Chapter 8
Multimedia Quality of Experience

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ABSTRACT

This chapter introduces the overall concept of multimedia Quality of Experience (QoE) over the Internet. It presents all the elements of multimedia QoE ecosystem and emphasizes their roles in determining the user satisfaction. The chapter also presents different multimedia transmission components and how these components contribute to successful transmission of the media content. In addition, some key performance indicators relevant to the multimedia QoE are presented with more emphasis on network and application level indicators. Furthermore, different QoE estimation methods and techniques along with QoS/QoE learning algorithms are presented. Finally, the chapter includes some of the future challenges and issues related to multimedia QoE.

INTRODUCTION

The multimedia era started in the middle of the last century, when the television appeared and people got used to watch TV shows and movies at home. Moreover, with the VCR, DVD and Blue-ray disks and players, viewers could use the TV set to watch recorded material. In parallel, in the late 90s internet

DOI: 10.4018/978-1-4666-8850-6.ch008

video service started. This was a time when video Internet technologies were merely innovation and novelty. Due to the technological limitations with dial-up connections and slow modems, it was hard to achieve good transfer rate and superior quality. In addition, the limited graphics processing power at that time prevented wide adoption of high quality videos. However, with the proliferation of broadband Internet and the tremendous increase in processing power, multimedia technologies boomed (Motorola, 2012). The combination of high speed Internet and sophisticated powerful devices introduced a completely new way for multimedia consumption through Internet. It was the boom of "Over the top" and "Video on Demand" services.

Moreover, the advancement in different concurrent digital multimedia technologies and the proliferation of smart mobile terminals with their application ecosystem have exponentially increased the popularity of Internet multimedia services. Multimedia services are a key player in current ICT business. It is expected that video traffic will reach 66% of the global mobile traffic by the year 2015 with one million minutes of video content crossing the Internet every second (Cisco, 2011). At the same time, video consumers are getting more demanding about the quality of multimedia content. Therefore, in order to satisfy users' demands with acceptable viewing quality, it is utmost necessary to monitor their satisfaction.

Traditional approach of measuring the user satisfaction relies on Quality of Service (QoS) parameters collected from the network. In this case, the QoS parameters are monitored and controlled in order to provide a satisfactory level of service quality. Different QoS parameters like bandwidth, delay, packet loss etc. are essential metrics for determining the service quality from technical point of view. However, QoS parameters do not necessarily reflect the user's satisfaction and feelings towards a particular service. In order to accurately address the human perception of the service quality, a new concept of measuring the *Quality of experience* (QoE) is involved.

The QoE refers to "*the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user's personality and current state*" (Brunnström et al., 2013). Accordingly, the QoE is a subjective metric and can vary due to the user expectation and context. Moreover, the QoE is a reliable indicator for service providers and telecommunication operators to convey overall end-to-end system functioning (client, terminal, network, services infrastructure, media encoding, etc.). Furthermore, it is a multi-disciplinary approach when determining QoE, which involves user psychology, engineering science, economics etc. The QoE depends on different elements (i.e. content, network, application etc.) that directly or indirectly affect the user's perception towards the multimedia service. These elements should perform at their best to provide high user experience. However, the diversity in these elements makes the QoE estimation rather complex and unpredictable.

It has been shown that multimedia customers are willing to pay for better quality of experience with multimedia services (Accenture, 2012). The success of paid VoD services (not to mention that of Netflix) is just a simple proof. However, customers get intolerant if a multimedia service is not satisfactory and they easily shift to other options, if their needs are not fulfilled. Therefore, the user satisfaction is utmost important for retaining customers and has become the main differentiator for the success of network operators and service providers. Correspondingly, network operators and service providers should accurately estimate and monitor the multimedia QoE in order to track the performance and quality of a particular service.

In the following sections, we consider different components of the multimedia QoE ecosystem and their roles in the multimedia QoE. We present different multimedia transmission components and highlight some key performance indicators relevant to the multimedia QoE. We also explain different multimedia