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Research paper

Power Efficient Resource Allocation of OFDMA Wireless Network

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Abstract

Multihop cellular network have drawn great attention for the future generation cellular network because of it through put and coverage. But still there are few problems facing by MCN's are interference and frequency resources which leads to traffic congestion and lack in QOS. Thus paper introduces the heuristic algorithm which provides a good Quality of Service (QoS) and reduced interference compared to the existing techniques. Power allocation of cell-edge users is optimized through radio resources. Simulation result shows the through-put achieved for cell-edge and cell-centre users using power allocation.

Keywords: *Multihop cellular Network, Mobile station, relay station, co-channel interference, OFDMA, load Balancing.*

1. Introduction

Orthogonal frequency division multiple access plays a very important role in the future generation wireless technology to get very high data rate with secured throughput over the network. Orthogonal Frequency Division Multiplexing (OFDM) is a multiplexing technique in which large data has been divided into smaller data and then transmitted through the transmitting antenna. Then transmitted along with sub-carrier which are modulated with amplitude modulation in the same bandwidth. But in general, wireless cellular Networks are multi user N/W's, When the radio resource were limited to bandwidth and number of channels. As some radio resource is limited to some frequencies are reused among the users. Due to which interference may rise at the cell edge users with the adjacent cell users. Due to this, OFDMA technology is in need with the improved radio resource management (RRM) techniques. But in multi-cell scenario, inter-cell interference(ICI) play's a major issue as resource schemes have to use single frequency reuse pattern, which increases the inter channel interference at cell boundaries, this in turn reduces the overall throughput of the system. To find better solution for this is either to develop the best sub carriers allocates schemes or by power allocation to improve the through put. This paper deals with the power allocation to improve the system through put.

2. System Model

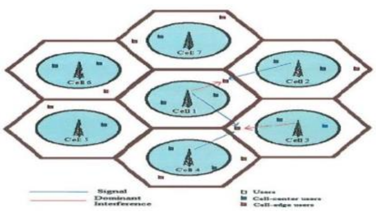

Fig 1: Seven-cell Hexagonal model

A multi-cell OFDMA down link network is considered in this paper as shown in Fig.1. Here we consider 7 cells in which the cells are equipped with a base station at the centre. The antenna at the BS server the users randomly in the all. In long term evolution (FTE) standard, the smallest radio resource unit is traffic bearer. This transports the data b/w each transmission time and is known as physical Resource Block (PRB).In OFDMA the time resources and frequency resources is divided into plots and subcarriers respectively. These PRB consists both frequency and time resources, where it requires only 0.5 more of each slot duration to transmit 12 consecutive subcarriers.

2.1 Power Allocation

Here we considered 43 DBM power for the total transmission in each cell. After PRB allocation, the power is allowed separately for each active PRB. The transmission power must be equal to sum of overall allocated power is particular cell. The occurring ICI is the interference from the adjacent cells. In addition with this there is a chance of inter channel interference from at most 2 preceding cells at the corner of cell between three cell boundaries.

3. Proposed Power Allocation Scheme

The main aim of our work is to increase the power of cell-edge users, without affecting the functions of cell-center users. To make the power distribution process more understandable, the power distribution to the cell can be divided into two parts. They are power for cell edge and cell-center users.

To specify clearly let P_E^j and P_C^j be power of cell-edge and cell-center user's for jth cell respectively and $P_E^j + P_C^j = P_{max}$ which is same for all cells. To reduce the large distance path users, the cell edge users must have high power with respect to cell-center users.

B_E^j and B_C^j be the number of PRB, for cell-edge and cell-center which is proportional to power of their respectively

$$\frac{P_C^j}{P_E^j} = \alpha \frac{|B_C^j|}{|B_E^j|}$$

$$P_E^j + P_C^j = P_{max}$$

Where, α is the proportionality constant, the higher weight to the cell-edge users is indicated by the above equation with (0< α<1). We can find the values of B_E^j and B_C^j from the PRB allocation in the radio resource allocation. i.e., $|B_C^j|+|B_E^j|$=N, N is the total number of PRBs and $|B_C^j| \cap |B_E^j| = \emptyset$.

3.1 Cell-centre Users Power Allocation

Compared to cell-edge users, the cell-centre users are less suffered to interference. Because of this we are considering to maximize the performance of cell-edge users. And optimization is not required for the cell-centre users because of less interference. Total power distribution for cell-centre users is expresses as, $p_{\bar{m}n}^{j(c)} = P_C^j / B_C^{j^*}$. The power is distributed only if any PRB is allocated to the particular user i.e. $a_{\bar{m}n}^j$=1. Therefore $p_{\bar{m}n}^{j(c)}$=$p_n^{j(c)}$, $\bar{m}$ is omitted. There should be a condition that the performance or the throughput of cell-centre users should not decrease by the power allocation of cell-edge users.

3.2 Cell-edge User Power Allocation

The cell-centre users, power allocation and PRB allocation are considered. The optimization problems is as follows.

Intra-cell Interference

$$\sum_{m=1}^{M_c^j} R_m^j \geq R_t, \forall j \in J$$

Where, R_m^j denotes the data rate fo user 'm' in the cell 'j', R_t denotes throughput condition of cell-centre user and M_c^j denotes the number of cell-centre users. The equation states the occurrence of intra-cell interference when throughput of cell-centre user greater than or equal to the data rate or throughput of the particular user 'm' in the cell 'j'.

$$\sum_{m=1}^{M_c^j} \sum_{n=1}^{N} P_{mn}^j = P_{max}, \forall j \in J$$

$$M_E^j + M_c^j = M^j$$

Where, M_E^j is the number of cell-edge users, M_c^j is the number of cell-centre users, M^j is the total number of users in the cell 'j'. P_{mn}^j is the individual power.

$$\sum_{m=1}^{M_c^j} a_{mn}^j = 1, \forall j \in J, \forall n \in \{1, 2, ... N\}$$

When a_{mn}^j=1, means there is Inter-cell Interference. To its best, for getting the better performance, we should get the desired data rates for different users in cell rather than collecting together from geographical locations. For the above optimization problems, the equation is subjected to convex function of power of cell edge users. An example of a convex function, consider a curve in as shown in the figure 2.

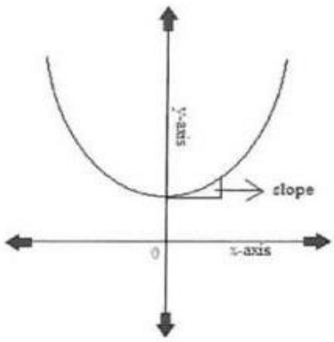

Fig 2: an example of a curve

The equation to the convex curve in the fig 2 is $f(x) = x^2 + 2x + 1$

First derivative of the curve f(x) is,

$$\frac{d\,f(x)}{dx} = 2x + 2$$

Second derivative of the curve f(x) is,

$$\frac{d^2 f(x)}{d^2 x} = 2$$

If the second of the curve is positive, then 'x' is a minimum value or if it is negative, then 'x' is a maximum value.

In this optimization problem, R is the throughput

$$f(x) = R = BW \,.\, \log_2(1 + SINR)$$

The equation is based on power,

$$f(p) = R(p) = BW \,.\, \log_2[1 + SINR(p)]$$

$$f_{ij}(p_{ij}) = \log_2[\, 1 + \frac{p_n^{j(e)} h_n^j}{\sum_{j^* \in s_n^j} p_n^{j^*} h_n^j + N_0} \,]$$

In the above equation, h_n^j is the channel impact (gain and path loss), N_0 is the noise

$$h_n^j = g_n^{(j \to m)} L(d^{(j \to m)})$$

The conditions to maximize (max R(p)) the equation is $\sum p^e \leq p_{max}$, this means the power of cell-edge users should be less than the transmission Power and $R_c \geq R_{th}$, the throughput of cell-centre users should be greater than or equal to the threshold throughput, in other words there shouldn't be harm to the throughput or data rate of cell-centre users when the power is maximized to cell-edge users..

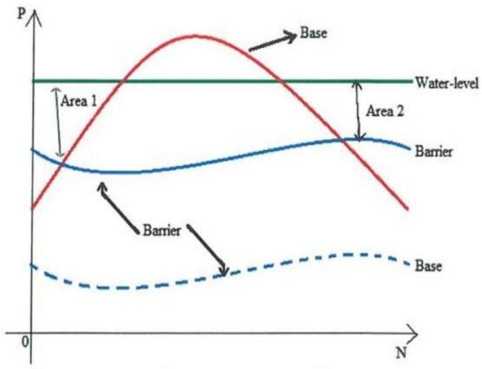

Fig 3: a barrier constrained water-filling process graph

Each Base station knows the level of power allocation to the cell-centre users of the adjacent cells. Fig 3. Shows the Barrier-constrained water falling process which helps to allocate the power to cell-edge users. By the fig 3, the allocated power is decided by the area 1 & 2. The area 1 and 2 is below the water level and above from both base and barrier. If the base or barrier is above the water level, then the power is allocated as '0'.

