A Novel OFDMA-Based Multicarrier Rate-and-Power Control Based Energy-Saving System

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ABSTRACT
Hence the proposed suboptimal heuristic algorithms can achieve a close performance to the matching upper bound algorithm. Simulation result shows that the impact of user's excellence of service is small on the energy efficiency when an enormous spectral efficiency is required.In this paper, we survey the energy-efficient resource share problem in a single-cell OFDMA system to achieve the energy competence tradeoff among users. Our main objective of the proposed system is to increase the energy efficiency each and every individual user. The spectral-energy competence trade-off is of primary consequence to determine how much energy per bit is required in a wireless communication system to attain exact spectral effectiveness. The sum-of-ratios optimization method and comprehensive fractional programming are utilized for the weighted sum problem and the maximum-minimum problem, respectively. The Mathematical results demonstrate that the both weighted-sum and the maximum-minimum approaches can effectively resolve the EE maximization problem. To discover its solution, we first change it into two different single-objective optimization troubles using proposed approaches such as weighted-sum and the maximum minimum approach. The single-objective optimization troubles are non-convex due to the combinatorial channel allotment variables. Consequently, for both problems, we first give an upper bound algorithm through soothing the combinatorial variables and then expand a proposed method of suboptimal heuristic algorithm.

Keywords: -Rate-and-Power, Control Based Energy-Saving, OFDMA-Based Multicarrier Base Stations

1. INTRODUCTION

It is well known that the fourth generation base station (BS) has been developed to havethe promising feature of carrier aggregation (CA) [1] jointly utilizing its multiple componentcarriers (CCs) based on respectively corresponding transceivers for transmissions, in order toachieve high total network capacity. The long-term evolution-advanced (LTE-A) BS (refer to[1]–[2] for more details), which has been specified by the third generation partnership project(3GPP), is nowadays a typical representative. Nevertheless, activating a transceiver in such amacro level BS will consume large-scale.Energy consumption [3]. As a result, problems with energy consumption of the access network,especially for those BSs, and the environment impacts on greenhouse gases emissions like thecarbon dioxide (CO2) have become common critical concerns. The role of green communications([see for example [4]–[5]) has therefore become increasingly important. Green communicationsis considered to be a new concept to minimize the total energy consumption in communicationactivities, while maintaining other certain constraints, different from the traditional idea of thepower allocation by setting the objective function to maximize the throughput.Due to the rapid development of DSP and VLSI, wirelesscommunication systems have been explosive enlargement inthe past decades. Next invention wireless networks asexpected to carry huge number of subscribers, while at theequal time deal with the different service necessities of eachuser. Thus OFDMA forms the radio resource share scheme forthe previous method and envisioned networks to hold thegrowing number of users with the restricted spectrum level.OFDMA allows numerous users to transmit concurrently atminor data rates. The obtainable spectrum band is separatedinto a number of sub-channels and each user is provided witha put out of joint set of subcarriers. After the subcarrier shareis determined, the bit and power allocation algorithm can befunctional to each user on its owed subcarriers. The user cansend out his data in the owed subcarriers. A most importantchallenge in OFDMA is for a given number of users andsubcarriers, how to assign a disjoint set of subcarriers amongstthe users. The traditional approaches for the crisis are difficultand NP hard. The energy-saving of mobile devices isbecoming gradually more important due to the quicktemperedgrowth of wireless mobile applications. Since ahuge amount of energy is extremes by data transmission,energy-efficient wireless communications enclose arousedmuch research interest in recent years. On the threehand,OFDMA have been broadly applied in wirelesscommunication systems owing to its high efficiency andstrength against broadband channel desertion. Hence, lots ofwork has been completed to get better the energy efficiency ofusers in the OFDMA system. For the single user case, the Maximization for OFDM systems has been investigate inprevious works, bearing in mind of both circuit and spreadpower consumption. These works have been wide into OFDMA systems, where energy-efficient resource sharingmethods have been developed for both down-link and up-link.In the finest EE has been investigated for a flat-fadingcommunication link by means of rate-dependent circuit powermodel. The energy- and spectral- efficiency tradeoff has beeninvestigated for the up-link matched multipoint systems anddispersed antenna systems. The EE maximization for up-linkusers has been investigating in single-cell OFDMA, multi-cellOFDMA, multi-user multiple-input multiple-output, andcarrier aggregation systems. Normally, maximize on thewhole EE can be formulate as a single-objective optimizationdifficulty. Though, if allowing for entity EE, the EE of eachuser should be optimized concurrently, and then a multiobjectiveoptimization difficulty is formulate in this paper. Inwide-ranging, multi-objective optimization is hard to resolvebecause it has a lot of Pareto optimal solutions. A multiobjectiveoptimization difficulty can be efficiently resolved byconverting into a solo objective optimization problem. In thispaper, we will adopt two different approaches to resolve thedifficulty. The first one is the weighted-sum approach, whichmaximizes the weighted summary of the EEs of each user,and the second one is the max-min approach, whichmaximizes the smallest amount EE among users. Bothapproaches can attain the Pareto optimal solution of the multiobjectivedifficulty. As the channel sharing indicators arebinary variables, the problem becomes a combinatorialoptimization and is tough to resolve. We first slow down thechannel allotment indicators into continuous variables toexpand the upper-bound algorithms. The main dare of EEoptimization is the partial structure in the EE expression

