Optimisation of Variable Bit Rate Traffic Delivery in LTE Networks

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Abstract – **Current trends in mobile networking exhibit that live voice and video content are the most popular forms of network traffic. Both these forms of content can be encoded as variable bit rate streams for improved quality-to-capacity ratios. Live VBR coded video and voice streams are guided by strict delay and jitter constraints. Quality of experience for users accessing this content over the wireless LTE interface is compromised by competition for radio resources and unpredictable channel conditions. There is a need to optimise the delivery of VBR content to mobile LTE subscribers and this work in progress paper proposes a scheme for achieving this.**

Index Terms — LTE, VBR, User QoE

I. INTRODUCTION

The increase in demand for higher network capacity and the need to offer services at a reduced cost to cellular network subscribers have compelled the 3GPP to work on standardising Long Term Evolution (LTE). Another motivating factor for the development of LTE is improved usage of the spectrum because the wireless medium, on which LTE operates, is a scarce resource which has to be managed efficiently [1]. The management of these radio resources is done by schedulers, through scheduling algorithms, and in a wireless environment they must ensure that all users are served with fairness while also achieving the highest throughput by limiting transmission over poor channels which might result in packet loss.

LTE schedulers do not have application-specific considerations of traffic transmitted through the network. This is despite different forms of traffic having different quality of service requirements such as the maximum delay threshold characteristic of live video and voice. Trends in mobile network data indicate that these two forms of content are the most common services accessed by subscribers. Voice and video streams coded using variable bit rate (VBR) provide more content per bits in a time segment than content coded using constant bit rate data techniques.

To improve user quality of experience for subscribers accessing VBR content over LTE networks, application layer techniques that reduce content size, hence reducing the delay during transmission, can be used. Shen *et al.* [4] explore two common classes of encoding. One is precoding, where content is stored on a media server encoded in different rates and hence different sizes. Although Shen *et al.* discuss another form of content coding; scalable video coding, as best suited for video streams, the same technique can be applied for voice or audio encoding [5]. In this method, the content stream is coded into layers, the first and most basic of which is the base layer. This layer contains the lowest content quality and is transmitted first. Each successive enhancement layer, transmitted after the base layer, improves the quality of the content.

Scheduling occurs on the media access control layer and scheduling mechanism give no consideration to adapting application layer content for the conditions of the channel. In the same way, VBR data encoding techniques are applied on the application layer where conditions of the channel are abstracted. When the two techniques complement each other, quality of service will be provided for sensitive data such as VBR over the wireless LTE interface.

The remainder of this paper is organized as follows: Section II discusses related work in this field and the third section presents the architecture of our proposed system to optimize delivery of VBR traffic in LTE. Section IV covers the system's evaluation and testing, and section V concludes.

II. RELATED WORK

Developments in LTE standardisation were only seized in December 2009, any further development will contribute to LTE-Advanced. Due to this, not much literature is available on the subject. Luo *et al* in [2], however, propose a dynamic resource allocation scheme for video delivery in LTE based on the weighted round robin scheduling algorithm. The system factors in each user's link quality but does not adapt the application layer content to suit these conditions.

In [3], the authors discuss optimised rate adaptation in wireless multi-user networks, not specifically LTE. The proposed framework aims to counter the effects of the time-varying channel conditions by adapting the video source coding rate accordingly. This approach uses rate adaptation which is not practical for live streams.

Both schemes in [2] and [3] focus exclusively on video delivery optimisation. The same techniques employed for encoding video data can be employed for encoding voice. This is illustrated by the usage of scalable coding for voice in the IPMR codec [5]. The optimisation of the delivery of variable bit rate content can hence be approached as a single aggregated problem not solved for voice and video delivery in isolation.

III. SYSTEM ARCHITECTURE

To address the problem of delivering VBR content to mobile LTE users, we propose a system that comprises of three sub-modules. The first of these sub-modules is a channel estimator. The work presented in [6] by Rana *et al.* is adopted for the design of a low-complexity LTE channel estimator. Signal strength reports from this estimator are fed into a central Decision Engine sub-module. Based on the reports, the decision engine analyses the channel conditions of each of the mobile stations ready for receiving data. The engine then selects the next user to allocate bandwidth. This selection is made with the aims of achieving overall fairness and improved system throughput.

The stream of data to be delivered to each user is then selected from a third module, the Encoder. This module will adopt the scalable content coding scheme therefore the decision engine decides upon the number of enhancement layers to be transmitted along with the base layer. The Channel Estimator and Decision engine both operate on the physical and data link layer respectively, while the Encoder is an application layer module. The flow of data between these sub-modules is illustrated below.

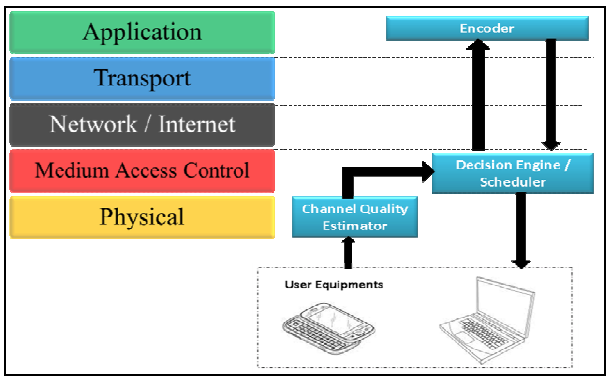

Fig 1: Optimisation System Data Flow

IV. EVALUATION AND TESTING

The proposed system will be tested on a network simulation tool; Network Simulator 3. The simulations will model a typical LTE access network in which users compete for network resources.

The performance of the proposed scheme will be evaluated using analysis of data extracted from the simulation. The results from simulations where the proposed scheme is implemented will be compared to results from simulations where it is not employed. The key parameters which will form the basis of the evaluation are time delay, jitter, overall system throughput and the system's fairness in scheduling.

V. CONCLUSIONS

Guaranteeing good user quality of experience for subscribers accessing variable bit rate content over LTE cellular networks is made difficult by competition from other network users and the unpredictable conditions that the air interface experiences. Schedulers and content encoders each provide limited solution to the VBR delivery problem in LTE. We propose an optimisation scheme which will ensure improve user QoE while also ensuring efficient radio resource utilisation and scheduling fairness. The NS3 simulator will be used to model the system, and generate graphs to assess its performance. More literature is being reviewed and algorithms design is in its early stages. The greatest challenge is integrating scalable content encoding with the simulator.

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BIOGRAPHY

Joel Makara received his B. Eng. degree from the National University of Lesotho in 2009. He is studying towards an MSc (Eng) degree at the University of Cape Town. His research interests include quality of service in next generation networks.