IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735
PP 11-17
www.iosrjournals.org

Coordinated Qos Aware User Scheduling And Power Allocation Scheme For Ofdma System

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Abstract: *In recent years many papers have been published for energy-efficient resource allocation in a cellular OFDMA system. In this paper we carried out combined user scheduling and power optimization based on per subcarrier or per base station for each with maximum transmits power in coordinated BS. Here three definitions of the energy efficiency are considered for system design with channel rate and the power level. The resources allocation and power allocation are optimized across a cluster of coordinated base stations with a constraint on the maximum transmit power (either per subcarrier or per base station). And we prove the efficiency of quality of service aware channel allocation gives better performance over conventional packet scheduling for OFDMA users. And the maximization of the energy efficiency is approximately equivalent to the maximization of the spectral efficiency for small values of the maximum transmit power and moderate reduction of the data rate leads a larger saving of energy. Also, the performance gap among the considered QOS aware resource allocation strategies over power level based user scheduling reduces the scope of energy centric OFDMA scheduling methods.*

I. INTRODUCTION

Exploiting renewable energy (e.g. solar energy, wind energy and so on) from the surrounding environment to support wireless transmission data transmission, known as energy harvesting technology, can support the operation of battery powered devices. Intelligently adapting the resource allocation of base stations (BSs) with energy harvesting equipment is a candidate solution to reduce the network energy consumption [1]. However, due to the limited Availability of harvested energy as well as the uncertainty about the timing and the quantity of energy collected, there is a tradeoff between the quality of service (QoS) and the available power budget.Specifically, increasing the active wireless resource enhances the system capacity and users' service experience, but at the same time increases the probability of energy depletion, which will ultimately degrade users' QoS since the wireless resources may have to be powered down. Hence, in energy harvesting systems, wireless resource allocation should be optimized jointly considering the traffic profile, the users' QoS requirement, and the renewable energy statistics. Resource allocation for energy harvesting systems has be extensively studied recently. J. Yang et. al. analyzed the offline optimal power allocation policy in a non-fading channel [2]. In the fading channel, the optimal power allocation is interpreted as the directional water-filling policy[3].The offline analysis is extended to broadcast channel [4], multiple access channel [5] and MIMO channel [6]. However, in practice, the energy arrival profile can not be known in advance due to uncertainty concerning the energy source. Consequently, the offline optimal policy is not applicable in real systems.A practical way is to optimize the resource allocation using statistical information for harvested energy, for instance, the average arrival rate or the statistical distribution. Ref. [7] considers a cross-layer resource allocation problem to maximize the total system utility using a Markov decision process (MDP) approach [8]. The packet dropping and blocking probabilities are analyzed with different sleep and wake-up strategies using queuing theory in sensor/mesh networks with solar power [9]. In [10], it is shown that the wireless link performance is strongly influenced by the renewable energy profile, and parameter adaptation is considered to improve the performance. The closed-form maximum stable throughput is studied and derived in cognitive radio networks [11] and cooperative networks respectively. Nevertheless, most of existing work focuses on link level analysis, while the problem of how to efficiently allocate wireless resources according to the network traffic profile and the harvested energy profile from network point of view still remains open. Based on the measured data, the statistics of the network traffic profile and the harvested energy profile have been studied.

In this paper, we make use of the statistical information for traffic intensity and harvested energy to study the wireless resource allocation problem in cellular networks. A mixed power supply from both renewable energy sources and power grid is adopted, which is considered as a candidate solution to minimize the energy consumption while at the same time guaranteeing users' QoS. Specifically, the reliable grid power guarantees that the service requirement is satisfied, while effective renewable energy allocation policy reduces the grid power consumption. In the literature, power allocation [7], coordinated MIMO [1] and network planning [9] has been studied in the mixed power scenario.