2. RELATED WORK

Basic Assumptions:

Consider the downlink transmission in a single-cell cellular network. A list of all notationsused in this paper for describing the considered model and its analysis is provided in theNomenclature section. In this model, the BS can jointly utilize two CCs that are classified intoprimary CC (PCC) and secondary CC (SCC). The PCC is looked upon as the main CC fortransmissions, while the SCC is thought of as the supplementary CC when the traffic is relatively

Heavy. Assume that the two CCs are consecutively located in the same band and each hasbandwidth B in Hz. The LTE-A frame structure that the scheduling process is executed subframeby subframe is followed. In each subframe, there are J subchannels and two time slots. Theresource block (RB), which consists of seven OFDM symbols in one time slot and 12 subcarriersin one subchannel, is set as the smallest allocation unit.

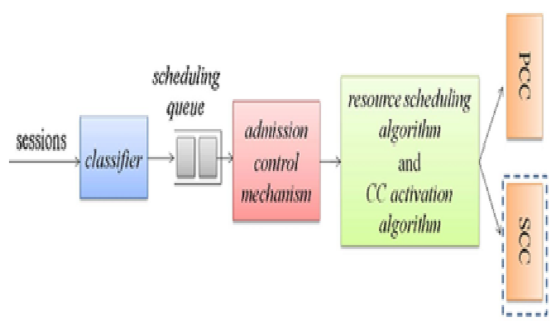

Fig1: system model

The considered system model is conceptually shown in Fig. 1. The session-level transmissionis assumed in the model. Assume that the maximum number of sessions that each CC canaccommodate is constant denoted as S. When a session request arrives, the classifier in thesystem will first classify it into either RT or NRT session, and then it will be forwarded to thescheduling queue. Next, the admission control mechanism is proposed to be used to determinewhether to block the session request in the scheduling queue and further which CC should be assigned to the session if it is allowed to access the network. The mechanism is to assure thesystem not being heavily congested; those allowed sessions aresubsequently through a resource scheduling algorithm and a CC activation algorithm for transmissions,whose details are elaborated in respectively.

Component carrier activation algorithm

Energy Adaptive Rate Control Algorithm (EARCA)

In EARCA, there are three Levels of reduction ratios that can be employed. They areindicated as Level i, i=0,1,2, re-spectively. The reduction ratio represents how much reduction indata rate is enforced for an NRT user when compared with the largest allowed data rate. Anillustration of the reduction ratios of the three Levels are designed to respectively.The natural log function of the Level 1 is designed on the basis of the classic PF [10] criterion,in order to maintain the fairness among users in a certain level. The design approach iselaborated as follows. A large number of NRT users are randomly placed in the cell, and they areallocated RBs based on the PF criterion under the assumption of equal power allocation on eachRB. After a long-term simulation, the NRT users' averaged data rate as a function of their pathloss gains is calculated. Then the natural log function based on the fitting method of minimummean squared error is used. Notice that the natural log function is normalized so that thereduction ratio of the NRT user having the maximum channel gain equals to 1.The operation for determining which Level should be adopted where γ is thelower marginal factor.

