International Journal of Engineering Applied Sciences and Technology, 2017
Vol. 2, Issue 7, ISSN No. 2455-2143, Pages 38-43
Published Online in IJEAST (http://www.ijeast.com)

INTERFERENCE MANAGEMENT IN FEMTOCELLS

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Abstract- Users need to be provided with high data rates and reliable service irrespective of their mobility or location. Therefore, it is becoming an important problem that how to meet the greater demand with limited resources? Femtocell has recently gained considerable attention. It is an emerging wireless access point that can improve indoor coverage as well as reduce bandwidth load in the macrocell network. However, a key challenge of the public femtocell networks is the utility-based resource management. There is often heavy resource competition as well as mutual interference between multiple femtocells. Therefore, it's very critical to optimize the radio resources allocation to meet femtocells' requirement as possible and reduce interference. This calls for dynamic and intelligent resource allocation for these networks. In this paper, we have mentioned various challenges faced while allocating resources & we have also proposed systematic ways to optimize the resource allocation for public femtocell networks in order to minimize interference.

Keywords-**Co-tier interference, Femto to Macro Intercell Interference Coordination, DPC,DATP**

I. INTRODUCTION

The femtocell ecosystem is one of the later and conceivably problematic in-building wireless initiatives , containing at least one little UMTS base stations that can be sent in homes or independent companies to improve in-building cellular coverage where the full scale signal is lacking, or, to give restricted ability to information hungry consumers .Irrespective of such a large number of preferences of Femtocells it is looked with Resource Allocation issue. Considering the large number of FBSs (femtocell base stations) and the requirement of multiple units' cooperation, it becomes very costly and inefficient to manually allocate resources for each FBS. There is more path loss between femtocells in public places, so the interferences between femtocells are relatively serious and the common macrocell resource management schemes may not solve this problem well. Moreover, there is often heavy resource competition as well as mutual interference between multiple femtocells. Interference from the neighboring BS may adversely affect the cell-edge UE throughput, which is connected to the distant BS. This calls for the maintenance of radio resources among BSs to prevent interference.

II. TECHNICAL CHALLENGES IN DEPLOYMENT OF FEMTOCELL

There are many challenges in deploying a disruptive technology such as femtocells into a preexisting 1cellular infrastructure. Interference amongst femtocells and the large scale network; interference between femtocells; confined access to users (closed user groups); interoperability of femtocells with existing handsets. Huge numbers of these difficulties have been overcome, be that as it may, two or three these difficulties are as yet the subject of some examination and merit developing.

III. INTERFERENCE IN FEMTOCELL NETWORK

The significant technical issue related to the mass deployment of femtocells is the interference administration amongst femtocell and macrocell and among neighboring femtocells. By and large, the interference can be arranged into two noteworthy sorts [7]; co-level obstruction and cross-level obstruction as appeared in fig 2 and fig 3.

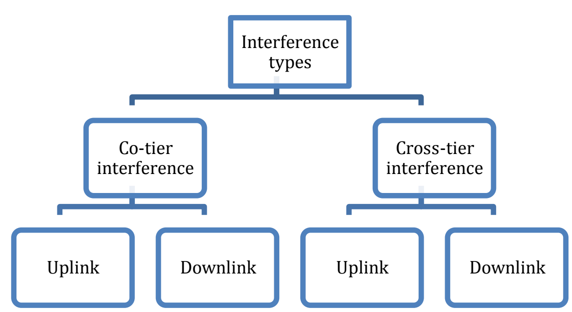

Fig.1. Classification of Interference

A. Co-tier interference (Femto to Femto):
This interference is caused by one femtocell to another femtocell, more often than not the neighboring ones, of a similar layer. This kind of interference happens among network parts that have a place with a proportional level inside the system. If there should arise an occurrence of a femtocell organize, co-level interference happens between neighboring femtocells.

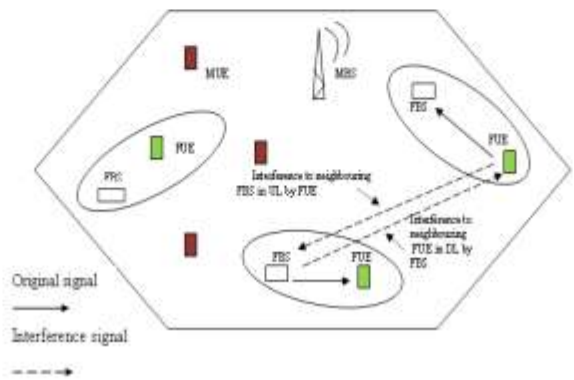

Fig 2 Co-Tier Interference

B. Cross-tier interference (Femto to Macro):
This sort of interference happens among arranging components that have a place with the distinctive levels of the system, i.e., interference amongst femtocells and macrocells. The uplink cross-level interference is caused by femtocell UEs and macrocell UEs to the serving macrocell base station and the close-by femtocells, separately.

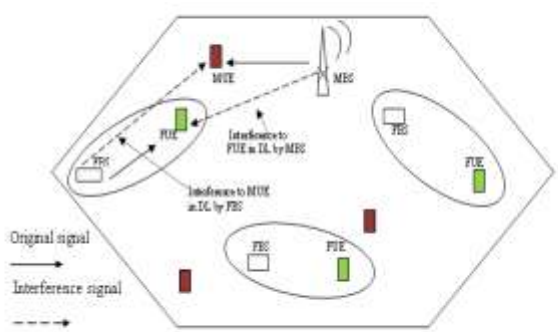

Fig 3 Cross-Tier Interference

IV. Dynamic Resource Handling Techniques

Radio resource management (RRM) is the system level control of co-channel interference and other radio transmission qualities in wireless communication networks, for instance, cell systems, wireless systems and broadcasting system. Typical resource allocation methods are arranging orthogonal resources between macrocell and femtocells such as in frequency domain in inter-cell interference coordination (ICIC) or time domain in enhanced ICIC (eICIC).

Intercell Interference Coordination (ICIC) :
Inter-Cell Interference Coordination (ICIC) methods, display an answer by applying limitations to the radio resource management (RRM) block, enhancing ideal channel conditions crosswise over subsets of clients that are seriously affected by the interference, and accordingly achieving high spectral proficiency.

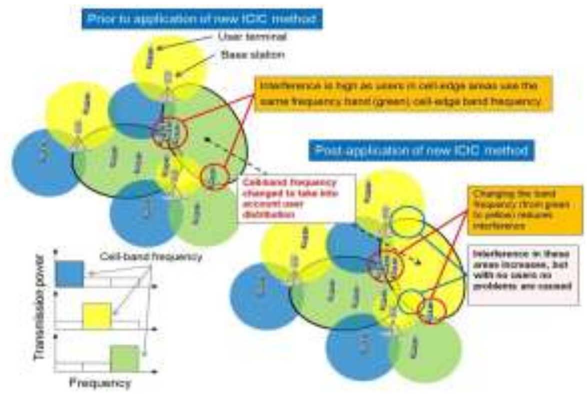

Figure 4: ICIC technique

ICIC can be executed as static, semi-static, and dynamic as in fig 5.

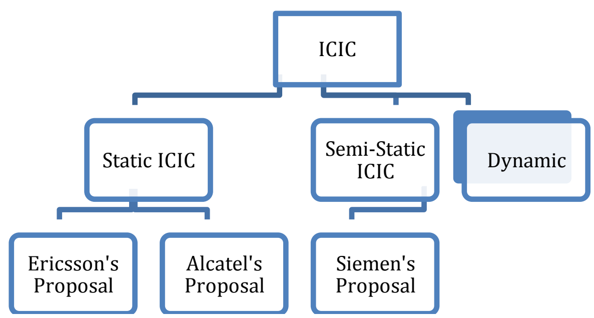

Fig.5. Implementation of ICIC

A. Static ICIC: Different schemes on static ICIC solutions are –

i. **Ericsson's Proposal:** In this scheme, a portion of frequency spectrum is used at cell edge while entire spectrum is used at centre of cell where transmission is power limited to reduce interference with cell edge users. Frequency reuse factor is ⅓ at cell edge.

