Unperturbed video streaming QoE under web page related context factors

Michael Seufert, Ondrej Zach, Martin Slanina, Phuoc Tran-Gia

Angaben zur Veröffentlichung / Publication details:

Seufert, Michael, Ondrej Zach, Martin Slanina, and Phuoc Tran-Gia. 2017. "Unperturbed video streaming QoE under web page related context factors." In *Ninth International Conference on Quality of Multimedia Experience (QoMEX), 31 May - 2 June 2017, Erfurt, Germany*, edited by Stephan Werner, Steve Göring, Glenn van Wallendael, and Werner Robitza, 1–6. Piscataway, NJ: IEEE. https://doi.org/10.1109/qomex.2017.7965675.

Unperturbed Video Streaming QoE Under Web Page Related Context Factors

Michael Seufert*, Ondrej Zach†, Martin Slanina†, Phuoc Tran-Gia*

*University of Würzburg
Institute of Computer Science
Würzburg, Germany
Email: seufert@informatik.uni-wuerzburg.de

†Brno University of Technology
SIX Centre, Department of Radio Electronics
Brno, Czech Republic
Email: ondrej.zach@phd.feec.vutbr.cz

***Abstract*—Quality of Experience (QoE) of Internet services is affected by human, system, and context influence factors. While most QoE studies so far are focused on system factors only, this work will assess the impact of context factors of video streaming on QoE. As video streaming is mostly consumed from web pages, such as video portals, the investigated test conditions are applied to the web page, which embeds the video player. Therefore, the study of context factors is implicitly conducted within a crowdsourced QoE study. The test conditions considered different page load times, poster image qualities, and displayed advertisements on the web page, which are typical context factors when consuming a video streaming service. The results of the study show that the modification of the context factors on the streaming web page leaves the users' QoE rating unperturbed, which suggests that the investigated context factors have a negligible impact on video streaming QoE, or that the rating task of the subjective QoE study superimposed the context factors.**

I. Introduction

The subjective perception of the quality of a service as a whole is described by the concept of Quality of Experience (QoE) [1]. It has become the main focus of network and service providers, which strive to deliver the best service to end users in order to increase customer satisfaction and decrease the churn rate. Extensive subjective studies have been conducted for different Internet services, such as video streaming (e.g., [2], [3]) or other web services (e.g., [4], [5]). However, these QoE studies mainly focus on system factors, i.e., the technically produced quality of an application or service [6]. For example, for HTTP adaptive video streaming (HAS), these include video encoding, initial delay, stalling, and adaptation, and their impact was well investigated in many studies [2].

Next to system factors, also human and context factors may have an influence on QoE [1], but they have not been in the focus of research yet. The reason to postpone the investigation of human factors might be that large longitudinal studies and psychological pre-tests are required to determine the impact of predisposition, parenting, education, social role, constitution, or emotional state. In contrast, current QoE studies target a large user diversity, e.g., by crowdsourcing [7], to reach meaningful mean opinion scores (MOS) for test conditions, thereby ignoring the human influence factors of individuals. Additionally, context factors, which describe the users' environment, may impact the QoE. While again, the influence of physical, temporal, or social context factors can hardly be evaluated with the current subjective QoE study design, first studies have considered the economic [8] and task context [9] of QoE. Finally, the technical context factors, which describe technical interactions with the system of interest have to be considered. These include, for example, device characteristics, service presentation, user interfaces, or coexistent services.

This work investigates the impact of technical context factors for video streaming. As video streaming is mostly consumed from video portals, i.e., from web pages, the focus is on technical context factors related to the web page, which embeds the video player. In particular, the impacts of different page load times, poster image qualities, and displayed advertisements are investigated. Therefore, a crowdsourced study on the impact of encoding bit rate on the QoE of H.264 videos was conducted, which included an implicit study of the context factors. While the actual QoE results for the video quality are of minor importance, the impact of the technical context factors on the QoE will be evaluated.

