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Co-tier and Cross- tier Interference Mitigation in LTE based Femtocell Network using CASFR Scheme

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Abstract: One of the effective techniques of improving the coverage and enhancing the capacity and data rate in cellular wireless networks is to reduce the cell size and transmission distances. Long Term Evolution (LTE) has developed small cellular base stations called femtocells that can dramatically improve voice and data coverage for the indoor subscribers. Therefore, the concept of deploying femtocells over macro cell has recently attracted growing interests in academia, industry, and standardization forums. Various technical challenges towards mass deployment of femtocells have been addressed in recent literature. However, the inter- and intra tier interferences in such systems can significantly reduce the capacity and cause an unacceptably high level of outage. In this paper we propose a scheme which mitigates co-tier as well as cross tier interference using cluster aware soft frequency reuse scheme. That assigns distinct set of Physical Resource Blocks (PRB)s to each interfering femtocells. The scheme first uses periodic messages from the femto-user (FUE) to identify the interfering femtocells. It then divides each femtocell area into cell-center and cell-edge. Finally, it uses the CASFR algorithm to assign un interfering sets of PRBs to the cell-center and cell-edge users of all the interfering femtocells Same process is followed by macrocells. The proposed interference mitigation scheme for femtocell networks offers significant performance improvement over the existing methods by substantially reducing the co-tier and cross-tier inferences in the system.

Keywords: Physical Resource Blocks (PRB), Femto-user (FUE), Inter-cell interference (ICI), PRB Swapping and Exchange (PSE).

I. INTRODUCTION

In the recent years, a rapid increase of data traffic in the cellular services point towards a data explosion in the near future. To cater to the increasing demands for transmission speed and low latency, the Universal Mobile Telecommunications System (UMTS) cellular technology has been upgraded and dubbed as Long Term Evolution (LTE). However, indoor coverage problem will continue to exist due to propagation path loss suffered by radio signals while travelling through walls from the outside macro base station (MBS). Since more and more people are ditching their landlines in favor of mobile phones, as well as because of the simple fact that people want to be able to talk on their cell phones wherever they are, it has become necessary to work on new technology that will facilitate calling coverage both indoor and outdoor. Femtocell technology could be the answer. In addition to facilitating better indoor call coverage, this emerging technology reduces the drain that advanced mobile services (such as mobile broadband) are placing on the capacity offered by phone companies. One of the solutions that people have started to use is femtocell technology. This technology may be better known to the user as an Access Point Base Station, a small device which is installed in the home or office in order to offer better support to mobile phones there. These base stations can accommodate up to five cell phones which means that you can get increased coverage for your whole household. Essentially, you set up the femtocell technology in your home and it serves to enhance the cell phone signal that you receive indoors so that your call quality isn't decreased when you're talking indoors. "Femtocell" is a wireless access point that improves cellular reception inside a home or office building.'' A femtocell is a miniature cell tower for homes or small businesses that extends a carrier's traditional network's range. Femtocells connect to a carrier's network over the customer's broadband internet connection and provide a strong local signal that cell phones in the building can use for any of the typical voice or data applications. Unlike macro networks, femtocells are usually deployed in an unplanned manner with overlapping coverage areas. In such a multicellular environment, ICI occurs when users from different cells are present on the same sub-carrier during data transmission. This is most seriously noticed in the cell edge terminals as a result of frequency collision with neighboring cells. For addressing this problem many solutions have been proposed. In this paper we introduce a novel Cluster Aware Soft Frequency Reuse (CASFR) scheme and PRB Swapping and Exchange (PSE) scheme that effectively mitigates co tier as well as cross tier interference. Co-layer is the interference of the same network, i.e. a FAP interfere with the neighboring femtocell user. Cross-layer refers to the interference between the users of two different network layers as the FAP and the macro cell.

II. LITERATURE REVIEW

As femtocells are sometimes embedded inside a MACRO

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cell, both macro and femtocell should operate on a certain frequency. The operators need to specify the allotted frequency range for the macro and femtocells. This frequency allocation is a tedious job. A little mismanagement can lead to various levels of interference problems. For addressing this problem many solutions have been proposed. In the proposed scheme[1], macrocell coverage area is divided into two zones i.e. central zone and edge region. These two zones are further divided into three sectors. The frequency band is also divided into two parts, in which one part is further divided into three portions. The total frequency band is denoted by A, B, C and D in Figure .

