Analysis of quality parameters influence to translation of IPTV service

RASA BRŪZGIENĖ, LINA NARBUTAITĖ, TOMAS ADOMKUS
Department of Telecommunications
Kaunas University of Technology
Studentų st. 50-452, LT – 51368 Kaunas
LITHUANIA
milisentuke@gmail.com lina.narbutaite@ktu.lt tomas.adomkus@ktu.lt

Abstract: - The most important for everyone of people to have good time and relax during TV translations in the work day evening. Nowadays interactive TV, as IPTV (Internet Protocol Television - digital television, transmiting over IP networks) is very popular in each country. TV signals for end-users are transmitted by broadcast Internet network, using Internet protocol (IP). The most important for end-user is receiving qualitative IPTV service with no any interference during TV translation. One of the most impact for qualitative IPTV service is effective and optimal assignment of data streams. It depends on processing time of data streams in nodes of network. Operative assignment of data streams is a critical problem for qualitative broadcasting of IPTV service. In this paper we analyse the assignment of data streams in core and access networks, influence of intensity and delay for assignment of data streams in different nodes of real and simulated IPTV networks. The main results showed that the efficiency of real IPTV network is less than efficiency of simulated IPTV network.

Key-Words: - IPTV, MOS, Data streams, Video streams, Delay, IPTV Headend, Access network, End – user, Quality of IPTV, STB

1 Introduction

Internet Protocol Television is a serious competitor for standard TV as satellite, cable or overground television. The basis of translating digital IP television is to use Internet and telephony networks. IPTV is a video service supplied by a telecom service provider that owns the network infrastructure and controls content distribution over the broadband network for reliable delivery to the consumer.

The concept of IPTV integrates into methods of transmitting video, audio and other multimedia over Internet networks. The concept of IPTV includes both broadcast TV translations and Video On Demand [1].

IPTV uses a two-way broadcast signal sent through the provider's backbone network and servers. The typical IPTV network is separated into three physical locations: the Video Serving Office (VSO), the Local End Office (LEO) and the viewer's home. [2] The VSO is responsible for gathering video from a variety of sources and converting the signals into IP video streams. The LEO is responsible for combining video, data and voice signals into a form that can be transmitted over a network to the home. Inside the home, the incoming signal is split and reformatted for a number of purposes, including telephone service, high-speed data service and video that is fed to a television by way of an IPTV set top box (STB). The viewer must have a broadband connection and a set-top box programmed with software that can handle viewer requests to access to many available media sources.

IPTV uses multicasting with Internet Group Management Protocol (IGMP) for live television broadcasts and Real Time Streaming Protocol for on-demand programs. Compatible video compression standards include H.264, MPEG-2 and MPEG-4

1.1 Architecture of IPTV

IPTV technology is operating by client – server architecture, based on multicast protocols. IPTV servers are high-power computers, connected into fast Internet network. IP television is using two different servers:

- one server is responsible for live scaning of video and audio translations, encoding and transmitting by network;
- second server is responsible for VoD.

Fig.1 shows simplified IPTV network topology on Windows Media platform [3]. This topology consists of these componens:

✓ Broadcast source - Live feed from a broadcaster, such as a commercial cable network or on-air television station.

Broadcast encoder - inputs the analog signal or high bit-rate digital stream from the source, and outputs a stream that is compressed and formatted for delivery over the IP network. An encoder is typically a software program running on a PC, for example, or a dedicated hardware device.

✓ Broadcast streaming system - a media server that hosts a number of encoded broadcast streams for a large number of clients on the network. The broadcast server can deliver multicast or unicast streams, and typically consists of multiple servers configured as a server farm to provide fault tolerance. If unicast, the server farm must manage connections to potentially many thousands of clients.

✓ VOD source - content that is pre-recorded on a medium such as videotape or hard disk.

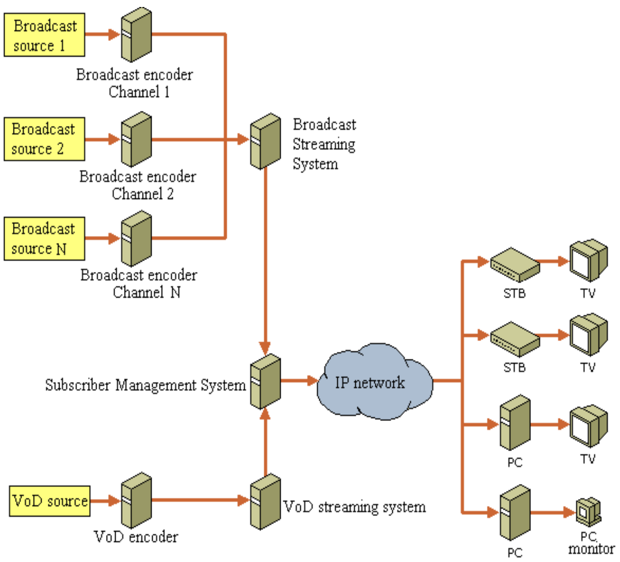

Fig.1. Topology of IPTV [3]

✓ VOD encoder - inputs the pre-recorded content and outputs a VOD file that is properly formatted and compressed. Encoders that output VOD content are typically software programs.

