Femto Cell Power Control Mechanisms To Reduce Interference In 5G SCN(Small Cell Networks)

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Abstract- *The demand for mobile data has been growing exponentially in these days. Technology vision 2020 for future mobile networks should support up to 1000 times more capacity hence need of 5G / LTE next advanced generation. As these technologies are using various types of cell networks i.e. macro, pico, femto etc. to provide quality of service to the customers, it becomes a hot topic to carry on research. Although these networks provide several benefits for operators and users alike, their massive installations comes with a number of technical challenges in which interference among them is a major problem. In this work, we have presented three power control mechanisms which helps in shifting in femto cell power according to different types of interferences. It has been found that first algorithm can be used when operator decides the fix femto power. The second algorithm considers the femto indoor and outdoor pathloss and assists the femto user to change the power according to maximum available power of femto cell. The third algorithm uses the interference between macro cell and femto user which uses pathloss between femto cell and its macro cell as a negative function which causes reduction in sub-carrier power depending upon its distance from macro cell. It has been observed that three can be used in a combination by femto cell in different neighborhood condition can provide better quality of service.*

Keywords- Femto cells, macro cells, 5g networks, power, throughput etc.

I. INTRODUCTION

Recent years have seen exponential development of worldwide mobile data traffic [1]. This expanding interest for high data rates is filled by the ubiquity of smart phones and the expansion of mobile Internet applications and services. Be that as it may, this is confronted by shortage and wasteful use of spectrum resources. In addition, current cell innovations and organization frequently show poor indoor coverage, particularly for rapid speed data services whose broadband prerequisite endures extreme channel mutilation and packet loss in complex indoor environment. This has turned out to be hazardous since recent measurements have demonstrated that beyond half of voice calls and beyond 70% of information burdens start from indoor cellular subscribers [2]. General directions for improving system throughput incorporate expanding number of radio wires, range expansion, upgrading sign to interference in addition to commotion proportion (SINR) through interference administration, versatile regulation and coding, and so on, and range reuse. In the course of recent years, the majority of limit increment has been licensed to more range reuse by decreasing cell sizes and expanding area spectral efficiency [2]. Thusly, network densification has been seen as an exceptionally encouraging course for system limit increment. One conceivable method for system densification is to send more macrocell base stations (cell towers). This network, be that as it may, is extremely costly because of the high establishment, operation, and support cost of cell towers. A late encouraging proposition for network densification and enhancing indoor remote scope is the deployment of femtocells[3]. A femtocell is an indoor cellular base station that associates supporters at a fast and low power via precisely reusing cellular spectrum. Femtocell base stations connect with the center service network by using broadband association, for example, Digital Subscriber Line (DSL), link modem, or radio recurrence (RF) backhaul channel. The idea of femtocells has been summed up to small cells including femtocells, picocells, and metrocells. This offers ascend to the general wording of heterogeneous systems (HetNets), where heterogeneity alludes for the most part to scope and transmission control [4]. From the system administrator's perspective, small cells enhance indoor scope and can offload activity from macrocells which enhances macrocell throughput and connection unwavering quality. Besides, the cost of a small cell, including hardware and organization, is much lower than that of a macrocell base station sent by the administrator. From user's point of view, the organization of femtocells builds user hardware's battery life because of utilizing lower uplink transmission control since the femto base station is currently nearer to the user. The idea of heterogeneous systems administration, and femtocells specifically, has as of now been presented in the institutionalization procedure for next generation communication systems, for example, LTE(- An) and WiMAX[4]. Femtocell base stations are alluded to as Home eNB (HeNB) in LTE institutionalization. Since the backhaul association of HeNB to the center system depends on corporate Internet, HeNB control channels and information movement can't be completely planned by the administrator's radio network controller (RNC). Indeed, HeNB can get control data of its neighboring macrocell base station (MBS). Yet, such data experiences Internet delays and can't be depended upon for HeNB resource task and interference control.

Although small cell networks give a few advantages to administrators and users alike, their massive deployment accompanies various specialized difficulties. Eminently, an essential and adverse issue confronting SCN's is the presence of interference among neighboring SCN's, and between the SCN's and the full scale cell LTE network [2].

