Quality of experience optimized scheduling of YouTube video streaming

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Trend towards Quality of Experience

▸ Keep customers happy, attract new customers
⇒ Improving subjective quality perception of end-users

▸ Shift from Quality of Service (QoS) to Quality of Experience (QoE)
  • QoS: packet loss, delay, jitter, …
  • QoE: subjective experience/satisfaction of users of a service

▸ Example: web user interested in short page load times
  VoIP user interested in speech quality
  video user interested in video quality and smooth playout w/o interruptions

▸ What are key QoE influence factors and appropriate QoE models?
▸ How to control QoE? How to optimize QoE?

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QoE optimized scheduling of YouTube

1) How to model YouTube Quality of Experience?
2) What are requirements for optimal video transmission with respect to QoE?
3) Utilizing buffered YouTube playtime for QoE-oriented scheduling in OFDMA Networks.
QoE issue: waiting, waiting, waiting…

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Key influence factors on YouTube QoE

- Derive key influence factors on QoE
  - Interesting: no correlation of QoE and
    - video characteristics like resolution, type of content, ratio of audio/video, etc.
    - users preference, whether they liked video
    - demographical features

- Stalling frequency and stalling duration determine the user perceived quality
YouTube QoE model

- Lab studies with UniWue’s CrowdSourcing and at FTW’s i:Lab
- Mapping functions between MOS and stalling pattern, i.e. event length and the number of stalling events, are provided

Users only accept almost no stalling or only short stalling
1) How to model YouTube Quality of Experience?

2) What are requirements for optimal video transmission with respect to QoE?

3) Utilizing buffered YouTube playtime for QoE-oriented scheduling in OFDMA Networks.
Video bit rate as information

- Stalling occurs, if video bit rate $V > B$

- No stalling although $V > B$
  $\Rightarrow$ reason: initially buffered video data (and actual video duration)

- Stalling sometimes occurs, if $V < B$ $\Rightarrow$ reason is variability of video codec

$\Rightarrow$ Video bit rate as only information is not sufficient to avoid stalling
Scene changes have to be considered!

- Scene changes may lead to significant changes of video bitrate

- Options for improved approximation
  - Statistical description of frame sizes per scene
  - Complex frame size models taking into account correlations across scenes

But: YouTube videos are short!

- Specify sizes of all frames in meta information of video file
- Statistical approximation of video characteristics
Buffered playtime as information

Feedback application information: buffered playtime of the player

YouTube playtime buffer

- Trying to keep $\beta$ over a certain limit
  $\Rightarrow$ no stalling

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Scenario: Improving YouTube download quality

Utilizing buffered playtime for scheduling decision

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Simulation

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Application unaware scheduling

Case 1 – Application unaware

- Fair share with respect to network throughput
- Download performance: good
- YouTube quality: bad

Throughput 1.4 MHz LTE, round robin scheduler

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Application unaware scheduling

Case 2 – Application *unaware*

- YouTube + 1, 5, and 12 web users
- Statistical web user model: one main object, # embedded objects
- YouTube quality good for 1-5 users
- YouTube quality bad for 12 users

Throughput

```
(1 web user)
(5 web users)
(12 web users)
```

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Utilizing YouTube playtime buffer

Case 3 – Application aware
- YouTube + 12 web users
- YouTube is prioritized in case of low YouTube buffer
  - E.g. buffered playtime $\beta < 15$ s
  - YouTube is playing fine
  - Download performance only marginally influenced

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Intelligent access control & schedules

- Future Work: Impact on other users
- Here: impact on web users
- Application aware: Utilizing YouTube playtime buffer

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