✓ VOD streaming system - a media server that hosts the VOD files for clients on the network. The server must be capable of storing a large number of large files, and then streaming the files to many thousands of viewers. Often, the system consists of multiple servers configured in a server farm to deliver the maximum number of required streams and provide fault tolerance. Storage is often handled by a storage area network (SAN) system that also provides fault tolerance.

✓ Subscriber management system - integrates customer activity and provides additional customer services, such as an electronic program guide (EPG) and billing.

✓ IP network - typically, a high-speed, reliable, IP-enabled network.

✓ Customer set-top box (STB) or PC - the device on the customer end that converts the data stream from the media servers into a standard analog or digital signal that can be fed directly into the television. The STB also provides any interactive features, such as an EPG, Web browsing, and PVR (Personal Video Recorder) functionality.

✓ Television or monitor - currently, IPTV is aimed at providing a quality, standard-definition television signal (SDTV) and high definition television (HDTV).

Using Windows Media platform may realize various methods of transmitting multimedia [4]. This platform has such characteristic as flexibility, because you can create solutions that consist of a mix of Windows Media platform components and third-party software and hardware. The Windows Media platform is capable of unicast or multicast delivery to Windows Media Player, and can host live or VOD content.

2 Simulated IPTV network

To evaluate the assignment of data streams for IPTV service we analyzed architecture of IPTV and made simulated IPTV network sample. The results of simulation was compared with results by experiment on really exist IPTV network in the country. For simulation of IPTV network was used the simulator „OPNET Modeler 10.5“. Fig.2 shows simulated IPTV network.

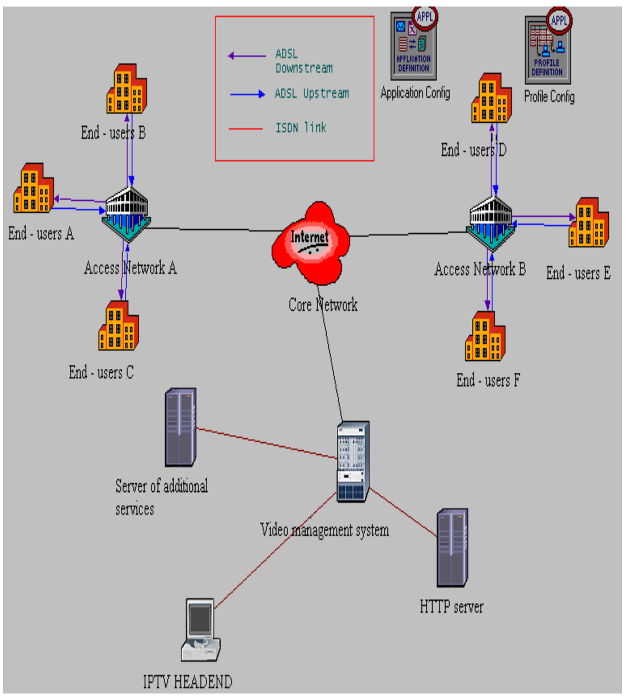

Fig. 2. Simulated IPTV network

The simulated Internet Protocol Television network consists of these components:

- ✓ IPTV Headend – responsibles for formatting of video streams, processing, saving and transmitting the content of multimedia for video management system;
- ✓ Video management system – responsibles for transmitting of formatted video streams and additional services for core IP network and access network, also transfering VoD to end – user;
- ✓ HTTP server – responsibles for transmitting HTTP services (Internet) for end – user;
- ✓ Server of additional services – responsibles for transmitting additional services (like FTP) for end – user;
- ✓ Core IP network – safe and fast Internet network;
- ✓ Access network – consists of access router and DSLAM. Fig.3 shows the structure of access network.

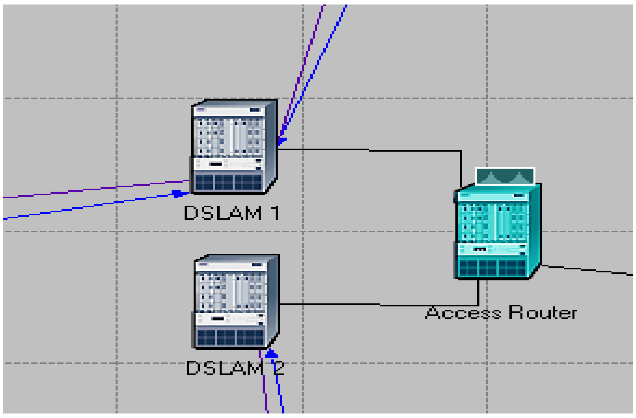

Fig.3. Structure of access network

- ✓ End – users – the equipment of end-users (Fig.4).