Therefore, the work is structured as follows. Related works on context factors and the QoE of video streaming and web browsing are outlined in Section II. The crowdsourced QoE study and the implementation of the investigated context factors is described in Section III. Section IV presents the results of the study, and Section V discusses the results and concludes.

II. Related Work

The QoE of multimedia is a complex issue. One of the most common factors that influence the users' experience, are the parameters of the encoded video sequence itself (e.g. video bit rate, resolution, video encoding algorithm) [10]. Other factors that can have impact on the QoE in video streaming or web browsing are technical issues , such as delay, stalling etc.

However, it was shown, that not only these parameters have an impact on the resulting QoE [11]. In [12], the influence of social context on the QoE was investigated. The authors focused on the influence of presence of co-viewers, gender and age of the participants, and their interest in the watched video, on the final QoE. The presence of co-viewers could increase

the QoE, however, only a group of friends was investigated, hence, the co-viewers had a relationship between each other. The influence of the day time, when users watch the video, on the perceived QoE is addressed in [13]. The authors found out that usually higher MOS was observed when the users watched the content in the afternoon, which may be explained by current mood and psychological issues of the participant over the day.

In this work, three context factors of video streaming on web pages will be investigated, namely, the page load time, the poster image quality, and displayed advertisements. The relationship between the waiting times of interactive data services and QoE is discussed in [14] and [15]. The authors focus on the time perception and its relation with the users satisfaction. In case of web browsing, which is often part of consuming a video from a video portal, the page load time of a web site has the most dominant impact on perceived QoE [15].

The effect of advertisement in video streaming on the QoE is presented in [16]. The authors investigated the influence of in-stream video advertisement and the position of the ad clip in the streamed video sequence. The most disturbing case for the users is when the advertisement clip is placed in the middle of the video they watch. Furthermore, longer duration of the advertisement resulted in lower MOS. However, the study is focused on video advertisement only and the influence of advertisement in side banners was not taken into account.

In [9], the authors examine the influence of presence and content of a task on video quality perception. Though the presence of the task did not influence the final QoE, its presence can have an impact on the focus of the participants.

In the following, the conducted crowdsourced QoE study will be described, which implicitly included the actual study of the web page related context factors.

III. Study Description

A crowdsourcing study was conducted similar to [17], in which the users had to rate the quality of H.264 video sequences having three different bit rates (500 kbps, 1000 kbps, and 2000 kbps). Three source sequences were used, namely, 10 s long clips from a rock concert, a basketball match, and a leopard documentary, which cover wide variety of characteristics. All source video sequences were available in 1080p resolution at 25 frames per second. The source video sequences were downscaled using *ffmpeg*[1] tool to standard resolution (576p) to meet the possibly low Internet connections of the crowd workers and were encoded using the *x264*[2] implementation.

The online test framework of [17] was used, which adheres to the best practices described in [7] including monitoring of test execution and automated reliability checks. The participants had to access the test framework, read the task description, complete a pre-test, and answer a short demographic questionnaire. In the meantime, the required videos were downloaded to the local browser cache to avoid network induced perturbations, such as initial delay or stalling, during the playback. Then, the framework introduced the next video clip. It ensured that the clip was in the local cache before the user could proceed to the video web page, which contained only the video player on a gray background, cf. Fig. 1-a. After clicking the video player, the playback started, and the user was redirected to submit the quality ratings on a 5-point ACR scale after the playback ended. This process was repeated for all three clips. Finally, the user had to answer some more personal questions, before the task was finished and he was given his payment code. The reliability of users was checked according to the clicking behavior during a pre-test, which indicated if users read the instructions or not. Moreover, consistency questions, content questions, and the monitored task execution, i.e., whether users watched all videos in their full lengths, were used to check the reliability. Ratings of unreliable users were filtered out before the result evaluation. Additionally, ratings were excluded if technical problems with the test framework occurred, such as stalling of the video playback.

