Chapter 71

Advances in QoS/E Characterization and Prediction for Next Generation Mobile Communication Systems

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ABSTRACT

The scope of this work is to present a holistic approach in quality of service (QoS) and quality of experience (QoE) characterization and prediction in modern mobile communication networks. Analytically, multi radio access technologies have been deployed in order to deliver mobile services to quality demanded consumers. Quality of Experience (QoE) parameters describe the End-to-End (E2E) quality as experienced by the mobile users. These parameters are difficult to be measured and quantified. System Quality of Service (SQoS) parameters are metrics that are closely related to the network status, and defined from the viewpoint of the service provider rather than the service user. Moreover, E2E Service Quality of Service (ESQoS) parameters describe the QoS of the services and they are obtained directly from the QoE parameters by mapping them into parameters more relevant to network operators, service providers and mobile users. A useful technique for mobile network planning and optimization is to build reliable quality estimation models for mobile voice and video telephony service.

INTRODUCTION: QOS/QOE ISSUES

Mobile user experience (mUX) is a holistic perspective to how a mobile user feels about using services providing by wireless networks. This term is subjectively described by factors influenced by user's state and previous knowledge, network properties and usage context De Moor et al. (2010). Therefore, mUX is a field where studies are rapidly executed and lean prototypes are quickly built and explored with us-

ers to evaluate the potential for new services. Whilst, mUX highlights subjectively the experiential user to mobile network/service interaction, various performance evaluation algorithms have been developed for objective E2E quality experience characterization Menkovski el al. (2010). Network-based SQoS and service-based ESQoS are defined in ETSI TR 126 944 (2011), and they are important factors when providing multimedia services to mobile customers Soldani et al. (2006). Both network monitoring systems as well as on-the-field or emulation measurement campaigns Li et al. (2014); Malkowski and Claßen (2008), are useful in radio network planning and optimization. Indeed, measurements can be utilized in content delivery systems, energy saving in smart devices, and cell selection. Since network planning today is based on coverage prediction from planning soft-tools Mousa et al. (2013), taking into account factors like base station antenna heights, tilts and directivity, cell interference and topography of the terrain, the predicted coverage area is always based on a certain value of SQoS parameters. Consequently, ESQoS prediction is one of the most significant research areas in mobile computing technologies Louafi et al. (2013); Fiedler et al. (2013). Advanced statistical analysis, such as linear and non-linear regression modeling, has been used in order to build prediction models Sun and Ifeachor (2006), for the simulation a VoIP mobile network as well as for interactive voice response service (IVR) Lovrenčič et al. (2014). Moreover, regression and logarithmic models are proposed in Reichl et al. (2013); Shaikh et al. (2010) for QoE prediction. Analysis and modeling of video traffic is presented in Koumaras et al. (2009). Beyond the statistical approach, adaptive neuro-fuzzy inference Pitas et al. (2012), Pitas et al. (2013a) and modern data mining algorithms Casas et al. (2013); Pitas et al.(2011a); Pitas et al. (2014), have been employed. Extending the approach on the problem Pitas et al., (2011b), a robust optimization framework for multimedia QoS estimation which is based on a drive-test E2E measurement campaign of live UMTS/3G network with (SwissQual Diversity Benchmarker) is proposed.

The rest content of this paper is organized in five sections. Section 2 reviews radio-SQoS key performance indicators (KPIs) of commercial mobile networks as well as modern ESQoS aspects regarding voice and video telephony services. Followingly, Section 3 focuses on statistical and computational methods in QoE prediction. Specifically, robust optimization, neuro-fuzzy inference and data mining models are introduced. Finally, the conclusions Section 5 discuss the major endowment of our research work on statistical prediction of objective ESQoS.

FUNDAMENTALS OF QUALITY

Quality of Radio Coverage

Nowadays, mobile networks have been implemented on second (2G), third (3G) and beyond 3G (B3G) generation RAN's. KPIs of 2G and 3G RANs are recommended in recommendation. GSM networks were initially deployed in order to provide CS (circuit switched) mobile telephony service while enhancements like GPRS (General Packet Radio System) and EDGE (Enhanced Data Rates for GSM Evolution) delivered data services to the mobile users. Recently, WCDMA (Wideband Code Division Multiple Access) networks were planned to deliver multimedia services like video telephony and broadband packet data services. Nowadays, LTE (Long Term Evolution) networks based on OFDMA (Orthogonal Frequency Division Multiple Access) and MIMO (Multiple-Input and Multiple-Output) radio technology will launch the data rates to tens Mbps in order to provide bandwidth and QoS demanding full PS (packet switched) services.

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