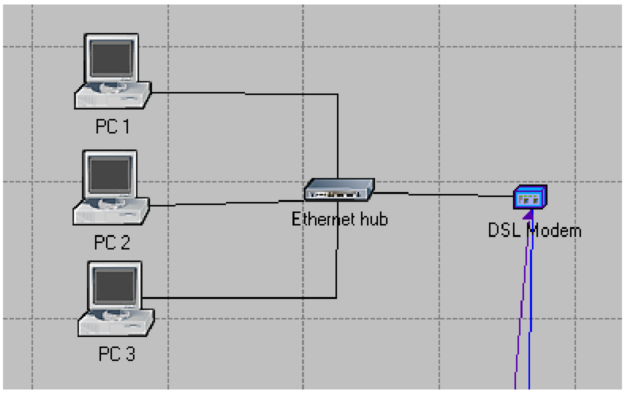

Fig.4. Equipment of end-users

Everyone IPTV end-user got video, Internet and FTP services. The simulation was made in several methods to get the correct results.

2.1 Measurements in different nodes of simulated IPTV network

In Table 1 showed determined similar values for nodes and services of simulated IPTV network, as real IPTV network.

Table 1. Information of simulated IPTV network

Data rate between video management system and core and access networks	20Mbps
Amount of end-users	100% end-users
ADSL downstream	5 Mbps
ADSL upstream	1,5 Mbps
Additional services	HTTP and FTP
TV quality	SDTV
Simulation time	600 s

First of all we quantified all sent/get video traffic intensity in all simulated IPTV network. The percentage of sent/get video traffic intensity is showed in Fig.5.

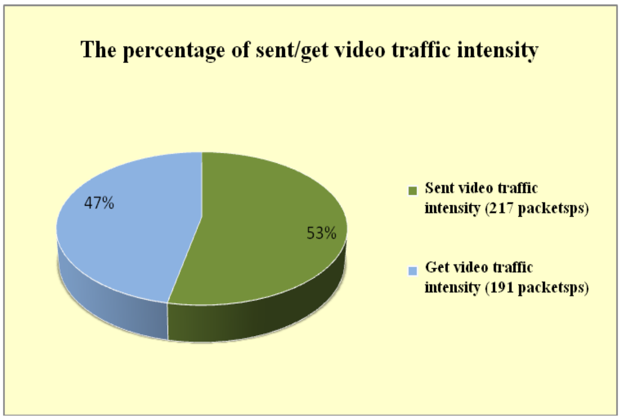

Fig.5. Percentage of sent/get video traffic intensity

When compared sent video traffic intensity with get video traffic intensity, it showed, that the difference between them are 6%. The average of delay of video packets is 5,31 ms. In that case, the results of simulation were similar with parameters of real

IPTV network in the country, because the providers undertook to afford the quality of IPTV service none the less than 97%.
Generally, total delay of video stream in IPTV network is not inconsiderable and that influence to all loss of video packets. The better quality of IPTV service and less delay of video packets would be, if the provider would decrease the distance between nodes, processing time, number of couplers on branches and others.
The next step was simulation in IPTV Headend, access network and end-user equipment. Measurements was made for sent/get data stream intensity (packetps), sent/get video stream intensity and video packets delay in every node.

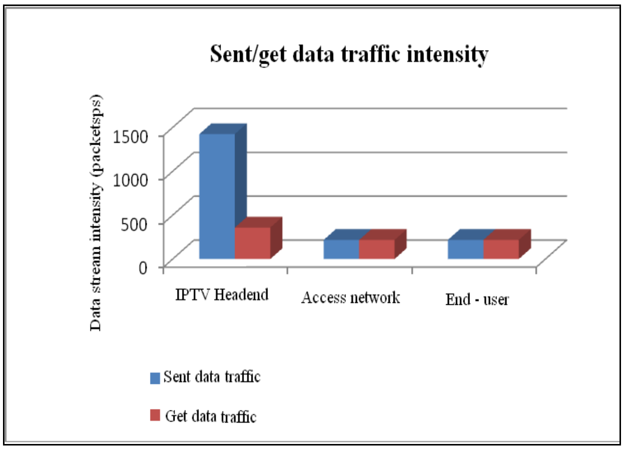

Fig.6. Intensity of data traffic

The maximum of sent data traffic intensity is in IPTV Headend (Fig.6) – 1423 packetsps, in access network and end-user the results were similar (217 packetsps and 216 packetsps).