The baseline QoE for the three video clips and the three bit rates was obtained from the study conducted in [17]. It featured a plain video web page without any added context factors. From September 2016 to January 2017, for each investigated context factor, the web page, which embeds the video player, was unknowingly modified, and a separate campaign was submitted for each investigated context factor on the crowdsourcing platform Microworkers[3]. Note that only one context factor was modified per campaign. The workers, which were unaware of the technical context factors, were instructed to watch and rate three differently encoded video clips, and were rewarded with 0.20$ after the completion of the test. On average, 12 reliable ratings per condition, i.e., a variation of video content, video bit rate, and the investigated independent variable, were gathered.

A. Page Load Time

The QoE of web browsing is significantly influenced by the page load time [15]. The idea of this study is to investigate if the page load time of the video page influences the perceived quality of the video streaming. Therefore, a delayed page loading was implemented. When the user progressed to the video web page, the display of the video player was hidden and a spinning load indicator (transparent animated gif), similar to the stalling animation of YouTube, was shown. After a random delay of either 500 ms, 2000 ms, or 4000 ms, the video player was displayed, and the video playback could be started. After the playback, the users were asked to rate the quality of the video clip. 352 users participated in this campaign. After the filtering, the ratings of 174 users were used for the evaluation.

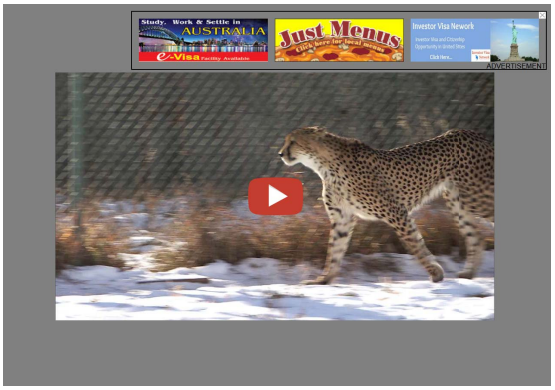
In case of this study, for which the video web page contained only the video player, the delayed page loading closely resembles the initial delay of video streaming. The only difference is whether the delay happens before or after the user clicks the player. Therefore, the analysis of the impact of page load time was complemented by a study on the impact of initial delay on QoE. It was implemented such that the player was displayed immediately on the video page, but after the user clicked to start the playback of the video, an initial delay was simulated by pausing the video and displaying the

[1] http://www.ffmpeg.org

[2] http://www.videolan.org/developers/x264.html

[3] https://microworkers.com

(a) Video web page containing only the video player.



(b) Video web page with additional advertisement banner.

Fig. 1. Video web page used in the study. The poster image is the displayed video frame with the overlay play button.

spinning loading animation. After a random initial delay of either 500 ms, 2000 ms, or 4000 ms, the playback continued. 332 users participated in this campaign in total, 162 of them were considered reliable.

B. Poster Image Quality

When a user accesses a video web page, he spots the video player, which typically displays a frame of the video and an overlay with a play symbol, cf. Fig. 1. The displayed frame of the video player is called the poster image. It provides users a first impression of the video and also its quality. Therefore, its quality might anchor the user to expect a certain video quality, which will influence his QoE. For example, if the poster image has a low quality with many artifacts, but the actual playback has a high visual quality, the user could be positively surprised, and vice versa. Although the poster image can be specified in the HTML5 video element, in this study, the poster image of the video clips was modified by adding overlay images in front of the video player. If the overlay image is clicked, it is removed from the web page and the video playback is started at the same time. For each video clip, the same frame was extracted from the 500 kbps, 1000 kbps, and 2000 kbps version of the clip to be used as poster image. The test conditions were constructed by selecting randomly one of the three poster images and one of the three video bit rates for each clip. 153 out of 332 participants were considered reliable in this campaign.

