Ensuring QoS Over Wireless Channels for E-Learning

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INTRODUCTION

E-learning refers to the medium of learning where educational contents are electronically delivered to distant learners via a computer network. The scope of E-learning includes both asynchronous learning based on self-study and synchronous learning directed by an instructor. In asynchronous learning, different participants exchange idea or information, without requiring them to get involved at the same time. In contrast, synchronous learning involves participation of learners for the same period of time.

In comparison with traditional classroom learning, e-learning offers a flexible, self-paced learning environment. E-learning provides an opportunity to the learner to selectively re-experience the educational content, thus promoting learner-centered activity and interactivity. Thus, a learner can select a particular piece of lecture and replay it until he/she has fully understood it. In this way, e-learning can be helpful in complementing the classroom learning. E-learning has recently emerged as a promising solution to foster lifelong learning and on-the job training to employees. Since effective training methods are extremely important to companies to ensure that the employees are equipped with the advanced work skills, e-learning solutions are also crucial for business corporations.

To support the requirements of e-learning, the demands for the multimedia services over wireless have greatly increased in the recent years (Bell and Federman, 2013, Mittal, Zhang and Cao, 2013). At the same time, the expectation of quality for these services has also increased. However, several limitations, such as limited channel bandwidth and unpredictability of the channel propagation become significant obstacle in offering high quality, reliability and data rates at minimum cost. Transmission and streaming of e-learning videos is a challenging, yet vital issue for providing critical infrastructure (Clark et al. 2011). Real time delivery of educational videos is extremely important, since many institutes, such as MIT (http://ocw.mit.edu/index.html) have opened their Web servers for free lecture-on-demand on several courses.

To see the typical size of data transmitted, we take the following example. Assuming a resolution of 800 * 600 pixels, and each pixel requiring 3 bytes of storage (one for Red, Blue and Green respectively), each uncompressed image requires 1.373 MB of storage. Thus, one hour video at 15 frames per second will require 72.07 GB of space and even with MPEG (motion picture experts group) standards coding, this video still takes 500-600 MB of storage. Clearly, compressing the videos is extremely important. Transmitting the compressed video also requires that a high quality of service (QoS) should be ensured (Melodia et al. 2010, Pudlewski et al. 2010).

In this chapter, we discuss the challenges and state-of-the-art in ensuring QoS for multimedia content delivery over wireless channels for the purpose of e-learning (Jethro et al. 2012, Augar et al. 2012). We also discuss the use of MIMO techniques and FPGA platforms for achieving efficient implementation of multimedia transmission. The contributions of the chapter are twofold. First, it discusses the use of MIMO communication system for achieving high-fidelity

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data transfer. Second, to provide high processing power, which is required to manage the challenges of video-processing, we discuss the use of FPGA platforms. Taken together, these contributions enable the e-learning providers to enable multimedia QoS while transmitting the e-learning content to distant learners. Our work is especially useful for future e-learning solutions, which will focus on providing video and feature-rich multimedia data, which requires high bandwidth, high-fidelity and processing power for near real-time or real-time content delivery.

BACKGROUND

In literature, several tools and technologies have been proposed to aid e-learning, while include question answering systems (Mittal and Mittal, 2011), virtual mentor program (Zhang et al. 2004), online courses (http://ocw.mit.edu/index.html), Computer-supported collaborative learning (e.g. Google Docs), computer based training and mobile-learning (also called m-learning, Pande et al. 2007) etc.

M-learning refers to the ability to obtain meaningful educational content on personal portable devices such as smartphones. The similarity between e-learning and m-learning lies in the fact that both promote user-centric, technology-assisted learning. However the difference between them is that while e-learning is generally provided in Internet labs or classrooms, m-learning promotes learning anytime. Thus, e-learning is provided in private locations, while m-learning generally does not have such geographical boundaries.

Compare to m-learning, the advantage of e-learning is that it can be presented in a formal and structured manner, under the guidance of an instructor. Through this, the information content presented to the user can be monitored and the instructor can also take feedback to further improve the course. In contrast, the limitation of m-learning is that it is generally self-paced and informal. Moreover, it is usually not monitored. The advantage of m-learning lies in the fact that it provides flexibility to the learner to access the educational content at any time and from any location. This is especially useful for distance learners. Also, due to its self-paced nature, the user can go over a previously presented content and study it until it is fully understood.

In e-learning environment, the ability of the users to benefit from the multimedia delivered crucially depends on the quality of the content (Liu et al. 2009, Sun et al. 2008). Moreover, inadequately equipped e-learning solutions can even result in frustration, confusion, and reduced learner interest. For e-learning, streaming media also has been effectively used, since ‘streaming’ enables large files to begin playing before the entire file has been received (downloaded). In e-learning environment, several media, such as text, graphics, audio, video and animations can be integrated. In the context of e-learning, in this chapter, we discuss the example of classroom video lectures.

Hwang et al. (2011) address the QoS challenges encountered in video over heterogeneous wireless broadband networks. Rho et al. (2011) discuss a method for multimedia information processing in wireless networks. Gupta, Mittal, & Dasgupta (2008) propose a framework for end-to-end e-learning solution capable of dynamic video compression and transmission over scarce resource wireless networks, while ensuring necessary quality of service. The QoS metrics include reliability, perceptual quality, high data rates and optimal power allocation for transmission at different bandwidth levels. They utilize the property of the classroom lecture videos that, the video of teacher and blackboard contains more meaningful information than the video of the background. Thus, by allocating higher bandwidth to more important videos, the quality of multimedia content can be improved.

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