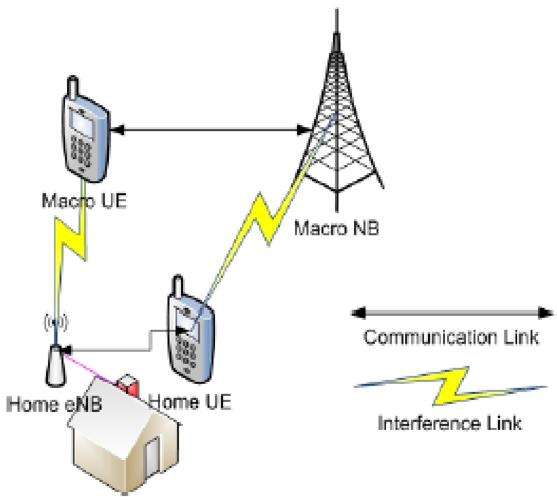

Figure 1: Topology of an FDD LTE Small Cell HeNB[2]

One approach to manage interference in SCNs is through Power Control Optimization. The primary reason for power control is to minimize the transmitted power, hence staying away from pointless high power levels and eliminating interference. By properly changing the downlink transmission control per Resource Blocks (RB) that is required to acquire an objective bit rate in femto cells, the general created interfernce in the SCN could be fundamentally decreased. As such, Home advanced NodeB (HeNB) modifies its transmission control in order to satisfy home user (HUE) Quality of Service (QoS) while securing macrocell users (MUEs) in its region by keeping the interference underneath a limit.A noteworthy part of the current writing has explored the interference administration issues of coordinated LTE and Small Cell networks. In this work we have picked three power control calculations which can be utilized for various situations .The most well-known algorithmss for HeNB Downlink Power Control as characterized by the 3GPP are exhibited underneath [2]:

1.) Fixed HeNB power setting [2]
2.) Smart power control based on interference measurement from macro NodeB
3.) HeNB power control based on HeNB-MUE path loss

In this work, these three algorithms has been simulated and power and throughput parameters has been investigated.

II. LITERATURE SURVEY

Khan et al. (2015) attempt to decrease interference by proposing a power enhancement algorithm that upgrades the estimation of the transmission power of the femto get to focuses in a decentralized way so that the interference with the contiguous cells and user hardware is lessened.

Lin et al. (2015) initially studied that provisioning the limit of remote networks is troublesome when peak load is fundamentally higher than normal load, for instance, out in the open spaces like air terminals or train stations. Service providers can utilize femtocells and small cells to increase local capacity, however deploying enough femtocells to serve crest loads requires a substantial number of femtocells that will stay sit without moving more often than not, which squanders a lot of force.

Rahman et al. (2016) present an adaptive resource allocation (i.e., bandwidth and transmit power of femtocells) scheme which tries to moderate the cross tier interference amongst femtocell and macrocell, guaranteeing general decency among cell center and cell edge users.

Saadat et al. (2016) propose a novel resource allocation plot for co-channel interference avoidance in LTE heterogeneous networks with universal reuse where both macro users (MUs) and intellectual femto base stations (FBSs) inside the same macrocell coverage can powerfully reuse entire spectrum. In particular, resource squares (RBs) are shared between intellectual FBSs in underlay mode while the resource sharing among FBSs and MUs is in overlay mode.

Li et al. (2016) studied that for fulfilling quickly expanding data rates at hotspots and improving coverage in structures, small cells, for example, femtocells, picocells, and microcells, are deployed in LTE-A. Femtocells are ordinarily introduced at hotspots and overlay with the macrocell to enhance vitality proficiency and information rates.

M. F. Khan et al. (2017) designed analysis of Macro user offloading and ultradensification of Future 5G Cellular Networks and Femto cells using CLSM. Different aspects of the proposed schemes have been evaluated, with the help of a simulator enabling reproducibility.

Murthy et al. (2017) focused on backhaul link scheduling for mmWave cellular systems. To achieve high resource utilization in mmWave based 5G cellular networks they proposed direct F2F communication which not only helps in offloading the data traffic from MiBS when the user traffic is destined to the same cell but also can act as a relay link for the other FBSs for routing the backhaul traffic to MiBS.