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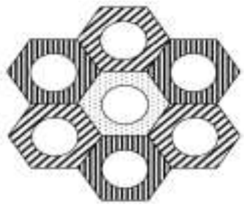

Fig 6. Ericsson's proposal for ICIC

ii. Alcatel's Proposal: This scheme is based on the concept of division of frequency spectrum into several sub bands (specifically 7-9 sub-bands) and center transmission use reduced power. The cell center utilizes all bands with low transmit power and cell edge utilizes any of the three sub-bands, to such an extent that sub-bands won't rehash in neighboring cells. The edge of the cell is divided into 3 divisions 120 degrees isolated from the origin**.** The three sub-bands are allocated individually to each sector such as sub-bands 6,1,2 in one cell, sub-bands 3,7,2 in adjacent cell and so on such that there could be 7 different combinations that could be used in adjacent 7 cell architecture. Frequency reuse factor is 3/7 at cell's edge.

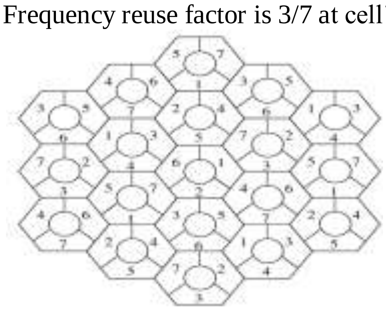

Fig7. Frequency Reuse of Alcatel's Proposal

B. Semi-Static ICIC

i. **Siemen's Proposal:** Available range is separated into X sub-bands. Y sub-bands are used at cell edge where Y is a subset of X while nearby cell edges are orthogonal to each other and X-3Y sub-bands are utilized for cell center. Cell centre can use a portion of available spectrum, cell edge can use multiple sub-bands depending on network load.

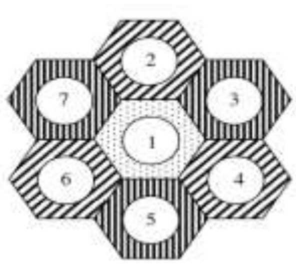

Fig 8. Frequency Reuse Scheme of Siemen's Proposal

ii. **Softer Frequency Reuse Proposal:** Soft Frequency Reuse (SFR) was adopted by 3GPP LTE as intercell interference coordination technique. The frequency spectrum is divided into three bands. Cell center users can utilize the entire spectrum having a frequency reuse factor of 1 and the cell center band is used in low power but as cell center users do not create any interference with different neighbor frequency band ,the high power band can also be used by them. The cell edge users can use 1/3 of the range and have frequency reuse factor of 3. The edge frequency band is utilized as a part of high power since cell edge clients must transmit in high energy to enhance information rate. Neighboring cell users use distinctive frequency band.

iii. **Proposal based on Users' Ratio and Multi-Level Frequency Allocation:** This plan depends on the Ericsson's proposition and Siemens' proposition. In this, the entire range is accessible in the cell focus and a subset of sub bands with the decreased power is accessible at cell edge. A cell on experiencing heavy load in its edge-area can borrow the frequency bands deployed in cell-edge of neighboring cells. In Fractional Frequency Reuse (FFR), whole frequency band is divided into several sub-bands, and each sub-band is differently assigned to center zone and edge zone of the cell. While reuse factor of the middle zone is one, the edge zone embraces greater reuse factor. Thus, intra-cell interference is expelled, and between cell interference is considerably diminished. In the meantime, the network throughput is upgraded. F1, F2 and F3 are diverse arrangements of sub-channels, assigned to clients at cell edges. F = F1+F2+F3. The entire sub-channels (F) are dispensed to clients at cell centers .

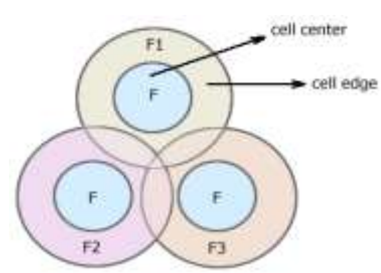

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Fig 9 : Fractional frequency Reuse.

