

Chapter 7

User Experience in 4G Networks

Pablo Vidales

Deutsche Telekom Laboratories, Germany

Marcel Wältermann

Deutsche Telekom Laboratories, Germany

Blazej Lewcio

Deutsche Telekom Laboratories, Germany

Sebastian Möller

Deutsche Telekom Laboratories, Germany

ABSTRACT

Forthcoming 4G networks will enable users to freely roam across different communication systems. This implies that formerly independent wireless and wired technologies will be integrated to deliver transparent access to a plethora of mobile services and applications. This will also involve changes in the user's experience mainly derived from (1) mobility across heterogeneous technologies, (2) drastic changes in the underlying link conditions, and (3) continuous adaptation of applications, e.g. flexible coding schemes. This chapter presents a detailed study of these so far unknown phenomena arising in the context of 4G networks. Current instrumental models employed to estimate user perception, such as PESQ (ITU-T Rec. P.862, 2001) for predicting the quality of transmitted speech, were designed to measure conditions that are common in today's wireless and wired systems. However, it is expected that new conditions encountered in 4G networks are not going to be accurately handled by today's models. Thus, they need to be adjusted, or new models should be proposed in order to predict the perceptual influence of new phenomena such as the three aspects aforementioned. The authors undertook this task and designed a novel methodology and experimental setup to measure user perception in future 4G networks. Moreover, the authors carried out an extensive set of subjective tests to accurately quantify user perception and derive conclusions for optimal user experience in 4G networks. These processes and initial results are included in this chapter.

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INTRODUCTION

A basic characteristic in the landscape of wireless access technologies is and will continue to be the ever increasing heterogeneity in networking characteristics. This results from the fact that emerging mobile services and applications demand different Quality of Service (QoS) levels, forcing the deployment of new wireless access technologies to cope with the new demands. Therefore, it is not a surprise that Fourth Generation (4G) wireless networks or Next Generation Mobile Networks (NGMN) will be formed by multiple heterogeneous access technologies, placing seamless mobility within and across technologies as a fundamental property of these types of systems.

Users will demand more access, better quality, and less complexity when using mobile services and applications. This poses pressure on operators and service providers to design and deploy better solutions to support seamless mobility in future communications. During the design of these solutions two important facts should be considered: heterogeneity of the underlying systems and user perception (QoE, Quality of Experience). In order to solve this twofold equation strong collaboration between networking and quality research communities needs to be accomplished. This chapter is an example of joint work between these two fields of the Information Technology and Communication (ICT) industry, and it represents a seminal effort into solving the described challenges in 4G networks.

Clear cases of the need for this type of cooperation are the current mobility management solutions. It is evident that in order to advance these solutions we should consider information beyond network performance metrics, i.e. user perception, when managing connectivity resources. Part of the proposal in this chapter is to observe metrics derived from user perception when designing future mobile networks, services and, in particular, implementing mobility management solutions. In

the following, a case study is briefly described to illustrate this.

In this chapter, it is explained how user perception may be included into the decisions about connectivity resources. Network quality is not enough anymore to base complex seamless mobility decisions in 4G networks on facts like overlaying heterogeneous networks, sudden and drastic changes in networking conditions, and independence between network operators (each network may offer different voice/video codecs, quality of service policies, etc.)

This work also discusses how user-driven evaluation of network phenomena can be used to improve existing speech quality prediction models such as PESQ or the E-model. Previous models were built to cope with the common conditions in existing (more homogeneous) communications systems, in which, for example, sudden drastic changes in lower layers are not so frequent. Therefore, current models do not cover the phenomena that occur in 4G networks. Moreover, users do not care where quality degradations stems from; they ask for at least the same quality they have been used to in the past – if the new NGMN technology does not provide this quality, the user may be dissatisfied, unless other advantages (mobility, costs) rule out the impact of degradations. As a consequence, the perceptual part of the mentioned quality models may still be valid, and the models just have to be adapted towards the new degradations found in NGMNs.

This chapter includes a detailed report of a case study and early results in the area of user-driven evaluation of 4G networks: the *Mobisense* project (Mobisense, 2007). It represents an initial hands-on evaluation of the concepts that are introduced in this chapter. For the purposes of this research, voice services, i.e. VoIP, were chosen as the main application. Thus, Mobisense is focused on the evaluation of the following scenario: “*In 4G networks, handovers between different wireless access technologies provide seamless roaming*

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