A NOVEL CHUNK-BASED RESOURCE ALLOCATION FOR OFDMA SYSTEMS

P.MONISHA
Assistant Professor
Department of ECE
PARK College of Engineering and Technology

S.BABY RANI
Department of ECE
Kathir College of Engineering

T.THENMOZHI
Assistant Professor
Department of ECE
PARK College of Engineering and Technology

J.R.JUSTILIN
Assistant Professor
Department of ECE
PARK College of Engineering and Technology

Abstract- Orthogonal frequency division multiple access (OFDMA) is becoming a widely deployed mechanism in broadband wireless networks due to its capability to combat the channel impairments and support high data rate. The proposed system considers the Resource allocation and Iterative sub-channel and power allocation scheduling in the downlink of OFDMA networks supporting Distributed network systems. The proposed framework considers the network resources limitations while attempting to improve resources utilization and heterogeneous users' satisfaction of service. The resource allocation problem is formulated by continuous optimization techniques, and an algorithm based on interior point and penalty methods is suggested to solve the problem. The numerical results show that the framework is very efficient in treating the non-convexity problem and the allocation is accurate comparing with the ones obtained by an Iterative power allocation algorithm. The proposed scheme efficiently schedules users by exploiting multiuser diversity gain, OFDMA resource allocation flexibility, and utility fair service discipline.

Keywords— Distributed antenna systems (DASs), energy efficiency (EE), proportional fairness, resource allocation, OFDMA.

I. INTRODUCTION

The distributed antenna system (DAS) has been proposed as a promising candidate for future wireless communication systems due to its advantages of increased capacity, extended coverage, and improved link reliability [1]–[4]. In the DAS, remote access units (RAUs) are geographically separated and are connected to a baseband processing unit via optical fibers. Thus, the DAS can reduce access distance; transmit power, and co channel interference, which can improve system performance, particularly for those mobile stations (MSs) near the edge of a cell. Therefore, DAS techniques have been paid intensive attention in the standardization of the Third-Generation Partnership Project (3GPP) Long-Term Evolution (LTE), LTE Advanced, and IEEE 802.16 Worldwide Interoperability for Microwave Access (WiMAX), where they are also referred to as cooperative multiple point techniques [5]. On the other hand, orthogonal frequency-division multiplexing (OFDM) can effectively combat multipath fading and has been used in or proposed for many of the wireless communication systems, such as the 3GPP LTE-Advanced and WiMAX. In an OFDM system, the maximum sum

Capacity can be achieved by first allocating each subcarrier to the user with high channel gain and then by adjusting the corresponding transmit power through water filling [6].

The surge in demand for methods to transmit large amounts of data over the wireless channel has led to recent interest in orthogonal frequency division multiplexing (OFDM). The time dispersive and frequency-selective nature of the wireless channel causes inter-symbol interference (ISI) and signal degradation (due to fading) which are serious impediments in wireless communications. OFDM combats frequency-selectivity fading, by dividing the channel into subcarriers much narrower than the channel coherence bandwidth. This reduces a frequency-selective fading channel into a set of flat fading subcarriers, multiple measurement studies, [3] have validated the existence of frequency diversity in practice. The current implementations as specified by the IEEE standards for such systems do not include schemes for adaptively assigning powers to subcarriers based on CSI (Channel State Information); instead, these systems evenly distribute the total transmission power budget across all subcarriers. However, at a receiver, since each sub-carrier typically experiences a different fade the transmission rates that can be supported by the different sub-carriers can differ. Figure 1, shows such a scenario where different subcarriers show a difference in SNR of up to 12dB on a single link.

