GA Based Optimization in LTE for Different Data with different Loads

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Abstract - We propose the genetic algorithm (GA) based cross-layer resource allocation for the downlink multiuser wireless orthogonal frequency division multiplexing (OFDM-LTE) system with heterogeneous traffic. The GA is used to maximize the sum of weighted capacities of multiple traffic queues at the physical (PHY) layer, where the weights are determined by the medium access control (MAC) layer. Simulation results demonstrate that the GA significantly outperforms the existing algorithm in terms of the system bandwidth efficiency, best-effort (BE) traffic and quality of service (QoS) traffic delay.

Key Words: *GA, OFDM-LTE, QoS, etc…*

1. Introduction

Conventional network architectures, where each layer is designed to operate independently, do not utilize resources effectively. With the rapid increase of demands for high speed multi-media services of wireless networks, which are con-fronted with fading channels, limited bandwidth and competition of limited air resources among multiple users, a cross-layer design to meet the required quality of service (QoS) is desirable [1].

In [2], a cross-layer scheduling scheme for the medium access control (MAC) layer was proposed, which assigns priorities of connections according to the channel quality, QoS satisfaction and service priority across layers. In [3], a so-called modified largest weighted delay first (M-LWDF) scheduling scheme was proposed, based on the head-of-line (HoL) packet delay, relative data rate and QoS requirement. However, [2] and [3] assumed single carrier systems.

Orthogonal frequency division multiplexing (OFDM-LTE) [1] is effective to combat frequency selective fading channels and support high data rate services, which has been widely used in WLAN (IEEE 802.11a & 11g), WiMAX (IEEE 802.16) and 3GPP LTE downlink systems [4]. In [5], a scheduling scheme was proposed for OFDM-LTE systems, which serves the QoS traffic and best-effort (BE) traffic together if the delays of the QoS packets do not approach the maximum allowable delay. In [6], an urgency and efficiency based packet scheduling (UEPS) scheme, which utilizes the HOL delay and channel quality, was proposed for OFDM-LTE systems. However, [5] and [6] only considered scheduling for the MAC layer, but did not Consider adaptive resource allocation for the physical (PHY) layer.

To exploit the synergy between scheduling and resource allocation at the PHY layer, a so-called maximum delay utility (MDU) cross-layer resource allocation and scheduling scheme was proposed in [7], which maximizes the utility function of the delay. How-ever, the work in [7] is based on the sequential linear approximation algorithm (EARLIER) [8], which may generate a local optimal solution instead of a global optimal solution. The genetic algorithm (GA) is a family of computational models, which was first proposed in [9]. Since the GA is an effective search technique, it has been applied to wire-less communications recently [10] [11]. However, in most previous work, GA was used for channel equalization [10], multiuser detection .In this paper, we propose the genetic algorithm (GA) based cross-layer resource allocation for the downlink multi user OFDM-LTE system with heterogeneous traffic.

2. GENETIC ALGORITHM BASED CROSS-LAYER RESOURCE ALLOCATION

The genetic algorithm [9] based cross-layer resource allocation is presented in this section. In the GA based cross-layer resource allocation, we define a chromosome is a string of N elements, where each element represents a queue index which the corresponding subcarrier is allocated to, i.e., if the nth (8n 2 f1;:::;Ng) element is valued i (i 2 f1;:::;3Kg), it means the subcarrier n is allocated to queue i. Therefore, each chromosome represents a sort of subcarrier allocation results, and is associated with a fitness value indicating how good the chromosome is with respect to the optimization problem. During the evolution, chromosomes with higher fitness values, which are also called elites, have a higher chance to survive. Fig. 1 shows the flow chart of the GA based cross-layer resource allocation.

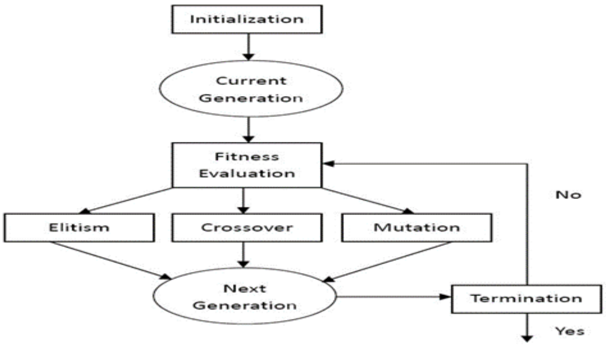

Figure 1: Block diagram of the GA

The procedure of the GA based resource allocation is described as follows:

