QoE and QoS by Triple Play Services: A Comparison Study

Tadeus Uhl
Maritime University of Szczecin
Szczecin, Poland
email: t.uhl@am.szczecin.pl

Paweł Bardowski
Wrocław University of Science and Technology
Wrocław, Poland
email: pawel.bardowski@pwr.edu.pl

***Abstract*— The applications available on the Internet can generally be divided into three categories: audio, video and data. This has given rise to the popular term Triple Play Services. Quality of Service is currently especially important in digital networks and can now be measured in two ways: subjective techniques and objective techniques. This paper elaborates on the most important techniques for measuring Quality of Experience (QoE) and Quality of Service (QoS) in Triple Play Services, comparing the most widely used QoE and QoS measurement methods in several series of analyses.**

Keywords-Triple Play Service; QoS; QoE; VoIP; VSoIP; WWW.

I. INTRODUCTION

In modern digital networks, it is not difficult to identify three parties: network providers, service providers, and users. All three parties have a common interest: Quality of Service (QoS). When the quality of service in networks is there, everybody is happy. In order to be sure that quality of service is being delivered, QoS measurements must be constantly made, and should the quality of service fall for any reason, countermeasures must be taken immediately. Preventive measures are, of course, preferable to corrective measures, and monitoring is best done unobtrusively in the background and fully automatically (cf. Figure 1).

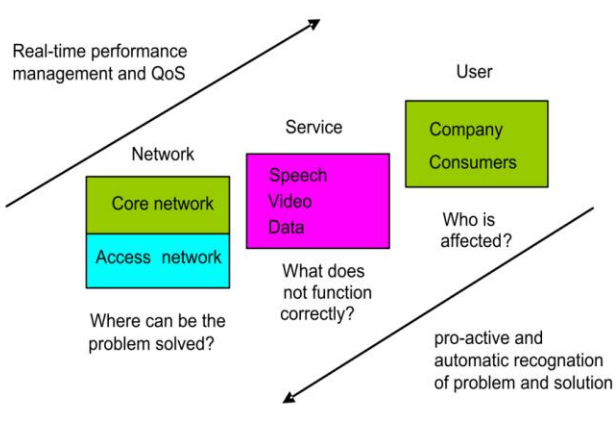

Figure 1. The three parties in digital networks.

In order to determine the QoS/QoE in a network, two models are generally used: a) the dual-ended model and b) the single-ended model [1]. In the case of the dual-ended model, two signals are used: a) the original signal and b) the degraded signal. These two signals are available uncompressed. For this reason, measurements can be carried out for both Quality of Experience (QoE, a subjective evaluation) and Quality of Service (QoS, an objective evaluation). In the case of the single-ended model, only the impaired signal (compressed) is available. This allows normally only an objective evaluation of QoS to be made (exception ITU-T P.563 [2]).

Two measurement techniques can be used in the two models cited: a) signal-based and b) parameter-based measurement. The dual-ended model uses specialised algorithms to compare the input and output signals of signal-based measurements. In the case of the single-ended model this comparison is not possible. In this case, the QoS will be determined by using the degraded signal only. In both cases, the system to be assessed is treated as a “black box”. When carrying out parameter-based measurements, a distinction is made between two types: a) “glass-box” and b) “black-box”. In the first case, both the structure of the system to be assessed and the reaction of the individual system components to the reference signal are known. This knowledge is then taken into consideration in a suitable model. Additionally, the network parameters measured can be included in the calculation of the QoS. In the second case, not all details of the system to be assessed are known, so only the measured network parameters and the characteristic parameters for the respective service are taken into account.

QoE refers to the appraisal of quality by test persons—the end users. It is an extremely complicated method: among other things it relies on reference signals that have been specially recorded in sound and video studios. The room, too, in which the audio and video tests are conducted, must also be specially designed. Even the selection of the test persons proves to be problematic. To achieve any reliable results at all series upon series of tests must be run. This understandably takes a lot of time and involves a lot of specialised equipment. The method is therefore fully unsuitable for analyses of quality in real networks. That is

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why great efforts have been made to simulate the human eye and the human ear with electronic means and to incorporate those simulations in QoE algorithms.