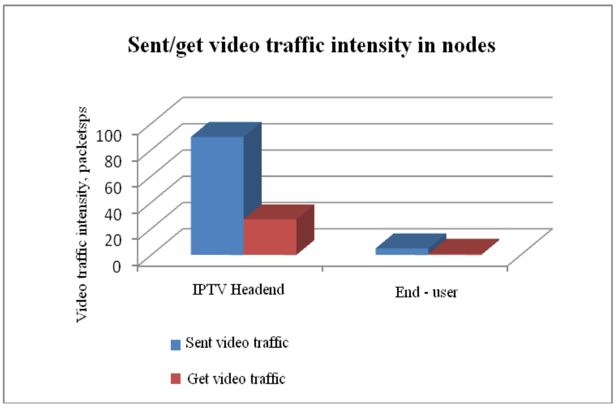

Fig.7. Intensity of video traffic

Evalue of transmitting video traffic by nodes of simulated network shows, that transmission of video streams in IPTV Headend is several times better than transmission in equipment of end - user. Naturally, the last node of transmission of video streams is equipment of end – user, so the delay of every nodes in IPTV network or delay in channels between these nodes influence transmitting of video streams by equipment of end – user. Moreover, IPTV Headend is the first node, where video streams are encoding.
Processing of video streams in real existing IPTV network is swayed not only by delay in nodes or channels between them, but also it depends on ambient air as rain, snow, natural forces and other mechanism, like encoder, processing time of data streams.

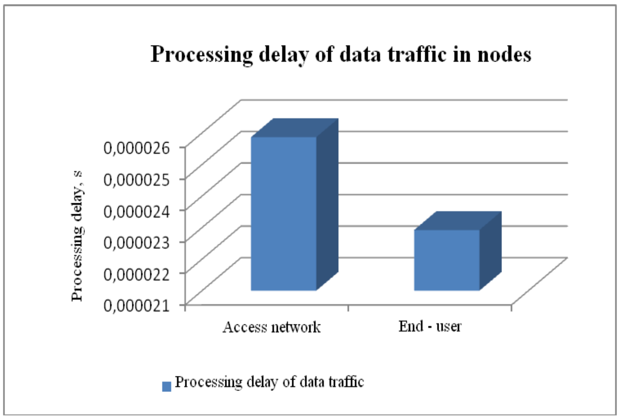

Fig.8. Alignment of processing delay for data streams in nodes of network

According to simulation results, the difference between delay of video streams in IPTV Headend and end – user equipment is too small, because total delay in all simulated IPTV network is unchanged.
Processing delay of data streams in access network is enlarged than in end – user equipment. It is understandable that distribution of data streams for end – user is processing in access network.

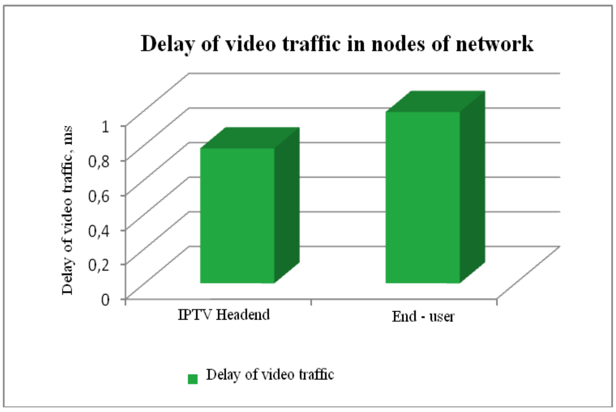

Fig.9. Alignment of delay for video streams in nodes of network

In this case, processing of data streams has big influence to quality of assignment of data streams for end – user.

3 Evaluation of quality for IPTV translations using method of MOS (mean opinion score)

To evaluate the influence of quality parameters and data traffic intensity for IPTV translations we made the experimental IPTV network, shown in Fig. 10.

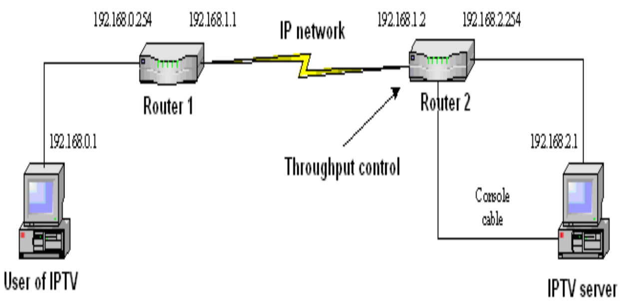

Fig. 10 Structure of experimental IPTV network

We made experiment with 4 types of video films (Table 2) in objective and subjective ways due to evaluate the quality of IPTV translations.

Table 2. Types and parameters of testing video films

Type	Resolution	**Video rate, kbps**	**Audio rate, kbps**	**Total rate, kbps**
1	544 x 224	91	106	197
2	576 x 240	128	107	235
3	640 x 336	160	129	289
4	640 x 288	319	191	510

Experiment was made with VLC v0.8.6c program. The throughput of network was 512 kbps, 768 kbps, 1Mbps, 1.5 Mbps, 2 Mbps and 4 Mbps. Fig.11, Fig.12, Fig.13, Fig.14, Fig.15, Fig.16, Fig.17 shows the results of experiment.