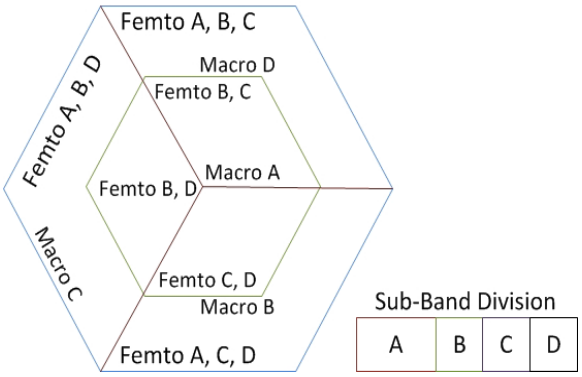

Fig: Sab-Band Division Model

The macrocell's center zone uses the frequency band A while the edge users uses the B, C and D sub-bands. The femtocell chooses the bands which are not used in the particular macrocell sub-area e.g. as shown in Figure 1. The center zone femtocells uses the B, C and D frequency bands while the edge region femtocells chooses the sub-bands which are not used by particular edge region macrocell. Due to small coverage of femtocell the sub-bands are reused as much as possible. The proposed scheme enhances the overall throughput, especially throughput of the edge users. It also reduces the interference problem. In [2][3], fractional frequency reuse (FFR) strategy adopted by macrocell in two tier macrofemto network is presented. The macrocell located at the origin transmits its signals in a circular disc shape as shown in Figure 2. This coverage zone is divided into two sub-regions i.e. inner circle and outer circle. This coverage zone is divided into two sub-regions i.e. inner circle and outer circle. By using FFR strategy, the allocated set of channels within the bandwidth is divided into two sub-bands i.e. one band for inner circle and other for outer circle. The femtocells are randomly distributed over the entire area. The macrocell and the femtocell schedule one sub-channel to one Mobile Station (MS) at a time. This scheduling is performed in a round robin fashion. The proposed strategy achieves a substantial gain in transmission capacity.

However a drawback in the proposed approach is that in practical environment, the cell shape is hexagonal not circular shaped. In [4][5], FFR scheme is presented. The proposed scheme adjusts the frequency reuse according to the working environment.

