provide a multimedia service desired by the user. Multimedia content that may be provided to IMS users may be hosted on a number of streaming servers located in the same or different administrative domains. Offering the information about services available for particular users is a big challenge in such network environment since there is no single point of contact that can be used by the user to discover and select an appropriate multimedia service in the network. Every time the user wants to get access to a multimedia content, e.g. to a video data, it has to discover the SIP identifier and the identifier of the content it wants to retrieve from a media streaming server. Only after that the user is able to initiate a session to the selected application server that will trigger the media streaming server to deliver the selected multimedia content to the requiring user. The exact methods which can be used to discover and select a specific content or a particular service are undefined in the current IMS standardisation activities.

We have implemented a simplified service architecture comprising proposed functions presented in Figure 1 to provide IMS based IPTV services in a CAAN shown in Figure 2. The implemented network architecture comprises application servers that provide a flexible and scalable discovery and delivery of multimedia services available for particular IMS users as shown in Figure 3.

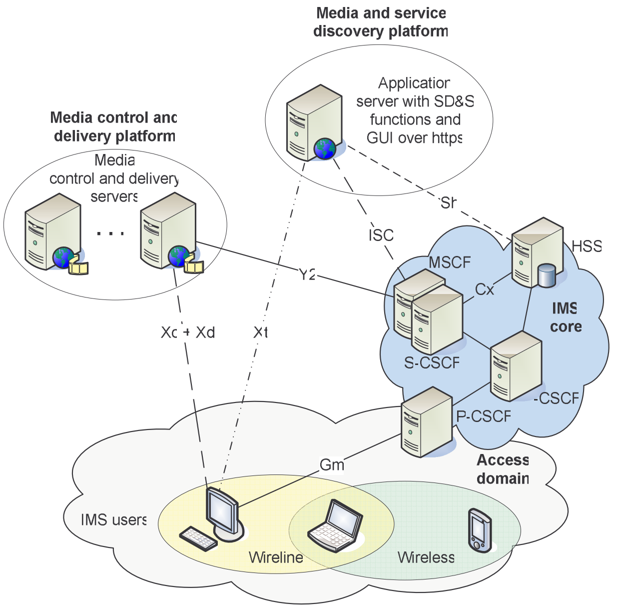

Figure 3. IMS based network architecture for delivery of multimedia services.

The application server (AS) with service discovery and selection (SD&S) functions is used to provide service information for IMS users. It has associations to a number of media service control servers (MSCF) via the ISC interface so that it can collect information about media content available from media delivery servers achievable through these MSCF servers. This

interface is also used to connect the AS to the IMS core so that it understands SIP based signalling from IMS users. The AS supports also Sh interface to the Home Subscriber Server (HSS) to retrieve user profiles with all user subscriptions and preferences. Using the information retrieved from associated media control servers and applying IPTV user profiles from the HSS a list of available multimedia services may be created for a particular IMS user considering its preferences and subscriptions. Thereby the personalisation, policy-based service discovery and value added multimedia services may be integrated and deployed using this SD&S scheme. Media discovery information can be provided to users in form of multimedia web pages using a secure https connection on the Xt interface. The IPTV application server is therefore a single point of contact for IMS users for service discovery and can be seen as a key element to select and to initiate multimedia services available for registered IMS users. A step-by-step overview of the service discovery, service selection and further session establishment performed in a typical usage scenario using the described scheme is presented in Figure 4.

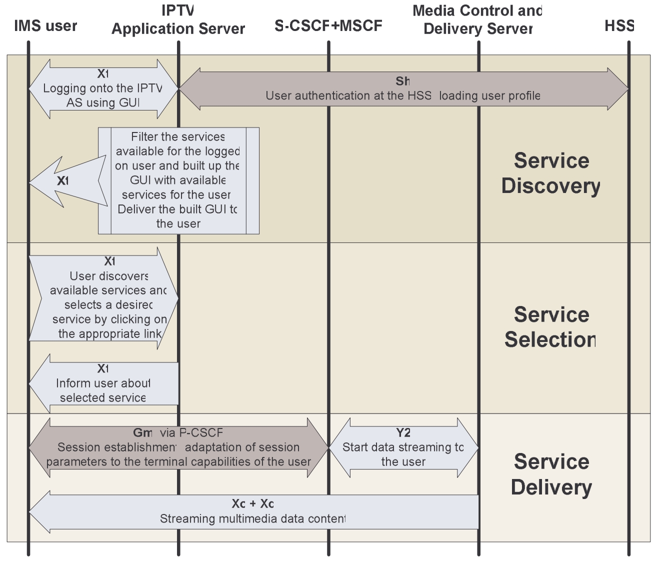

Figure 4. Discovery and selection of the IPTV service and establishment of an IPTV session