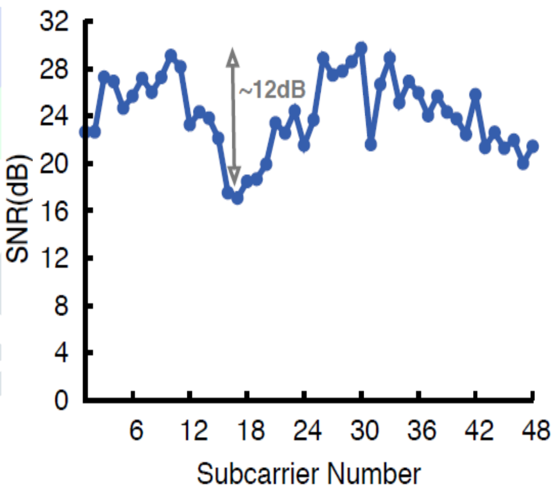

Fig. 1. Frequency selective fading across 20 MHz of spectrum

The Orthogonal Frequency Division Multiple Access (OFDMA) is a promising multiple access technique for next-generation wireless communications because of its high spectral efficiency and inherent robustness against frequency-selective fading. In the emerging OFDMA-based standards such as 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) and IEEE 802.16j, the multi-hop relay concept has been introduced to provide ubiquitous high-data-rate coverage. IEEE 802.16j was approved and published by IEEE in 2009 as an amendment to IEEE Std 802.16.

1.1 OFDMA Network Architecture

To consider an OFDMA relay-enhanced cellular network with a Base Station (BS), multiple Relay Stations (RSs), and multiple Mobile Stations (MSs) or users shown in Figure 2.1.

Let k ∈ {0, 1, ..., K} denote the index of the BS or a RS, and k = 0 for the BS. The notation k also represents one of the total (K + 1) downlink paths for every user, k = 0 for the direct transmission path whereas k ∈ {1, ..., K} for the relaying path through the k^{th} RS. m ∈ {1, ..., *M*} is the index of a user.

All nodes including the Base Stations, Remote Stations and Mobile Stations work in the half-duplex mode thus they cannot transmit and receive simultaneously. We do not consider the full-duplex radios since they are hard to implement due to the dynamic range of incoming and outgoing signals and the bulk of ferroelectric components like circulators. In the downlink direction, users can receive data directly from the BS or via a RS. We call a user communicating directly with a Base Station a single-hop user, and a user alternatively receives data via a Remote Station a two-hop user. Two-hop relaying has been proven to give the highest system throughput, and when the number of hops is larger than three, the system overhead for exchanging control messages uses a great amount of resources.

Cooperative selection diversity, which dynamically selects the best transmission scheme between direct transmission and decode-and-forward relaying, is used in the network to achieve the multiuser diversity. Among the four representative cooperative relaying schemes which is shown in Figure 2, cooperative selection diversity has been proven to be the most promising one in terms of throughput and implementation complexity since no signal combing is needed in Mobile Stations (MSs).

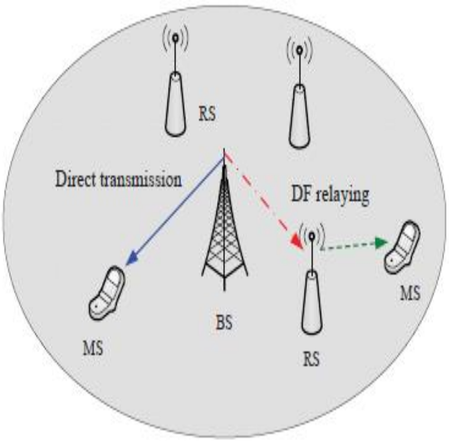

Fig. 2. The architecture of OFDMA relay-enhanced cellular networks

II. OPTIMAL ENERGY-EFFICIENT RESOURCE ALLOCATION IN OFDM

The first formulate the instantaneous optimal resource allocation into an optimization problem which can achieve proportional fairness in the long-term. Proportional fairness provides a reasonable function to trade the total system throughput with users' fairness. The problem is a NP-hard combination optimization problem with non-linear constraints. To reduce the computational complexity on solving the problem, we assume a constant uniform power allocation to linearize the problem, and then use an iterative power allocation method to fulfill any unoccupied resource caused by unbalanced data rates on the two hops of a relaying path. Combining the constant power allocation and sub-channel allocation, we propose a low-complex resource allocation algorithm named Iterative power allocation. The proposed architecture diagram is shown in Figure 3.

2.1 SUBCARRIER ALLOCATION

Sub-carrier allocation is determined at the base-station as a function of the perceived signal strength of each user on each sub-carrier as well as the user requested rate. In the uplink environment, after the allocation is conveyed to the user (we assume the implicit presence of such a mechanism.

