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Fast Optimal Resource Allocation Possible for Multiuser OFDM-Based Cognitive Radio Networks

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ABSTRACT: A resource allocation is possible for multiuser orthogonal frequency division multiplexing (OFDM) based cognitive radio (CR) networks, where secondary users (SUs) have flexible traffic demands, including heterogeneous services and try to maximize the sum capacity of non-real time (NRT) users and maintain the minimal rate requirements of real time (RT) users. Combinational of real-real and non-real time user's services is called heterogeneous services. The interference introduced to primary users, which is generated by the access of the SUs, should be kept below a predefined threshold, but which makes the optimization task has more complex. The contribution of this work is twofold: First, we show the barrier method to ignore the optimal solution and fairness. Second, we propose an efficient power distribution schemes and fast barrier method. The fast barrier method produces solution close to the optimal with much lower complexity.

KEYWORDS: Cognitive radio, OFDM, optimization, resource allocation.

I.INTRODUCTION

Despite the emerging crisis of spectrum shortage in wireless communication, it is inconsistent that radio spectrum is far from fully utilized due to conventional regulatory policies [1]. Cognitive Radio (CR) is envisioned as a promising paradigm for improving the usage efficiency of radio spectrum [2] [3]. Although radio spectrum has been assigned to primary users (PUs) in a licensed network, CR technology allows secondary users (SUs) in a CR network to sense spectrum environment and dynamically adjust their transmission parameters to access the licensed spectrum in an opportunistic manner, as long as the interference to the PUs is kept below a preset threshold, such as interference temperature level [4]. Since the physical layer of a CR network should be very flexible to meet the requirements of opportunistic access, it necessitates multicarrier methods to operate in CR networks [5] [6]. Owning to the inherent significant advantages of flexibly allocating radio resource [7], Orthogonal Frequency Division Multiplexing (OFDM) is deemed as a promising air interface for CR systems.

In [8], subchannel, bit and power allocation schemes in OFDM systems are developed. The proposed algorithm shows significant advantages compared with other methods. A margin adaptive algorithm is discussed in [9] for real-time services in a multiuser OFDM system. In [10], sum capacity of an OFDM system is maximized by allocating each subchannel to the user with the highest channel gain over this channel and distributing power among subchannels in a water-filling manner. However, fairness is ignored because the user with poor channel condition may be unable to receive any data. An iterative algorithm in dual domain is proposed to find the optimal solution of power distribution. In [11], user's utility is defined as a concave function and a low complexity algorithm is developed, which can work out the optimal solution. However, it is impractical to assume that a user can occupy a non-integer number of OFDM subcarriers. In [12], RA for OFDM based CR network is formulated as a multidimensional knapsack problem, also for single SU case. A greedy heuristic algorithm is proposed, which can produce solution close to the optimal. However, the computational cost would be very high if generalizing it to multiple SUs setting.

In [13], an optimal power distribution algorithm is developed, whose complexity is linear related to the number of subchannels. However, only single SU is considered in [13], which limits their applications in practical wireless networks. In [14], the interference to the PUs is assumed to be yielded in two mechanisms: CR out-of-band emissions and imperfect spectrum sensing. Suboptimal RA algorithms are also developed.

In this paper, we investigate a general spectrum-sharing case for a CR system: The SUs can access the regulated portion of licensed spectrum as long as the interference to the PUs is kept below their tolerable thresholds. The CR system adopts OFDM modulation and operates in a centralized manner, that is, an access point serves all SUs in the CR network, just as a conventional base station does. We do not assume that the licensed system serving the PUs also

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operates in an OFDM manner. We analyze the formulated optimization problem intensively and develop a fast *barrier* method to work out the optimal solution by exploiting its structure and we propose an efficient subchannel allocation and power distributed scheme to achieve a tradeoff between capacity and complexity by jointly considering the signal-to-noise ratios (SNRs) of OFDM subchannels and their interference levels.

II. SUBCHANNEL ALLOCATION SCHEME

We propose an efficient subchannel allocation scheme and an OFDM-based CR system, an OFDM subchannel with high SNR for an SU may also generate more interference to the PUs. That is to say, the water-filling-like method [8] for conventional OFDM systems is no longer suitable for CR scenarios because interference constraint also lays an upper bound of the transmission power for each subchannel. So the SNR of an OFDM subchannel and the interference introduced to the PUs should be jointly considered to measure the capacity of the subchannel.Our our subchannel allocation scheme is consists of two steps. First, we allocate the RT SUs subchannels to meet their minimal rate requirements. Then we allocate the remaining subchannels to the NRT SUs. The principle of our subchannel allocation algorithm for the RT SUs is that the SU whose current rate is the farthest away from the target one has the priority to get a subchannel among the available ones. This procedure continues until all RT SUs'rate requirements are satisfied. Preferably, the subchannel with the highest achievable rate associated with an RT SU will be chosen at this step.

III. OPTIMAL POWER ALLOCATION: FAST BARRIER METHOD

Fast barrier method is followed by barrier method and barrier method is followed by heuristic method. The optimal power allocation is to solve the following optimization problem. Generally, barrier method [15] is treated as a standard technique to solve convex optimization problems with inequality constraints. In the barrier method, the original problem is converted into a sequence of unconstrained minimization problems by introducing a logarithmic barrier function with a given parameter t. Particularly, each unconstrained minimization problem determined by the parameter t can be solved by Newton method, and the solution to this problem is called a central point in the central path related to the original problem. As t increases, the central point will be more and more accurate to approximate the optimal solution of the original problem. The barrier method consists of two stages: centering step and Newton step. The former is the outer iteration to compute the central point, while the Newton step is the inner iteration executed in the centering step. The barrier method is complexity. Since there are always thousands of subchannels in OFDM systems, the computation cost is unacceptable because RA should be processed online. In this section, we propose a fast barrier method to work out the optimal solution by exploiting its special structure. The high computational load is dramatically reduced. For a given number of PUs, the complexity of our proposed fast *barrier* method is approximately linear to the number of subchannels. In this barrier method first to find the feasible point and outer loop for barrier method is find based on centering point will be compute via the newton method so, initialize the newton method and starting point to be calculated additionally inner loop for newton method to be calculated based on backtracking line search method so these are the following method to be followed the optimal power allocation scheme called fast barrier method.