The IPTV application server is realised as a usual web portal. The GUI of the portal consists of a graphically adapted links to the multimedia services available for the IMS user. The IMS users use secure https connections to access the GUI provided by the IMS Application Server (AS). Hence, the https protocol is used on the Xt interface in our implementation. During the logon stage the user credentials received via the Xt interface are compared with user data required via the Sh interface from the HSS. The information about subscribed services of the user is also required via this interface and is then available to the AS that filters its database with the information about all available services and builds a web page with only links to services available for the logged on user. The preferences of the user stored in the HSS are considered to build the page according to the policies defined for every particular user or for groups of IMS users. As result, personalisation of the content offering is realised where both user subscriptions and preferences are considered. IMS user can then navigate on the built page and decide about the multimedia service it wants to initiate. To select the desired multimedia service the user can simply click onto the appropriate link or icon leading to the informing the user about selected multimedia session via the Xt interface. After that the IMS user can either automatically or manually initiate the selected IPTV session using IMS enhanced SIP signalling.

Any type of multimedia sessions may be established using this method. Thereby there is no need to know, notice or store any identifiers of the content or streaming server providing this content. The IMS client that we have developed during our implementation exchanges session related data in the background that is transparent for the IMS user. That allows a fast and simplified service selection and establishment of multimedia sessions to the desired multimedia content.

During IMS defined session establishment via the Gm interface the IMS client is able to inform the Server deploying Multimedia Service Control Functions (MSCF) the capabilities of the user terminal so that appropriate QoS parameters for the multimedia stream can be selected. After selection of appropriate QoS parameters the MSCF informs the Media Delivery Server (contains media control and media delivery functionalities) via the Y2 interface to stream data of the selected multimedia content to the requesting user via the Xd interface. In our implementation we use RTP and RTSP protocols on this interface. Using RTSP protocol the user may also control data delivery in the case the user requires Content on Demand It can be paused, played faster or slower, etc. The RTSP protocol is then used for media control that take place on the Xc interface between the user and media streaming server.

3.3 Performance of QoS adaptation

The most demonstrative performance evaluation that can be performed using developed testbed is the demonstration of IPTV QoS adaptation depending on the used terminal device. For that we use two terminals with different capabilities and perform a session handover of established IPTV session between them. The capabilities of both terminals are given in Table 1.

Table 1. Capabilities of terminals used for IPTV service

Option	Desktop (TV)	MDA
Processor power	2.2GHz Core Duo	400MHz
RAM	2Gb	128Mb
Screen resolution	1920x1280	320x176 (landscape format)
Bitrate	Video: 8Mbis/s Audio: 192Kbit/s	Video: 256Kbit/s Audio: 12Kbit/s
Access Network	Ethernet, 100Mbps	Wireless LAN, 54Mbps

In the current implementation of our testbed network resources available for IMS users in different access networks are not evaluated during session establishment. The QoS parameters of multimedia streams are only adapted to the terminal capabilities. Since the maximal bitrates that can be delivered to the terminal devices are lower than bitrates available in used access networks that do not have any impact on the maximal session quality available at the particular terminal.

During the trial we established an IPTV stream to the desktop computer and after a time of approx. 20s the stream was handed off to the MDA. Figure 5 is a snapshot of one test showing throughputs of adapted IPTV data flows transmitted to both terminals as well as triggers for different events. The measurements were performed using Wireshark (Ethereal) protocol analyser [6].

