A Data Rate Maximization Algorithm for Multiuser OFDM Systems

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Abstract— **In this paper, we present suboptimal integer bit allocation algorithm that maximizes overall data rate in multiuser orthogonal frequency division multiplexing (OFDM) systems implemented in wireless networks.**

Assuming knowledge of the instantaneous channel gains for all users, we propose a new multiuser OFDM loading algorithm, *with constrains*, that maximizes the total data rate in downlink transmission. This is done by solving the maximization problem in two steps. First step provides subcarrier assignment to users based on users' requests on quality of service (QoS) expressed in terms of a minimum signal-to-noise ratio (SNR) on each subcarrier. The second step provides bit and power allocation to subcarriers in order to maximize overall data rate. In order to reduce the computational complexity of the proposed problem we propose a simple method, in the form of a theorem, which assigns subcarriers to users and distributes bits and power among them.

We have tested the proposed algorithm in a multiuser environment for various subcarrier SNR values requested by users, and for various levels of interference in the OFDM system.

The results show that our loading method obtains a better data rate in some situations than the algorithm described in [5], which states that the data rate of a multiuser OFDM system is maximized when each subcarrier is assigned to only one user. Results show that the total number of bits per OFDM symbol or data rate grows with the number of users in the system.

Index Terms— **loading algorithm, subcarrier assignment, OFDM, multiuser environment.**

I. INTRODUCTION

An OFDM system, [7], implemented in a multiuser environment demands optimal power and bit distribution as well as optimal distribution of subchannels between users in order to achieve maximum data rate. The algorithm that adaptively allocates transmit power and bits for each subchannel in the multicarrier system is known as a loading algorithm

Numerous loading algorithms have been developed for OFDM systems. Most of them have been developed for a single user environment [1], [2], [3], [8], [9]. These methods are both suboptimal and computationally efficient [1]–[3], [9] or optimal but slow in delivering the power and bit allocation [8]. In a single user environment the major goal is to distribute more power in subchannels having the best channel gain. This, of course, assumes a perfect knowledge of the channel state in a transmitter. The same principle can be applied in a multiuser environment. However, in that case, there is a conflict between users who have a good channel gain in a common subchannel. The problem is to determine which subchnnels should be associated to which user. Some authors have already published papers about this problem [4], [5], [6], [10]. However, algorithms proposed in all of these papers do not allow subchannel sharing among different users. In [5] there is an explicit theorem which states that "maximum" data rate of a multiuser OFDM system is achieved only when a subchannel has been used by a single user.

Therefore, in this paper we focus on the development of a new suboptimal loading algorithm for a multiuser OFDM based wireless networks that maximizes the overall data rate while achieving proportional fairness amongst users under a users' QoS requirements and a total power and bits constraints on each subchannel.

The algorithm has two goals:

- assignment of subchannels to users;
- distribution of transmitted signal power and bits among subchannels in such a way that overall data rate of the system is maximized.

The organization of the paper is as follows. Section II introduces a system model for a multiuser environment. Section III describes a new loading algorithm, proposed by the authors, and some of its modifications. In section IV simulation results are presented. Conclusion of this paper is given in section V.

II. MULTIUSER ENVIRONMENT

In the downlink transmission of the multiuser OFDM wireless system analyzed in this paper, modulated signals on a number of subcarriers for multiple users are all summed together and they are transmitted through a channel with fading. A block diagram of the downlink transmission system of the multiuser OFDM system is depicted in Fig. 1.

Let M be the number of users in the system. In the figure, $d_{j,i}$ denotes a set of data symbols for the j-th user on i-th subcarrier, and $s_j=[s_{j,1}\ ,\ s_{j,2}\ ,\ldots,s_{j,N}]$ represents the optimal transmitted power vector of some user j. Vector of data rates is

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