Fig.11 1 type of video film translation, when throughput 512 kbps

Fig.12 1 type of video film translation, when throughput 2 Mbps

According to experiment results for video film of first type, the better quality of video transmission was with network throughput on 2 Mbps.

Fig.13 2 type of video film translation, when throughput 512 kbps

Fig.14 2 type of video film translation, when throughput 2 Mbps

According to experiment results for video film of second type, the better quality of video transmission was with network throughput on 2 Mbps.
In this case, these two films were similar to each other for their resolution, audio rate and total rate, so results of experiment were similar.

Fig.15 3 type of video film translation, when throughput 2 Mbps

In this instance, the better quality of transmission of third type of video film was only with throughput of 2 Mbps, because 512 kbps, 768 kbps, 1 Mbps or 1.5 Mbps throughput was unworkable for digital IP television translation.

Fig.16 4 type of video film translation, when throughput 2 Mbps

Fig.17 4 type of video film translation, when throughput 4 Mbps

The better quality of transmission of fourth type of video film was only with throughput of 4 Mbps, because this film had the biggest resolution and video/ audio rates for translation.
Generally, the biggest throughput of IPTV network guarantee the best quality of video films with any resolution or other parameters.
Finally, the translation of each film were evaluated in subjective way of two persons. Fig. 18 shows the evaluation of 4 types of films translations by two independence persons.

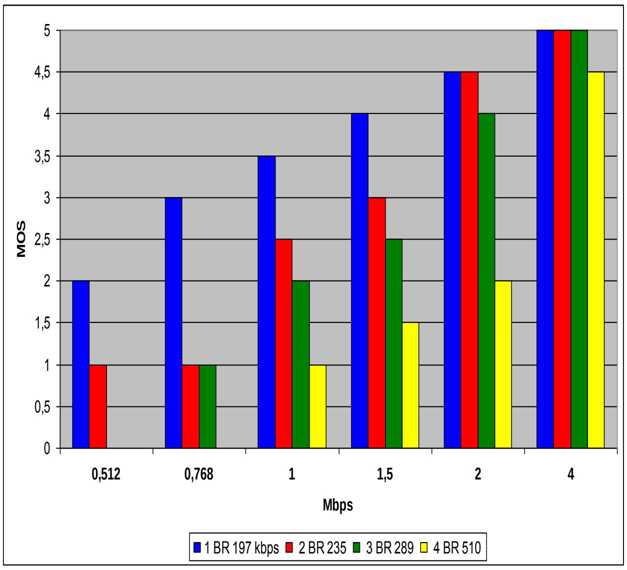

Fig. 18 MOS evaluation (subjective evaluation of quality for IPTV translations)

In this case, when throughput was 512 kbps the best quality of video translation was for the first type of film. When throughput was 1 Mbps the worst quality of video translation was for the fourth type of film. When throughput was 4

Mbps all types of films were evaluated on 4.5 – 5 points.
The next step was objective evaluation using NetStat Live program and measuring of loss and delay of video packets.

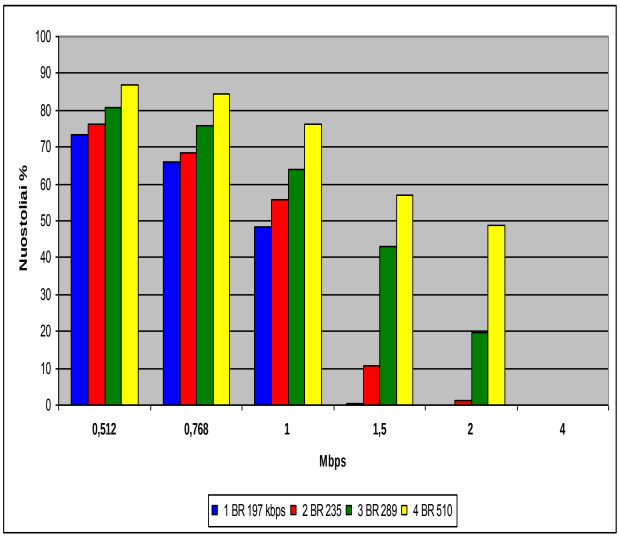

Fig. 19 Dependence of loss of transmission of IPTV packets on throughput of network

The worst results of loss of video packets were on throughput of 512 kbps (70 – 87%). The best quality and minimum loss of video packets were for first and second type of films on throughput of 4 Mbps. Interestingly, the biggest loss of video packets were for fourth type of film, because it depends on requirements for transmission of this type film.