A subcarrier is one telecommunication signal carrier that is carried on top of another carrier so that effectively two signals are carried at the same time. A subcarrier is a separate analog or digital signal carried on a main radio transmission, which carries the extra information such as the voice or data. More technically, which is an already-modulated signal, which is modulated into another signal of higher frequency and bandwidth. This is an early and simple method of multiplexing. The first step of the algorithm initializes all the variables. R_k keeps track of the capacity for each user and N is the set of yet unallocated subcarriers. The second step assigns to each user the unallocated subcarrier that has the maximum gain for that user. The advantage is gained by the users that are able to choose their best subcarrier earlier than others, particularly for the case of two or more users having the same subcarrier as their best. The third step proceeds to assign subcarriers to each user according to the greedy policy that the user that needs a subcarrier most in each iteration gets to choose the best subcarrier for it. The fourth step assigns the remaining unassigned subcarriers to the best users for them, wherein each user can get at most one of the unassigned subcarrier. This is used to prevent the user with the best gains to get the rest of the subcarriers. This policy balances achieving proportional fairness while increasing overall capacity.

2.2 POWER ALLOCATION USING GRADIENT ALGORITHM

The first steps are a subcarrier allocation for each user, reduces the resource allocation problem to an optimal power allocation. The Power allocation across subcarriers per user gives the total power P_k for each user *k*, which are then used in this final step to perform sub-gradient power allocation across the subcarriers for each user. The Mobile Stations and the subcarriers have been determined for each RAU, we have the following energy-efficient optimization:

$$\underset{p}{MAX}\ \eta EE = \frac{1}{N}\frac{\sum_{K=1}^{k}\sum_{n\epsilon\Omega m} log_2(1+p_{k,n,m}H_{k,n,m})}{\frac{1}{\tau}\sum_{K=1}^{k}\sum_{n\epsilon\Omega m} p_{k,n,m}+P_c+MP_o)} \quad (1)$$

where *K* is number of users size; *p* is probability of large scale fading; *m* represents mobile channels; P_o is gradient power allocation. For each RAU, assign the overall power $p_{max}m$ for the selected subcarriers and MSs to maximize the *EE* while enforcing proportional fairness using the sub-gradient algorithm.

2.3 ITERATIVE SUB-CHANNEL AND POWER ALLOCATION

In conventional OFDM systems, given the sum transmit power constraint or the target rate, the optimal power allocation that aims at maximizing the sum rate or minimizing the required power can be achieved by the well-known water-filling algorithm. In OFDM-based distributed systems, the power allocation should also satisfy the sub-channel transmit power constraints which are introduced by the interference power limits of the PUs. Therefore, the power allocation algorithm needs to be modified. The following steps to modeled the iterative sub-channel and power allocation,

- The iterative algorithm that jointly allocates sub-channels and powers in an OFDMA based mixed network.
- The Iterative Bit and Power Allocation (IB&PA) algorithm is for the bit and power optimization. We denote the power required for transmitting m_c, i bits as $P(m_c, i)$ for a specified BER.
- The two power allocation solutions can be different, their corresponding sub-channel assignments ρ[t+1] and ρ∗[t+1] in the next iteration t+1 can also be different; and so are their corresponding final joint sub-channel and power allocation solutions.
- The iterative method with a globally optimal power allocation would outperform that with any local power optimization, the proof of such is unavailable. What can be proven is that these joint solutions both give some local maxima. Nevertheless, it should be mentioned that the successive convex approximation (SCA) approach often empirically achieves the globally optimal power allocation in algorithm 1.

Algorithm 1: Iterative Sub-channel and Power Allocation

Step 1: Initialize: t := 1
Step 2: Compute p[0] = vec(p*0, 0N,….,0N) according to Subcarrier.
Step 3: repeat
Step 4: For a fixed p[t−1], find optimal subchannel assignment ρ[t].
Step 5: For a fixed ρ[t], find optimal power allocation p[t] by Solving with the SCA approach, i.e., solving a series of subproblems(Prob-tp) in [by AGM approximation], or in [by logarithmic approximation], or in [by D.C. approximation].
Step 6: Set t := t+ 1.
Step 7: until Convergence of p and ρ

III. RELATED WORKS

Some of the recent research works related to OFDM based resource and power allocation is discussed as follows.