Different from the existing work, we aim to optimize the network operation according to the long-term network information with mixed power supply. Specifically, we consider the grid power minimization problem with users' QoS constraints in a downlink cellular network by adjusting BSs' on-off states and resource blocks allocation, where the BSs are equipped with energy harvesting devices. The preliminary results in single-cell case have been presented in [20]. This paper extensively studies the problem in multi-cell case.

The main contents and contributions are listed as follows:

1. We formulate the problem of average grid power minimization taking into account the user QoS (weighted blocking probability) constraints for a pre-defined time period (e.g. 24 hours),using knowledge of the traffic load profile and the energy harvesting statistics. The blocking probability is analyzed based on Erlang's approximation method [21] jointly considering the BSs' on-off states and the harvested energy profile.
2. The grid power minimization problem is transformed into an unconstrained problem of minimizing a weighted combination of grid power consumption and blocking probability,
   which can be solved by a dynamic programming (DP) approach [8].
3. A two-stage DP algorithm, which determines the BSs' on-off state in the first stage, and then optimizes per-BS resource allocation in the second stage, is proposed to reduce the computational complexity. The performance of the proposed algorithm is evaluated by simulations and compared with the optimal DP algorithm and some heuristic algorithms.

II. RELEATED WORK

Gaurav Bansal *et al*. [10] investigated the optimal power allocation techniques in the OFDM based cognitive radios. The downlink transmission capacity of the system is maximized while keeping the interference to the primary users within the tolerable range. The performance of the optimal and suboptimal schemes is then compared with the classical power loading schemes for example water-filling and uniform power loading algorithms. These results also shows that the suboptimal schemes have certain degradation as compared to optimal schemes but they are far better than the classical power loading algorithms.

Hichan Moon *et al.* [11] see that the water filling power allocation schemes for general fading distributions converges point wise to the functions in which power allocated to all the non-zero channel gains is fixed as the SNR approaches towards infinity. Here the convergence speed for the above scheme is also investigated. Daniel Pérez Palomar *et al.* [12] proposed in MIMO systems power will be allocated to all the channels adaptively when the channel state information is available at the transmitter to achieve the large channel capacity.

The maximum value of the difference between the channel capacity of the conventional water-filling algorithms and non-optical power allocation algorithms is also derived here. Compared with the simple constant power allocation scheme, the constant power water filling scheme achieve more capacity to the system with the reduced complexity.

Wei Yu *et al.* [13] proposed that the resource allocation for the uplink orthogonal frequency division multiple access (OFDMA) networks which coexists with the primary networks will be studied. Here with the objective of maximizing secondary users sum rate we investigate both the joint subcarrier and power allocation approaches in consideration with both the transmit power constraints and the interference of the power limit to the primary users.

After simulation of the above technique we observed that the water-filling algorithm which is based on the above proposed model yields the good performance gains as compared to the classical water-filling algorithm for the single secondary user and the multi PU spectrum sharing case. Gesualdo Scutari *et al.* [14]shows that most of the engineering problems that are also considered as constrained optimization problems mostly result in solution given by the water filling structure, the classical example is the capacity achieving solution for the frequency selective channel. For the water filling solutions with single water level and a single constraint, typically a power constraint, some algorithms are proposed to compute the solutions of these problems numerically, but some of the other optimization problems results in the more complicated water filling solutions with the multiple water levels and the multiple constraints. But it is still be possible to obtain the practical algorithms to evaluate the solutions numerically but only after the inspection of the particular water filling structure's. M. Mishra *et al* [15]shows that we have seen the performance of constant power water filling algorithms for the independent identically distributed faded channels and the inter symbol interference channel where a constant level of power is used for the for a properly chosen subset of channels. The performance analysis shows the upper bound of the maximum achievable rate under the true water filling and the constant power water filling schemes. Here it is shown that for the Rayleigh fading channels the spectral efficiency for the constant power water filling schemes is maximum up to 0.266b/s/Hz. Also the performance bound allow us logarithm free, very low complexity, power adaptation algorithm to be develop.