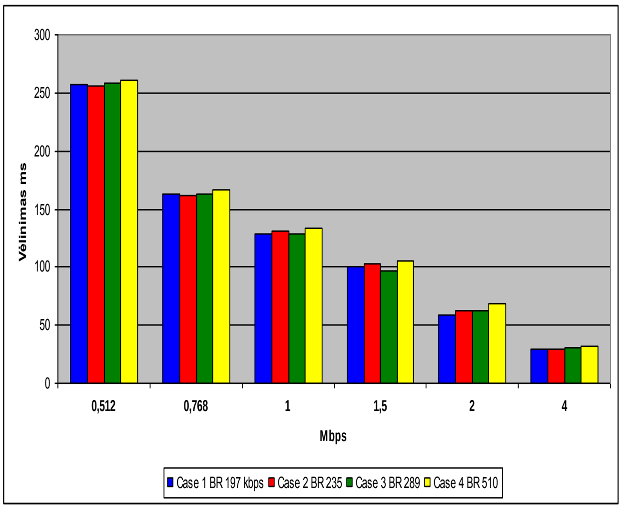

Fig. 20 Dependence of delay of transmission of IPTV packets on throughput of network

The biggest delay of transmission of IPTV packets were for all types of films on throughput of 512 kbps. The minimum delay of transmission of IPTV packets were for all types of films on throughput of 4 Mbps. For this reason, the best throughput for qualitative transmission of IPTV service was 4 Mbps. In real IPTV network the minimum throughput of qualitative TV transmission must be 4 Mbps.

4 Measurements in different nodes of real IPTV network

Due to simulation results, the decision was to make experimental measurements in real IPTV network. The measurements was made in three nodes of IPTV network, existing in the country:

1. IPTV Headend;
2. Access network;
3. End – user equipment.

Measurements was made at 10 a.m and 12 a.m in the morning with "AGAMA Technologies" software. The results of experiment was compared with the results of simulation (Table 3 and Fig.21 - 27).

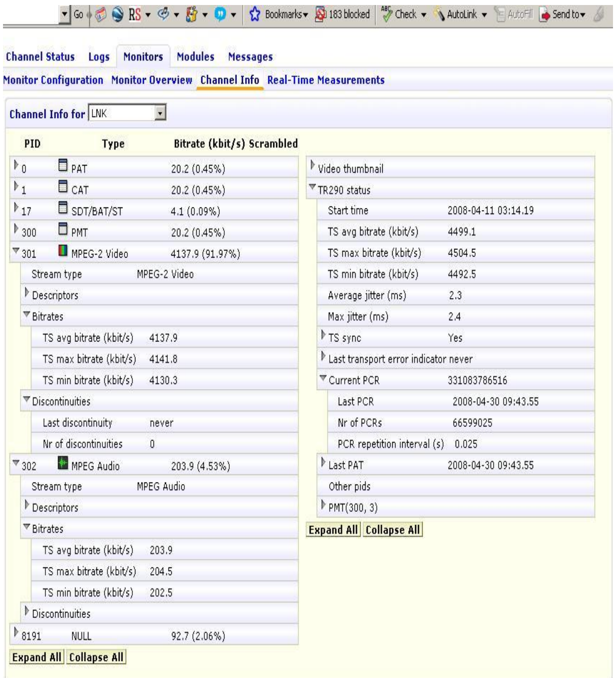

Fig. 21 Measurements in IPTV Headend

As we saw, the video stream type - MPEG 2, TS average bit rate – 4137,9 kbps, the audio stresam type – MPEG, TS average bit rate – 203,9 kbps.

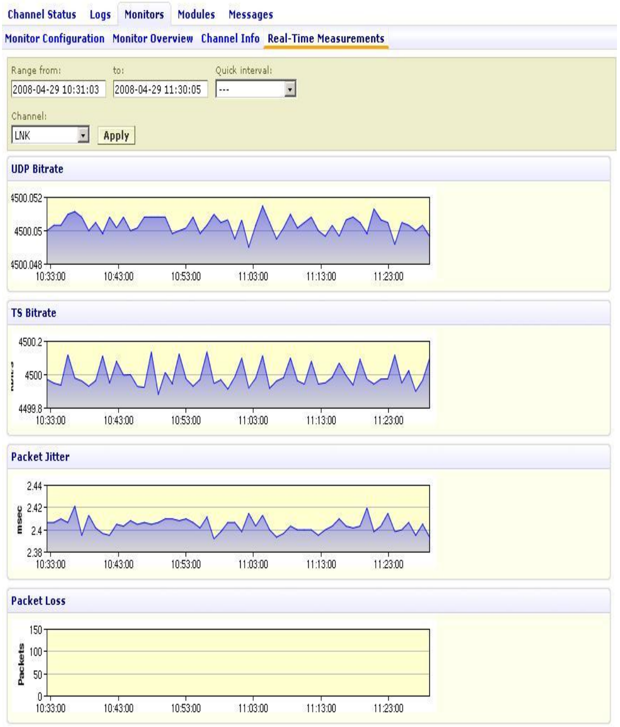

Fig. 22 Measurements in IPTV Headend

In Fig. 22: the average jitter – 2,3 ms, maximum jitter – 2,3 ms.