C. Displayed Advertisement

The most popular video portals offer free of charge video streaming. However, advertisements are included in the web page to finance the service provision. The presence of advertisements on the video web page before and during the playback can distract the user's attention or even annoy the user, and thus, influence the QoE of the streamed video. In this study, a single advertisement banner was added to the plain video web page, cf. Fig. 1-b. The banner consisted of either one or three ads. In case of one ad, either a static image or an animated gif was used. The animated ads showed oscillations between images and flickering. In case of three ads, either zero, one, or two ads were animated gifs, the remaining ads were static images. Thus, in total five advertisement conditions were investigated, which were randomly assigned to the users. Note that the advertisement condition was constant for the whole task, i.e., for all three videos. However, the content of the ads was randomly chosen from a pool of ten static and ten animated images. A sample inspection before the study ensured that the banner was not removed by widely used ad blocking browser plugins. In this campaign, 377 workers participated. The ratings of 161 users could be evaluated.

IV. Results

In the following, the results of presented crowdsourcing QoE studies are described, and the impact of the web page related context factors is investigated.

A. Page Load Time

In the case of the page load time study, two different types of delay were investigated. In Fig. 2 the MOS scores along with the 95% confidence intervals are plotted for different player delays. The data are grouped by video content and different colors represent different delay values. The data for the baseline condition without delay were taken from the study in [17]. From the first look, there is not any observable difference in the gathered ratings, as the confidence intervals overlap. Therefore, we ran an analysis of variance (ANOVA) to verify this assumption. The p-value of 0.634 confirms this statement. Furthermore, the behavior of the participants during the delay was monitored. Among all gathered data, the reliable participants switched to another tab during the delay in 11 cases (about 3% of all ratings). The average value of the time spent in different browser tab is 7 s, the median is 4 s, and we did not observe any correlation between the delay value and the time spent in other browser tab.

Results gathered from the study focusing on initial delay are presented in Fig. 3. Again, the colors distinguish different delay values, however, in this case, this delay was introduced after the viewer clicked the player button. Together, we gathered 387 reliable ratings, which corresponds to approx. 14 ratings per condition on average. However, the widths of the confidence intervals do not allow for making a clear conclusion. The p-value from ANOVA was 0.131, therefore, the impact of the initial delay on MOS is not significant. In the case of initial delay, only 5 users switched to another browser tab during the simulation. With one exception, this occurred only with the delay of 4 s. Therefore, the bigger values of initial delay encouraged the users to switch from

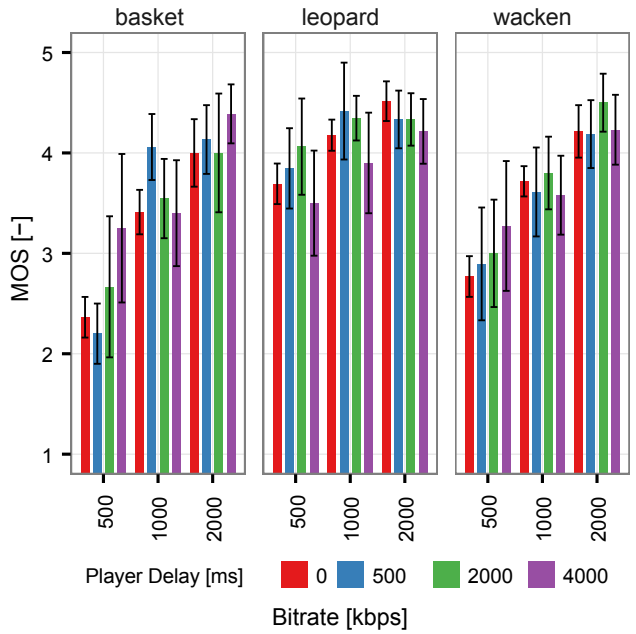


Fig. 2. Impact of player delay on MOS.