The worst case here is that after analysis and simulation it is shown that the approximate water filling scheme is very close to the optimum scheme. Raphael Cendrillon *et al.* [16]shows that we have studied the non-cooperative maximization of mutual information in the vector Gaussian interference channel in the fully distributed fashion with the help of game theory. This technique is very much used and studied in the number of works in the last decade for frequency selective channels, and even recently for multiple input multiple output(MIMO) case in which the state of art results are valid for the nonsingular square channel matrices, but these results have some limitation and hence cannot be true for rectangular and rank deficient matrices.

The aim of this paper is to provide complete characteristic of MIMO game theory for the arbitrary channel matrices with the conditions guaranteeing both the uniqueness of convergence of the asynchronous distributed iterative water filling algorithms and the Nash equilibrium.

Here all of our analysis is based on the new technical intermediate results like that of mean value theorem for complex matrix-valued functions, MIMO water filling projection valid for singular matrices and a general contraction theorem for the multiuser MIMO water filling mapping valid for all arbitrary channel matrices. The surprising result of the above technique is that uniqueness or convergence conditions for all the cases of tall channel matrices are more restrictive than those which are required for fat channel matrices.

Here it is also proposed a modified game algorithm with the milder conditions for the uniqueness of the equilibrium and the convergence and same performance in terms of the original game.

III. COORDINATED SCHEDULING AND COORDINATED BEAMFORMING

The idea of CB emerged in the mid-nineties ,mainly targeting a so-called signal-to-interference-plus-noise ratio (SINR) leveling problem [2], in which the power levels and the beam forming coefficients are calculated to achieve some common SINRs in the system or to maximize the minimum SINR. CS is a relatively newer idea. The first studies [3] mainly divide the entire network in clusters and apply centralized scheduling within each cluster in order to determine which TPs in the cluster should transmit in each time slot and to which UE. Later studies jointly use CS/CB as a tool to reduce multi-user and multicell interference. Different approaches jointly combining CS and CB have been studied in LTE-Advanced ,which can be classified by increasing order of complexity and requirements in terms of CSI feedback and CSI sharing. Coordinated beam pattern is a low feedback overhead approach targeting highly loaded cells that consists of coordinating the pre-coders (beamforming matrices) in the cooperating TPs in a pre-defined manner in order to reduce interference variation and enable accurate link adaptation, while avoiding spatial CSI feedback from the UE. Relying on a TP-specific beam pattern in the time and/or frequency domain, the TPs cycle through the fixed set of beams where the cycling period is decided by a central controller and conveyed to the TPs.

Based on reports of the best resources and associated channel quality in each cycling period, the UE can be scheduled in the subframes or subbands where the coordinated beams provide the best channel conditions. Pre-coding matrix indicator (PMI) coordination mitigates the inter-TP interference based on the report of a restricted or recommended PMI, which corresponds to a potential pre-coder at an interfering TP. Assuming that the UE and base stations have knowledge of a codebook composed of quantized pre-coders, PMI restriction and PMI recommendation techniques constrain the interfering TPs to use only those pre-coders that belong to a subset of the codebook in order to enhance cell edge performance. In the case of PMI restriction (or recommendation), the cell edge UE calculates and reports to their serving cell the restricted (or recommended) PMIs, defined as the PMIs that create the highest (or lowest) interference if used as a pre-coder in the interfering TPs. With these techniques, transmitters may be constrained to use a specific quantized PMI in the codebook as the actual pre-coder in a downlink transmission. Interference suppression-based coordinated beam forming refers to a coordinated selection of the transmit pre-coders in each TP that aims at eliminating or reducing the effect of inter-TP interference. Contrary to the PMI coordination, the base stations compute a new transmit filter based on the CSI feedback from the serving and interfering TPs, relying typically on zero-forcing beam forming (ZFBF) or joint leakage suppression (JLS) criteria. While ZFBF filter is designed by forcing the interference from a reference TP to UEs served by other TPs to zero, JLS filter is obtained by maximizing the signal-to-leakageplus-noise ratio (SLNR) of the UE served by the reference TP. Interference-suppression-basedCB provides more design flexibility than PMI coordination, but is more demanding in terms of complexity, CSI accuracy, feedback overhead, backhaul overhead, and scheduling coordination.

A) Joint Transmission

Joint transmission can be broadly described as a simultaneous transmission of data to a UE terminal from multiple cooperating TPs. The transmission could be coherent or non-coherent and aims to improve the overall system throughput or a similar system-wide performance metric. It is particularly helpful to improve cell edge performance by converting an interfering signal to a desired signal. With dense small cell deployments and heterogeneous networks with lowpower nodes, there could be many UE terminals that receive significant signal strength simultaneously from multiple TPs. Furthermore, in RRH deployments, a single BBU controlling multiple TPs can enable very low-latency coordination among them and allow joint scheduler implementations.

A joint scheduler allows resource pooling, by dynamically adapting to short-term channel conditions and different traffic loads experienced across the control area of the BBU. In general, large cluster sizes improve these gains. However, the backhaul constraints in real deployments may limit the cluster size over which joint transmission and scheduling may be performed, or it could also be constrained by the network to simplify scheduler operation. The centralized scheduler can be implemented for each such cluster. Non-coherent JT may use techniques like single-frequency network (SFN) or cyclic delay diversity (CDD) schemes, which target diversity gains and also enable increased transmit power to the UE. On the other hand, coherent transmission could be based on spatial CSI feedback relative to two or more TPs, which can be used to perform MIMO transmissions from the corresponding antennas.

However, better synchronization and much smaller timing error differences between transmission points are needed to realize the full potential gains of cohere nt JT schemes, which may limit their applicability only to TPs connected by a fast backhaul. The information theoretic bounds with ideal CSI predict significant gains with multi-TP coordination schemes [4]. However, the CSI available at the transmitter is often limited by the feedback currently supported on the uplink channels. For 3GPP specifications, the focus has been on enabling linear pre coding techniques at the transmitter, and extensions of codebook based PMI feedback that are currently supported for single-TP MIMO are the most likely candidates for multi-TP feedback. To enable JT, the UE may report a PMI and corresponding channel quality indicator (CQI) with the assumption of JT from a set of aggregated antennas corresponding to the JT TPs. The TPs for JT may be set up semi-statically by the network. On the other hand, using more TPs incurs a network resource cost not known to the UE, since it may depend on dynamic conditions introduced due to traffic load, quality of service (QoS), and fairness at the network level. More flexibility can be achieved if the UE could feedback PMI/CQI corresponding to multiple JT transmission hypothesis. Clearly, there is a tradeoff between flexibility and overhead. One approach is to design codebooks with a hierarchical approach. With this approach, precoding matrix codebook may be used for single TP transmission to derive the PMI/CQI of each TP. For multi-TP joint transmission, JT CQI and PMI can be derived by concatenating each TP's CQI and PMI with inter-TP co-phasing information. More generally, multi-user JT schemes can also be used where the JT PMI received from multiple UE terminals can be used to perform multi-TP ZFBF.

In a typical operation, the centralized scheduler controlling a cluster of TPs obtains the PMI/CQI corresponding to joint transmission hypothesis from UE in the cluster and assigns UE to TPs such that a certain metric (e.g., sum proportional rate) is maximized.

B) Transmission Point Selection (Tps)

In LTE-Advanced, transmission point selection (TPS) is investigated by extending to an orthogonal frequency-division multiplexing (OFDM) system the idea of site selection diversity transmission power control proposed for highspeedHSDPA [5].

With TP selection, the signal to a given UE is transmitted from a single transmission point within the CoMP cooperating set on a certain time-frequency resource. The UE basically reports the index of its preferred TP (e.g. the TP with the highest received SINR) and corresponding CSI, which is subsequently used for transmission.