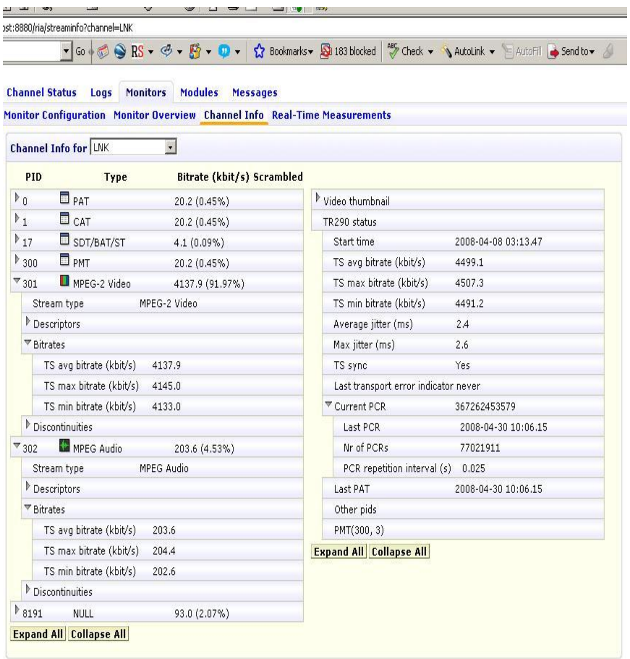

Fig. 23 Measurements in Access network

Measurements in access network showed, that the video stream type - MPEG 2, TS average bit rate – 4137,9 kbps, the audio stresam type – MPEG, TS average bit rate – 203,6 kbps.

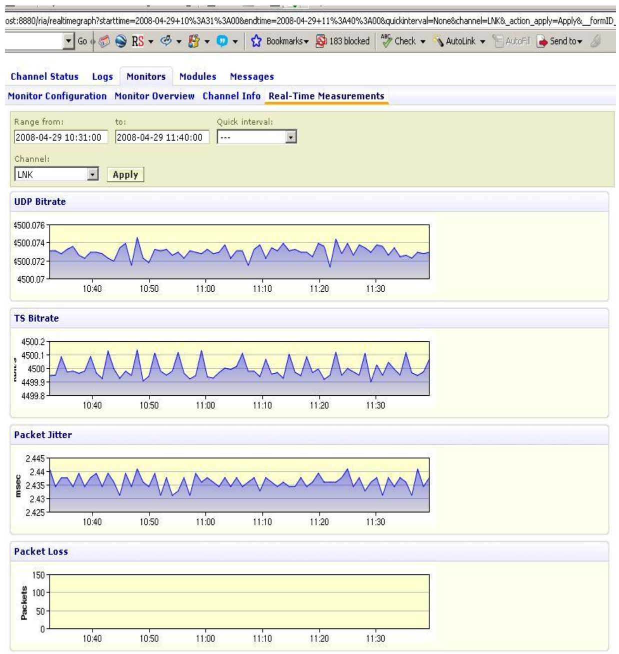

Fig. 24 Measurements in Access network

In Fig. 24: the average jitter – 2,4 ms, maximum jitter – 2,6 ms.

Fig. 25 Measurements in End – user equipment

Measurements in end – user equipment showed, that the video stream type - MPEG 2, TS average bit rate – 4091,1 kbps, the audio stresam type – MPEG, TS average bit rate – 203,4 kbps.

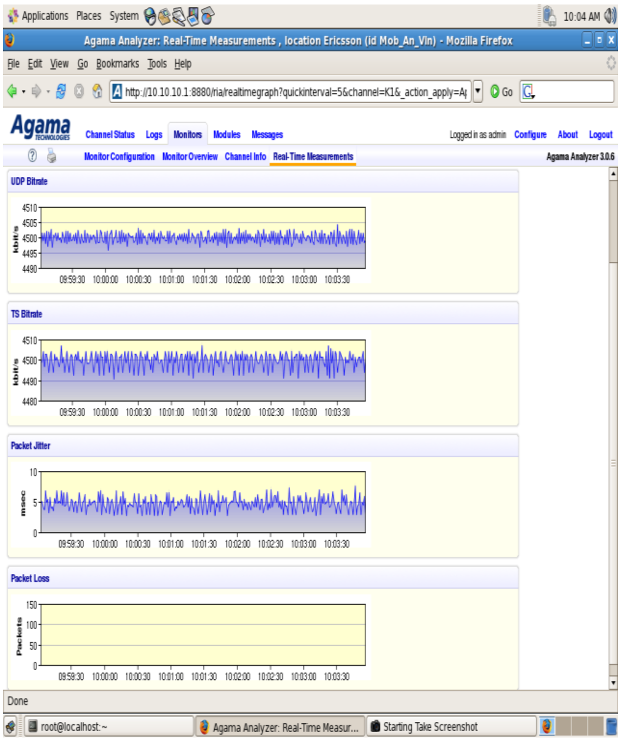

Fig. 26 Measurements in End – user equipment

In Fig. 26: the average jitter – 4,4 ms, maximum jitter – 6,3 ms.