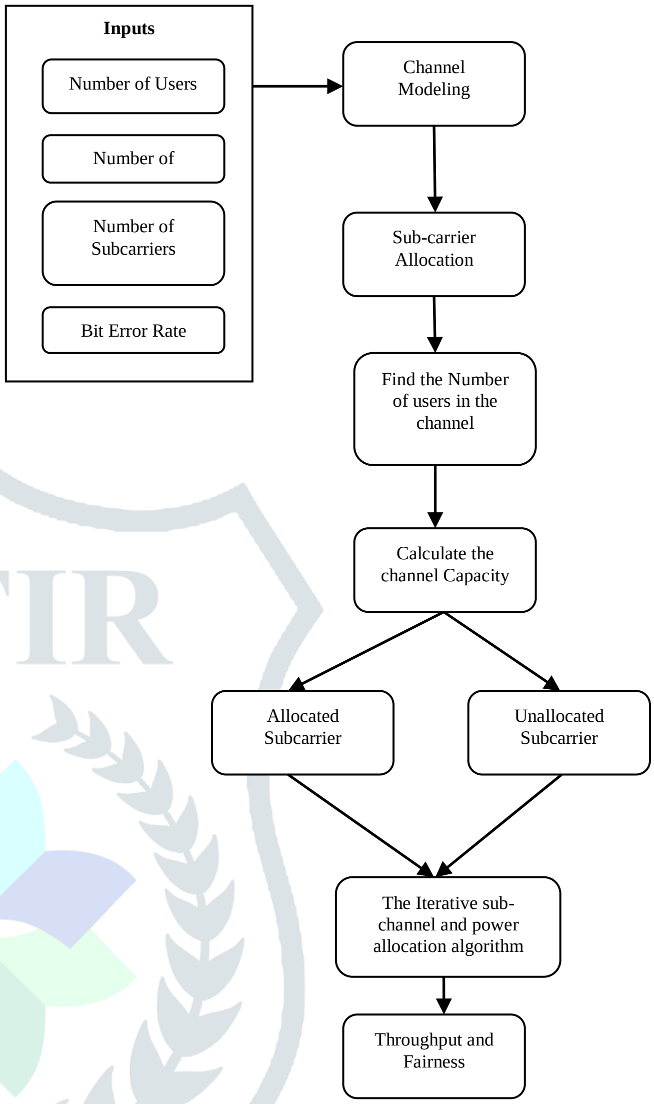

Fig. 3. Proposed Architecture Model

X.-H. You *et al.* [1] have proposed the conceptual description of a cooperative DAS for mobile communications is presented together with key techniques for DASs, including distributed multiple- input multiple-output for single and multiple users, handover, and transmit power allocation. H.-L. Zhu, [2] presented the average spectrum efficiency and the cell edge spectrum efficiency between the two cellular systems in the downlink transmission. In order to achieve high spectrum efficiency, frequency reuse and/or spatial diversity are exploited in these two systems. H.-L. Zhu, S. Karachontzitis, and D. Toumpakaris, [3] discussed t he chunk-based resource allocation approach is first introduced for single-antenna base stations with the consideration of guaranteeing an average bit error rate constraint per chunk and is compared to subcarrier-based allocation. H. Kim *et al.* [4] a transmission selection scheme based on the derived expressions which does not require channel state information at the transmitter. The average bit error rate is overcome this channel state. X.-H. You *et al.* [5] discussed the cell edge effects of traditional cellular systems and distributed cellular systems are evaluated and compared in environments with or without inter-cell interference (ICI). Z.-K. Shen *et al.* [6] discussed a set of proportional fairness constraints is imposed to assure that each user can achieve a required data rate, as in a system with quality of service guarantees. G.-W. Miao *et al.* [7] presented a Energy-efficient design requires a cross layer approach as power consumption is affected by all aspects of system design, ranging from silicon to applications.

IV. SIMULATION & RESULTS

The proposed energy-efficient resource-allocation scheme is evaluated via OFDMA simulations. In our simulation, the number of RAUs $M = 10$; $K=8$ and subcarriers $N = 64$. Noise power σ2z is − 104 dBm, and the maximum power p_{max} n is 36 dBm. Cell radius R is 1 km, and the system BER requirement is 0.001.