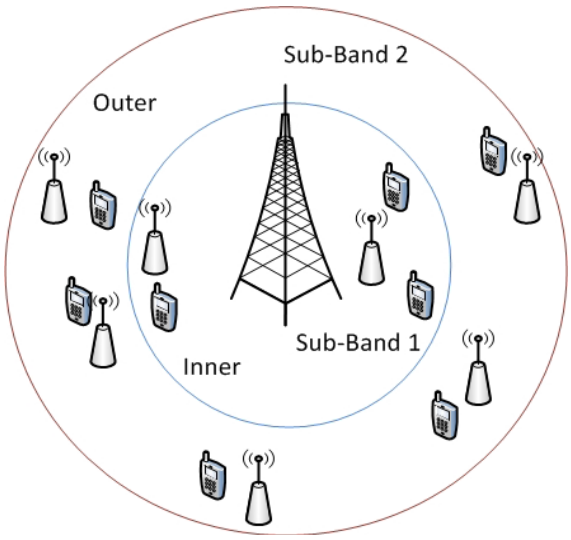

Fig. Network Model Based on Two Sub-Bands

This technique helps in mitigation of inter femtocell interference. Based on the mutual interference information, the femtocell gateway classifies femtocells into number of groups. It then allocates minimum number of orthogonal sub channels for each group of femtocell. After allocation, the transmit power of each femtocell is adjusted to provide target performance. This scheme does not work properly in dense femtocell environment when each femtocell has different load. In [6], frequency planning scheme for femtocells in the existing macrocell environment is presented. The scheme presented is based on soft frequency reuse. In the proposed scheme, macro and femtocells are divided into two regions i.e. inner and outer region The inner macrocell and the outer femtocell use the same frequency band while the outer macrocell and inner femtocells uses the same frequency band. In this scheme the femtocells do not cause co-channel interference to nearby macrocell users and there is no use of signaling between the MS and femtocell for resource allocation. However, the inner femtocell throughput increases while the outer femtocell throughput decreases as power ratio and transmission power of femtocells increases. In [7] Adaptive Soft Frequency Reuse (ASFR) scheme was proposed which allows the cell-edge users to borrow Physical Resource Blocks (PRBs) from the neighbouring cell that has the highest numbers of free cell edge PRBs. Only those PRBs that are reserved but not in use by cell edge users in the neighbouring cell can be borrowed. However, ASFR cannot guarantee low ICI, as borrowable PRBs in one neighboring cell may be in frequent use by cell edge users in another neighboring cell. In [8] Cluster Aware Soft Frequency Reuse (CASFR) scheme and PRB Swapping and Exchange (PSE) scheme was proposed that effectively mitigates the downlink and uplink interference within the femtocells. The main contributions of our scheme are: 1) In contrast to other SFR scheme, CASFR divides the bandwidth in each cell based on the number of interfering FBSs. This flexible resource allocation guarantees complete obliteration of ICI in the downlink of LTE femtocell networks; 2) The PSE

scheme takes care of the uplink interference by avoiding PRB reuse and swapping the interfering PRBs with the PRBs from the non interference zones. This scheme mitigates only co tier interference.

III. PROPOSED MODEL

Femtocells are not only a good solution to overcome the indoor coverage problem but they can also deal with the growth of traffic within the network to some extent. However with the deployment of new femtocells, the performance of macrocell layer can be undesirably impacted. The challenges that can arise are the allocation of spectrum resources and avoidance of electromagnetic interferences.

Co-layer is the interference of the same network, i.e. a FAP interfere with the neighboring femtocell user. Above schemes are useful to mitigate co tier interference.

Cross-layer refers to the interference between the users of two different network layers as the FAP and the macrocell. This type of interference results in poor signal quality. To mitigate cross tier interference along with co tier interference we proposed new scheme "co tier and cross tier mitigation in LTE based femtocell network using cluster aware soft frequency reuse scheme".

A. Project Algorithm Steps

Project solves both Co-tier Interference and Cross-tier Interference in femtocell network based LTE.
1] Simulation parameters are defined 2] LTE network comprising of macrocell and femtocell are defined. 3] Number of Femtocells interference is placed in the network scenario. 4] The Coverage Probability for the LTE network is calculated. 5] Dynamically allocate Resource Blocks (RBs) to the User Equipment (UE).

B. Mitigating Co-tier Interference in the network

i) FBS Continuously receives periodic information from its FUE & all FBS should synchronize with each other. ii) Threshold is defined iii) Calculate SINR (interference) for the network iv) Condition check as if Interference > Threshold v) If condition is true then make group of interfering FBS & perform cell partitioning: - cell center as well as cell edge area. vi) Allocating RBs which is not in used by any interfering FBS & serving FBS. vii) Then again check above condition. viii) If condition is true then exchange RBs with neighboring cell edge. ix) If condition is false then END process.

C. Mitigating Cross-tier Interference in the network

i) MBS Continuously receives periodic information from its MUE & all MBS should synchronize with each other. ii) Condition check as if Interference > Threshold iii) perform cell partitioning: - cell center as well as cell edge area. iv) RBs which is free i.e. not in used by any interfering FBS/MBS & serving MBS/FBS that can be Reuse. v) Then perform adaptation process for above & check Interference is below threshold level then END process.

IV. CONCLUSION

In this paper we propose a soft frequency reuse scheme for the 3GPP LTE femtocell networks. The scheme is triggered every time a FUE experiences strong interference from its neighboring femtocells. By allocating distinct set of PRBs to the cell edge users, our scheme considerable reduces the interference, which automatically increases the throughput of the cells. As future enhancement the performance of this scheme can be improved by increasing numbers PRB's

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