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Resource Allocation for Multi-Cell OFDMA Based Downlink Network

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Abstract

This paper presents best method for management of resource allocation to OFDMA (Orthogonal Frequency Division Multiplexing) based multi cells which are subjected to Inter Cell Interference (ICI) from adjacent cells. This paper implements allocation of resources that is frequency allocation and power allocation separately to provide quality of signals and compatible power to cell edge users. So to achieve frequency allocation Low-complexity heuristic algorithms are first proposed. To mitigate Inter Cell Interference (ICI) graph-based framework and fine physical resource block (PRB) assignment are performed and hence improve the network performance. After having frequency allocation then we will have a good allocation scheme for power distribution which is distributive to optimize the performance of cell edge users under the condition that desirable performance for cell-center users must be maintained. Then Lagrange method is used to solve iterative barrier-constrained water-filling problem which is formulated by power optimization. Finally from simulation results our proposed scheme can achieve significantly balanced performance improvement between cell-edge and cell center users in multi-cell networks compared with other schemes, and therefore by adopting this scheme for resource allocation we can provide good performance to anyone from anywhere.

Keywords: OFDMA, Interference management, resource allocation.

Introduction

Next generation wireless networks target at ubiquitous high data rates, efficient resource (e.g., spectrum and power) usage and economical network deployment. Given the fact that radio spectrum is becoming a costliest resource in wireless communications, the orthogonal frequency division multiple access (OFDMA) has been proposed as a state-of-the-art air interface technology to enable high spectrum efficiency and to combat frequency-selective fading. Due to its reliable features, OFDMA is adopted in many emerging cellular systems such as the Long Term Evolution or LTE and IEEE 802.16m for achieving those ambitious objectives of next generation networks.

In order to realize the efficient usage of radio resources, OFDMA poses a new challenge for radio resource management or RRM. A good RRM scheme with subcarrier allocation, scheduling and power control is crucial to guarantee the high system performance for OFDMA-based networks. Traditional design of RRM, most published work concentrate on the single-cell case where resources are allocated to deliver a local performance optimization with respective to a single cell. In future wireless networks, however cells placed adjacently allocated with same frequency bands which impose interference. This made the study of RRM for multi cell systems. In multi cell context the ICI plays a major role which should be mitigated since the preferred frequency reuse-1is accepted as next generation OFDMA based deployment for modern cellular networks. Due to the similar spectral usage in adjacent cells, ICI can result in severe performance degradation to users of reuse-1 OFDMA systems, particularly those at the cell edge of network. Thus, developing RRM for multi cell schemes with an emphasis on ICI reduction in the multi cell scenario is of significant interest to recent research work.

The RRM scheme with ICI aware networks, in general, this can be formulated as global performance optimization problem by considering the signal-to-interference-and noise ratio (SINR) instead of the signal-to-noise ratio (SNR).But finding the optimal the solution for such an problem is extremely hard and normally not applicable in practice. It is because the problem has been known as a mixed integer programming (MIP) and proven to be NP-hard, that is computationally impossible to find the

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solution that is prohibitive to tackle [10], [11]. So to understand this work it has been analyzed different perspectives and then divided into two categories as system model and problem formulation. Different simulation results demonstrates that proposed schemes can provide significant performance improvement for both cell edge and cell-center users compared with existing schemes. It is also shown that substantial fairness can be further addressed by the proposed schemes in terms of achieving balanced performance between cell-edge and cell-center users in the cellular network with efficient usage of radio resources.

Materials and Methods

The existing frequency allocation for cells is Fixed Channel Allocation (FCA) which is used in current multiple access schemes such as TDMA and FDMA based systems. In the case of multi cell networks co-channel interference from nearby cells that reusing the same channel is very high. One of the ways to avoid such interference is using Spread Spectrum technique .Spread spectrum technique helps out from interference but efficiency is very less. So in order to have a good RRM scheme for multi cell a new method is imposed. So to overcome all this we go for OFDMA with frequency allocation in such a way that interference is nullified.

A multi-cell OFDMA-based downlink network is considered in this paper. One example of the network with seven hexagonal cells is displayed in Fig. 1, where a Base station with unidirectional antenna is placed at the centre of the cell to serve the users within a cell. In OFDMA systems, the frequency resource is divided into subcarriers or small frequency bands while the time resource is divided into time slots. Traffic Bearer is the smallest radio resource unit that can be allocated to transport data in each transmission time. As specified in the LTE standard, a physical resource block is the traffic bearer, which consists of twelve consecutive subcarriers in the frequency domain and one slot duration that is 0.5 msec in the time domain [24]. In other words, the PRB is a group of subcarriers that can be coherently allocated to users in a given time. For understanding purpose we will use the term PRB to represent the single unit of radio resource for allocation in the OFDMA-based network. In addition, the following fundamental assumptions are made in this paper.

