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Resource dynamic frequency interference mitigation based on LTE-A & neighboring node network communication

[1]Malarvizhi A, [2]Ponlatha S

[1]PG Scholar, Mahendra Engineering College, Namakkal
[2]Professor, Mahendra Engineering College, Namakkal

ABSTRACT

The wireless spectrum frequencies used in communication are regulated by national organizations, which specify which frequency ranges can be used by whom and for which purpose. The Wireless spectrum is scarce resource. Spectrum shortage is one of the most important discussed parameter in wireless domain. Frequency Reuse (FR) concepts are evolved to solve the Spectrum scarcity in wireless communication systems. It is a promising development to fulfill the requirement of Long Term Evolution Advanced (LET-A). However the Frequency Reuse technique leads to Inter Cell Interference (ICI) as the neighboring eNodeB's (eNB) which uses the same frequency band. These eNodeB's itself will act as an interference source. In this paper, a Dynamic Frequency Reuse (DFR) method is proposed. Continuous optimization of resource allocation of each cell is considered in this proposed. The important focus of the paper is to extend the capacity of the users placed in cell edge areas by reducing out of cell interference. Simulation has been done to prove that the proposed method leads to better resource management.

Keywords: Frequency Reuse, LTE, LTE-A, DFR, ICI, Capacity, Network.

INTRODUCTION

High speed, uninterrupted service and reliable connections are the requirement for present day's communication network users. Adding up to that, with the increased number of users, people need something new that will fulfill all their above requirements people need something new that will fulfill all their above requirements. The term radio spectrum typically refers to the full frequency range from 3 kHz to 300 GHz that may be used for wireless communication. Long Term Evolution (LTE) is the cellular standard that can solve all the issues regarding the problems of the network. LTE is considered as the standard for high speed and reduced latency in the service. LTE is also known as the standard of the fourth generation (4G) technology in communication system. Many developed countries are now using this technology to attend to their need of reliable connection.

For mobile standard system, the 3rd Generation Partnership Project (3GPP) is currently the main standards development group. They are considered as 2nd Generation system. The Third Generation mainly known as the Universal Mobile Telecommunication System (UMTS) family which has introduced Code Division Multiple Access (CDMA) technology and became known as Wideband CDMA, commonly known as WCDMA. Finally, LTE has taken Orthogonal Frequency Division Multiple Access (OFDMA) technique that is a technology to access, which is dominating the newest mobile technologies.

Author for correspondence:
Department of ECE, Mahendra Engineering College, Namakkal

Fig1. Inter Cell Interference (ICI) Scenario

Orthogonal frequency division multiple accesses have been recently adopted as the multiple access schemes for the state-of the-art LTE. The orthogonally among the sub-carriers per cell makes the intra-cell interference almost negligible. However, with universal frequency reuse among cells the ICI at each sub-carrier may cause severe degradation in the network performance. Inter Cell Interference (ICI) is one of the main restrictive factors. This problem is mainly caused by two sources, the first is the frequency reuse factor equals to 1in LTE-A system. This means all the neighboring eNodeB's (eNB) use the same frequency channels which will act as an interference source. Which the same frequency can be used in the network is considered to be frequency reuse factor as shown in Fig.2. It can be denoted as 1/K, where K denotes the number of cells which cannot operate in the identical frequency for transmission of data. The second limitation is the heterogeneous positioning of LTE-A networks containing of traditional Macro base stations overlapped with Low Power Nodes (LPN). Often haphazard and unintentional location of these points of access can create severe interference scenario primarily for the users located in cell edge. Figure 1 illustrates the condition of ICI in LTE-A network. For this ICI the efficiency of the system decreases as both the LTE and LTE-A System is planned for frequency reuse factor of 1 to maximize the spectrum capacity. If no accurate planning for the interference management, there is a high probability of call drops and low throughput. Traditional Fractional Frequency Reuse is an effective solution of this problem.

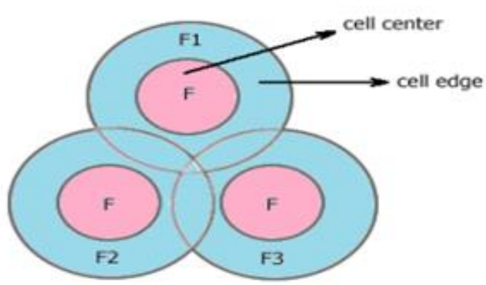

Fig2. Fractional Frequency Reuse Concept

The rest of the paper is organized as follows. Section II describes the related works. Section III describes the proposed frame work. Section IV described the results and discussion. Section IV concludes this chapter.

RELATED WORK

Application of fractional frequency reuse in the LTE-A system has been a highly-discussed topic in communication society. Adaptive partial frequency reuse has been proposed an improve the system capacity [1][2][3][4]. However different transmit power and positions has been assumed. Contention based FFR is proposed but the algorithm is applicable for ertain conditions only. Congestion management intellectual transportation system is proposed. Soft Frequency Reuse (SFR) is proposed. However, most of the paper of them does not consider the effect of inter cell interference [6][7][8]. Dynamic allocation of frequency is considered. However, none of these considered multiple base stations with each serving randomly placed users. As the ICI mitigation technique has become one of the major concerning issues in the communication sector, there are many researchers working on this topic to improve the condition [9][10][11]. Some of the leading techniques that are being discussed are pointed out in the next section. In this paper, a novel interference coordination scheme based softer frequency reuse (SerFR) to mitigate intercell interference in Orthogonal Frequency Division Multiple Access (OFDMA) cellular systems is presented [12][13]. In OFDMA systems inter-cell interference is the most important interference source. Inter-cell interference coordination is considered to improve coverage and increase date rate at cell edge. Soft Frequency Reuse (SFR) interference coordination scheme is proposed in 3GPP Long Term Evolution (LTE) [4]. But the scheme cause frequency selective scheduling gain loss, and the peak rate for cell edge users is low because the cell edge users only can use a fraction of the entire frequency band. However, in SerFR scheme, cell edge users can use the entire frequency band, so there are more frequency selective scheduling gain and more peak date rate than SFR scheme[1][14][15][16].

PROPOSED FRAMEWORK

The proposal of initial dynamic frequency reuse includes two steps of initialization. The first is implementation of an empirical, circulated algorithm for ideal resource allocation in LTE-A system. When there is no chance of communication with other Base stations (BS), each BS can dynamically assign resource for each of its users. But assigning resources allocation to improve the capacity leads to Non-Deterministic Polynomial Time Hard (NP-Hard) problem. A problem is considered NP-hard, if an algorithm for simplifying it can be interpreted into one for explaining any NP problem. So, NP-Hard means it is as hard as any NP problem even though it can be even tougher. Due to this problem, computational complexity arises. In order to avoid this, a proposal has been made in this paper called Dynamic Frequency Reuse scheme. The total power allocated is minimized with a constant data rate for each of the user by resources allocated by BS. The idea is to grouping the sub-carriers into sub-bands. In telecommunication system, the sub-carriers are signal carrier which is passed on top of an additional carrier. As a result, two signals can be carried at the same time. In the receiver side, the main carrier and the sub-carrier signals are demodulated distinctly.

In this paper, the problem of resource allocation for D2D communication is investigated for both the uplink (UL) and the downlink (DL) directions. Similarly, the discussion through the rest of the paper is applicable (if not stated otherwise) to either direction. Consider a basic LTE-A network which consists of one eNB operating on a fixed spectrum band spanning K RBs numbered RB1, , RBK. Let K = 1, , K be the set of the all RBs indices comprising the available bandwidth. Described network operates on a slotted-time basis with the time axis partitioned into equal non-overlapping time intervals (slots) ofthe length Ts, with t denoting an integer-valued slot index. In D2D-enabled cellular networks, the modes, RBs and transmit power levels of the users should be allocated effectively to maintain their traffic demands and improve their QoS. The interference between different users operating on the same RBs should be kept at the desired level (this can be done by controlling the power of individual UEs). A single frequency resource in the LTE standard of OFDMA cellular system consists of a set of subcarriers, called a frequency resource block (FRB). One FRB spans a frequency band of 180 kHz in the LTE standard, which consists of 12 sub-carriers separated by 15 kHz between two adjacent sub-carriers. the frequency allocation in heterogeneous LTE networks should be executed at the timescale of hundreds of milliseconds in order to take advantage of time-varying loads at TPs.

PBS only network (1-tier network)

We assume users associate with the BS that provides the highest SNR. When the coverage areas of the BSs overlap, users may experience varying levels of interference from non serving BSs. On one hand, in order to minimize the total number of required FRBs, each BS should try to maximize sharing FRBs with neighboring BSs. On the other hand, some users may be close to neighboring BSs, and serving such users using FRBs shared with the neighboring BSs may not be beneficial when served using shared FRBs. We aim to achieve the right balance by considering the efficiency of different FRB types for each user.

Tier network with MBS

MBS as well and uses the 1-tier algorithm described above as a subroutine. In the rest of this paper, we refer to this procedure as the 2-tier algorithm as it considers a heterogeneous network containing one MBS and multiple PBSs. The input to the 2-tier algorithm is the same as the 1-tier network case. The MBS first creates a feasible FRB allocation for its users only. In doing so, the MBS can choose to share FRBs with some of the PBSs. We describe the procedure used by the MBS. The PBSs then take the FRB allocation from the MBS and run the 1-tier algorithm, initializing the mapping stage with the FRBs shared with the MBS.

RESULTS AND DISCUSSIONS

The proposed model is simulated under NS-2 environment. The combination of these to reuse factors gives the capacity of the FFR scheme. In the simulation for our proposed model, a limit has been considered for the users to be assigned in the sub-bands and power consumption. The simulation will stop when there is lack of sub carriers or power. User's placement and fading has been considered multiple times. Then the data are analyzed and stored for the use of simulation and take care of randomness. New users are added from the different locations. The system capacity based on the number of users supported using DFR comparing to the FFR. From the simulation results, it is clear that DFR outperforms the FFR in terms of increasing the system capacity. The capacity of FFR scheme can be seen at different power levels. When the power level is increasing the capacity also increasing with the distance.

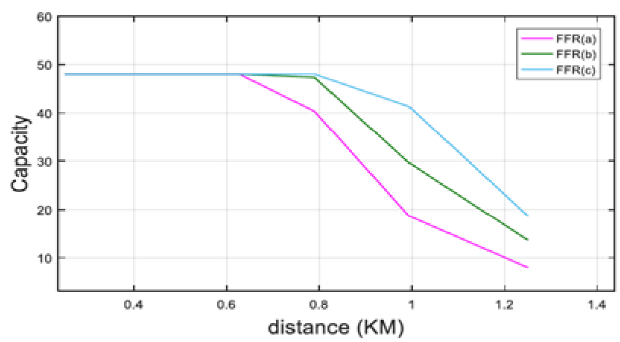

Fig.3. Performance of FFR at different Power Levels

CONCLUSION

Inter cell interference avoidance in LTE-A system through Dynamic Frequency Reuse has been discussed in this paper.

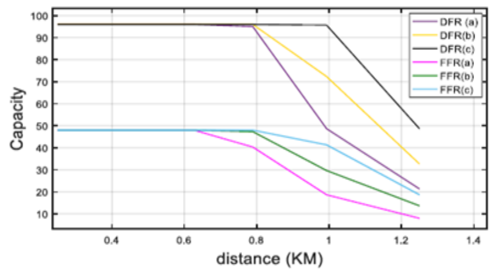

Fig4. Performance Comparison of DFR vs FFR

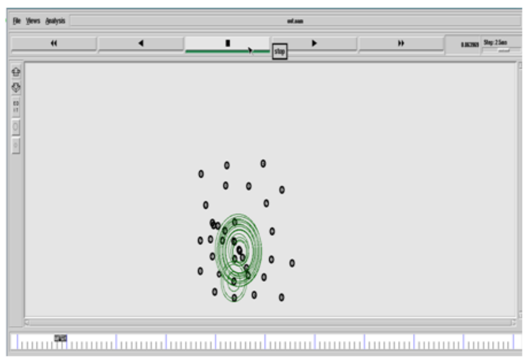

Fig5. Node Communication

The proposed scheme compares the available sub-bands and then chooses the best sub-band for the users. Simulations results also indicate that this scheme outperforms the traditional FFR scheme. At the cell edge area and also the cell center area, the capacity is almost double comparing to FFR. Simulation has been used to justify the proposed method. Adding up to that, in the simulation, the environment is considered with the realistic parameters. Further studies regarding this matter may lead to efficient radio resource management. While this scheme increases the capacity of the system through interference avoidance, there are some parameters which are assumed. To take care of the randomness some of the parameters are considered constant which is need to be taken care of in future researches. Different data rates, path loss models may also be considered for the future research.

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