4. Performance Analysis

To appraise the performance of the proposed strategy for the OFDMA network, a system-level simulator. The analysis consists of the configuration, parameters included and simulation results.

A. System Configuration:

To reduce the computational complexity, a 7-cell network topology is considered. The middle cell is taken as reference due to two reasons i.e., centre cell is entirely covered by other cells in the network and may suffer severely from Inter-cell Interference (ICI) and the second reasons that, the centre cell accurately reflects the performance of other cells in the Large-scale network.

Constraint	Significance
Number of cells	7
Cell radius	1 km
Bandwidth	5 MHz

Carrier frequency	2 GHz
Cell-edge area ratio	1/3 of the total cell area
Total number of PRBs	24
Frequency spacing of a PRB	180 kHz
Total Transmission Power per cell	43 dBm
LOS path loss model	103.4+24.2log$_{10}$(d) dB, d in km
NLOS path loss model	131.1+42.8log$_{10}$(d) dB, d in km
Shadowing standard deviation	8dB
Channel model	Rayleigh multipath model
Thermal noise	-174 dBm/Hz

B. System Analysis

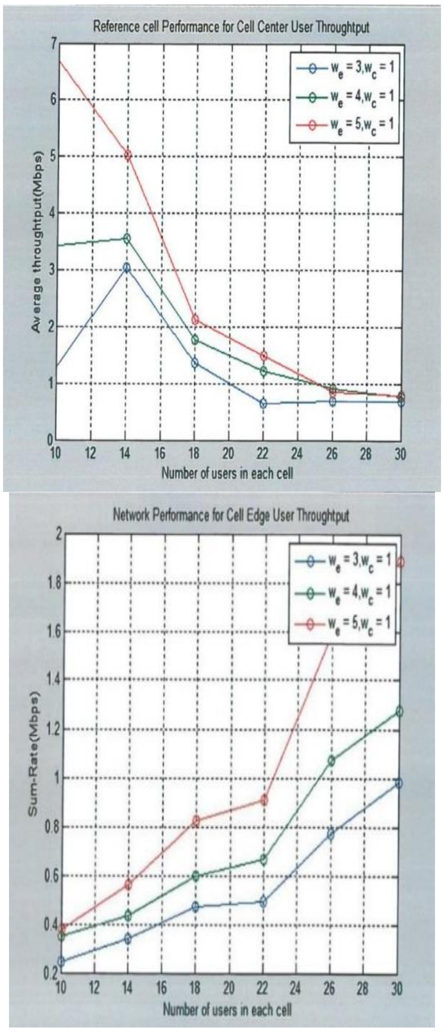

Fig 4: Average throughput achieved by different schemes in the reference cell under various number of users.

The fig.4 shows the performance of the cell-centre and cell-edge users in the particular reference cell. From the simulation result, we can notice that as the number of users' increases, the performance reduces due to the over load in particular cell. Here cell-centre users will have the weightage value (w_c) is equal to 1.

From the simulation, we can conclude three types of results depending the weightage values of cell-edge users (w_e) are 3, 4 & 5and also can be seen that the throughput of cell-centre users is not decreased even when the weightage of the cell-edge is increased in the particular reference cell. Therefore, cell-edge users in the particular cell will also have good performance. The red line, green line & blue line in the simulation is the throughput of the cell-centre user in the particular reference cell when w_c=1 and w_e=5, 4 & 3 respectively.