1. Initialization: generate a population N pop of chromosomes, where each bit of all the chromosomes is randomly picked from f1;:::;3Kg.
2.Fitness evaluation: update power allocation for each chromosome by using the subcarrier allocation presented by the chromosome and (7); utilizing the corresponding power and subcarrier allocation of each chromosome, obtain the fitness value of each chromosome, which is the value of (3).
3. Elitism: find Nelite chromosomes with the highest fitness values, copy them into the next generation directly.
4.Crossover: pick two chromosome parents from the current generation to create chromosome children for the next generation; parents can be chosen with equal probability; randomly obtain a crossover point for the parents; the parents are split into two parts, one child chromo-some consists of the first part of the first parent and the second part of the other, while the other child chromo-some consisting of the second part of the first parent and the first of the other; generate N crossover children chromosomes for the next generation.
5. Mutation: randomly pick a chromosome from the current generation, each bit of it can be changed with a chance of Pmu; generate Nmu mutation children chromosomes for the next generation.
6. Repeat Steps 2, 3, 4 and 5 until reaching the maximum generation limit Ngen.

3. SIMULATION RESULTS

We use simulation results to demonstrate performance of the proposed cross-layer design for a system with a total transmit power pT = 1 W, a slot duration of T slot = 4 ms, and a total bandwidth of B = 5 MHz which is divided into N = 512 subcarriers. Conventional network architectures, where each layer is de-signed to operate independently, do not utilize resources effectively. The channel has six independent Rayleigh fading paths with an exponentially delay profile and a root-mean-square (RMS) delay spread of 0.5 ms. The maximum delay tolerances for VoIP, VBR video and BE traffic are 100 ms, 400 ms and 1000 ms, respectively. The VoIP traffic queue and BE traffic queue have a constant data rate of 64 Kbps and 500 Kbps, respectively. To exploit the synergy between scheduling and resource allocation at the PHY layer The data rate of the VBR video traffic follows a truncated exponential distribution [14] with a minimum of 120 Kbps which assigns priorities of connections according to the channel quality,, a maximum of 400 Kbps, and a mean of 239 Kbps. The duration for each data rate of the VBR video traffic follows an exponential distribution with a mean of 160 ms. The signal-to-noise ratio (SNR) is defined as the average received signal power to noise power ratio for each queue This is be-cause The EARLIER based cross-layer resource allocation might stop searching when it finds a local optimal solution while the GA based resource allocation manages to. Figs. 2 to 5 demonstrate the impact of the number of users on performance of different searching algorithms for the cross-layer deign, with SNR=20 db. The system capacity and the BE traffic throughput are shown in Fig. 2 and Fig. 3, respectively.

