Chapter 14

An Intelligent Scheduling Architecture for Mixed Traffic in LTE-Advanced Networks

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ABSTRACT

In this chapter, an intelligent scheduling architecture is presented for the downlink transmission of LTE-Advanced networks to enhance the Quality of Service (QoS) provision to different traffic types while maintaining system level performance such as system throughput and fairness. Hebbian learning process and K-mean clustering algorithm are integrated in the time domain of the proposed scheduling architecture to intelligently allocate the available radio resource to Real Time (RT) and Non-Real Time (NRT) traffic types. The integration of these algorithms allows just enough resource allocation to RT traffic and diverts the remaining resource to NRT traffic to fulfil its minimum throughput requirements. System level simulation is set up for the performance evaluation, and simulation results show that the proposed scheduling architecture reduces average delay, delay violation probability, and average Packet Drop Rate (PDR) of RT traffic while guaranteeing the support of minimum throughput to NRT traffic and maintaining system throughput at good level.

INTRODUCTION

The rapid development in all IP based next generation mobile communication networks, such as Long Term Evolution-Advanced (LTE-A), is expected to support the outburst of high-speed packet based applications. These applications have a large variety of QoS requirements such as reduced latency and packet loss rate and high throughput. Radio Resource Management (RRM) faces challenges when come across such a large variety of conflicting QoS requirements (Zhen,
Yu-Kwong, Jianzhou, 2009). This is due to, limited radio resource, rapidly changing wireless channel conditions and ever increasing number of mobile users. Packet scheduling being one of the cores of RRM is very crucial to make an effective utilization of available radio resource (Rehana, 2010). In a scheduling algorithm, variable QoS requirements of different traffic types must be analysed and weighted appropriately to reach an balanced solution (Zhen, Yu-Kwong, & Jianzhou, 2009).

The classic packet scheduling algorithms are Round Robin (RR), MAX C/I and Proportional Fairness (PF) algorithms. RR algorithm allocates resources cyclically thus achieving the maximum fairness. MAX C/I and PF algorithm exploit multiuser diversity to enhance system throughput. MAX C/I algorithm allocates a Physical Resource Block (PRB) to a user with the highest channel gain on that PRB, and can maximize the system throughput (Harri & Antti, 2009). PF algorithm takes both system throughput and fairness among users into consideration and allocates resources to users based on the ratio of their instantaneous throughput and acquired time averaged throughput (Stefania, Issam, & Matthew, 2009). However, RR, MAX C/I and PF algorithms aim only at improving fairness, system throughput or the trade-off between fairness and system throughput, respectively. QoS requirements, for example delay requirements of RT traffic or minimum throughput requirements of Non NRT traffic, are not considered at all. In the next generation of mobile communication networks, apart from system throughput and user fairness, the crucial point is to fulfill users’ QoS requirements in a multi-service and multi-user mixed traffic environment. This is because of resource contention among users of different traffic types. To allocate radio resources efficiently and intelligently in such complex environments is very challenging.

## QoS Aware Scheduling

Several scheduling algorithms are presented to achieve higher performance to fulfill QoS requirements of different traffic types, in the next generation of mobile communication. A low complexity QoS aware PF multicarrier algorithm is presented for OFDM systems in (Zhen, Yu-Kwong, & Jianzhou, 2009). The objective is to achieve PF in the system while improving QoS performance. A greedy method based multi carrier PF criterion is proposed with the consideration that traditional single carrier PF is not suitable for OFDM systems. A sub-carrier reassignment procedure is used to further improve QoS performance. This paper proposes Packet Scheduling (PS) algorithm specifically for the multimedia traffic and improves QoS, throughput and fairness in the system. However, there is a need to analyze the behaviour of the proposed algorithm when the system has to deal with different traffic types such as interactive, background traffic, etc. In (Jani, Niko, Martti, & Mika, 2008), a service classification scheme is used which classifies mixed traffic into different service specific queues and grants different scheduling priorities to them. QoS of RT traffic is improved at the cost of system spectral efficiency, when the RT queue is granted the highest priority and fairness is significantly improved when fair scheduling is used in the Time Domain (TD) to pick users from the queues instead of strictly prioritizing RT traffic queue. Fair scheduling picks users one-by-one from each queue and strict priority empties queues one after the other, giving the highest priority to RT queue. Conventional PF and MAX C/I are used to sort the priority of users in the queues, which improves system throughput and fairness among users. However, the QoS of RT and NRT traffic can be improved by using service specific queue sorting algorithms to prioritize users. In (Gutier-
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