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CROSS TIER INTERFERENCE & ICI MITIGATION IN FEMTOCELL BY USING CLUSTER AWARE SOFT FREQENCY RE-USE SCHEME

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Abstract----- Now a days all wireless communication systems demands for high capacity and high data rate. The long term evolution(LTE) wireless communication standard is used to achieve the high data rate during mobility. For the increase in coverage area LTE has developed the small cellular cells. These cells are known as femtocells[2]. Femtocells improves data and voice capacity dramatically. But there is one problem regarding with femtocell and that is the interference between two femtocells called as Intercell interference(ICI) and interference between one femtocell and one macrocell called as Cross tier interference. This interference problem causes significant degradation in performance. We are trying to propose a system which will together mitigate the Intercell Interference and cross tier interference. In this project, we propose a scheme called Cluster-Aware Soft Frequency Reuse (CASFR) which will assign the set of Physical Resource Blocks (PRB)s to each interfering femtocells. The CASFR first uses periodic messages/symbols from the user to identify the interfering femtocells. It then splits each femtocell area into cell-edge and cell-center. At the last, it uses the algorithm to assign the sets of PRBs which are not interfering to the cell-edge and cell-center users of all the interfering femtocells. We also proposed a PRB Swapping and Exchange (PSE) algorithm for the to reduce any interference that may remain after performing CASFR. CASFR is used for downlink interference mitigation and PSE for uplink interference mitigation.

Index Terms--- LTE(Long Term Evolution) , CASFR(Cluster Aware Soft Frequency Reuse),PRB(Physical resource Block),PSE (PRB Swapping and Exchange)

I.INTRODUCTION

Mobile communication is one of the most important way of communicating in our life. The main objective of mobile communication is to transfer the voice and data without any disturbance. As the number of users increasing rapidly, It is being very difficult to manage spectrum allocation and mitigation of interference for cellular communicating systems. As the result of this the performance of the network system degrades; Which further decreases the system capacity and throughput.

Femtocells are the low power base stations which can be implemented in home or building or office etc. They are used to improve the coverage and its cost is low. If we compare femtocell and marocell both use air interface as the communication standard. Range of femtocell is 15 to 20 meters and for macrocell it is 200 to 300 meters. Power consumption of femtocell is low as compare to macrocell.

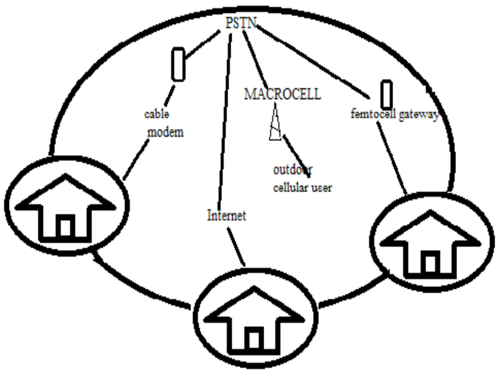

Fig 1: cross tier interference between femtocell and macrocell

As shown in the Fig 1. The cross tier interference is present between macrocell and femtocell and intercell interference is present between femtocell and femtocell..There are some existing systems which mitigates the these interferences separately; but there is no system present which will simultaneously mitigate both interferences. Our proposed system will mitigate both the cross tier interference and inter cell interference.

II. PROBLEM DEFINITION

Femtocells are not exactly in the hexagonal shape. They are placed randomly so the chances of interference in femtocells are more as compared to the other cells. Many solutions have been proposed for this problem. One of the most successful from them is the SFR i.e. Soft Frequency reuse.SFR is more bandwidth efficient but it results in interference. Fractional frequency reuse[6] and flexible bandwidth [4] are the other two solutions but these results in low capacity and low spectrum allocation. To avoid this we can reduce the bandwidth allocation to some extent of the entire bandwidth but this results in flexible frequency and decrease in spectrum allocation. In our propose system these problems are eliminated as we are splitting the cell into two regions cell edge and cell center, so there is no flexible frequency.

So we will be trying to improve the throughput, uplink power control, path loss, Uplink and downlink interference and SINR ratio.

III.DESIGN THEORY

A. Calculation of parameters

As stated the objective of this system is to mitigate the interference. For these purpose we have to calculate all the parameters related to interference.

sources in time and frequency domain the interference should be consider in both. So the interference is given as,

$$I_n^r = \sum_{i \in M'} P_n^m G_n^{r,i} + \sum_{j \in F'} P_n^f G_n^{r,j}.$$

Where n denotes the total number of users. P^m denotes the transmit power of the MUEs in the uplink and MBS in downlink.$G^{r,i}$ is the gain between interfacing MUEs and FBS.P^f denotes transmit power of FUEs in the uplink and FBS in the downlink.$G^{r,j}$ is the gain between interfacing FUEs and MBS.

