YoMoApp: a Tool for Analyzing QoE of YouTube HTTP Adaptive Streaming in Mobile Networks

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Performance Objectives

- **Performance goals for mobile operators**
  - User satisfaction = Important objective for mobile operators
  - Mobile subscribers expect a high-quality and smooth-running application
  - Ultimately, trade-offs between service quality and network cost efficiency are in focus for design, deployment, and optimization

- **Quality of Experience (QoE)**
  - QoE describes subjectively perceived quality and user satisfaction with network and service
  - Subjective studies are required to derive QoE models (i.e., mappings between key performance indicators and quality scores)

- **QoE assessment determines the current QoE and provides important feedback for network operators**
QoE Assessment

- **Subjective user studies** (costly, time consuming)

- **Application monitoring** in the network, e.g., with Deep Packet Inspection (DPI) mechanisms
  - Estimation of application parameters as input for QoE models
  - No changes in applications / on end devices required
  - Inaccurate in case of user interaction
  - Not possible with encrypted connections (HTTPS)

- **End device reports to the network**
  - Application parameters as input to QoE models
  - Additional programs monitor parameters at the end device
  - Example: YouTube application monitor YoMo for desktop computers
YoMoApp: QoE Evaluation of HTTP Adaptive Streaming in Mobile Networks

Goal of the App
- Implementation of measurement concept on monitoring of application-layer key performance indicators of YouTube
- Key performance indicators are chosen, which have a high correlation with actual QoE of mobile users

Basic functionalities
- Investigating the playback behavior of YouTube video streams
- Monitoring of playback events and buffer level
- Cloud-based storage of monitored data

Type of Mobile App
- Android mobile app for YouTube playback based on Android WebView with HTML 5
QoE Performance Monitoring App

- Manually upload measurement data
- Start YouTube
- Start pre-defined YouTube test scenario
- Show statistics

Apps
Benutzerdefiniert

Google+
Runtastic PRO
AntiVirus
dict.cc
YouTube
TV Programm
Einkaufsliste
Das Örtliche
Freeletics
wetter.com
HTC Guide
QoE Performance Monitoring App

- Start YouTube
- Start pre-defined YouTube test scenario
- Manually upload measurement data
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Exactly the same user experience as in the normal YouTube App

Even YouTube settings can be used and changed

Performance Analysis App for YouTube Video Streaming

QoE Performance Monitoring App

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Exactly the same user experience as in the normal YouTube App
QoE Performance Monitoring App

Manually or automatically upload to database
Evaluation: Lab Study

**Measurement scenario**
- Dedicated lab study with 52 participants
- Each participant uses YoMoApp
- Downlink traffic was routed through network emulator
- At the end of study: user survey about YouTube quality

**Monitored parameters** (partly used as performance metrics)
1. Player state/events
2. Video playback time
3. Buffer filling level
4. Video quality level
5. Device characteristics: screen size, type of connection, etc.

**QoE models can be applied to determine the video session QoE based on these parameters**
Video Playback

- Example output: time series graph of a video playback
- Illustration of monitored parameters for an exemplary video
Video Playback

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Comparison of measured stalling length and rating

- Only less stalling detected for constant network conditions (Adaptive Streaming)
- QoE ratings of participants reflect the measured results → outage condition: avg. MOS of 2.83
- 95% confidence intervals; Q.: "How did you experience the stalling?"
Video Quality Switches

Monitoring of video quality and resulting image QoE

- Percentage of time on each quality layer
- All available resolutions were used: 1Mbps → 360p with 92.89%, 2Mbps → 480p with 88.84%, 4Mbps → 720p with 67.15%
- Outage condition similar to 4Mbps; Variable condition → 240p with 80.86%
- Q.: “Rate the image quality of the playback?”; MOS of at least 4.17
Conclusion

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- **Basic functionalities**
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  - Monitoring of playback events and buffer level
  - Cloud-based storage of monitored data

- **Outcome**
  - Evaluation of subjective ratings from lab and field studies
  - Comparison of classical and adaptive video streaming
  - Influence of network parameters on adaptation behavior
Thank you for your attention!

Screencast available at YouTube
Keyword: YoMoApp
QoE Performance Monitoring App
Performance Analysis App for YouTube Video Streaming

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- **QoE models** can be applied to determine the video session QoE based on these parameters

Illustration of monitored parameters for an exemplary video
Performance Analysis App for YouTube Video Streaming

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![Illustration of monitored parameters for an exemplary video](image)

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**Performance Analysis App for YouTube Video Streaming**

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**Illustration of monitored parameters for an exemplary video**
Performance Monitoring of Mobile Networks
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