An Efficient Approach to Audio/Video QoS Monitoring for IPTV Services

| D. ERCOLE, G. PIERSANTELLI | TI.IE.CA.BS |
An Efficient Approach to Audio/Video QoS Monitoring for IPTV Services

Agenda

- Telecom Italia profile
- Introduction to QoE monitoring
- IPTV delivery chain and AV impairments
- QoE, network probes and lab tests
- Tests’ results
- TILab proposals to improve QoE monitoring
With the brand Alice Telecom Italia provide broadband services

<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice ADSL</td>
<td>DSL lines, 640 kbps, 7Mbps, 20 Mbps; add’l services available</td>
<td>2€/hr, 19.95/mo, 24.95€/mo</td>
</tr>
<tr>
<td>RossoAlice</td>
<td>multimedia content portal; live (sport events), VoD (movies), D&amp;P (music tracks)</td>
<td>0.99-2.99 € ppv</td>
</tr>
<tr>
<td>Alice Home TV</td>
<td>IPTV over 20 Mbps DSL with streaming VoD and live content; SKY premium channels; PPV content; hybrid Set-top box provided</td>
<td>22.95 €/month SKY: 15-59 €</td>
</tr>
</tbody>
</table>
Telecom Italia IPTV QoS. Introduction

- QoS/QoE monitoring is relevant to us in order to:
  - provide customers with an increasingly high quality multimedia experience
  - detect possible A/V impairments and their origin, for a fast, cost efficient fixing
- Telecom Italia is currently using a set of QoS network probes to analyze A/V quality
  - Lab tests showed that the analysis of synthetic results not always help to exactly find out where the error generates
- Telecom Italia LAB (R&D branch) proposals:
  1. Separating head-end errors from network errors
  2. Introducing controls system
The industry is focusing on measuring parameters which impact video quality at the receiver. In video IP delivery system the following components can impact the quality:

1. **Head End/Encoder**: The encoder takes a source video signal and codes it into the chosen digital form. Key configuration choices of the encoder, such as bandwidth and format can impact quality. Sport content and high speed motion video require high quality encoding and bitrates.

2. **IP Distribution Network**: IP networks do not guarantee any quality of service; packet loss can be expected. Quality of video delivered via an IP network can be impacted.

3. **Receiver / Decoder**: Compressed digital video (MPEG2/MPEG4) typically requires a significant amount of decoding resource on the playout device.

→ Rise of troubleshooting / help desk costs

**Worst case**: 1 packet lost (statistically, 1 video packet) = 1 artifact
Video impairments and carrier’s operations: laboratory tests

- Telecom Italia adopts analyzers, probes and agents to measure its IPTV’s QoS and QoE to detect and solve problems.
- Nevertheless, the probes’ synthetic results based on MPQM (Moving Picture Quality Metrics) models not always provide accuracy in QoS metering.
  - In particular they make it difficult to distinguish between different ranges of errors.
- In our labs, we emulated audio and video impairments introducing errors in a video clip* to generate video artifacts and audio glitch.
- Commercial network probes** have been used to measure the impact on QoE.

---

* 15 minutes loop of a MPEG2, 4.0 Mbps, Standard Definition videoclip, delivered by our IPTV platform to a commercial Pirelli Set-top box
** with default configuration
An Efficient Approach to Audio/Video QoS Monitoring for IPTV Services

Test configuration in Telecom Italia LAB

- **Aim of the test:** introducing, measuring and evaluating AV impairments in an IPTV delivery chain to correlate artifacts with actual network errors
- A commercial IPTV service is accurately replicated in a lab environment
- A disturb generator introduces in a 15 minutes video clip different errors:
  - Uniform Packet Loss (0.1%, 0.01%, 0.001%, 0.0001%) and Burst Packet Loss (10, 20, 50 packets single burst)
  - Uniform and Exponential Jitter
  - Constant (5, 10, 20, 50 ms) Packet Delay
- The probe analyzes the errors and aggregates the results in a synthetic index based on MPQM
**Video impairments and perceived quality: test results**

- Uniform and Burst Packet Loss can be considered as **critical issues**
- **Jitter** and **Delay**: not an issue in AV perceived quality

