BLOCK ADAPTIVE SUBCARRIER ALLOCATION FOR WIRELESS MULTIUSER OFDM SYSTEM

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Abstract  In this paper, a blockwise adaptive subcarrier allocation algorithm for multiuser Orthogonal Frequency Division Multiplexing (OFDM) system is introduced. Assuming the knowledge of channel information for all users, the algorithm minimizes the total transmit power while satisfying the total power and users' rate constraints. The result of simulation shows that the proposed algorithm reduces the average bit Signal-to-Noise Ratio (SNR) by approximately 4 dB compared with OFDM-Frequency Division Multiple Access (OFDM-FDMA), and supports more users in a multiuser Rayleigh fading channel. As assigning subcarriers in block, the computational complexity of the algorithm is much lower than that of the derivation of “water-filling” algorithm.

Key words  Orthogonal Frequency Division Multiplexing(OFDM); Multiuser; Subcarrier allocation; Rayleigh fading channel

I. Introduction

Orthogonal Frequency Division Multiplexing (OFDM) is a kind of multicarrier transmission technique, which can provide broadband, high-speed data transmission over wireless channels. In OFDM system, the channel is divided into $N$ narrowband subchannels that can be considered as parallel independent Additive White Gaussian Noise (AWGN) channels provided $N$ is sufficiently large. One of the advantages of OFDM system is to combat InterSymbol Interference (ISI), which is the main problem in wideband transmission over multipath fading channels.

In the case of multiple users, a wireless system should support different users with different Quality of Service (QoS) requirements. This demand has led to the problem of resource allocation, including bit loading, subcarriers and power allocation because there are diverse channel patterns between the basestation and users. Refs.[1–3] provide bit loading algorithm for single user in Discrete MultiTone (DMT) system, and the simulations of Refs.[4, 5] show that a substantial performance improvement can be obtained with the use of bit-loading in OFDM system for a typical office environment. A blockwise loading algorithm for single user in OFDM system is also introduced in Ref.[6].

It is generally considered that many deep-fading subcarriers may not be used when adaptive bit-loading algorithm is applied for one user. But in a multiuser environment, these subcarriers are quite unlikely in deep fade for all users because the fading channels for different users are mutually independent. Ref.[7] proposed a multiuser OFDM subcarrier, bit and power allocation algorithm to minimize the total transmit power. Since this algorithm can be viewed as a counterpart of multiuser “water-filling” solution, the iterative computation is much complex. Compared with Ref.[7], Ref.[8] gives a simplified multiuser
loading algorithm, which divides allocation problem into two steps, resource allocating and subcarrier assignment, but it assumes that each user’s channel across all subcarriers is flat.

In this paper, a new blockwise subcarriers allocation algorithm for the downlink of OFDM system is proposed. Assuming the knowledge of the channels of $M$ users, the algorithm divides all subcarriers into blocks, and assigns certain number of blocks to each user according to this user’s data rate and Bit Error Rate (BER) requirement. The objective of the subcarriers allocation here is to satisfy the data rate and BER requirement of each user while the required transmit power is minimized. Therefore, the number of users is maximized when the total transmit power of an OFDM system is limited. In Section II, we describe the model of the downlink of the multiuser OFDM system with the blockwise adaptive subcarrier allocation algorithm, and formulate the subcarrier allocation problem. The process of this blockwise adaptive subcarrier allocation algorithm is described in Section III. In Section IV, some simulation results are given to show the performance of our allocation algorithm compared with traditional OFDM-FDMA scheme. The conclusion is given in Section V.

II. System Model

The downlink of a multiuser OFDM system with blockwise adaptive allocation algorithm is shown in Fig.1. Let $N$ be the total number of OFDM subcarriers to be assigned...