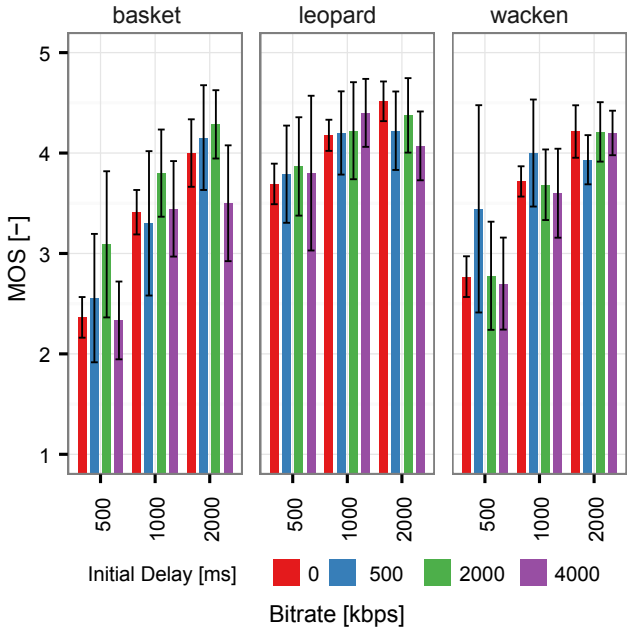


Fig. 3. Impact of initial delay on MOS.

the task. However, when such a behavior was monitored, the user was shown a warning with a request to properly focus on the video after they started the playback with their click, hence, none of the users switched to another tab more than once. If we try to compare both types of delay, there is not any observable difference, as the p-value was 0.341. This suggests that there is not any difference between the two types of delay from the perspective of MOS as evaluated by the users.

B. Poster Image Quality

In the poster image quality study, the users watched again three video sequences, each with different content. The quality

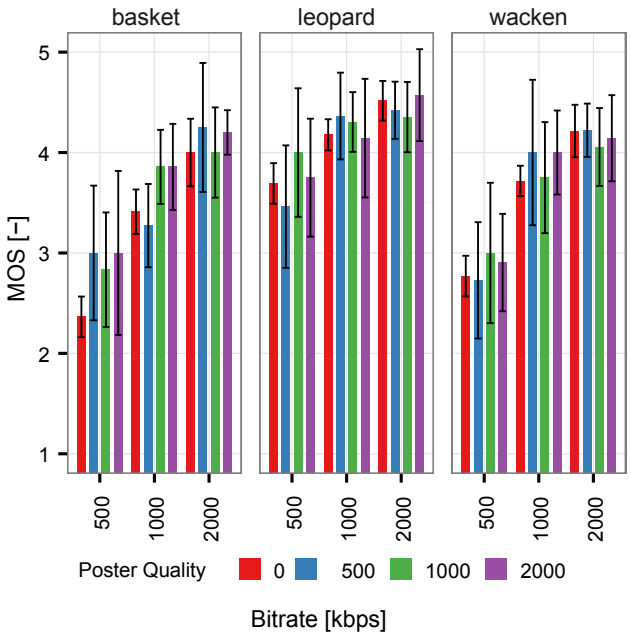


Fig. 4. Impact of poster image quality on MOS.

of the poster image was chosen randomly from three levels. Altogether, we used 27 different conditions (combination of content, video bitrate and poster quality). During the run of the study, we gathered 465 ratings from reliable users. However, as some users experienced stops during playback, such ratings were omitted from the further processing. After this, we had 361 rating, which represents 13 ratings per condition on average.

Fig. 4 shows the results of the experiment. The horizontal axis depicts the bitrate of the video sequences, the vertical axes shows the MOS with the 95% confidence intervals. The values are grouped by the content and the different colors of the bars represent the poster quality. Value ”0” means no poster change and data to plot these bars were gathered from the study in [17]. From the figure, no specific conclusion can be made, as the confidence intervals of the MOS almost always overlap. Therefore, we ran the ANOVA to verify, if there is any significant impact of the poster quality. The ANOVA resulted in a p-value of 0.558, which means, there is not any significant difference of the MOS corresponding to different qualities of poster images.

We also investigated the influence of the time the users spent on the page with the poster image before they hit the play button. The majority of the users spent less than 1 s (153 cases) or between 1 s and 2 s (147 cases). Only in 3% of all ratings, the users spent more then 5 s on the poster page. However, we did not observe any correlation between the time spent on the poster page and the ratings given afterwards.