The power utilized in a sensor network is consumed as sensors are performing sensing, processing and communication tasks. Due to the limited energy nature of the sensor nodes, network lifetime is dependent on the efficient use of this energy. The primary comparison measurement when looking at the efficiency of a given algorithm is the network lifetime. The Table 1 shows the simulation parameters.

Table 1: Simulation Parameters

Simulation Parameters	**Existing System Values**	**Proposed System Values**
No of Users	16	8
Number of channels	16	10
Initial Power	1	1
Time sample	20000000	1000000
Bit Error Rate	$1e^{-11}$	$1e^{-3}$
Subcarriers	128	64

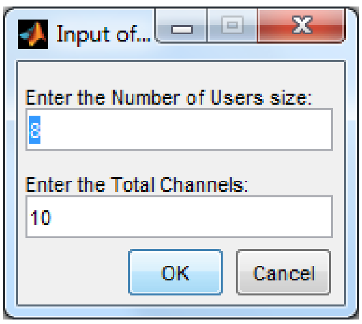

Fig. 4. Input values to the users

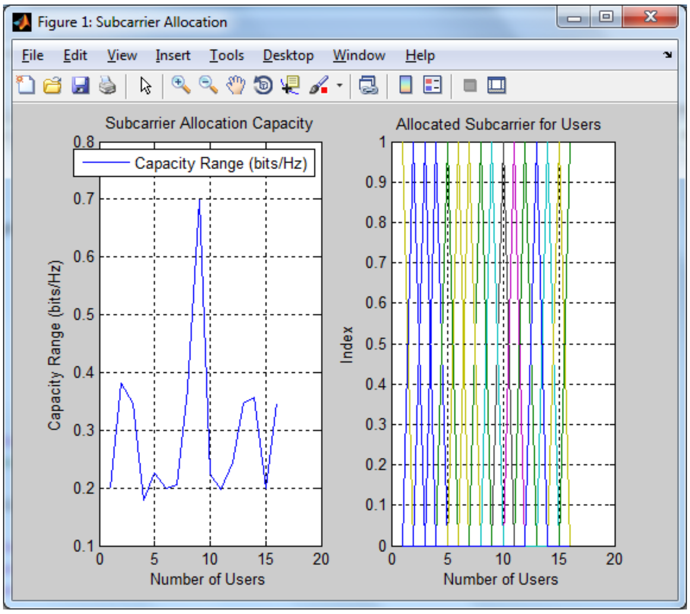

Fig. 5. Achievable rate of the users with Subcarrier allocation

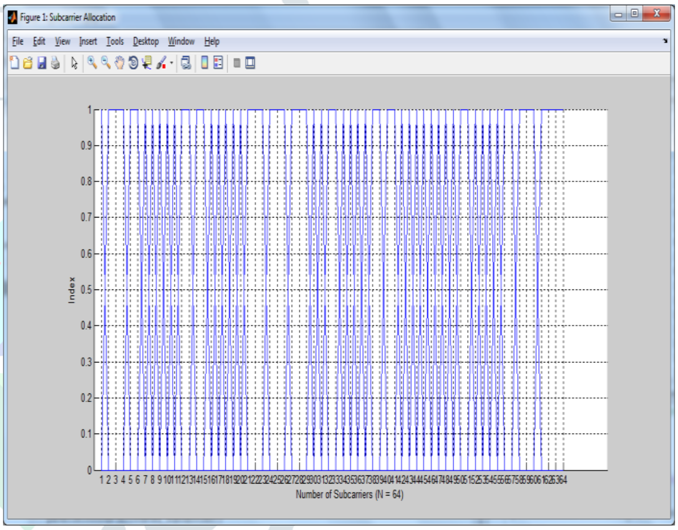

Fig. 6. Subcarrier Allocation to Individual Users

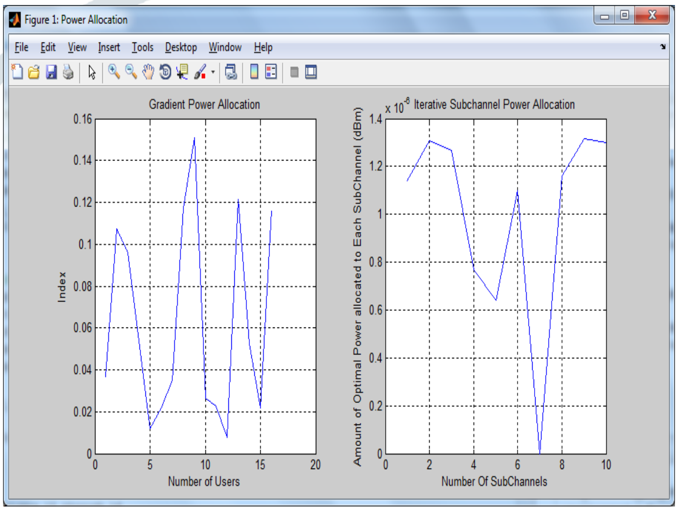

Fig. 7. Effect of Power Allocation of the proposed system

V. CONCLUSION

The proposed system has considered an optimal resource allocation and power allocation problem for OFDM-based distributed networks which is a non-linear problem with integer variables. We proposed a technique that iteratively computes the optimal solution with the help of a commercial integer program solver. An iterative power algorithm for the joint allocation of sub-channels and power allocation in the downlink of an OFDMA-based distributed antennas system. It improves on the previous work in this area of sub-gradient power allocation by developing a novel Energy Efficiency Iterative subcarrier allocation and Power allocation scheme that achieves approximate rate proportionality while maximizing the total capacity. This scheme was also able to exploit the special linear case, thus allowing the optimal power allocation to be performed using a direct algorithm with a much lower complexity versus an iterative algorithm.

REFERENCES