QoS works on the principle of parametrised models. Naturally, test persons had to be involved during the development stage of the models, which was costly, time-consuming and elaborate. Once developed, however, QoS models can be used quickly and without the need for test persons in real environments to evaluate all manner of electronic service. This is the great benefit of using parametrised QoS models and the reason why they were developed.

This paper will review and discuss the application of common QoE/QoS measuring methods to Triple Play Services (audio/video/data).

In Section II, the QoE/QoS in the VoIP service (audio) will be described. Section III provides information about QoE/QoS in the VSoIP service (video). Following that, Section IV discusses QoE/QoS in the WWW service (data). The paper concludes with a summary and an outlook on future work.

II. QoE AND QoS IN THE VoIP SERVICE

The most widely used QoE measurement techniques for the VoIP service are currently PESQ [3] and POLQA [4]. Both techniques are very accurate; they are, however, time-consuming and can often only be implemented with a licence. Both algorithms incorporate an electronic emulation of the human ear, so it is permissible here to speak of QoE values.

The most widely used QoS measurement techniques for the VoIP service are currently the E Model [5] and E(IP) Model [6]. Both of them are parametrised models. They are very practical: easy to use and time-saving. They do not need reference signals, which is a great benefit in practice. But how good are parametrised models in comparison with QoE measurement techniques?

To answer this question several analyses were conducted during the course of the work presented in this paper, using the numerical tool QoSCalc(VoIP) [7] (see there also the setting parameters for investigations). Figure 2 shows some quite representative results.

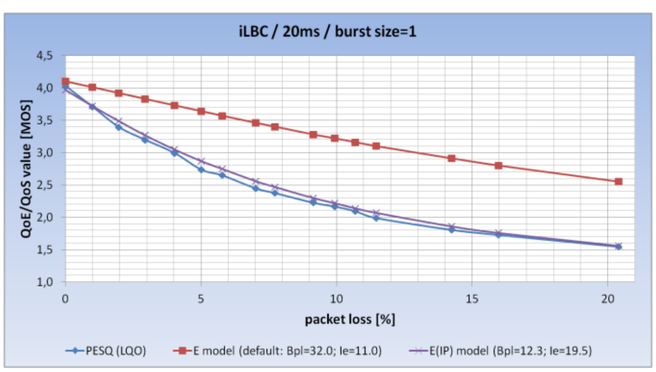

Figure 2. QoE/QoS values as a function of packet loss for different measurement techniques (codec iLBC).

It is evident that the curves from the PESQ algorithm and the E(IP) Model agree whilst the curve for the E Model deviates significantly. The E Model is unsuitable for analyses in an IP environment. The study has confirmed that with a suitable parametrised QoS model values can be achieved that come very close to QoE values. This is of substantial practical benefit!

III. QoE AND QoS IN THE VSoIP SERVICE

The most widely used QoE measurement techniques for the VSoIP service are currently PEVQ (J.247) [8] and VQuad-HD (J.341) [9]. These techniques are very accurate; they are, however, time-consuming and can often only be implemented with a licence. Both algorithms incorporate an electronic emulation of the human eye and so one can justifiably speak of QoE values.

The most widely used QoS measurement techniques for the VSoIP service are currently Rec. ETSI 101 290 [10] and the VSoIP Model [11]. Both measurement techniques are classed as parametrised models because they work on the basis of network and service parameters. In practice, they are quick and easy to use. They need no reference signal, which is of great practical value. But how good are parametrised models in comparison with QoE measurement techniques?

To answer this question several analyses were conducted during the course of the work described in this paper, using the numerical tool QoSCalc(IPTV) [12] (see there also the setting parameters for investigations). Figure 3 presents some typical results.

