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, transmitting 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 scanning 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.

- 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.
The simulated Internet Protocol Television network consists of these components:

- **IPTV Headend** – responsible for formatting of video streams, processing, saving and transmitting the content of multimedia for video management system;
- **Video management system** – responsible for transmitting formatted video streams and additional services for core IP network and access network, also transferring VoD to end-user;
- **HTTP server** – responsible for transmitting HTTP services (Internet) for end-user;
- **Server of additional services** – responsible 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>
<thead>
<tr>
<th>Data rate between video management system and core and access networks</th>
<th>20Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of end-users</td>
<td>100% end-users</td>
</tr>
<tr>
<td>ADSL downstream</td>
<td>5 Mbps</td>
</tr>
<tr>
<td>ADSL upstream</td>
<td>1.5 Mbps</td>
</tr>
<tr>
<td>Additional services</td>
<td>HTTP and FTP</td>
</tr>
<tr>
<td>TV quality</td>
<td>SDTV</td>
</tr>
<tr>
<td>Simulation time</td>
<td>600 s</td>
</tr>
</tbody>
</table>

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.

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

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.
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](image)

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>
<thead>
<tr>
<th>Type</th>
<th>Resolution</th>
<th>Video rate, kbps</th>
<th>Audio rate, kbps</th>
<th>Total rate, kbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>544 x 224</td>
<td>91</td>
<td>106</td>
<td>197</td>
</tr>
<tr>
<td>2</td>
<td>576 x 240</td>
<td>128</td>
<td>107</td>
<td>235</td>
</tr>
<tr>
<td>3</td>
<td>640 x 336</td>
<td>160</td>
<td>129</td>
<td>289</td>
</tr>
<tr>
<td>4</td>
<td>640 x 288</td>
<td>319</td>
<td>191</td>
<td>510</td>
</tr>
</tbody>
</table>

Experiment was made with VLC v0.8.6c program. The throughput of network was 512 kbps, 768 kbps, 1 Mbps, 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](image)

![Fig.12 1 type of video film translation, when throughput 2 Mbps](image)

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](image)
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.

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.

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.
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.

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 ).

As we saw, the video stream type - MPEG 2, TS average bit rate – 4137.9 kbps, the audio...
stream type – MPEG, TS average bit rate – 203.9 kbps.

In Fig. 22: the average jitter – 2.3 ms, maximum jitter – 2.3 ms.

Fig. 22 Measurements in IPTV Headend

Measurements in access network showed, that the video stream type – MPEG 2, TS average bit rate – 4137.9 kbps, the audio stream type – MPEG, TS average bit rate – 203.6 kbps.

In Fig. 24: the average jitter – 2.4 ms, maximum jitter – 2.6 ms.

Fig. 24 Measurements in Access network
Measurements in end – user equipment showed, that the video stream type - MPEG 2, TS average bit rate – 4091,1 kbps, the audio stream type – MPEG, TS average bit rate – 203,4 kbps.

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

<table>
<thead>
<tr>
<th>Node of network</th>
<th>Processing delay of data streams in node of simulated network</th>
<th>Processing delay of data streams in node of real network</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPTV Headend</td>
<td>0,78 ms</td>
<td>2,4 ms</td>
</tr>
<tr>
<td>Access network</td>
<td>0,86 ms</td>
<td>2,43 ms</td>
</tr>
<tr>
<td>End - user</td>
<td>0,99 ms</td>
<td>4,4 ms</td>
</tr>
</tbody>
</table>

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 for the solution to increase the efficiency and reduce the delay of assignment of data streams in real IPTV network.

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

\[ E_j(t) = \sum_{j=1}^{n} \int_{X_{ijv, \min}}^{X_{ijv, \max}} f_{T_{ij}}(x_{ijv,t}) \times E_{ijv}[x_{ijv}(t) | x_{ijv}(t)] \, dx_{ijv}, (1) \]

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

\[ E_j(t) = \sum_{j=1}^{n} \int_{X_{ijv, \min}}^{X_{ijv, \max}} f_{T_{ij}}(x_{ijv,t}) \times E_{ijv}[x_{ijv}(t) | x_{ijv}(t)] \, dx_{ijv}, (2) \]

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.
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: