Indian Journal of Science and Technology, *Vol 8(S3), 24–27, February 2015*
*ISSN (Print) : 0974-6846*
*ISSN (Online) : 0974-5645*
DOI: 10.17485/ijst/2015/v8iS3/62296

# Optimization of Radio Resource Allocation in Energy Efficient OFDMA Systems

**M. Vadivel***

Department of ETCE, Sathyabama University, Chennai-119, India; drmvadivel79@gmail.com

## Abstract

**Background/Objectives:** Proficient usage of available spectrum and energy are playing an essential role in case of wire communication as well as wireless Communications with necessitate of high data rate and superior quality. To enhance energy efficiency and spectral efficiency in OFDMA systems through effective allocation of radio resources. **Methods/Statistical Analysis:** Optimization problem is formulated to minimize the power consumption and maximize the energy efficiency. **By using the proposed algorithms which include Adaptive sub-carrier allocation algorithm, sub-**channel assignment algorithm and Transmit Power allocation algorithm, it is possible to increase energy efficiency and spectral efficiency with reduced bit error rate. **Results/Conclusion:** The parameters and its value used for simulation result of proposed system are given in the form of table. The proposed optimized algorithm can achieve higher energy efficiency by considering total power, cell radius, number of users and average channel gain to noise ratio.

**Keywords:** BER, CNR, Energy Efficiency, Quality of Service, RBS, Spectral Efficiency

## 1. Introduction

Efficient usage of radio resources is necessary for future generation of wireless communication[1] systems to provide high data rate in a safe and trustworthy way. Due to the limitation of radio resources, energy efficient operation is becoming a serious issue in most of the wireless communication systems.

Wireless communications will consume much more energy due to the huge exploitation of advanced mobile communication 3G systems and 4G systems. As a result, energy efficient system should be designed to reduce energy consumption in both academic as well as and industrial world. Day to day advancement in wireless communication tends to increase the demand for high data rates which consumes more energy. Energy efficiency plays an important role in wireless communication networks. Spectral efficiency[2] also considered while designing wireless communication networks. The subsequent parameters transmit power[3], fairness among users and channel gain to noise ratio (CNR) are considered to effectively utilize energy efficiency. Quality of Service (QoS) plays an important role in wireless networks to minimize energy consumption[4]. It is used to maximize energy efficiency.

Based on this proposed system model, there is a feasibility to comprise a circulated[5] protocol which improves the spectrum efficiency of the system also proportional fairness among the throughputs of clients. Effective problem is formulated to minimize the power consumption[6] and maximize the energy efficiency. Majority of the papers focuses on Radio Base Station (RBS) which use major portion of energy. Also there is a possibility to reduce the consumption of energy in communication equipment by improving the spectral efficiency of wireless networks.

## 2. System Model of Downlink OFDMA System

In case of wireless communication systems, Spectral efficiency and Energy efficiency[7] are having an essential role. So optimization of Radio Resource Allocation[8,9] in Energy Efficient OFDMA Systems[10] is necessary to support the need of high data rate as well as energy efficiency.

**Author for correspondence*

The system model of downlink OFDMA system is shown in Figure 1. It has N number of subcarriers, K number of Mobile stations (MS's) and M number of Base stations (BS's). Each base station is connected with another base station through optical fiber cable. Let us assume that channel state information is known to both transmitter and receiver.

# 3. Proposed Algorithms

## 3.1 Adaptive Sub-Carrier Allocation Algorithm

The main objective of Adaptive sub-carrier allocation algorithm is to reduce transmission power as well as interference from BS to the MS's in nearby cells. There are three stages in sub-carrier allocation algorithm[11]. According to the Channel State Information from each user, the number of sub-carriers assigned to each user is determined. Then sub-carriers allocation is done by using the proposed algorithm. Based on the subcarrier allocation information bits to be loaded into each user. BER requirement criteria also taken into account.

The number of each subcarrier n to be assigned to each user k is given by

$$S_{k,n} = \frac{N}{\sum_{n=1}^{N} R_{k,n}}$$

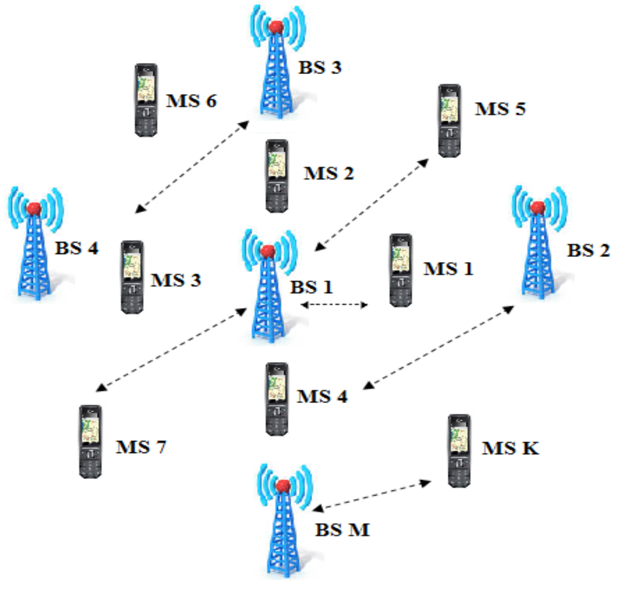


**Figure 1.** System model of downlink OFDMA system.

Total data rate of $n^{th}$ subcarrier of $k^{th}$ user is also given by

$$R_{k,n} = \sum_{n=1}^{N} \frac{B}{N} \log_2\left(1 + p_{k,n} H_{k,n}\right)$$

Where

B = Total Bandwidth

$p_{k,n}$ = power allocated to the $n^{th}$ subcarrier of $k^{th}$ user

$H_{k,n}$ = channel to noise ratio of the $n^{th}$ subcarrier of $k^{th}$ user

## 3.2 Subchannel Assignment Algorithm

Energy Efficiency of each user in any system is directly proportional to its channel gain. So subchannel assignment also plays a major role. The subchannel assignment algorithm assigns the subchannels with high channel-to-noise ratio for each user. A particular subchannel is selected by the user who is having the lowest proportional capacity.

## 3.3 Transmit Power Allocation Algorithm

After the allocation of subcarriers and subchannels to the users, it is possible to allocate the transmit power for the allocated subcarriers to maximize the capacity. Transmit power allocated to the $n^{th}$ subcarrier of $k^{th}$ user is given by

$$p_{k,n} = P_{total} \sum_{n=1}^{N} h_{k,n}^2$$

Where

$P_{total}$ =Total transmit power

$h_{k,n}$ = channel gain of $n^{th}$ subcarrier of $k^{th}$ user

# 4. Simulation Results and Discussions

Simulation of downlink OFDMA system for proposed system can be done by using MATLAB 2010 software. Parameters used for simulation is given in Table 1.

Simulation result obtained for Number of Mobile Station $V_s$ Energy Efficiency for the downlink OFDMA system with proportional fairness is shown in Figure 2.

Simulation result obtained for maximum power $P_{max}$ $V_s$ Spectral Efficiency for the downlink OFDMA system with proportional fairness is shown in Figure 3.

**Table 1.** Simulation parameters of downlink OFDMA system

| S.No. | Simulation Parameters | Value |
|---|---|---|
| 1 | Total Number of subcarriers | 256 |
| 2 | Total Number of users | 32 |
| 3 | Bit Error Rate | 1e-5 |
| 4 | Maximum power | 50dBm |
| 5 | Range of Cell radius | 1500m |
| 6 | Bandwidth | 1MHz |

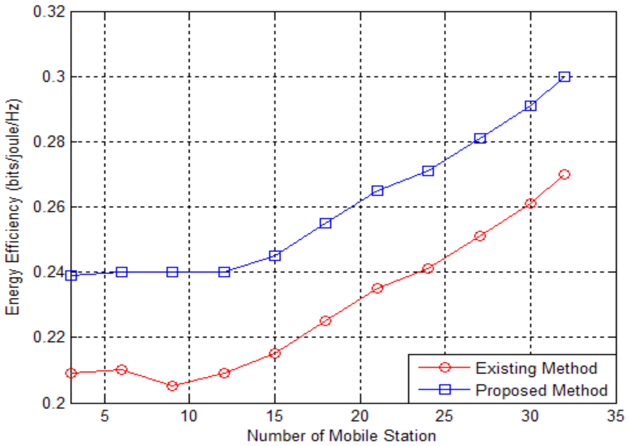


**Figure 2.** Number of Mobile Station $V_s$ Energy Efficiency.

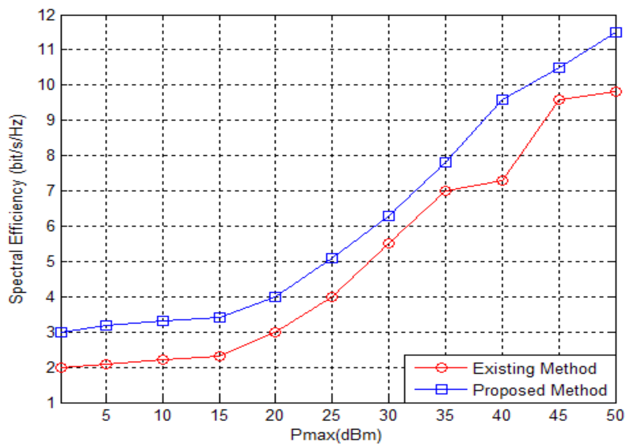


**Figure 3.** $P_{max}$ $V_s$ Spectral Efficiency.

Similarly the simulation results obtained for Cell Radius $V_s$ Energy Efficiency, Average Channel gain to Noise Ratio $V_s$ Energy Efficiency and SNR $V_s$ BER for the downlink OFDMA system with proportional fairness is shown in Figure 4, 5 and 6.

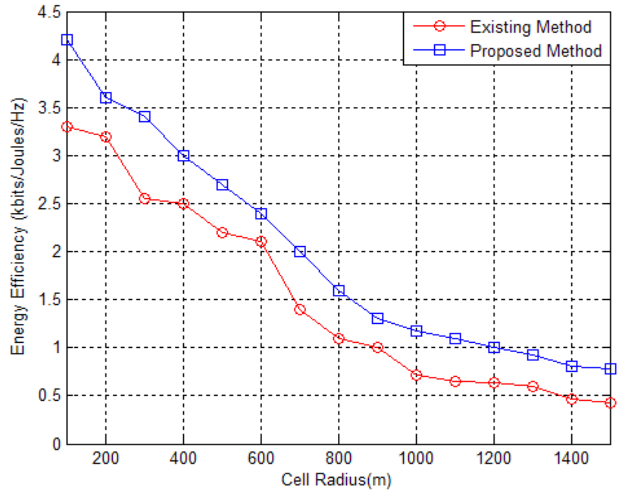


**Figure 4.** Cell Radius $V_s$ Energy Efficiency.

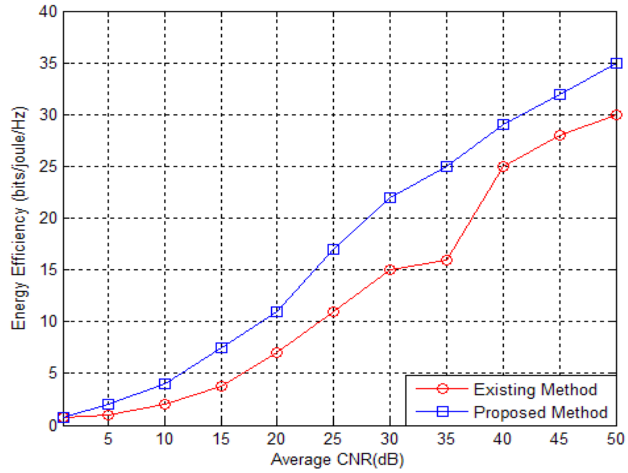


**Figure 5.** Average CNR $V_s$ Energy Efficiency.

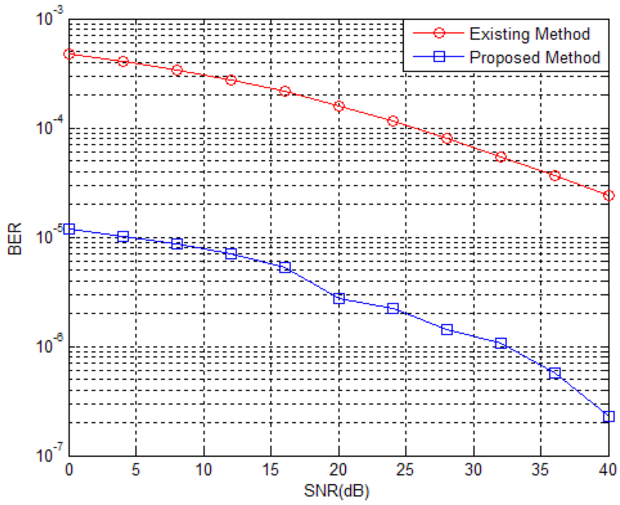


**Figure 6.** SNR $V_s$ BER.

## 5. Conclusion

The optimal energy efficient radio resource allocation methods were studied for the downlink OFDMA system that can be examined with proportional fairness. The proposed optimized algorithm have achieved higher spectral efficiency and energy efficiency compared to exiting algorithms by considering the number of parameters such as the number of mobile station, total transmit power, range of cell radius and average channel gain to noise ratio through the simulation results.

## 6. References

1. Hoshyar R, Akbari A, Tafazolli R. Energy efficient resource allocation in wireless OFDMA systems. IEEE International Symposium on Personal, Indoor and Mobile Radio Communications; 2010. p. 1731–5.
2. Nanthini SB, Hemalatha M, Manivannan D, Devasena L. Attacks in Cognitive Radio Networks (CRN) - A Survey. Indian Journal of Science and Technology. 2014 Apr; 7(4):530–6.
3. Naeem M, Illanko K, Anpalagan A. Frequency and power allocation for energy efficient OFDMA systems with proportional rate constraints. IEEE Wireless Communicatons letters. 2014; 3(3):313–6.
4. Lo SE, Ng DWK, Schober R. Wireless information and power transfer: energy efficiency optimization in OFDMA systems. IEEE Transactions on Wireless Communications. 2013; 12(12):6352–70.
5. Li GY, He C, Zheng F-C, You X. Energy-efficient resource allocation in OFDM systems with distributed antennas. IEEE Transactions on Vehicular Technology. 2014; 63(3):1223–31.
6. Ermolova NY, Makarevitch B. Low complexity adaptive power and subcarrier allocation for OFDMA. IEEE Transactions on Wireless Communications. 2007; 6(2):433–7.
7. Radha V, Vadivel M. Performance analysis of energy efficient power allocation for secure OFDMA based cognitive radio networks. IJAREEE. 2013 Mar; 2(3):1039–44.
8. Xiong C, Li GY, Zhang S, Chen Y, Xu S. Energy-efficient resource allocation in OFDMA networks. Conference on Proceedings of 2011 IEEE Global Communications; 2011 Dec. p. 1–5.
9. Yu Q, Wu G, Tang Q, Li S. Low-complexity energy-efficient resource allocation in OFDMA networks. International Conference on Wireless Communications & Signal Processing; 2012 Oct. p. 1–5.
10. Wu F, Mao Y, Huang X, Leng S. Low-complexity optimal energy-efficient resource allocation in downlink OFDMA networks. 2012 Conference on International Computational Problem-Solving; 2012 Oct. p. 46–51.
11. Haider F, Wang C-X, Haas H, Ge X. Energy-efficient subcarrier-and-bit allocation in multi-user OFDMA systems. 75th Conference on IEEE Vehicular Technology; 2012 May; p. 1–5.