Quality of service challenges

SERVQUAL, Special session along with
SERVICE COMPUTATION 2017, February 19 - 23, 2017 - Athens, Greece
The Ninth International Conferences on Advanced Service Computing

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***Abstract*— The paper discusses two different approaches to the quality of service assessment in circuit- and packet-switched networks. It shows the fundamental differences between these environments, traffic characteristics and their impact on key performance indicators. The author presents an example of quality evaluation in legacy and modern networks. He also highlights the multi-service character of current packet networks and underlines the need for diverse quality measures to describe individual services. The heterogeneous character of the Next Generation Networks determines new challenges in the area of quality assessment, which is also addressed here. The paper introduces the special session on Service Quality (ServQual), which is included in the Ninth International Conferences on Advanced Service Computing – Service Computation 2017, held in Athens, Greece.**

Keywords- QoS; QoE; benchmarking measurements, quality model, customer experience.

I. INTRODUCTION

In the past several years we have witnessed a huge development of digital communication technologies at both hardware and software levels. All these solutions became more accessible to the customers who not only communicate with one another via legacy fixed telephone lines, but also using different applications on mobile devices like laptops, notebooks, tablets, smartphones, etc. This was possible due to the new IP-based services offered by Internet Service Providers (ISPs). Packet-based communication raised new opportunities, but also new challenges – especially in the scope of Quality of Service (QoS) assurance.

The legacy, circuit-switched, solutions were based on bandwidth reservation in order to establish a service. In packet-based networks, by definition, there is no resource reservation. These two approaches mean that different quality metrics should be used to assess the quality of services offered in these networks. Moreover, different quality parameters of the specific services should be monitored. For each service, an individual set of specific parameters called key performance indicators (KPIs), which describe service quality, can be defined. Many of them come from the network and are connected with its physical capabilities, dimensioning aspects, used communication protocols and, finally, from traffic load in general. All these factors influence the network performance, which can be described by Grade of Service (GoS). GoS is defined by the ITU-T Recommendation [1] as a number of traffic engineering variables that provide a measure of adequacy of a group of resources under specified conditions. These variables may be probability of loss, tone delays, etc.

II. QUALITY EVALUATION IN CIRCUIT- AND PACKET-SWITCHED NETWORKS

In circuit-switched (CS) networks, a resource (channel) reservation takes place according to the service requirements. When there is no channel available, a blocking state occurs (Figure 1).

One of the most popular services in the telecommunication network is voice transmission. In such a case GoS can be determined by blocking probability (E), as follows:

$$E = \lim_{T \to \infty} \frac{T_b}{T}, \quad (1)$$

where:

Tb - is the blocking time, i.e., the time period in which all network resources (channels) are occupied,

T - is the observation time (a measurement period).

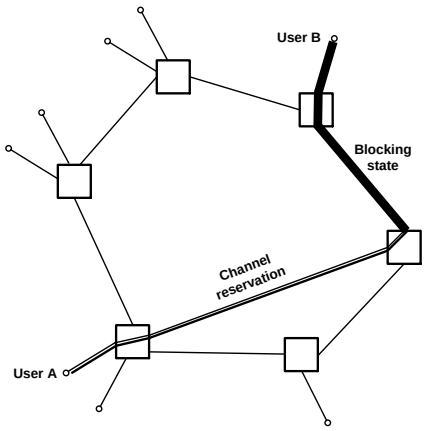

Figure 1. Blocking state in the CS network.

In order to avoid blocking states, the network operator's quality management procedures are introduced. They mainly rely on network dimensioning and traffic engineering procedures. In practice, it does not completely eliminate blocking states, but minimizes the probability of blocking.

While GoS views the situation from the network point of view, QoS is often connected with a specific service or application.

Overall, voice transmission QoS not only takes into account the network performance aspects, but also encoder schemes, used bandwidth, end-user equipment etc. From the operator's point of view, however, the network performance is the most important factor.