Radio Resource Allocation Algorithm (RRAA)

RRAA is designed on the basis of the resource allocation approach employed in [9], for its computational complexity advantage. Pseudo codes for the detailed operation are written in in each decision epoch of every sub frame, the *BAA* sub-algorithm in will be executed first. All wireless users will feedback their channel gains to the BS so that averaged squared channel gains can be calculated as input arguments. Also, the number of required RBs for all the after the execution of BAA, the RBAA sub algorithm in will subsequently be executed. In RBAA, channel gains and the number of every user session' required RBs are used as input arguments. For each RB, the sub algorithm intends to find the user who has the largest channel gain among all the users. After finding the user, check whether the number of the current allocated RBs of the user equals to the number of its required RBs. If yes, set the channel gain of the user equal to 0, and find another user whose channel gain is the largest among all the users till the while loop is over. After the while loop, allocate the RB to the user session picked during this run. Once the two sub algorithms are finished in sequence, every user session's available RBs are determined. Next, the desired data rate of each user session will be distributed equally over its allocated RBs, and the energy for each RB is subsequently determined.

3. IMPLEMENTATION

Clipping and Filtering

This is a simplest technique used for PAPR reduction. Clipping [8] means the amplitude clipping which limits the peak envelope of the input signal to a predetermined value. Clipping causes in-band signal distortion, resulting in Bit Error Rate performance degradation. It also causes out-of-band radiation, which imposes out-of-band interference signals to adjacent channels. This out-of-band radiation can be reduced by filtering. This filtering of the clipped signal leads to the peak regrowth. Thatmeans the signal afterfiltering operation may exceed the clipping level specified for the clipping operation. Sowe came to know that this clipping and filtering technique has some sort of distortionduring the transmission of data.

Partial Transmit Sequence

In the Partial Transmit Sequence (PTS) technique, an input data block of N symbols is partitionedinto disjoint sub blocks. The sub-carriers in each sub-block are weighted by a phase factor forthat sub-block. The phase factors are selected such that the PAPR of the combined signal isminimized. But by using this technique there will be data rate loss.

MIMO

To achieve MIMO from a conventional SISO system, several technologies have been proposed. Beamforming alters the phase of each element in an antenna array to create spatial beamPatterns through constructive and destructive interference.Space-time coding/processing performs antenna diversity with multiple antennas at eithertransmitter or receiver side or both sides, where every antenna element is separated fromits nearest element by around 4 to 10 times the wavelength to keep the signal througheach multi-path independent. The distance between two adjacent antenna elements isrelying on the angular spread of the beam signal.SDMA is a common and typical multiple input multiple output scheme in cellularwireless systems. SDMA is often referred to as simply a MIMO system since the halfport of a SDMA system also consists of multiple users. Although SDMA is indeed aMIMO technique, MIMO is not necessarily SDMA.Spatial multiplexing is performed by multiple antennas equipped at both a transmitter anda receiver front end.

MU-MIMO

Multi-user MIMO can leverage multiple users as spatially distributed transmission resources, at

The cost of somewhat more expensive signal processing. In comparison, conventional, or singleuserMIMO considers only local device multiple antenna dimensions.Multi-user MIMOalgorithms are developed to enhance MIMO systems when the number of users, or connections,

Numbers greater than one (admittedly, a useful concept). Multi-user MIMO can be generalizedinto two categories: MIMO broadcast channels (MIMO BC) and MIMO

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multiple accesschannels (MIMO MAC) for downlink and uplink situations, respectively. Single-user MIMO can

Be represented as point-to-point, pairwise MIMO.

4. SIMULATION RESULTS

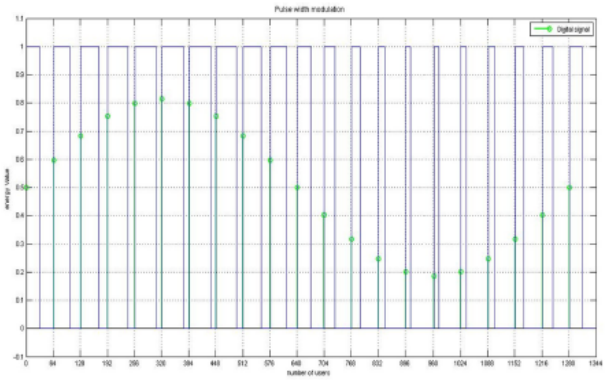

Fig:-2 Parameter SettingsIn the considered cell environment, it is assumed that all users are generated with a spatiallyuniform distribution. The moving speed of every user is assumed slow and set equal to 3 km/h ofuniform distribution in a random direction. The ratio of the number of RT users to the number ofNRT users is set to 1:1. The arrival-session process of users of each type is assumed to be anon-stationary Poisson process