The selected TP may dynamically change from one subframe, which is the minimum signal transmit time unit equivalent to 1ms, to another subframe via time-frequency domain dynamic scheduling. In addition, if the neighboring TPs remain silent by not transmitting any data, the received SINR of the UE can be further improved.after CS/CB operation due to the imperfect PMI feedback, so this effect also needs to be taken into consideration in performing the interference measurement.

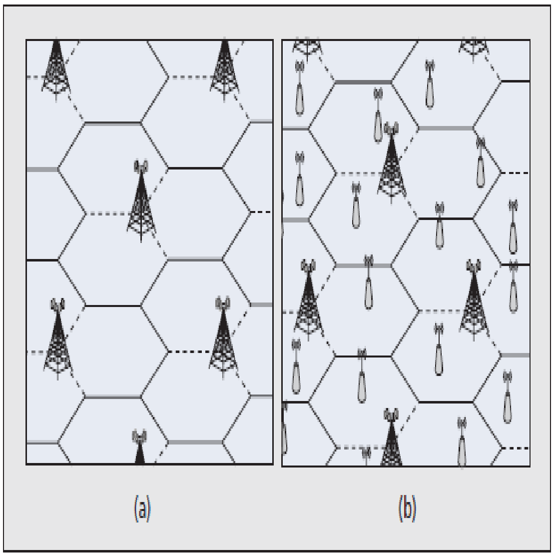
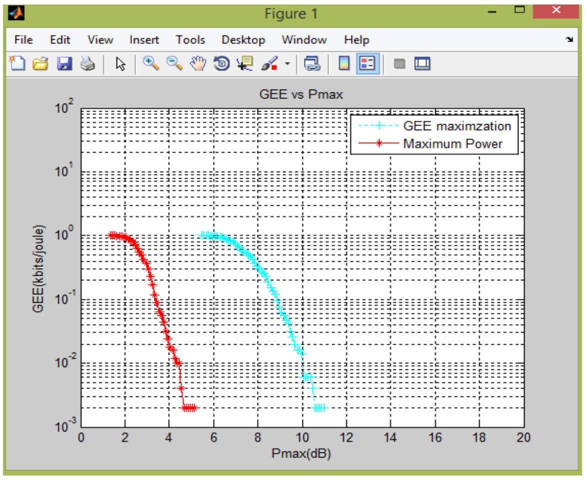


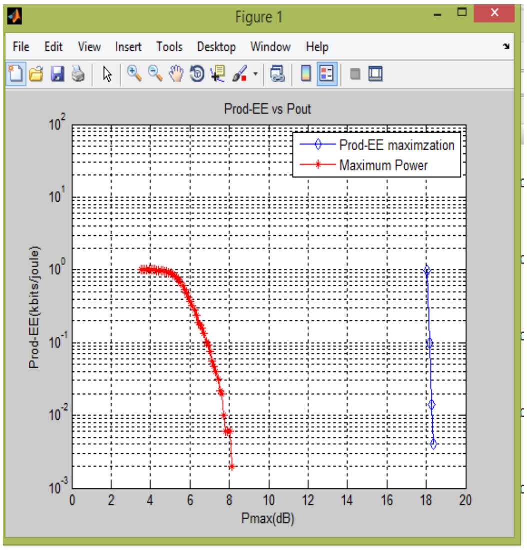
Figure 1. Deployment scenarios under consideration for CoMP technology: a) Homogeneous networks; b) Heterogeneous networks