Service quality evaluation in packet-switched (PS) networks involves more parameters being monitored, which is a serious challenge for the operator. The next challenges are connected with traffic engineering issues, which are quite complicated. Also the QoS management procedures are far more sophisticated. However, there is no channel reservation and consequently, there are no blocking states. Information is split into packets, which are carried via different routes, depending on their occupation, traffic engineering procedures and specific service requirements (e.g., maximum end-to-end delay) (Figure 2).

To manage GoS, the network operator must take into account such factors as packet loss, delay, jitter etc. All these phenomena affect the quality of specific services to varying degrees.

The analytical approach to the traffic engineering, as used in CS telephone networks, cannot be applied here, because of different characteristics of the traffic carried in these networks. In the legacy networks, the traffic generated by users fulfills the following assumptions: stationarity (time homogeneity), independence and regularity. IP traffic may be represented by self-similar process, described by heavy-tailed distribution. In order to manage such complex problems, network operators and service providers often use simulation tools [2] 3][4] instead of analytical approach.

As can be seen, network performance management plays very important role within the service provision process. However, it is insufficient, because it does not provide information about user perception of the service.

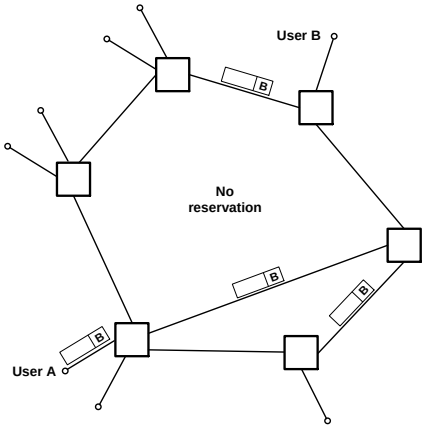

Figure 2. PS network.

III. QoE APPROACH

During the last several years Quality of Experience (QoE) based research mechanisms for the control and management of resources have received more attention in literature [5][6][7]. QoE can be treated as an extension of QoS, also taking into account the non-technical factors perceived by the user (Figure 3) [8].

It can be seen, that QoE is influenced by subjective human components, like emotions, experience, service billing, etc. For example, the same objectively measured service quality may be assessed differently by the user, depending on his emotional state at a given time. On the other hand the user score also depends on his satisfaction with the service. It strongly depends on the user's experience with the service. New users are usually eager to give higher grades than experienced users, who often have higher expectations.

Finding correlations between objectively measured network performance parameters and quality of services, as perceived by users, is a demanding challenge in current heterogeneous and multi-service networks. These correlations, after statistical validation, can be used for building the QoE models for the appropriate services. Due to different requirements and characteristics, each service requires an individual approach.

In the special session on Service Quality (ServQual), held as part of The Ninth International Conferences on Advanced Service Computing (Service Computation 2017) in Athens, Greece [9], four papers are presented. They discuss the challenges faced by, and also the payoffs expected from different methods and tools for service quality assessment and measurement. Uhl [10] presents an overview of different quality measurement techniques for the most popular telecommunication services that carry voice video and data, like VoIP, IPTV and WWW. He discusses signal- and parameter-based methods and gives an overview of the most relevant standards in the area. In the second paper, Oko and Średniawa [11] turn the spotlight on a number of paradigm shifts in many ICT areas, where 5G technology, Future Internet and Ultra High Definition Television has defined a new vision of services and approaches to their implementation. The paper surveys the change in QoE approaches and its interpretation in the context of new services and applications. The Authors pay attention to three categories of QoE influencing factors, classified as system, human and context. They underline, that the last two of them are subjective in nature and might not be directly expressed as values of parameters. In the last part of the paper the video QoE standards and the generic relationships between QoS and QoE were discussed, as described in literature [12]. Klink [13] continues in his paper the problem of QoS evaluation and its translation into subjective quality measures, as perceived by users. He shows a concept of Internet Access Service quality measurement and presents different approaches to this issue based on European standards and recommendations used in selected European countries. The Author also presents an approach to the QoE model for WWW service development. He shows the test-bed, the measurement procedure, analysis of results and QoE model derivation.