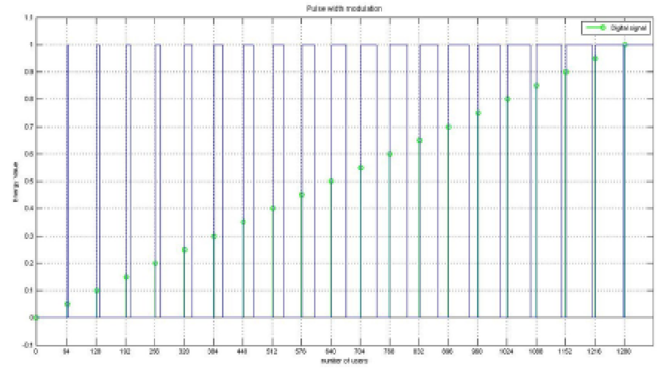

Fig:-3 Energy consumptions of the proposed scheme with different rate control Levels against abaseline design with no energy-saving are shown in respectively. Note that theEnergy consumption is calculated every α period. The baseline scheme is to exclude the CCactivation algorithm regardless of the dynamically fluctuating traffic load.

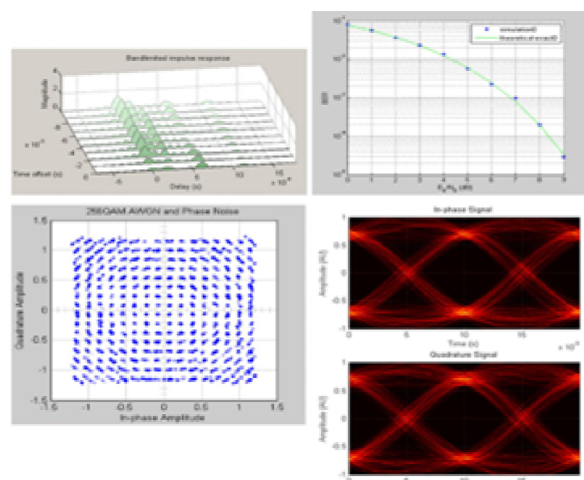

Fig:-4 BER plotsfor visualizing quantitative BER performance of a design candidate,Parameterized by metrics such as SNR and fixed-point word size.

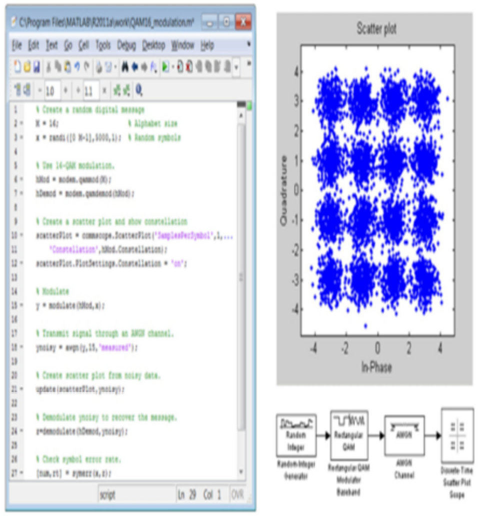

Fig:-5 MATLAB function (left) and Simulink model (right) with scatter plot for 16 QAM simulation.

5. CONCLUSION

In the "Rate-and-Power Control Based Energy-Saving Transmissions in DMABasedMulticarrierBaseStations"a novel energy-saving downlink transmission scheme inOFDMA-based multi-CC network systems was successfully proposed. The proposed schemecould allocate the radio resource with an adaptively rate-and-power control to users and supportan acceptable level of the QoS and the fairness at the same time. Compared with the currentlyexisting works, the proposed one had the great advantage of flexibility to activate/deactivate theSCC according to the dynamically fluctuating traffic load to effectively avoid unnecessarynergy consumption.It was shown from simulation results in Section V that when the CC activation algorithmwas employed, the energy con-sumption could significantly be reduced when the traffic load wasrelativly light. In addition, thanks to the assistance of the resource scheduling algorithm, theenergy could be efficiently utilized. It was thus believed that the presented energy-saving schemewas an excellent approach to be employed in the future multi-CC cellular system at the BS sidefor transmissions to overcome the increasingly crucial problem of the rising energy cost and theCO_2 emission concern.

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