C. Displayed Advertisement

The results from the advertisement study are depicted in Fig. 5. Again, the x-axis and y-axis show the used bitrate and MOS with 95% confidence intervals, respectively. The different colors of the bars represent different modes of the advertisement displayed to the viewers. The exact definition of these ad modes is given in Table I. Data to draw the bars

TABLE I. DESCRIPTION OF AD MODES

MODE	DESCRIPTION
0	No advertisement
1	1 static ad
2	1 animated ad
3	3 static ads
4	2 static ads, 1 animated ad
5	1 static ad, 2 animated ads

for ad mode ”0” are taken from the study in [17]. From the Fig. 5, no clear assumption can be made. The confidence intervals of MOS for different ad modes almost always overlap. The ANOVA of the results gives a p-value of 0.672 for the ad modes in which the advertisement is present. Therefore, there is not any significant difference in the MOS values stemming from different advertisements. When we include also mode ”0” to statistical processing, the p-value falls down to 0.0546, which, however, is still not significant on the typical level of significance of 5%.

The reason behind the higher widths of confidence intervals is the lower number of usable scores gathered from the participants. Together, we had 369 usable ratings (after filtering out unreliable users and ratings influenced by stops). As we used 45 different conditions, this makes approximately 8 ratings per condition.

Furthermore, the users were able to close the advertisement banner using the close button in the right corner of the banner. We monitored this together in 53 test sessions, from which only 10 belonged to reliable participants. On average, each of these users closed the advertisement banner twice. Nevertheless, there was no significant difference between their scores and scores of the users who kept the banner displayed. Another behavior of the participants we monitored was clicking on the ad. The ad image was an active link to a simple web page, which notified users that the ad link was disabled and warned them not to leave the test web page during the quality study. From all reliable users, only 10 clicked at least at one advertisement image. In one specific case, we monitored that the user clicked at all three shown ads. However, after the warnings, the user continued with fulfilling the task properly.

V. CONCLUSION

In this work, the impact of technical context factors on the QoE of video streaming was investigated. As video streaming is mostly consumed from web pages of video portals, which embed the video player, web page related factors were selected. In particular, the impact of page load times, the quality of the poster image, and the presence of advertisements was studied. Therefore, these technical context factors were unknowingly included in a crowdsourced video quality study. The unaware users were instructed to rate the subjective quality of different video clips with different encoding bit rates, while the video web page of the test was manipulated, and thus, constituted the actual test condition. The research question under investigation was whether the technical context factors on the video web page could influence the rating of the video clips.

The page load time, which is a major QoE factor of web browsing, could impact the QoE of the subsequent video session. However, the results showed no significant impact of the different page load times. This confirms that users are accustomed to small delays for web-based services [14] and short waiting does not negatively impact the QoE of Internet

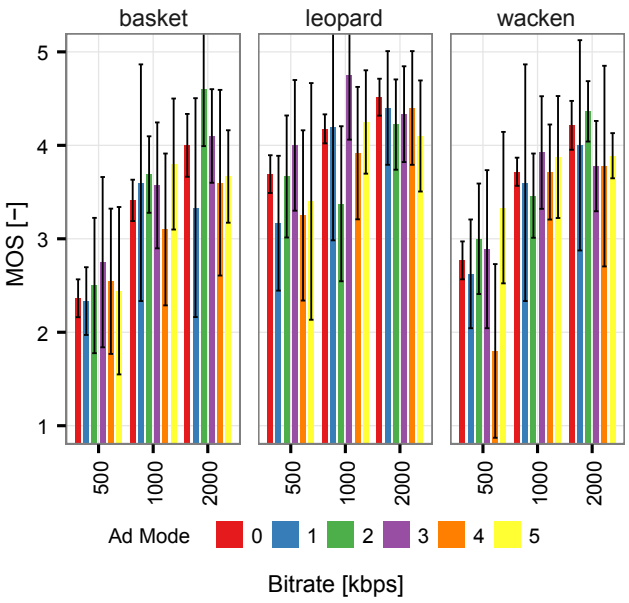


Fig. 5. Impact of ad modes on MOS.

services, especially if the users anticipate the service and are focused. In the context of video portals, the waiting time for the video service can also be initial delay after the user clicked to start the playback. In the conducted study, the system factor initial delay was compared to the context factor page load time, but also did not show a different effect on QoE.