<table>
<thead>
<tr>
<th>Uniform Packet Loss</th>
<th>Audio</th>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Artifact detection</td>
<td>Subj. evaluation</td>
</tr>
<tr>
<td>0.1% (1 error/2.7 s)</td>
<td>Yes</td>
<td>Very annoying</td>
</tr>
<tr>
<td>0.01% (1 error/27 s)</td>
<td>Yes</td>
<td>Annoying</td>
</tr>
<tr>
<td>0.001% (1 error/4.5 min)</td>
<td>Yes</td>
<td>Annoying</td>
</tr>
<tr>
<td>0.0001% (1 error/45 min)</td>
<td>Yes</td>
<td>Not annoying</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Burst Packet loss</th>
<th>Audio</th>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Artifact detection</td>
<td>Subj. evaluation</td>
</tr>
<tr>
<td>10 packets</td>
<td>Yes</td>
<td>Annoying</td>
</tr>
<tr>
<td>20 packets</td>
<td>Yes</td>
<td>Annoying</td>
</tr>
<tr>
<td>50 packets</td>
<td>Yes</td>
<td>Very annoying</td>
</tr>
</tbody>
</table>
Uniform packet loss ranges and MPQM index (sample 10 sec)

Subjective evaluation

- Very annoying
- Annoying
- Slightly annoying
- Good

Different ranges are aggregated
An Efficient Approach to Audio/Video QoS Monitoring for IPTV Services

Uniform packet loss ranges and MPQM index (sample 60 sec)

Subjective evaulation

- Very annoying
- Annoying
- Slightly annoying
- Good

Different ranges are aggregated
TILab Tests’ results and proposals

Results

- The MPQM synthetic index is an useful tool to evaluate the QoE but
  - It doesn’t help to exactly detect where in the delivery chain the error generates
  - Very different ranges of errors are aggregated as they were similar while their impact on QoE is quite different
  - Graphics not always describe the actual QoE

Proposals

1. Separating head-end errors from network errors when analyzing the A/V impairment analysis instead of relying on a synthetic, aggregated result
2. Introducing RTP control system on playout devices to collect statistics and help customer care to detect the error
3. Eventually, introducing Forward Error Correction (FEC) techniques
1. Improving the QoS Monitoring

- **MPQM** both analyzes video encoding and transport quality, then aggregates the results in a synthetic index.
  - The adoption of different and simpler metrics in QoS monitoring could help to distinguish head-end errors from transport network errors: graphics don’t describe the actual QoE.

- **MDI (Media Delivery Index)** is a measurement tool for monitoring and troubleshooting networks carrying any streaming media type; MDI only reports loss- and delay-related quantities.
  - MDI gives an indication of video transport performance based on network level (IP) measurements: this scaleable, lightweight tool doesn’t measure video encoding quality but it provides a simpler indication.
  - The MDI can be used to warn or alarm on impairments that result in unacceptable network margin before video quality is impacted.
  - Even if MDI gives less information than MPQM, it makes it easier to understand the results.
2. Improving the QoE with RTP

- In case of packet loss, the continuity counter in the Transport Stream (TS) packet header helps to identify the packet missed and to reconstruct the original sequence sent to the decoder, but its accuracy is limited.

- Realtime Transport Protocol (RTP) could be added to TS to improve IPTV diagnostic features.

- The implementation of RTP’s sequence number on IPTV Set-Top Box could improve the QoE by detecting packet loss and packet inversion in the received stream.
  - For each received stream, receivers periodically generate a report which shows the number of sent and lost packets, the jitter amount and the packet identifier. This report can be encapsulated in a RTCP packet.
  - RTP helps to know how many packet have been lost and to sort Out-Of-Sequence Packets.

- **RTP brings advantages:**
  - standard protocol with small overhead; video encoders feature RTP capabilities.
  - helpful to fine tune S/N ratio in DSL profiles.
  - integrated in Set-Top Box, helpful to collect information and statistics on QoE.
3. Forward Error Correction (FEC)

- In addition to RTP integration, QoE could benefit from other correction techniques
  - With Packet Retransmission, in case of packet loss, the sender retransmits to the decoder the lost packets in order to reconstruct the correct sequence. However it introduces some delay which is not desirable specially in live events
  - Alternatively, Forward Error Correction (FEC) techniques can be introduced to improve the IPTV quality of experience. In network environments, FEC refers to the method of preventing video errors by transmitting to the decoders redundant information without the need to ask the sender for additional data. The receivers can readily recover the original payload even when some communication is lost in the transmission
    - Compared to other error correction techniques (such as retransmission) this method introduces a lower transmission delay
Conclusions

- Packet loss affects IPTV QoE and costs money for troubleshooting
- Simpler metrics are needed to effectively monitor a video stream quality over an IP network
- Encoding quality can be optimized and controlled, monitoring activities should focus on network impairments
- Error correction techniques could be implemented in STBs to improve QoE and report impairments

Thank you!