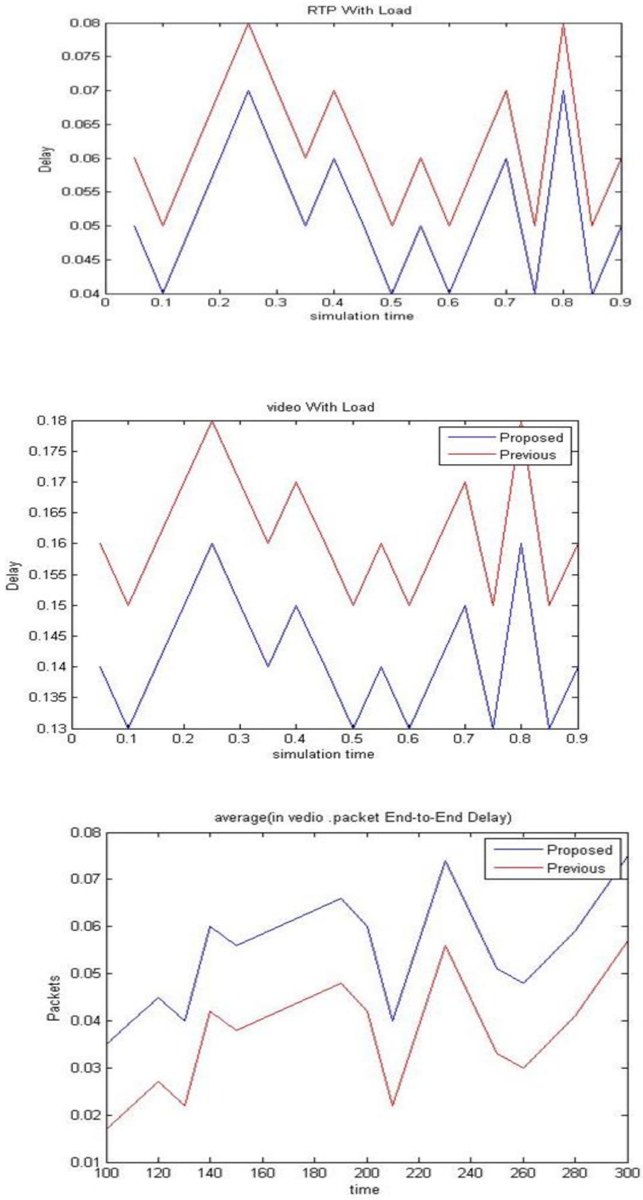

Figure 2-5: Different input data with GA

The GA based cross-layer resource allocation scheme provides significant performance advantages over the EARLIER based cross-layer resource allocation, with a wide range of the number of users (8 to 64 users), i.e., The GA based cross-layer resource allocation achieves the system capacity which is up to 35% higher than that of the EARLIER based one. Similar trends can be found in Fig. 3. This is be-cause The EARLIER based cross-layer resource allocation might stop searching when it finds a local optimal solution while the GA based resource allocation manages to approach the optimal solution during the evolution. Note that the BE traffic throughput decreases as the number of user increases. Since the number of QoS traffic queues augments as the number of user increases, the QoS queues occupy more resources, and the BE traffic throughput degrades.

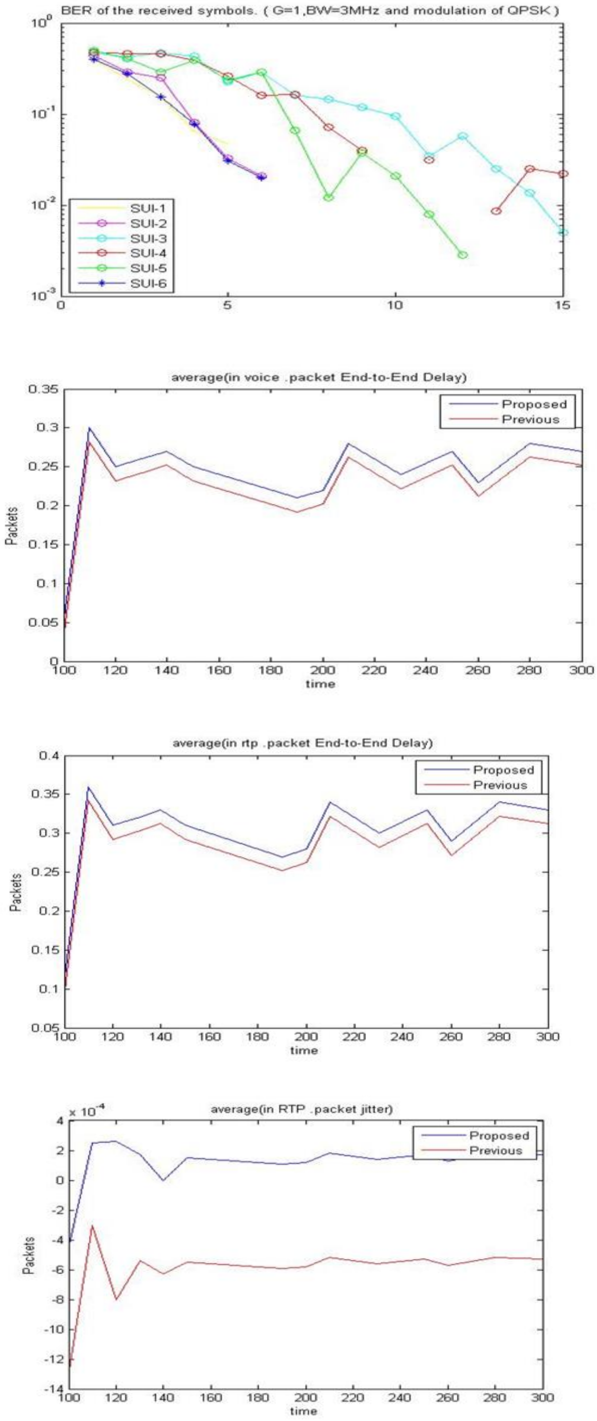

Figure 6-10: Different input data with GA and its comparison

CONCLUSION

In this paper a hybrid coupled interworking LTE network along with GA is proposed and its performance is compared with hybrid coupled interworking of WiMAX and WLAN network with LB. The performance evaluation shows that the proposed architecture outperforms the existing technology. We have proposed the GA based cross-layer resource allocation for the downlink multiuser OFDM-LTE system with heterogeneous traffic. Through simulation results, we demonstrated that the GA based cross-layer resource allocation provides significant performance advantages over the existing one, in terms of the system bandwidth efficiency, end to end delay and QoS traffic. delay, with a wide range (from small to moderate) of the number of users .In the near future incorporating Authentication, Authorization and Accounting (AAA) protocol into the proposed work of LTE architecture will improve the network performance and decrease the handover delay .

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