The users within a cell are either classified as cell centre or cell edge users. The users within the circle are called cell centre and users outside the circle are called cell edge users. The circle can be varied which is one of the design parameter. The geographic location information can be reported to the BS by users periodically via the uplink control channels. The base station is at centre of the cell with Omni directional antenna.

^In every transmission time interval or TTI, A decision has to be made by each BS on PRB resource assignment to its served users. One time slot of PRB is the duration of TTI. We also assume that BSs can have perfect knowledge of channel state information which is updated periodically via feedback channels for every TTI.

^The transmission power associated with each of the PRB is dependent on the geographical location of the user that is whether user is inside or outside the circle. If the user is away from centre then integer multiplicative is used in the dynamic power allocation scheme. But the sum of the overall allocated power in each cell cannot exceed the maximum transmission power of the BS.

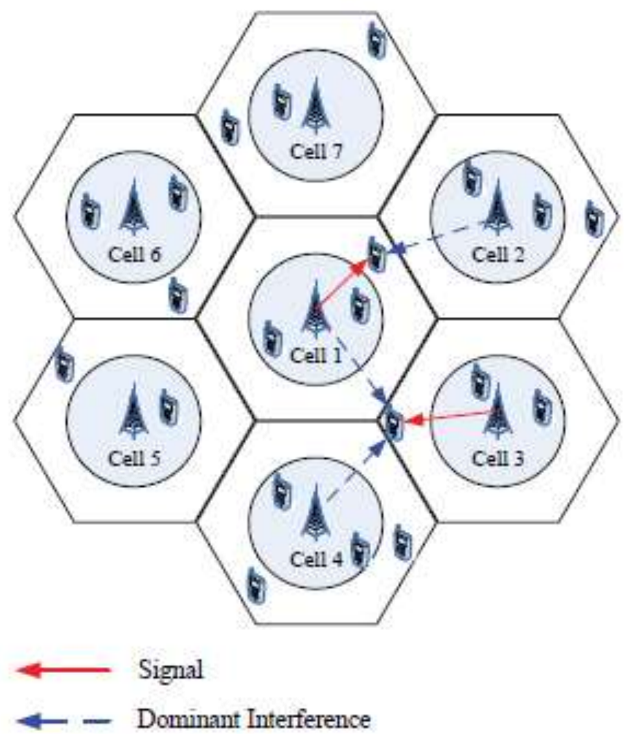

Fig.1. An example of LTE network with Interference

We assume that all Base Stations in the network are given the same maximum transmission power. Resource allocation goal is to maximize the overall throughput of cell-edge users while maintaining the required throughput for cell-center users which are within the circle. So as a result, a balanced performance improvement between cell edge and cell-center users is maintained in multi-cell

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systems. This is because cell-center users usually do not suffer from heavy Interference and relatively high performance is easy to be obtained for these users even in a network without optimization work, whereas cell edge users performance is very critical their improvements depends on the schemes which we have employed. Cell-edge users suffer from heavy interference due to the shorter distances to the adjacent BSs and possibility of same frequency allocation.

To solve this we have implemented frequency allocation on two factors.

1. Users within the cell are connected to one another. This is shown in fig.2 connecting graph.
2. The cell edge user is connected to other adjacent cell edge users.

The entire problem is solved using Interference graph and with users connections as mentioned above two factors. The figure for interference graph is shown in figure 2.From this graph we get a matrix of n*n .This matrix contains binary 1 or 0 .Binary 1 represents there is a connection between that two users and binary 0 means there is no connection hence no interference. As the number of binary 1s becomes more means that interference also becoming more.

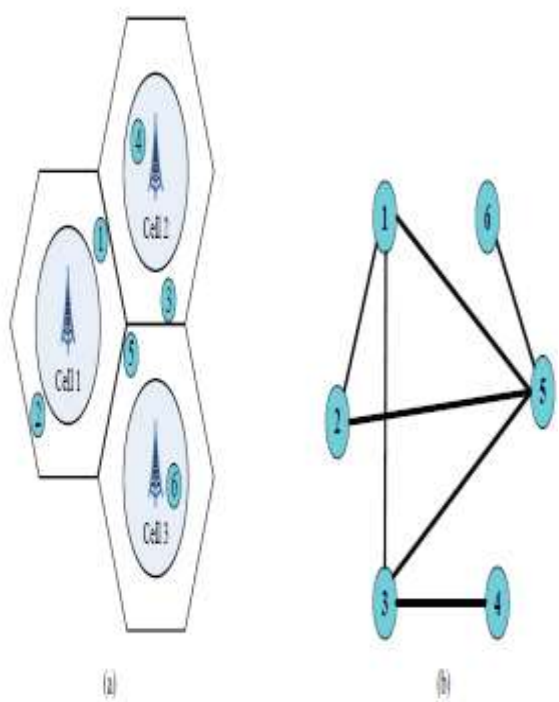

Fig.2. Example for Graph-Based Framework. (A) 3-Cell Scenario.(B)Interference Graph Constructions.