Disadvantages of ICIC scheme

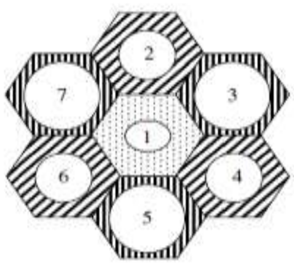
The significant increment in the signaling and many-sided quality if there should be an occurrence of substantial movement stack caused by obtaining the sub-bands from neighboring cells

V. Approach Problem Resolution

Dynamic Interference management scheme:

Here, we assume a heterogeneous network where network cells have different loads in them. We presume that the target cell i.e. cell 1 in below figure has, say 50%, more cell load than the load in its adjacent cells. In this scheme, Radio resources are managed frequently.

Since the distinguishing factor between cell centre users and cell edge users is the Threshold on PATH LOSS.



The target cell decreases the path loss threshold on an increase in the cell edge users while the adjoining cells increases the path loss threshold at the same time.Along these lines, there is lesser between cell interference in the cell edge zones. Assuming be that as it may, any of the bordering cells gets more clients in cell range then a similar strategy is rehashed.

VI. Pros and Cons of Dynamic Allocation Scheme

Dynamic resource allocation scheme is the good scheme but it has various disadvantages like it requires a lot of signaling regularly to maintain the limit on path loss threshold. This may result in performance degradation and lot of traffic generation.

VII. Resource Coordination Scheme for the Femtocell Networks

This scheme is based on broadcasting messages by femto mobile stations (fMS) to reduce system interferences and achieve higher capacities. The procedure is as follows:

When an fMS (femto mobile stations) sends request for data transmission, fBS (serving base stations) allocates frequency time resources to it. Then fMSi broadcasts its RRM (resource coordination request message) to all the BSs for resource coordination. This RRM includes: target SINR (Signal-to-interference-plus-noise ratio), required resource id, hashed serving base station id and data priority. The fBS which receives the RRM will do power control to limit the power on the required frequency source in order to reduce co-channel interference. After the power control step, each fBS will send out pilot with the controlled power on the required resource. Each fMS which sends RRM receives the pilots from fBSs, calculates its SINR and sends this CQI (channel quality indicator) information to its serving fBS. Then the serving fBS does scheduling and begins data transmission.

VIII. Power Control Algorithm for Interference Management

A. Distributed Power Control(DPC):

Distributed power control algorithm is executed by the terminals and they work on the basis of the terminals own transmission power Pi(n) in the nth time instant and the measured link condition corresponding to the same transmission. The algorithm updates the transmission power from the nth to the (n+1)th instant by some arbitrary constant ci(n) i.e. Pi(n+1) = ci(n)Pi(n). A key concern for distributed algorithms is the convergence time. If the situation is stationary then convergence time does not matter; however, if the average network condition is changing, then the convergence time for the power control algorithm has to be faster than the rate of change.

B. Dynamic Assignment of Transmit Power (DATP):

This algorithm is applicable to reduce both downlink and uplink co-tier interference. The existing power control algorithm (DPC), explains that power levels are adaptively increased or decreased with the step size of $\Delta 0$ which makes the femtocell network processing slower if more number of FBS are deployed due to iterativeness of the algorithm. Consider the Co-tier interference (femto to femto), interference avoidance described below is processed based on the threshold value of transmitter power of FUE and transmitter power of FBS (PtFUE / PtFBS) respectively. These power levels(in dB) if controlled and maintained by the Femtocell gateway center then this can control the uplink interference by instructing each FUE under its coverage to transmit at assigned power level as soon as FBS detects the respective FUE on first come first serve (FCFS) basis. FBS uses pilot signal to detect any FUE in its coverage and sets pilot bit i.e. Pbit to 1. Later instructs the FUE to operate at designated power level by synchronizing signal and once successful will set the Sbit to 1 and also PCbit to 1. In case of downlink, the FBS power levels are registered on start-up in femtocell gateway center and the power within the power level is assigned to each downlink channels of the particular FBS it handles.

IX. SIMULATION RESULTS

Here, Dynamic plan outflanks the static scheme since dynamic scheme handles more clients or offers more noteworthy throughput even in the cell edge area by maintaining the limit on path loss threshold which assumes a critical part in the decrease of inter cell interference. In this Simulation Graph we have described SIR (Signal Interference Ratio) with respect to the number of users within the number of iterations.