From the above equation we can calculate the SINR, Signal to Interference and Noise Ratio.

$$SINR_n^r = \frac{P_n^t G_n^{r,t}}{\sum\limits_{i \in M'} P_n^m G_n^{r,i} + \sum\limits_{j \in F'} P_n^f G_n^{r,j} + \eta}.$$

Where P^t is the transmit power per PRB and $G^{r,t}$ is the gain between receiver and transmitter. η is the thermal noise. Now we can calculate the throughput of the system from the SINR. To calculate throughput we will use Shanon's theorem. By this theorem the channel data rate is given as,

$$Thp_r = B_{PRB}.\log(1 + SINR_n^r)$$

Where B_{PRB} is the bandwidth of the PRB. To calculate SINR we requires P^t. Thus to calculate the uplink power, According to [13] the uplink transmit power is given by,

$$P_n^t = \min\left\{p^{\max}, \max\left[p^{\min}, p^{\max}\left(\frac{L}{\alpha}\right)^{\xi}\right]\right\}.$$

Where P_{max} and P_{min} are the maximum and minimum transmit power. α determines the path loss above which transmit power is maximum .ε is the balancing factor which determines the increase in the transmit power with the increase in the path loss.

Also we requires $G^{r,t}$ i.e. gain between transmitter and receiver. This depends upon the path loss and path loss depends upon the distance between the transmitter and receiver. The gain is given as,

$$G_n^{r,t} = 10^{\left(-\frac{LS}{10}\right)}$$

Where LS is the path loss. Now we have to calculate all the path losses described in [5].We will consider indoor, outdoor and indoor-to-outdoor path losses.

First we will calculate the path loss of the distance between femtocell user and macrocell user and the FBS. It is given by,

$$LS = 15.3 + 37.6\log_{10}\left(\frac{d}{1000}\right) \quad dBm$$

D is the distance between transmitter and receiver.Second path loss is between the MUe and MBS.It is given by,

$$LS = 15.3 + 37.6\log_{10}(d) \quad dBm$$

Last path loss is indoor user to MBS.It is given by,

$$LS = 15.3 + 37.6\log_{10}(d) + L_W \quad dBm$$

Where L_W is the penetration loss.From above three equations overall path loss is calculated.Average of all losses is calculated and used in the calculation of gain between the transmitter and receiver.Gain is calculated in db.

B.Cluster Aware Soft Frequency Reuse Scheme.

Interference occurs when two base stations having some overlapping regions uses the same set of frequency spectrum.We will consider two types of interference, Downlik interference and uplink interference.

I. Downlink interference mitigation.

In downlink interference is caused due to the FBS and MBS. The following figure shows the downlink interference.

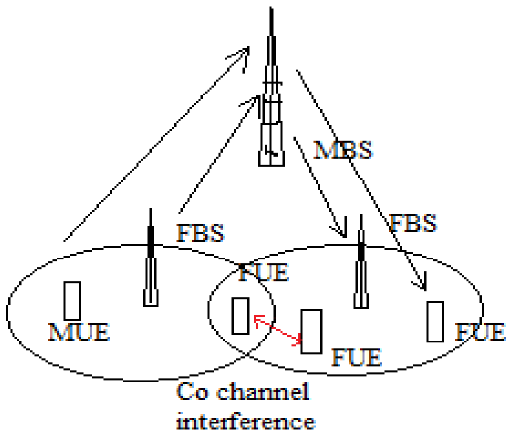

Fig.2 Downlink Interference in femtocells.

Interfering signals degrades the SINR ratio and then decreases the throughput. Interference can be mitigated by using our proposed CASFR algorithm.Fig.3 explains the CASFR algorithm.

First all the PRBs are allocated randomly by FBS and MBS to all FUEs and MUEs. This is done by mapping process. A specific message is sent to all the users periodically and according to that their reports are collected periodically by the MBs and FBs. If the message is not sent in the expected time then there is the chance of interference. From these results throughput is compared with the Intercell interference and cross tier interference. If throughput is greater than interference then there is no problem. If it not so then we have perform CASFR. If throughput is less then FBs and MBs creates the list of the interfering cells. Then it Divides the PRBs into a set 'N', Allocates distinct set of PRBs to interfering cells so that they can use the frequency from the allocated PRB's and then no two FUEs or MUEs will use the same frequency. Ultimately the interference will get reduced. Also the FBs and MBs makes the cluster of Two or Three interfering cells so that one set of PRB can be allocate to cluster and not to individual cell. It preserves the set of PRBs. This procedure is continued till the throughput becomes more than the interference and interference is mitigated

dramatically. At the end cell center radius is decreased till the cell edge radius becomes equal to the entire cell.