IV. SOFTWARE IMPLEMENTATION RESULTS

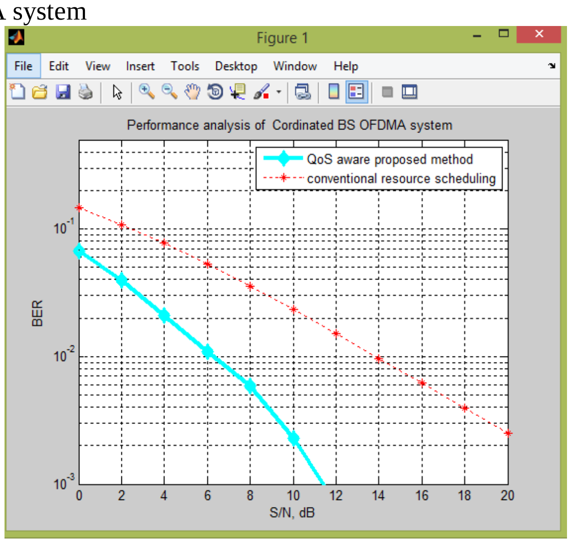
a) GEE vs Pmax



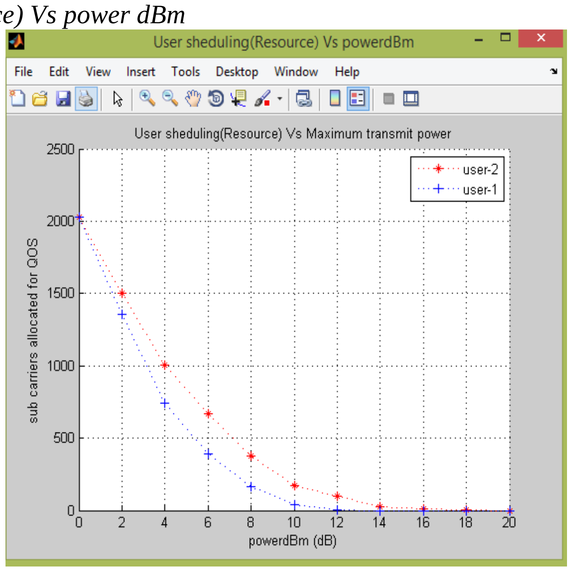
b) Prod-EE vs. Pout



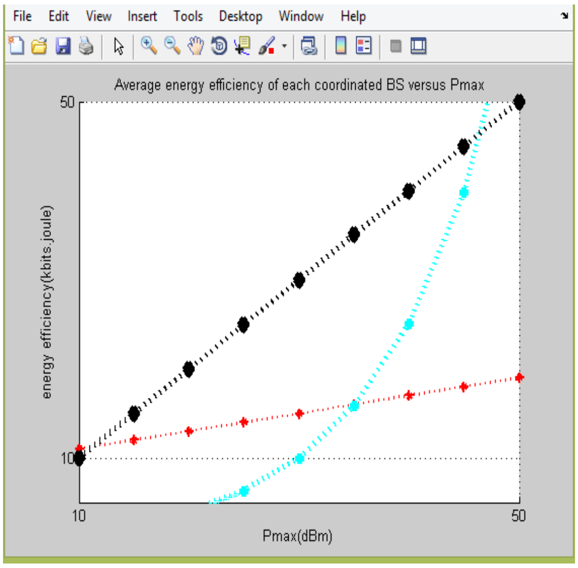
c) Coordinated BS OFDMA system



d) User scheduling(Resource) Vs power dBm



e) BS versus Pmax



V. CONCULSION

In this paper, we have developed a QoS-aware resource allocation scheme for the users with different QoS requirements in relay-based downlink OFDMA system. The proposed Co-RA scheme solves the relay-selection, sub channel-allocation and power-control problem, and aims at maximizing the system sum utility while satisfying the data rate requirements of QoS users. Due to the cooperative transmission between BS and RS, as well as the resource scheduling at both BS and RS, the proposed Co-RA scheme can fully exploit the time, spatial, frequency and multiuser diversity of system, and thus achieving significant performance improvement in terms of power saving, user utilities, system throughput, and the number of admitted users. Consequently, the proposed Co-RA scheme is an efficient resource allocation method for cooperative relay-based downlink OFDM system with heterogeneous services. In the future, it could be an interesting research topic to combine admission control and scheduling with the Co-RA scheme perfectly to further enhance the overall system performance.

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