The poster image, which is a frame of the video that is displayed before the playback start, could give users a first impression of the video quality of the streamed content and could raise expectations. Different combinations of poster image quality and video quality were investigated. Again the results were not significant, and users were not influenced by the quality of the presented image. Interestingly, users spent mostly less than 2 s on the page before starting the video playback, which could imply that users do not actually focus the image but just look for the play button to start the playback.

Finally, the impact of displayed advertisement during the video playback was studied. Therefore, a banner with five different ad modes, some including animated ads with flickering images, was added to the web page. The presence of such banners could distract or annoy users, which could also influence the perceived QoE of the video streaming. During the study, very few users closed the banner or clicked on an ad. As the participating crowdworkers use the Internet frequently, they might be used to advertisements and tend to ignore them. Also again no significant difference was observed in the ratings both between the conditions with and without advertisement, and also between the different ad modes. This suggests that users focus on the video, and did not consider the ads during the quality rating.

To sum up, the presented work is the first to investigate the impact of technical context factors of web pages on video streaming QoE. All results suggest that there was no significant impact on the obtained ratings for page load time, poster image quality, and displayed advertisement. Thereby, these results strongly suggest that there is no actual impact of the investigated factors, however, the possibility cannot be

excluded that the rating task superimposed the context factors [9]. This means, users could have possibly been focusing so much on only rating the video quality, such that they deliberately refrained from being influenced by context factors. Thus, in future work, it has to be cross-checked if the applied methodology, i.e., implicitly conducting the actual study within a subjective QoE study, is able to measure the impact of context factors on QoE.

ACKNOWLEDGMENT

The research published in this paper was financially supported by the Czech National Sustainability Program under grant LO1401 and by the Brno University of Technology Internal Grant Agency under project no. FEKT-S-17-4426. This work was partly funded in the framework of the EU ICT projects INPUT (H2020-2014-ICT-644672) and MONROE (H2020-2014-ICT-644399, through the open call project Mobi-QoE), and also supported by the Deutsche Forschungsgemeinschaft (DFG) under grants HO4770/1-2 and TR257/31-2 (OekoNet) as well as grants HO4770/2-1 and TR257/38-1 (Crowdsourcing). The authors alone are responsible for the content.

REFERENCES

[1] P. Le Callet, S. Möller, and A. Perkis, Eds., *Qualinet White Paper on Definitions of Quality of Experience (2012)*. Lausanne, Switzerland: European Network on Quality of Experience in Multimedia Systems and Services (COST Action IC 1003), 2012.

[2] M. Seufert, T. Hoßfeld, and C. Sieber, "Impact of Intermediate Layer on Quality of Experience of HTTP Adaptive Streaming," in *Proceedings of the 11th International Conference on Network and Service Management (CNSM)*, Barcelona, Spain, 2015.

[3] M.-N. Garcia, F. De Simone, S. Tavakoli, N. Staelens, S. Egger, K. Brunnström, and A. Raake, "Quality of Experience and HTTP Adaptive Streaming: A Review of Subjective Studies," in *Proceedings of the 6th International Workshop on Quality of Multimedia Experience (QoMEX)*, Singapore, 2014.

[4] P. Amrehn, K. Vandenbroucke, T. Hoßfeld, K. de Moor, M. Hirth, R. Schatz, and P. Casas, "Need for Speed? On Quality of Experience for File Storage Services," in *Proceedings of the 4th International Workshop on Perceptual Quality of Systems (PQS)*, Vienna, Austria, 2013.