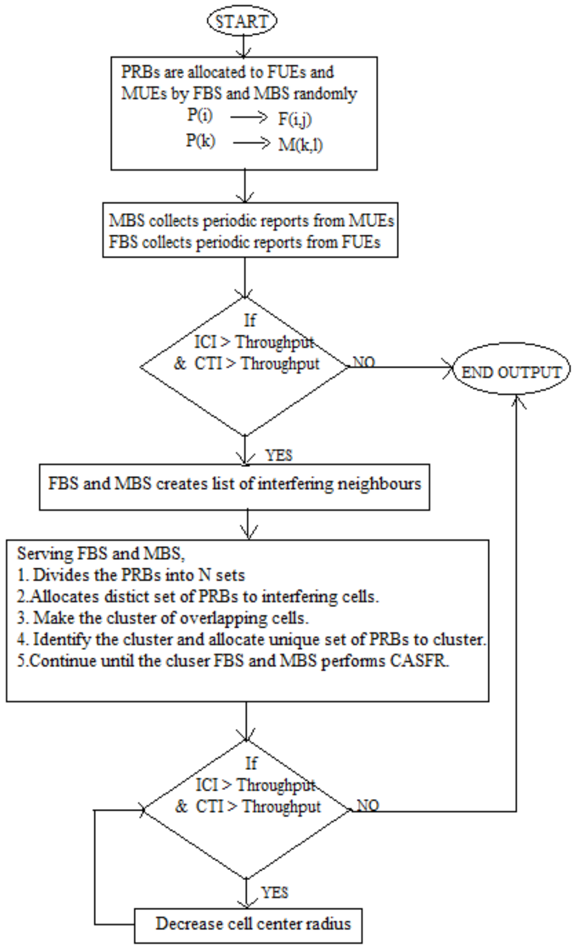

Fig.3 CASFR algorithm

II. Uplink interference mitigation.

As shown in Fig.2 there is interference present in uplink which causes due to the MUEs present in the FBs region of coverage and FUEs of other cells. To mitigate this interference we propose the concept of PRBs exchange and swapping. As we know interference is experience in only that area of the cell where the user is present in other area there may not be the same quantity of interference. Thus when some user experiences the interference in some area of the cell then that user can exchange its set of PRBs with the other user which is present in the same cell but in the other area where interference may be less. Thus we can use this concept of swapping and exchange of PRBs to mitigate uplink interference.

V. CONCLUSION

Thus we are trying to make a system which will mitigate the cross tier interference which is present in between the femtocell and marocell and Intercell interference which is present between two femtocells or two macrocells. Large coverage area and high data rate is the main demand of the cellular network This system will improve the coverage area and throughput of the femtocells .Which will be beneficial in future for mobile communication.

VI.REFERENCES

[1] Kuheli L. Haldar, Hailong Li, Dharma P. Agrawal,"A Cluster-Aware Soft Frequency Reuse Scheme for Inter-cell Interference Mitigation in LTE Based Femtocell Networks",2013 IEEE

[2]V. Chanrasekhar, J. G. Andrews and A. Gatherer, "Femtocell networks: a survey," IEEE Communications Magazine, Vol. 49, No. 9, pp.59-67, Sep.2008.

[3] J. Boccuzzi and M. Ruggiero, "Femtocells Design and Application," The McGraw-Hill Companies, 2011.

[4] B. Krasniqi, M. Wrulich and C. F. Mecklenbrauker, "Network-load Dependent Partial Frequency Reuse for LTE," 9th International Symposium on Communications and Information Technology, pp.672-676, Sep. 2009.

[5] A. Dalal, H. Li and D. P. Agrawal, "Fractional Frequency Reuse to Mitigate Interference in Self-Configuring LTE-Femtocells Network", 8th International Conference on Mobile Adhoc and Sensor Systems (MASS),pp. 49-54, Oct. 2011.

[6] D. Bilios, C. Bouras, V. Kokkinos, A. Papazois, and G. Tseliou,"Optimization of Fractional Frequency Reuse in Long Term Evolution Networks," IEEE Wireless Communications and Networking Conference (WCNC), pp. 1853 - 1857, Apr. 2012.

[7]Nazmus Saquib, Ekram Hossain, Long Bao Le, and Dong In Kim,"Interference Management in OFDMA Femtocell Networks: Issues and Approaches",A white paper

[8]M. Al-Shalash, F. Khafizov, and C. Zhijun, "Uplink Inter-Cell Interference Coordination through Soft Frequency Reuse," *IEEE Global Telecommu- nications Conference (GLOBECOM)*, pp.1-5, Dec. 2010.

[9]F. Wamser, D.Mittelstadt, and D. Staehle, "Soft Frequency Reuse in the Uplink of an OFDMA Network," *IEEE 71st Vehicular Technology Conference (VTC)*, pp.1-5, May 2010.

[10]X. Mao, A. Maaref, and K. H. Teo, "Adaptive Soft Frequency Reuse for Inter-Cell Interference Coordination in SC-FDMA Based 3GPP LTE Uplinks," *IEEE Global Telecommunications Conference (GLOBECOM)*, pp. 1-6, Nov-Dec. 2008.

[11]3GPP, "Power Control Assumptions for FDD HenB Simulation," in *3GPP TSG RAN WG4 R4-091769*, May 2009.

[12]T. Novlan, J. G. Andrews, S. Illsoo, R. K. Ganti, and A. Ghosh, "Comparison of Fractional Frequency Reuse Approaches in the OFDMA Cellular Downlink," emph IEEE Global Telecommunications Conference (GLOBECOM), pp. 1-5, Dec. 2010.

[13]Z. Bharucha, H. Haas, A. Saul and G. Auer, "Throughput Enhancement Through Femto-cell Deployment," *European Transactions on Telecom- munications*, pp. 469-477, 2010.