Quality of Experience – More Than Just Another Buzzword?

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I. Background and Motivation

User satisfaction with communication network and service performance has attracted increased attention during the recent years, mainly as a consequence of increasing competition amongst market players, the proliferation of resource intensive services (such as youtube.com) and the ever-present risk of customer churn caused by inadequate service quality. At the same time, demand for mobile broadband services (inherently based on scarce spectrum resources) grows at unprecedented rates[1], while generated revenues are strongly decreasing. These conflicting trends present huge challenges to network operators and service providers: on the one hand, they need to keep investing in sophisticated high-performance infrastructure and services that keep customers happy, while on the other hand, they need to operate on a profitable basis.

For these reasons, the concept of Quality-of-Experience (QoE) has gained strong interest, both from an academic research and an industry perspective. Linked very closely to the subjective perception of the end user, QoE is supposed to enable a broader, more holistic understanding of the qualitative performance of communication ecosystems and thus to complement the traditional, more technology-centric Quality-of-Service (QoS) perspective. However, as with any other dynamically evolving notion, QoE tends to convey fairly different meanings to different people, raising fundamental issues not only with respect to the actual scope of the concept, but also concerning its impact on the real world, eventually boiling down to the key question: are we dealing with just another buzzword, or do we rather experience a veritable paradigm change?

In order order to answer to this question, we need to illuminate Quality of Experience from three perspectives: (1) concept evolution and definition, (2) examples from current QoE research, (3) practical value and applicability.

[1] For example, Coda Research and Cisco expect global Mobile Broadband traffic volume to roughly double every year, with approx. 418 million users generating 1.8 exabytes by 2017 [1][2].

II. Concept Evolution and Definition

To clarify the concept of Quality-of-Experience, one needs to start with examining the relationship between QoS and QoE as well as the evolution of both notions since their early days. In this context, it is an interesting fact that QoS originally included a strong aspect of user-centricity (cf. [3]) which actually got lost over time – only to be picked up again as the defining element of QoE. Consequently, QoE reaches beyond the technical quality of the technical system to include softer aspects such as context and even the internal states of the perceiving end user (see Fig. 1).

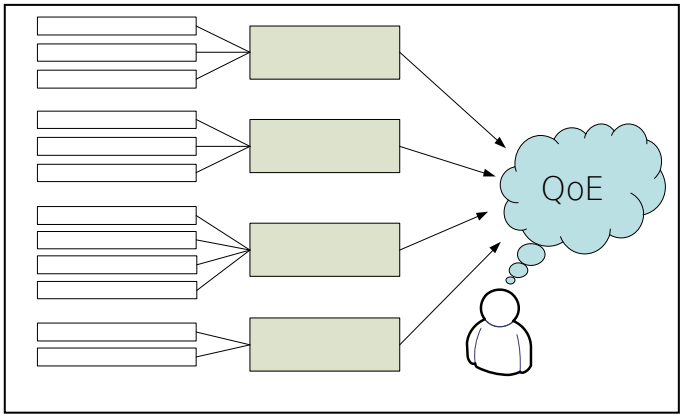

Figure 1. QoE as holistic concept shaped by a hierarchy of hard and soft factors.

Note that the corresponding actor roles are captured best in Kilkki's model of the QoE ecosystem [4], while the model presented in [5] describes QoE as result of a "quality chain" comprising core and access networks as well as the (mobile) end device running applications which interact directly with the end user.

III. Research on QoE for Mobile Broadband Internet Services

As second perspective, current research challenges and results in this field need to be highlighted. To this end, we present

selected results from subjective user studies (including work performed at FTW [6][7]), which are of specific relevance if it comes to investigating the underlying laws of quality perception, like for instance the logarithmic laws discussed in [7]. In addition, QoE research faces a number of open fundamental questions regarding subjective quality perception such as the importance of temporal effects and the relationship end user satisfaction and binary acceptance. Last not least, we want to point out the existence of close links between QoE and microeconomics, illustrated with the double role of charging as result of a quality evaluation process and at the same time as part of the user's context determining her QoE.

IV. Practical Value and Applicability

Finally, from yet another point of view, we need to reflect on the practical value and applicability of QoE. In this respect, it is important to acknowledge that different domains or stages of QoE research can be viewed along a chain where the output of one stage provides information and input for the next one, as follows:

- *Fundamental relationships and laws of quality perception*: we believe that the user-centricity of QoE not only inherently demands for performing extensive subjective tests with human participicants in order to generate ground truth data and perceptual thresholds. As a discipline, it also builds upon the basic psychological laws of perception and their reformulation and re-evaluation with respect to perceived service quality.
- *Guidelines for system design and network planning*: The insights gained on the fundamental level already allows to develop conclusive guidelines and recommendations for the design and planning of future communication networks and systems. These guidelines typically consist of acceptance thresholds in conjunction with quantified relationships between technical parameters and QoE.
- *QoE models and metrics*: Modeling QoE from different perspectives allows for a deep and comprehensive understanding of the fundamental relationships within the corresponding ecosystem of actors and technical environment, and thus provides a solid basis for formulating quantifiable metrics which describe QoE in a technically accessible way.
- *QoE measurement/prediction systems*: Given suitable metrics, the determination of their numerical value still requires sophisticated measurement frameworks, based on general network monitoring systems together with efficient algorithms for mapping network to user parameters. Once validated, these systems may then be extended towards quality prediction tools which allow reliable forecasting of perceived quality for given network scenarios.
- *QoE-centric network and service management*: Finally, the available tools and mechanisms can be applied to the actual management of operational networks and related communication services, including charging and accounting.

V. Summary and Conclusions

By choosing a strictly interdisciplinary point of view, we want to demonstrate that QoE not only represents a challenging field of research which brings together various scientific fields ranging from service provisioning to network monitoring, from cognitive psychology to microeconomics, from usability research to application design. Indeed, by now it should have become clear that we strongly argue to regard this novel quality concept as much more than a mere buzzword substitution, but rather as a new paradigm that enriches our understanding of the quality of technical systems and helps us to successfully improve their performance in ways the end user really needs and appreciates.

VI. References

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