So we allocate that user such a frequency which is not allocated to other edge users.So no interference from adjacent cells.We can allocate same frequency to centre user and edge user of different cell.

Power Allocation

In each cell the power allocation is decided individually which does not depends on other cells, and then subsequently power allocation is made by distributed manner. Therefore, a distributed power allocation approach is proposed in this Section with an emphasis on performance optimization for cell-edge users without degrading the performance of cell centre users.

Let us consider P as the power of the cell, Pe and Pc be the power of edge users and centre users respectively.

P=Pc + Pe

Then power distribution takes in such a way that power of cell remains same but power given to edge users depends upon their distances. If distance is more then more weightage integral is multified while power allocation to edge-cell users. The weightage may vary from 0 to 1 .But power allocation to centre users remains same that is Pc/n where n is number of centre users. Power allocation in such a way that performance of cell-centre users should not be degraded.

Result

From Figure 3.1performance of cell-centre users which informs that performance of the cell-centre users is not degraded by upgraded cell-edge users.

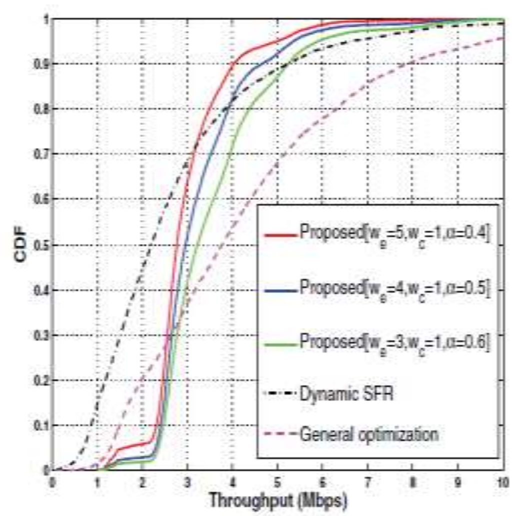

Fig 3.1 Performance Of Cell-Centre Users.

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Figure 3.2 shows the average throughput of the proposed scheme for both cell-edge and cell-center users in the reference cell as a function of the SINR threshold Λ.

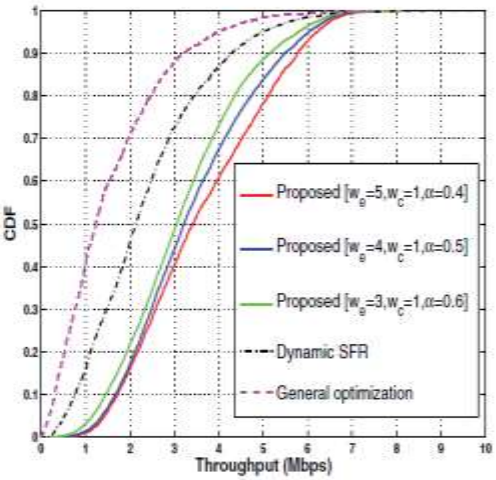

Fig 3.2 Performance Of Cell Edge Users.

Conclusion

In this paper, a comprehensive resource allocation scheme has been proposed for multi-cell OFDMA networks. The scheme includes radio resource and power allocations, which are implemented separately to address the formulated with reduced complexity problem. The graph-based framework combined with fine-scale PRB assignment algorithms are proposed to effectively manage Interference and improve performance of the network in a centralized manner. The optimal power allocation is performed independently in each cell to maximize performance of its own cell-edge users under the condition that performance of cell-center users of adjacent cells are not degraded much given the solution of radio center users compared with the reference cell schemes. Also the consistent improvement is verified by performance evaluation on different user densities in the network.

Therefore, the proposed resource allocation scheme can yield balanced performance resource allocation. Lagrange method is used to obtain the best solution. By the simulation results we can understand that the proposed scheme can achieve significant performance. Therefore, the proposed radio resource allocation scheme can yield balanced performance between cell-edge and cell-center users, which allows for future wireless networks to deliver consistent high Performance to any user to anywhere.

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