

Chapter 9

QoS Scheduling with Opportunistic Spectrum Access for Multimedia

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ABSTRACT

Thanks to the advances of multimedia application, mobile computing platform, and wireless communication technology, the research area has attracted serious attention in order to seamlessly provide interactive and ubiquitous user experience. To make it happen, the pursuit of higher system capacity in resource limited wireless networks is never-ending. Cognitive radio (CR) represents an exciting new communication paradigm with advantages on spectrum management so as to heighten channel utilization and capacity. The bandwidth demanding multimedia applications are excellent candidates to fully exploit the potential of CR. However, the research effort has been focused mainly on spectrum access while the application specific performance has been much less touched. The research considering both spectrum access and application data scheduling is emerging for maximal user experience. In this chapter, the authors first discuss advances in opportunistic spectrum access (OSA) strategies as well as multimedia QoS scheduling schemes, and then introduce the research trend on joint access and scheduling frameworks.

9.1 INTRODUCTION

Multimedia communication is exploding with growth. Thanks to the advances of multimedia application, mobile computing platform and wireless communication technology, the research

area has attracted serious attention in order to seamlessly provide interactive and ubiquitous user experiences. To make it happen, the pursuit of higher system capacity in resource limited wireless networks is critical and never-ending.

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Among emerging communication technology, CR represents an exciting new communication paradigm with advantages on spectrum management so as to improve channel utilization and overall available bandwidth (Sadler & Zhao, 2007). The bandwidth demanding multimedia applications are excellent candidates to fully exploit the potential of CR. However, research efforts have been focused mainly on spectrum access while the application specific performance issues have been relatively less touched. A novel aspect of view jointly considering spectrum access and application level quality of service (QoS) is desired to achieve maximal user experience.

The so called multimedia content is ranging from text, still images, audio, to video. With bandwidth hogging and interactive nature, delivering video is the most prominent topic in communication research. In comparison to non-real time types of multimedia applications, video streaming has stricter timing requirements while to other real time information, the need for bandwidth is considerably higher. As mobile data enabled handheld devices, such as smartphones and tablets, becoming rapidly ubiquitous, a growing group of users is expected to access popular video channels through wireless networks in the near future. Our focus is therefore on video over CR to demonstrate various design concepts under corresponding quality requirements.

Firstly, we define the background of video transmission through CR networks. Secondly the conditions under which this objective has to be achieved are discussed and problems, which might arise, are pointed out. Third, possible solutions are presented together with an outlook at the research directions. Overall, the chapter provides essential knowledge of transmitting multimedia in cognitive radio environment, most important problems, state-of-the-art solutions, and future perspectives.

9.2 QOS FOR VIDEO OVER COGNITIVE RADIO

In this section, we address related video coding technology, CR environment and QoS enabling mechanisms.

9.2.1 Video Coding Technology

Since the first introduction of digitally recorded video, the research and progress in this field had come a long way (Hwang, 2009). Due to the considerable data rate of raw video, effort towards effective video coding for enabling an effective transmission has been pursued early on with many variants being available at the current time. The evolution of video codecs brought better transmission efficiency with the same resulting quality and conversely better video quality at the same bit-rate. With scalable video coding extension of H.264/AVC called H.264/SVC presenting the state-of-the-art solution, the coding efficiency is comparable to that of the original H.264/AVC standard.

The video encoding scalability, indeed, is one of key factors to support high quality media over heterogeneous wireless medium (Schierl, Stockhammer, & Wiegand, 2007). Conventionally, source rate adaptation is realized through end-to-end (client to server) message exchange based on receiver side real-time bandwidth inference feedback. Scalable bit streams, in contrast, enable the capability of adaptation not only at end nodes, but also in intermediate entities. More robust rate adaptation corresponding to rapid fluctuating wireless channel condition can therefore be achieved. With H.264/SVC, one video stream is divided into a base layer providing basic video quality and one or more enhancement layers, which can be incrementally decoded by the receiver to achieve higher quality video playback. Users with heterogeneous channel throughput can therefore receive different amount of video data corresponding to their time varying receiving link condition. The capability to react

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