Chapter 7
The Four Facets of Multimedia Streaming

Florence Agboma
University of Essex, UK

Antonio Liotta
Eindhoven University of Technology, The Netherlands

ABSTRACT
Recent advances in media coding techniques and network access technologies have made multimedia streaming practicable and affordable in both fixed and mobile environments. Multimedia streaming services from anywhere and at anytime is fast becoming a reality. This chapter provides a snapshot of the facets involved in delivering multimedia streaming contents to the end user’s terminal. The facets discussed in the chapter extend from the streaming paradigms, media coding techniques, the network support for multimedia streaming services to the techniques used to evaluate the user’s quality of experience for multimedia streaming applications. Each facet is also discussed for both fixed and mobile environments.

INTRODUCTION
The term multimedia streaming refers to the instantaneous delivery of media contents (combination of voice, video and data) from a server application to a user’s device. Recent advances in media coding techniques and network access technologies have made multimedia streaming practicable and affordable in both fixed and mobile environments. Examples of the emerging multimedia streaming services include Video-on-Demand (VoD), Peer-to-peer (P2P) television, distance learning applications, digital video libraries, and Internet Protocol Television (IPTV). The beneficiaries of this service penetration include terminal manufacturers who will see increased sales in compatible terminals, service providers and network operators who will see a rise in their average revenue per user (ARPU), and content providers and aggregators who will be able to reach a wider audience. The other beneficiaries will be the consumers, who will be able to enjoy a wider range multimedia streaming services.

The service quality, service assurance (reliability and availability), and the user experience when using these services, will determine the
evolution of multimedia streaming. It is therefore important to provide a positive user quality of experience (QoE) in order to attract new customers and retain existing ones. QoE is defined as the perception of the user about the quality of a particular service or network (David, 2006, p. 3). The user’s experience will depend on the type of network environment (i.e. fixed or mobile) that the user’s terminal is operating in. In this chapter, the term “fixed environment” refers to a stationary terminal that is used from a fixed location within a network, whilst the term “mobile environment” refers to a moving terminal used across cell or network boundaries. Multimedia streaming in the mobile environment introduces new challenges such as the low transmission bandwidths, high error rates, poor network coverage, low device processing power and small-sized terminals. These shortcomings lead to unimpressive viewing experiences. This chapter discusses the facets of delivering multimedia streaming contents from four orthogonal angles. In the first facet, we review the streaming paradigms currently in use, paying attention to the key differences between real-time and on-demand streaming and between client-server streaming and peer-to-peer streaming architectures. The second facet introduces the media coding standards and discusses the techniques available to perform media adaptation, illustrating how media streams can adapt to the dynamic variation of network conditions. In the third facet, we discuss the various ways, in which the current networks support streaming services, starting off with Best-Effort networks and then proceeding to QoS-enabled networks. We later explain how and why real-time streaming services benefit from traffic engineering. Finally, the fourth facet deals with the evaluation of the multimedia streaming applications. We present the various methods used to assess the user’s QoE in the context of multimedia streaming services. The chapter concludes with our views on the evolution of streaming techniques. We identify potential areas of research that focus on three themes: ubiquitous streaming; peer-to-peer streaming; and streaming based on quality of experience management.

**FACET 1: STREAMING PARADIGMS**

Streaming multimedia services can generally be grouped under two main categories, real time and on-demand. Within the real time paradigm, the multimedia contents are usually broadcast in real time and are centrally controlled. There is an increased requirement to maintaining constant service availability. For example, a disruption in a broadcast session, means that a subscriber cannot go back to replay or continue from the missing session because content viewing is according to the broadcast timelines. The on-demand paradigm offers a more personalized service, where individuals can control the type of contents they want to watch. It allows the playback of an archived video and also facilitates the new growing demand of user-generated contents where users upload their personal video contents to a specific online community. Examples can be found in YouTube.com, myspace.com, etc. With a large number of users, the server capacity, storage and bandwidth requirements for on-demand services become challenging because the multimedia streams are unicast. The service availability requirements are not as stringent as that of the real time paradigm because of the degree of control that is given to the subscriber. A subscriber can interact with the multimedia streams using the start, stop, pause and replay functions on the device. This on the other hand, makes the client viewing behaviour more flexible. The on-demand paradigm enables service providers to differentiate their services, which could further lead to increase ARPU.

The traditional approach of client-server streaming and content distribution networks (CDNs) is gradually moving towards the area of (P2P) streaming. In the client-server architecture, a client hosts requests and receives service from an always-on server. The addition of new clients to