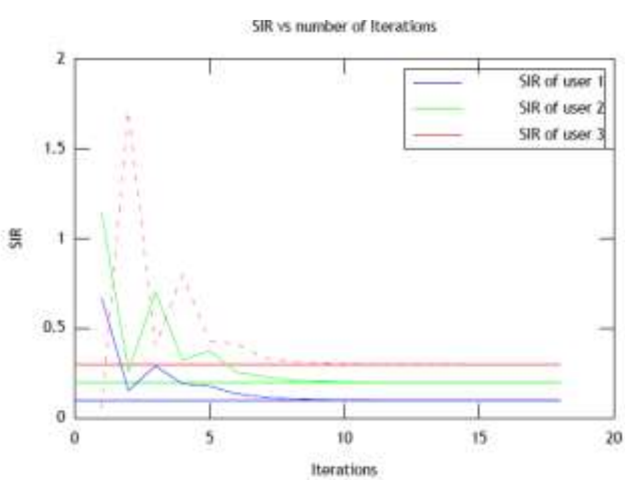


Fig.10.SIR Vs number of iterations

Indoor Path-Loss Model- Amid the signal propagation between the transmitter and the receiver, the signal quality debases because of the association with the encompassing condition which is called path loss. So it is imperative to foresee way misfortune to assess the wireless communication system. In short range systems, it is more precise to consider more particular points of interest notwithstanding the immediate way between the base station and the user equipment (UE). For this situation, the quantity of floors and dividers notwithstanding the furniture are extremely checking the signal quality. In this paper, we have conveyed indoor path loss estimations for Residential, Office, and Commercial Area. These models are studied based on different point of view like slope ,Line of Sight ,Free Space Losses. The Model which we have used here is ITU-R P1238 Model. This was proposed for a wide range of frequency, 900 MHz to 100 GHz .

$$PL = 20 \log(f) + N \log(d) + L_f(n) - 28$$

Where, N is the distance power loss coefficient.
f is the frequency (MHz).
d is the distance in meter between the access point and UE (d >1 m).
L_f is the floor penetration loss factor (dB).
n is the number of floors separate between the access point and UE.
Calculation of floor penetration loss factor:

Number of Floors	Residential Area	Office Area	Commercial Area
n	4n	15+4(n-1)	6+3(n-1)

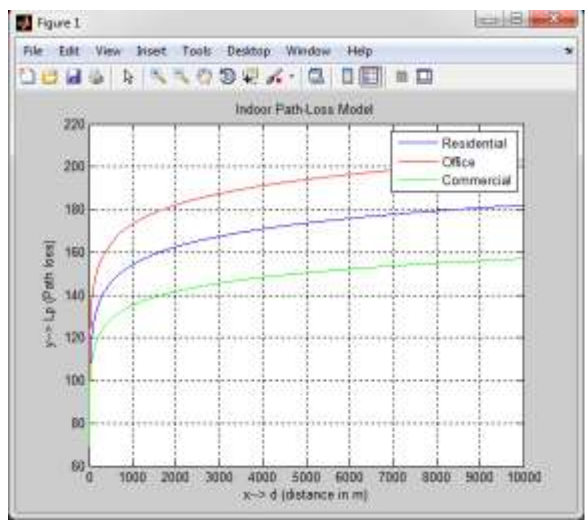


Fig 11. This model was proposed as a solution to the frequency reuse between floors, only number of floors is considered.

X. CONCLUSION

Femtocells are believed to be the technology of the future that could quench the thirst of the ever-growing demand for high data rates while maintaining the quality of service in the wireless cellular networks. Although femtocells offer several advantages there is a number of challenges to be dealt for it to be widely accepted. Currently, the deployment of femtocells is low, hence the challenges are not seen to be in practice, it is the deployment on a big scale that gives rise to serious challenges. It provides an insight into the potential research areas of femtocells that can be explored. Interference management plays a vital role in the successful deployment of a wireless system, and thus it has been explained in detail. The proposed work carried out in this project could successfully control interference at co-tier level (femto-femto) both in UL as well as in DL.

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