

Quality of Experience status in Industry

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Introduction

As noted in the workshop description, Quality of Service (QoS) technology in the Internet has been largely about measurements and techniques used to achieve a certain result. RFC 4594^[1], for example, focuses on traffic classes represented by common sets of applications, and assigns code points based on their presumed service requirements. Quality of Experience (QoE), on the other hand, is about what a user thinks about the result, whether those concepts are used or not. The common definition, found in P.10/G.100 (2008), is

Quality of Experience (QoE): The overall acceptability of an application or service, as perceived subjectively by the end-user.

NOTE 1 - Quality of experience includes the complete end-to-end system effects (client, terminal, network, services infrastructure, etc.).

NOTE 2 - Overall acceptability may be influenced by user expectations and context.

In Kuiper's words^[2],

“QoE thereby includes the complete end-to-end system effects (client, terminal, network, services infrastructure, etc.), where overall acceptability may be influenced by user expectations and context. This definition explicitly refers to QoE as a subjective measure and properly measuring QoE should therefore involve tests with actual users, which is a time-consuming and costly process. For service and network providers it is preferable to have tools that objectively reflect within reasonable accuracy the subjective mean opinion score of users.”

If QoS reasoning and technology is applied at the transport and network layers, often with support from the routing system and from link layer queue management services, QoE is a measurement of, and often by, the application or its user. It includes both tangible and intangible ramifications. In voice communications, a lost or delayed packet often results in a sound change, such as a pop or a garbled word. This may be subjectively disconcerting to the user; even if it isn't, is objectively measureable. Anecdotally, one intangible is the experience reported by some women using Cisco's early Telepresence video conferencing rooms, who noted that the impression of being in the same room with remote participants was sufficiently strong that when the remote participants looked down to view a slide or other display, they felt the need for a privacy panel shielding their knees.

Models, and the place of measurement

A number of models have been proposed for QoE. [3] comments on six models, including ITU G.1080[4] (which gives principles but has been largely superseded by P.10/G.100 for language and by the P.1201 and P.1202 series for measurement methodology), and goes on to propose a seventh. G.1080 asserts that “in principle, QoE is measured subjectively by the end-user and may differ from one user to the other. However, it is often estimated using objective measurements.” Other sources counter that, saying that to do so is to devolve into network QoS measurements, or that only human measurements are relevant. What is clear from a review of that literature is that there are many views of the fundamentals of the concept and the model.

This paper will not propose yet another model.

The analysis done by Kuiper is interesting in large part because he abstracts a number of sources of experience and then comments on the quality, or quality failures, they produce. With respect to Network QoS issues, he prefers to think of the network as a black box that has some set of attributes including capacity, delay, jitter, and loss. The one place he disregards that is in gaming; Wattimena’s G model [5], which he comments on, produces a number based on network behavior, and statistically correlates with gamer-perceived QoE. Voice, however, is measured by the sound produced, using MOS or PESQ scores, and video is measured by the quality of the picture produced, both of which are independent of the underlying transport.

Quality of Experience in Industry

Industry generally approaches QoE pragmatically. As noted, Cisco’s room Telepresence gives the user a strong sense of actually being in the same room with remote participants even though they are on another continent, which improves meeting effectiveness. Much of this derives from careful attention to details like the lighting, color, and arrangement of the room, in addition to the underlying communication infrastructure. Rooms have no windows, reducing the risk that time zone lighting differences are noticeable. Rooms are also all the same color, and the table (which is visible both locally and remotely) is designed to give the appearance of being continuous. Other sources of possible disruption are similarly mitigated. In that design, Cisco did not propose a QoE model, nor did it target a numeric value for how good the experience should be. But it did identify factors that would affect user experience and do what it could to make the experience seamless.

Similarly, network QoS technology was developed, in part, to pragmatically improve what today might be called QoE; if one is using objective measurements to estimate subjective QoE, many of those will be QoS measurements, as in Wattimena’s G model for gaming. Voice prioritization was deployed to reduce data stream jitter below the bounds of the jitter buffer, and as a result improve audio quality. It is often pointed out that Skype doesn’t have that problem; it runs

over the top without network support. However, Skype also keeps a deep jitter buffer, which is to say that it enforces significant delay when compared to common VoIP and Video/IP technologies, and occasionally freezes, or loses and resets synchronization between the endpoints, something that is acceptable in a free service but is not generally approved of in services one buys. Network video, whether RTP/UDP or ABR using TCP, is similarly designed to minimize the probability of a jitter buffer underrun or network overrun, and to pragmatically deliver the highest quality experience to the user.

Initial Thoughts

In a paper such as this, it is common to end with a set of conclusions. This author isn't sure that there is sufficient data that crosses boundaries between classes of traffic or applications, or sufficient consensus, to warrant drawing very many conclusions.

Many of the available models focus on physiological, psycho-physical, or cognitive issues that help the designer know what questions to ask regarding wall color, room design, and other issues. On a technology level, which some argue is really measuring QoS rather than QoE, Wattimena's G model for gaming and the ITU P.1201/P.1202 series for voice and video help extend the concepts of a MOS or PESG-like score into wider regions. There is still, however, little to guide the researcher in a generalized QoE model. Experience with Telepresence and other applications suggest that, for tangible QoE issues, network QoS measurements are among the relevant factors, and intangible issues, while important, remain intangible.

So, important thought and work is happening, but we're not done yet.

[1] "Configuration Guidelines for DiffServ Service Classes", J. Babiarz, K. Chan, F. Baker. August 2006. <https://tools.ietf.org/html/rfc4594>

[2] "Techniques for Measuring Quality of Experience", Kuipers et al, <https://www.acreo.se/sites/default/files/public/acreo.se/upload/publications/19.pdf>

[3] "Toward total quality of experience: A QoE model in a communication ecosystem", Laghari, Connelly, Crespi, <http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=6178834>

[4] "Quality of experience requirements for IPTV services", Recommendation G.1080 (12/08), <https://www.itu.int/rec/T-REC-G.1080-200812-I>

[5] F. Wattimena, R.E. Kooij, J.M. van Vugt, and O.K.Ahmed, "Predicting the perceived quality of a First Person Shooter: the Quake IV G-model," Proc. Of NetGames'06, Singapore, October 30-31, 2006.