Techniques for Measuring QoE

Fernando Kuipers, Robert Kooij, Danny De Vleeschauwer, and Kjell Brunnström

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Outline

ITU-T FG IPTV: Quality of Experience (QoE) refers to the overall acceptability of an application or service, as perceived subjectively by the user.

- QoE in perspective
- QoE of speech and audio
- QoE of gaming
- QoE of video
- QoE as design parameter
QoE in perspective

End-to-end perceived service quality (MOS)

End-to-end network quality

Terminal/content quality

Supported network QoS mechanisms

Terminal/content quality
QoE measurement methodologies

- No-reference model
- Reduced-reference model
- Full-reference model
No-reference E-model (speech)

\[ R = R_0 - I_s - I_d - I_e + A \]

- \( R_0 \): SNR
- \( I_s \): Speech signal
- \( I_d \): Delay
- \( I_e \): Equipment
- \( A \): Advantage

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<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<tbody>
<tr>
<td><strong>E-model according to updated Appendix I G.113</strong></td>
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<td>EchoLoss [dB]</td>
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<td>65</td>
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<td>MOS</td>
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<tr>
<th>codec</th>
<th>delay [ms]</th>
<th>loss</th>
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<tr>
<td>G.729</td>
<td>100</td>
<td>5.00%</td>
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Full-reference model speech & audio

- Full-reference speech: PESQ - ITU-T Rec. P.862
- Full-reference audio: PEAQ - ITU-R BS.1387

- Excerpts of reference and test signal are aligned and compared

- Tools:
  - Peaqb
  - PQeval Audio
QoE of gaming

• First Person Shooter games (Quake IV)

• No-reference **G-model**:

\[
\text{MOS} = \max(4.33 - 3.08 \times 10^{-9} X^3 + 1.18 \times 10^{-5} X^2 - 1.15 \times 10^{-2} X, 1)
\]
\[
X = \min(\text{AVGRTT} + 0.686 \times \text{JITTER}, 650)
\]
QoE of video – Visual quality

- Video quality metrics (Full Reference):
  - PSNR (ratio in dB between signal power of original signal versus power of reconstructed compressed signal)
  - VQM (software tool by ITS)
- Calibration is key
- No standards for no-reference models
QoE of video – A/V synchronization

- ITU-R Rec. BT.1359-1: no more than 90 ms audio leading video and no more than 185 ms audio lagging behind video
QoE of video – User synchronization
QoE of video – Zapping time

Experiments

SopCast: 50 s
QoE as design parameter – IPTV case

- Determine quality TV signal (visual quality)
- Desired quality impacts required bit rate (I-frame spacing)
- Zapping < 0.5 s for MOS 3.5
QoE Trends in Networking

- No-reference models for streaming services
- QoE as design parameter
- ...

Techniques for measuring QoE