[5] P. Casas, M. Seufert, S. Egger, and R. Schatz, "Quality of Experience in Remote Virtual Desktop Services," in *Proceedings of the IFIP/IEEE International Workshop on Quality of Experience Centric Management (QCMan)*, Ghent, Belgium, 2013.

[6] S. Jumisko-Pyykkö, "User-Centered Quality of Experience and Its Evaluation Methods for Mobile Television," Ph.D. dissertation, Tampere University of Technology, 2011.

[7] T. Hoßfeld, M. Hirth, J. Redi, F. Mazza, P. Korshunov, B. Naderi, M. Seufert, B. Gardlo, S. Egger, and C. Keimel, "Best Practices and Recommendations for Crowdsourced QoE - Lessons learned from the Qualinet Task Force Crowdsourcing," COST Action IC1003 European Network on Quality of Experience in Multimedia Systems and Services (QUALINET), Tech. Rep. Whitepaper, 2014.

[8] A. Sackl, P. Zwickl, and P. Reichl, "The Trouble with Choice: An Empirical Study to Investigate the Influence of Charging Strategies and Content Selection on QoE," in *Proceedings of the 9th International Conference on Network and Service Management (CNSM)*, Zurich, Switzerland, 2013.

[9] A. Sackl, M. Seufert, and T. Hoßfeld, "Asking Costs Little? The Impact of Tasks in Video QoE Studies on User Behavior and User Ratings," in *Proceedings of the 4th International Workshop on Perceptual Quality of Systems (PQS)*, Vienna, Austria, 2013.

[10] M. Rerabek, P. Hanhart, P. Korshunov, and T. Ebrahimi, "Quality Evaluation of HEVC and VP9 Video Compression in Real-time Applications," in *Proceedings of the 7th International Workshop on Quality of Multimedia Experience (QoMEX)*, Costa Navarino, Greece, 2015.

[11] S. Moller, K.-P. Engelbrecht, C. Kuhnel, I. Wechsung, and B. Weiss, "A taxonomy of quality of service and quality of experience of multimodal human-machine interaction," *2009 International Workshop on Quality of Multimedia Experience*, pp. 7–12, 2009. [Online]. Available: http://ieeexplore.ieee.org/document/5246986/

[12] Y. Zhu, I. Heynderickx, and J. A. Redi, "Understanding the role of social context and user factors in video quality of experience," *Computers in Human Behavior*, vol. vol. 49, pp. 412–426, 2015. [Online]. Available: http://linkinghub.elsevier.com/retrieve/pii/S0747563215001752

[13] H. G. Msakni and H. Youssef, "Impact of non-QoS related parameters on video QoE," in *Proceedings of the 4th International Workshop on Perceptual Quality of Systems (PQS)*, Vienna, Austria, 2013.

[14] S. Egger, T. Hoßfeld, R. Schatz, and M. Fiedler, "Waiting Times in Quality of Experience for Web Based Services," in *Proceedings of the 4th International Workshop on Quality of Multimedia Experience (QoMEX)*, Yarra Valley, Australia, 2012.

[15] S. Egger, P. Reichl, T. Hoßfeld, and R. Schatz, "Time is Bandwidth? Narrowing the Gap between Subjective Time Perception and Quality of Experience," in *Proceedings of the IEEE International Conference on Communications (ICC)*, Ottawa, Canada, 2012.

[16] M. Ljubojevi, V. Vaskovi, and D. Starevi, "The Analysis of the Users' Response to the Linear Internet Video Advertising by Using QoE Methods," *j-jucs*, vol. 19, no. 12, pp. 1736–1760, jun 2013, http://www.jucs.org/jucs_19_12/the_analysis_of_the.

[17] M. Seufert, O. Zach, T. Hoßfeld, M. Slanina, and P. Tran-Gia, "Impact of Test Condition Selection in Adaptive Crowdsourcing Studies on Subjective Quality," in *Proceedings of the 8th International Conference on Quality of Multimedia Experience (QoMEX)*, Lisbon, Portugal, 2016.