Dynamic Resource Allocation through Reinforcement Learning Approach in Multi-cell OFDMA Networks

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***Abstract*— In this paper, we present a distributed resource allocation algorithm for cellular OFDMA networks by adopting a Reinforcement Learning (RL) approach. We use an RL method which employ Growing Self Organizing Maps to deal with the huge and continuous problem space. The goal of the algorithm is to maximize the network throughput in a fair manner. Indeed, the algorithm maximizes the throughput until fairness violation does not exceed an adjustable threshold. Simulation results illustrates that the fairness definition leads to enormous extra throughput achievement relative to the fair algorithm.**

I. INTRODUCTION

The enormous demand for high data rate services, as a result of emerging new services and various applications in mobile communication networks, attracts the attention of researchers to resource management in broadband wireless networks. As the total bandwidth given to a wireless system is limited, allocating resources to the users should be in such a way that maximum total throughput of the system is obtained. To improve spectral efficiency, Orthogonal Frequency Division Multiple Access (OFDMA) has emerged as one of the most promising multiple access technique for 4th generation (4G) mobile communication systems and wireless broadband networks [1]. With respect to the fact that multi-cell OFDMA networks are more applicable for practical use, resource allocation in these networks is considered more intensely. The most striking challenge of cellular OFDMA networks is efficient resource allocation among the users with respect to the co-channel interference (CCI).

Several algorithms have been proposed to deal with resource allocation problem. These algorithms can be divided into centralized and distributed categories with respect. The centralized algorithms assign the resources considering the state of all cells, while in the distributed ones, the allocation is performed autonomously in each cell without considering the state of the other cells. The distributed algorithms are preferred to the centralized ones on the ground of the fact that cell coordination is not required to find the solution. The heuristic algorithms proposed in [2], [3], [4], [5], and [6] allocate the available resources in the hope of minimizing total transmission power at the base stations. The algorithms presented in [2], [3], and [6] are centralized, whereas the algorithm in [4] is a distributed one. A distributed algorithm presented in [7] utilizes a game theoretic approach. It first defines a utility function that can represent the system performance while taking into account the co-channel interference among cells. Then it models resource allocation problem as a noncooperative game that leads to a solution which maximize total system throughput. In [8], a throughput maximization algorithm is proposed, but without considering fairness; therefore, users experiencing high CCI receive less resources. The distributed algorithm proposed in [9] attempts to minimize the maximum value of the QoS violation for users in different cells. The algorithm works effectively in the conditions upon which the network resources are barely enough for the user demands. However, the issue of network throughput maximization is not considered when the users' demands are less than the capacity of the network. In [10], a linear programming formulation with the constraints of QoS and limited bandwidth is made to achieve optimal system throughput. Since finding optimal solution for linear programming has high computational complexity, a heuristic algorithm yielding a semi-optimal solution is proposed.

This paper specifically addresses the problem of resource allocation in OFDMA cellular networks using a distributed approach. The novel problem formulation presented in this paper maximizes the network throughput while considering the fairness and users' demand. Indeed, the corresponding algorithm should grasp throughput maximization until