[1] X.-H. You, D.-M. Wang, B. Sheng, X.-Q. Gao, X.-S. Zhao, and M. Chen, "Cooperative distributed antenna systems for mobile communications," IEEE Wireless Commun., vol. 17, no. 3, pp. 35–43, Jun. 2010.

[2] H.-L. Zhu, "Performance comparison between distributed antenna and microcellular systems," IEEE J. Sel. Areas Commun., vol. 29, no. 6, pp. 1151–1163, Jun. 2011.

[3] H.-L. Zhu, S. Karachontzitis, and D. Toumpakaris, "Low-complexity resource allocation and its application to distributed antenna systems," IEEE Wireless Commun., vol. 17, no. 3, pp. 44–50, Jun. 2010.

[4] H. Kim, S.-R. Lee, K.-J. Lee, and I. Lee, "Transmission schemes based on sum rate analysis in distributed antenna systems," IEEE Trans. Wireless Commun., vol. 11, no. 3, pp. 1201–1209, Mar. 2012.

[5] X.-H. You, D.-M.Wang, P.-C. Zhu, and B. Sheng, "Cell edge performance of cellular mobile systems," IEEE J. Sel. Areas Commun., vol. 29, no. 6, pp. 1139–1150, Jun. 2011.

[6] Z.-K. Shen, J. Andrews, and B. Evans, "Adaptive resource allocation in multiuser OFDM systems with proportional rate constraints," IEEE Trans. Wireless Commun., vol. 4, no. 6, pp. 2726–2737, Nov. 2005.

[7] G.-W. Miao, N. Himayat, G. Y. Li, and A. Swami, "Cross-layer optimization for energy-efficient wireless communications: A survey," J. Wireless Commun. Mobile Comput., vol. 9, no. 4, pp. 529–542, Apr. 2009.

[8] C.-L. He, B. Sheng, P.-C. Zhu, X.-H. You, and G. Y. Li, "Energy- and spectral-efficiency tradeoff for distributed antenna systems with proportional fairness," IEEE J. Sel. Areas Commun., vol. 31, no. 5, pp. 894–902, May 2013.

[9] D.-Q. Feng, C.-Z. Jiang, G. Lim, L. Cimini, G. Feng, and G. Y. Li, "A survey of energy-efficient wireless communications," IEEE Commun. Surveys Tuts., vol. 15, no. 1, pp. 167–178, 1st Quart., 2012.

[10] S. Althunibat and F. Granelli, "On the reduction of power loss caused by imperfect spectrum sensing in OFDMA-based cognitive radio access," in Proc. IEEE GLOBECOM, 2012, pp. 3383–3387.