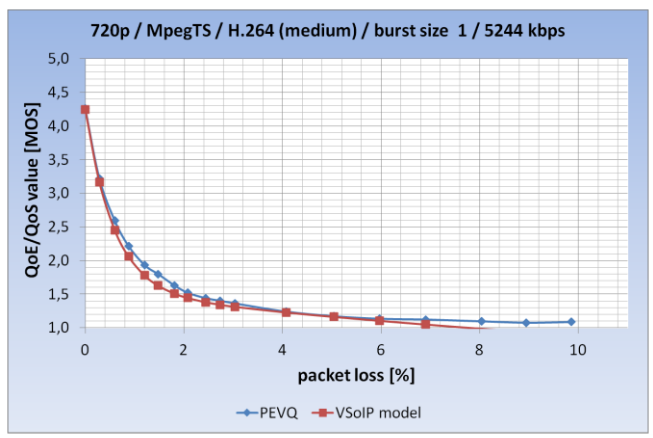

Figure 3. QoE/QoS values as a function of packet loss for different measurement techniques (codec H.264/720p).

It is evident that the curves for the PEVQ algorithm and for the VSoIP Model concur. This demonstrates unequivocally that by using a suitable parametrised QoS model it is possible to achieve values that come very close to QoE values. Another great practical benefit for all involved!

IV. QoS/QoE IN THE WWW SERVICE

At present there is only one standardised technique for measuring QoE in the WWW service: Rec. ITU-T G.1030 [13]. This method requires the participation of test persons and takes only one criterion into consideration: the web page opening time, which is actually of little practical significance.

The widely used QoS measurement techniques for the WWW service are currently Apdex Index [14] and Power Metric [15]. But they have not been standardised, meaning that there is an enormous need for further developments in this area, especially in view of the fact that the WWW service is one of the most widely used applications in the Internet and accounts for the lion's share of traffic. Here, too, the question arises: Just how good are the parametrised models in comparison with QoE measurement techniques?

In order to answer this question, some results from analysis [16] (see there also the setting parameters for investigations) are presented here. Figure 4 shows quite typical results that were gained (black dots indicate the mean values, the rectangles the standard deviation).

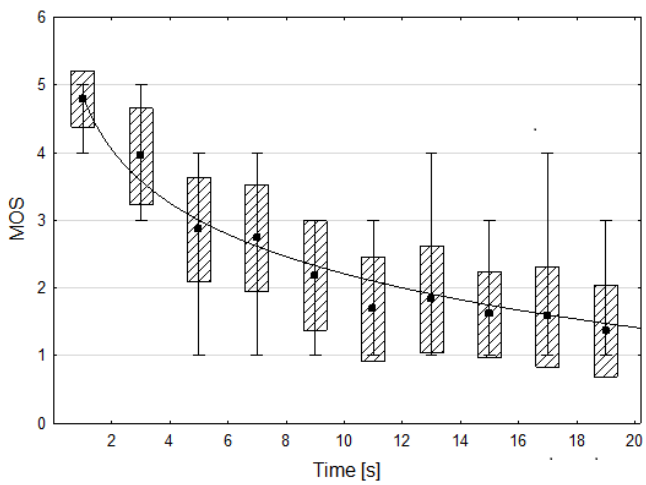

Figure 4. QoE values as a function of web page opening time for the service WWW.

It is evident that the QoE curve is subject to a logarithmic function [15]:

$$QoS_{MOS} = 4.84 - 2.63 \cdot \log T \qquad (1)$$

where T is the web page opening time.

The parametrised QoS model (given in (1)) is so simple because it is contains only one system variable: web page opening time. In order to take further system variables into consideration, the metric called Power [14] must be used. It has been demonstrated yet again that a parametrised QoS model is quick and easy to use. This is of great practical benefit!

V. Conclusion and Future Work

This paper has reviewed and discussed briefly the application of common QoE/QoS measuring methods in Triple Play Services (audio/video/data). The strengths and weaknesses of the individual QoS/QoE measurement techniques have been spelt out. It has been shown that by using suitable parametrised QoS models values can be achieved that come very close to QoE values. In practice it is highly beneficial to work with parameterised QoS models.

The number of electronic services in the Internet is increasing steadily. The philosophy behind the networks has changed: whereas networks have had clearly defined properties until recently, they are now assuming new properties dynamically during live operation. What effects will this have on the Quality of Service? Should we perhaps in future speak of Quality of Live (QoL) instead of Quality of Service (QoS)? It is a development in networks that must be followed at all costs. The authors are already planning future work in this direction.

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