IV. SIMULATED RESULTS

We evaluate our water-filling-like method for subchannel allocation scheme.In this method based on the gamma variation and linearity of all users in this channel. We assume eight users with ten channel model to be taken for these simulated results.

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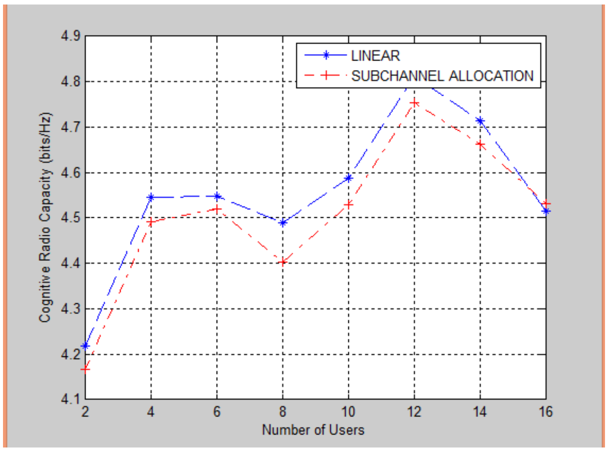

Fig.1: Number of users Vs cognitive radio capacity (bits/Hz). It shows that linearity function of all users in the channel and subchannel allocation is based on linearity function.

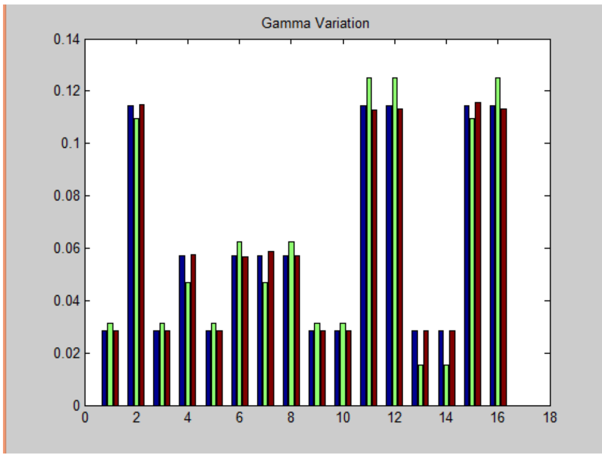

Fig.2: Number of users Vs cognitive radio capacity (bits/Hz).

It shows that subchannel allocation is based on gamma variation and linearity function.

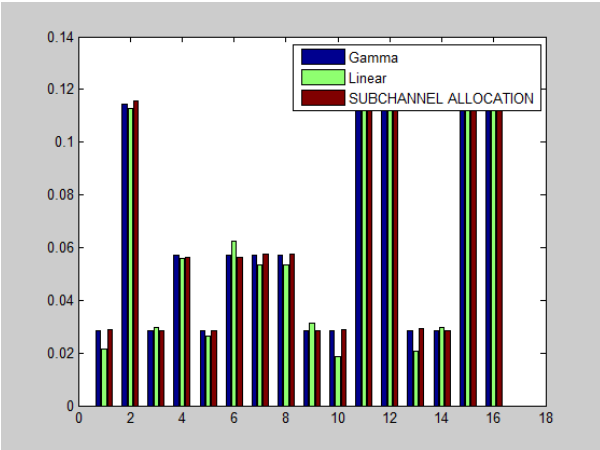

Fig.3: Number of users Vs cognitive radio capacity (bits/Hz).

It shows that subchannel allocation is based on gamma variation and linearity function. Linearity function increases in all users in the channel.

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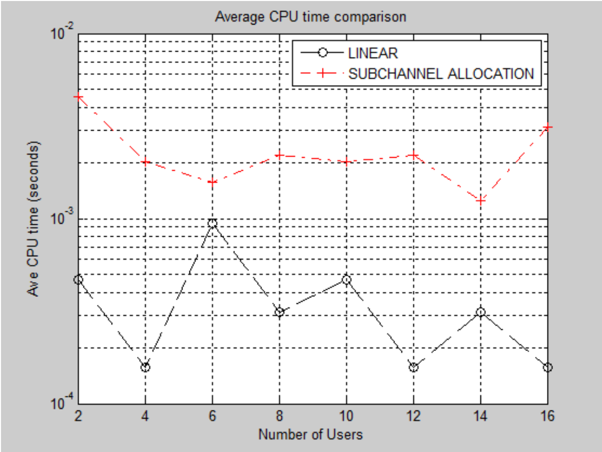

Fig.4: Number of users Vs average CPU time (seconds).

It shows that subchannel allocation is achieved and linearity function gets decreased.

V. CONCLUSION

We conclude the water-filling-like method for subchannel allocation was completed and analysis the results. In future work to propose the fast barrier method for optimal power distribution schemes in fast optimal resource allocation possible for multiuser OFDM-based cognitive radio networks. The solution is close to optimal with much lower complexity and fairness among all users and should be investigated in our future work.

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