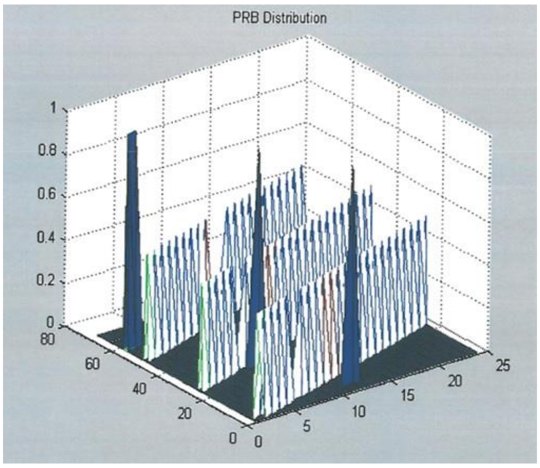

Fig 5: Simulation - IX

The simulation-IX represents the power allocation and PRB distribution. This is a 3-D plot, where x-axis represents the number of PRBs (24), y-axis represents the number of users (70), z-axis represents the normalized power which is shown in Fig 5.. The blue shaded thick lines represent the weightage power to the cell-edge users and the other lines represent the average power to the cell-center users.

5. Conclusion

The effort is to gain the fair throughput of the cell-edge users because, the cell-edge users are heavily suffer from the Inter-cell Interference (ICI) compared to the cell-centre users. The radio resource allocation scheme is combination of radio resource and power allocation. Based on the results of radio resource, power allocation is implemented. The power allocation can be done by using barrier constrained water filling process. In the power allocation is mainly focused on the cell-edge users. The power is allocated to the cell-edge users, in such way that the throughput of the cell-centre users should not change. The entire performance of the OFDMA network can be conferrer from the simulation results. The conclusion is that any user from anywhere can provide the data without any interference and great helpful to the future wireless network.

Reference

[1] S. S. Saravana Kumar, K. Umapathy "Efficient implementation of Downlink Resource Allocation in Wireless Networks with Inter-Cell Interference", JARDCS Vol. 9. Sp-14 pp. 2297-2312, 2017.

[2] Yiwei Yu, ErykDutkiewicz and Xiaojing Huang, "Downlink Resource Allocation for Next Generation Wireless Networks with Inter-Cell Interference", IEEE Transactions of Wireless Communiaction, Vol.12, No.4, April 2013.

[3] Ronald Y. Chang, Zhifeng Tao, Jinyun Zhang and C.C.jay Kuo, "Dynamic Fractional frequency reuse (D-FFR) for multicell OFDMA networks using a graph framework", IEEE Transactions of Vehicular Technology, Vol. 58, No. 7, September 2009.

[4] Gary Boudreau, John Panicker, NingGuo, Rui Chang, Neng Wang, and Sophie Vrzic and Notel, "Interference Coordination and Cancellation for 4G Networks", April 2009

[5] Guocong Song, Student Member, IEEE and Ye (Geoffrey) Li, Senior Member, "Cross-Layer Optimization for OFDM Wireless Networks—Part I: Theoretical Framework", IEEE, March 2009.

[6] MahmudurRahman, Halim Yanikomeroglu, and William Wong, "Interference Avoidance with Dynamic Inter-Cell Coordination for Downlink LTE System", 2008.

[7] KibeomSeong, Mehdi Mohseni, and John M. Cioffi, "optimal Resource Allocation for OFDMA Downlink Systems", July 2006.

[8] Jiho Jang, Student Member, IEEE, and Kwang Bok Lee, "Transmit Power Adaptation for Multiuser OFDM Systems", IEEE, February 2003.

[9] H. Liu and G. Li,"Downlink radio resource allocation for multi-cel OFDMA system," IEEE Trans. Wireless Communication., Volume 5, no. 12, pp. 3451-3459, 2006.
[10] Z. Tao, C. C. J. Kuo, R. Y. Chang and J. Zhang, "A graph approach to dynamic fractional frequency reuse (FFR) in multi-cell OFDMA networks," in Porc. 2009 IEEE International Conference on Communications, pp. 1-6.
[11] Xuehong Mao, Amine MaareXuehong Mao, Amine Maaref, Koon HooTeof and Koon HooTeo, "Adaptive Soft Frequency Reuse for Inter-Cell Inteference Coordination in SC-FDMA Based 3GPP LTE Uplinks", December 2008.
[12] Y. Yu, M. Mueck, E. Dutkiewicz and X. Huang, "Load Distribution aware soft frequency reuse for inter-cell interference mitigation and throughput maximization in LTE networks," June 2011.
[13] B. Ma, L. Cai, Z. Yang, and T. A. Gulliver, "Power allocation and scheduling for broadband wireless networks considering mutual interference," in Proc. 2011 IEEE International Conference on Communications, pp. 1–5.