The sum of experiment showed that processing delay of data streams in real IPTV network is several times upper than in simulated IPTV network.

In this instance, simulation was made with no external forces, any interference as conversely in real network.

Table 3. Results of measurements for simulated and real IPTV networks

Node of network	Processing delay of data streams in node simulated network	Processing delay of data streams in node of real network
IPTV Headend	0,78 ms	2,4 ms
Access network	0,86 ms	2,43 ms
End - user	0,99 ms	4,4 ms

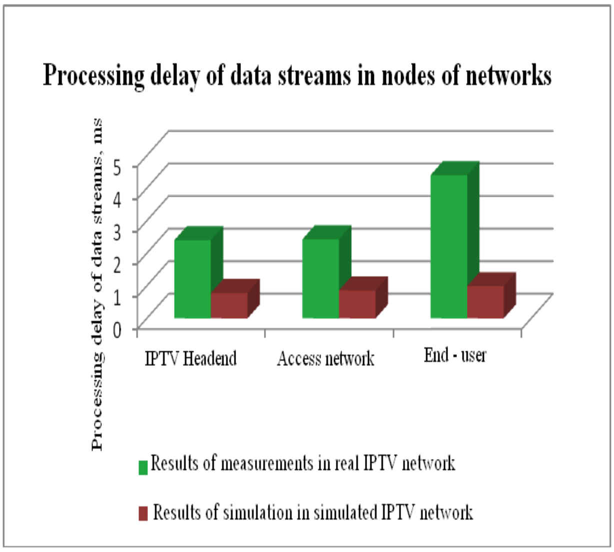

Fig.27. The processing delay of data streams in different nodes of simulated and real IPTV networks

For this reason, I computationally evaluated the efficiency of both networks. The general efficiency of IPTV service [5]:

$$E_i(t) = \sum_{j=1}^{n} \sum_{s=1}^{m} f_{Tij}(x_{ijvs}, t) \times E_{ij}[x_{ij}(t) \mid x_{ijvs}(t)]; \quad (1)$$

When value of service is limited by end-user requirements from $x_{ijv\min}$ to $x_{ijv\max}$, and $m \to \infty$:

$$E_i(t) = \sum_{j=1}^{n} \int_{x_{ijv\min}}^{x_{ijv\max}} f_{Tij}(x_{ijvs}, t) \times E_{ij}[x_{ij}(t) \mid x_{ijvs}(t)] dx_{ijv}; \quad (2)$$

In equations (1) and (2): n – index number of service; m – numbers of index expression interval for each service.

In this regard, the efficiency of real IPTV network is less than efficiency of simulated IPTV network. For this reason, the transmission of IPTV service must be over optical fibers for the solution to increase the efficiency and reduce the delay of assignment of data streams in real IPTV network.

5. Conclusions

During the analysis of quality for assignment of data streams for IPTV service was realized these recommendations for qualitatively IPTV service:

1. The throughput of real existing IPTV network could be increased by network reconstruction, transmitting IPTV service over

optical fibers. Increase of network throughput can reduce data packets loss, processing delay of data streams in nodes, exploitation of channels.

2. Delay of data streams in real IPTV network was within the mark, because our experiment was made by hardware (STB and routers) with implanted algorithms for reduce or stabilize the processing of data packets. In this case, available hardware can influence the quality of IPTV service for end – user.

3. Reconstruction of telecommunication network can increase the efficiency of IPTV service about 30 – 40%, herewith the increasing of quality of this service.

References:

[1] Chunlei L., *Multimedia over IP: RSVP, RTP, RTCP, RTSP:* Handbook of Emerging Communications Technologies. // LLC press. – Germany, 2000.

[2] W. Simpson, H. Greenfield, *IPTV and Internet Video*: first edition – Burlington, USA: Elsevier, 2007. 263p. ISBN 0240809548.

[3] *Delivering IPTV with the Windows Media Platform*. – Microsoft Corp., November 2003. Internet Task Force 2006 http://www.microsoft.com/windows/windowsmedia/proav/iptvbroadcastshowcase.aspx

[4] *IPTV Architecture*: International conference [Geneva, 2007 July 23 - 31]: working document/ ITU – T Focus Group. – USA: Textronic, 2007.

[5] Balaišis P., Eidukas D., Valinevičius A., Žilys M. *The efficiency of informative electronic system*: monograph: Kaunas University of Technology. – Kaunas: Technologija, 2004. – ISBN 9955–09-658-6