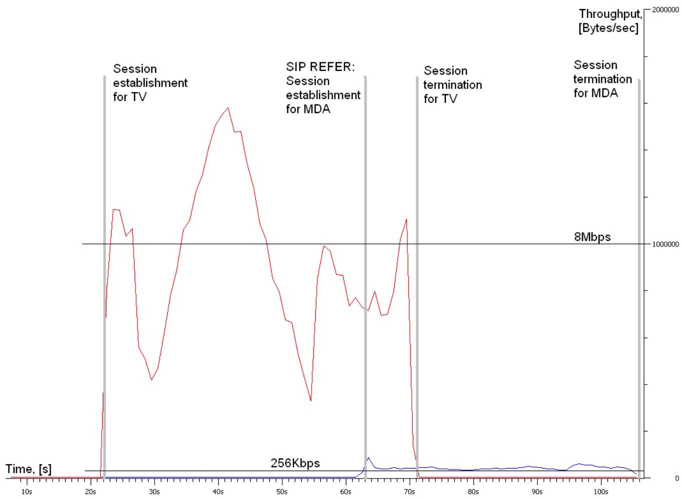

Figure 5. IPTV data flows adapted to different terminals

From Figure 5 it can be seen that after initial establishment of the IPTV session from the desktop TV the session throughput varies about 8Mbit/s. This is because the QoS parameters of the stream have been adapted to the desktop terminal that has enough processor power and a high resolution screen to produce such broadband data stream. The high variation of the required throughput is resulted by the live property of the IPTV data. After initiation of the session handover at 62.98s a new IPTV session is established to the MDA. The handover delay between a SIP message initiating session handover and first data packet with IPTV data received on the MDA is about 30ms. The session data does start from the same position of media the user initiated the handover so that the first stream to the desktop can be terminated. However, since the MDA has an inefficient processor and insufficient RAM, it would cause a huge delay until IPTV data are shown on the MDA screen although IP data packets are received by the MDA. That would cause a low service experience for the user since during this delay it does not have any content on the screens of both terminals. This is why an additional delay of 8s for session termination is introduced and the data flow to the first device is terminated at 71.05s only. If session data can be played back on the target terminal with a little or no delay after reception of IP data packets containing service data, two data streams with the same content are delivered to both devices. That situation is still better than a delay when no data are available for the user. The data stream to the MDA is adapted to its parameters so that video and audio are only transmitted to it with 256Kbit/s and 12Kbit/s respectively that is, however, still sufficient to achieve a very good user experience on the MDA with a small screen size.

3.4 Achieved public results

The ScaleNet testbed has been presented on the CeBIT 2007 [7] on the booth of German Ministry for Education and Research. The idea of the proposed IMS based IPTV service has found a big acceptance by both the exhibition visitors with professional knowledge about provisioning of multimedia services as well as by visitors without technical background of the problem.

4. CONCLUSION AND FUTURE WORK

Presented paper describes the development, implementation and evaluation of IMS based IPTV service realised within ScaleNet project. The objectives of IMS based IPTV approach have been explained and also reasons and advantages identified for the presented concept. Main components of IMS IPTV service architecture as well as the roles of different functions and reference points have been explained in the paper.

A prototypical implementation of the described IMS based IPTV functional architecture has been realised in the ScaleNet demonstrator. The main functions and IPTV related network elements have been realised in the testbed as "Click to Multimedia Service". The realised "Click to Multimedia Service" enables flexible personalised service discovery and selection functions for any type of multimedia sessions. To consider FMC environment where a multimedia service can be provided to the user independent from its terminal device and used access network, QoS adaptation mechanisms have been implemented to accommodate the parameters of IMS managed IPTV stream to the current user environment. Thus, the user can get access to the IPTV service from any location within the converged access aggregation network developed in ScaleNet. An evaluation of the performance has been presented on the example of session handover between two terminals with very different capabilities. Thereby the QoS parameters of IPTV data streams have automatically been adapted to the user device.

In our future work we plan to elaborate a further interaction between IMS mechanisms and IPTV service. First we want to enable a dynamic adaptation of IPTV QoS parameters depending on the network resources available for the user at any time. Second we plan to reuse IMS defined charging functions to be able to produce a single bill for all other IMS based and IPTV services Authors of the paper are also contributing to the standardisation of ETSI TISPAN NGN Release 2 especially to IMS IPTV specification prepared for release 2 [2].

5. REFERENCES

[1] A. Cuevas, J.I. Moreno,P. Vidales, H. Einsiedler. The IMS service platform: a solution for next-generation network operators to be more than bit pipes, IEEE Communications Magazine. Vol: 44 (8). ISSN: 0163-6804

[2] Draft ETSI TS 182 027 V0.0.9 (2007-04), Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IPTV Architecture; IPTV functions supported by the IMS subsystem, ETSI Technical Specification Draft, 2007

[3] WG2TD11_WI2048_Proposal_for_IMS_based_IPTV_-_service_and_media_control, TISPAN technical draft, adhoc IPTV TISPAN IPTV meeting, Madrid, 16 to 19 April 2007 2007

[4] M. Siebert, B. Xu, M. Grigat, E. Weis, N. Bayer, D. Sivchenko et al. ScaleNet – Converged Networks of the future. *it – Information Technology of Informatics and Information Technology 48 5/2006.* October 2006, Oldenbourg Wissenschaftsverlag, ISSN 1611-2776, pp. 253-263.

[5] ScaleNet - The *scalable* and *converged* multi-access operator's network from tomorrow, Project internet site, http://scalenet.de.

[6] http://www.ethereal.com/, Network protocol analyser

[7] http://www.cebit.de