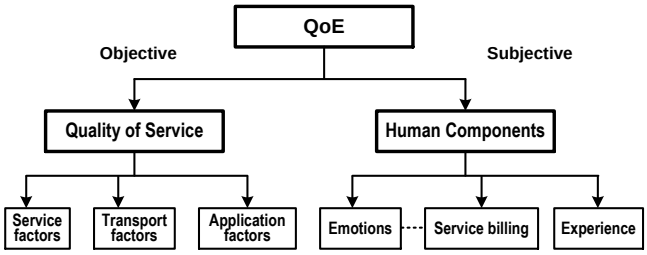

Figure 3. Quality of Experience.

In the last paper, Tzouflas [14] discusses benchmarking customer experience over mobile networks. He presents a scoring method, developed for assessing user perception of voice and data services after the benchmarking measurements. The purpose of the presented method is the receiving of a performance certificate for the best operator in the test. Data captured during the benchmarking tests are used to calculate ranking scores for all measured operators networks for both voice and data services. At the end the final score is presented as a single percentage value which can be interpreted as a level of fulfilment of user expectations by the examined operator's network.

REFERENCES

[1] ITU-T. Rec. E.600: *Terms and definitions of traffic engineering*. [Online]. Available from: https://www.itu.int/rec/T-REC-E.600/en. [retrieved: 01, 2017].

[2] *NS3. A discrete-event network simulator for Internet systems*. [Online]. Available from: https://www.nsnam.org. [retrieved: 01, 2017].

[3] *OMNeT++. A discrete event simulator*. [Online]. Available from: https://omnetpp.org. [retrieved: 01, 2017].

[4] *Riverbed Modeler. A discrete event-simulation engine for analyzing and designing communication networks*. [Online]. Available from: https://www.riverbed.com. [retrieved: 01, 2017].

[5] Yamada, H., Fukumoto, et al, A QoE based service control scheme for RACF in IP-based FMC networks, E-Commerce Technology and the 4th IEEE International Conference on Enterprise Computing, E-Commerce, and E-Services, 23-26 July 2007, Page(s):611 – 618.

[6] De Vleeschauwer, B., De Turck, et al, End-to-end QoE Optimization Through Overlay Network Deployment, International Conference on Information Networking, 2008, 23-25 Jan. 2008 Page(s):1 – 5.

[7] J.M. Monteiro and M.S. Nunes, "A subjective quality estimation tool for the evaluation of video communication systems, computers and communications," 12th IEEE Symposium (ISCC 2007), 1-4 July 2007.

[8] W.C. Hardy, QoS: Measurement and Evaluation of Telecommunications Quality of Service. J. Wiley&Sons, Ltd., 2001.

[9] Service Computation 2017, The Ninth International Conferences on Advanced Service Computing, February 19-23, Athens, Greece 2017.

[10] T. Uhl, "Quality of services everywhere," The Ninth International Conferences on Advanced Service Computing (Service Computation 2017) IARIA, Feb. 2017, Athens, Greece, in press.

[11] M. Średniawa, "Impact of Network and Service Paradigm Shift on Evolution of QoS and QoS Concepts," The Ninth International Conferences on Advanced Service Computing (Service Computation 2017) IARIA, Feb. 2017, Athens, Greece, in press.

[12] M. Fiedler, T. Hossfeld, and P. Tran-Gia, "A Generic Quantitative Relationship between Quality of Experience and Quality of Service," IEEE Network Magazine, vol. 24, no. 2, pp. 36-41, 2010.

[13] J. Klink, "Selected issues of Internet Access Service quality assessment," The Ninth International Conferences on Advanced Service Computing (Service Computation 2017) IARIA, Feb. 2017, Athens, Greece, in press.

[14] Y. Tzouflas, "Benchmarking customer experience over mobile networks. A scoring algorithm for network quality," The Ninth International Conferences on Advanced Service Computing (Service Computation 2017) IARIA, Feb. 2017, Athens, Greece, in press.