III. PROPOSED WORK

Steps in simulation of proposed work

Flowchart for initial random deployment of Macro and Femto cells and users

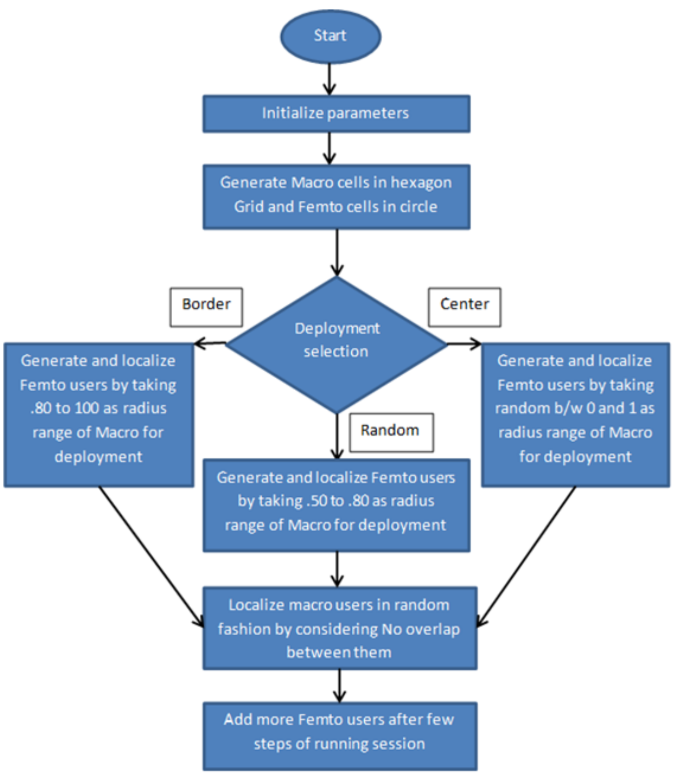

Figure 2: Flowchart for initial random deployment of Macro and Femto cells and users

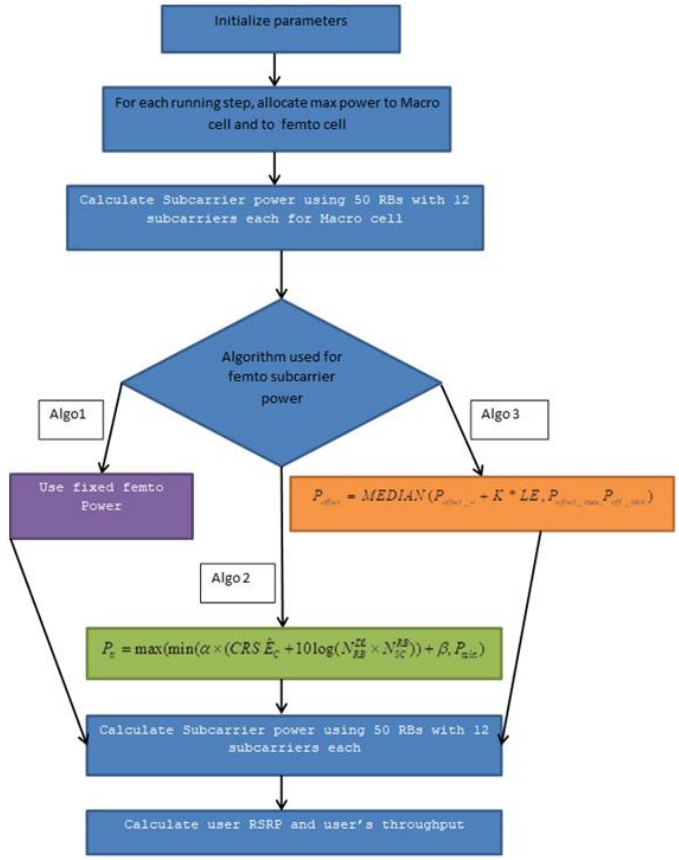

Figure 3: Flowchart for Femto power calculation and throughput calculation

- **Downlink control level setting plans**

Numerous interference mitigation procedures to relieve the Macro-Femto interference issue utilizing Femtocell power level setting in DL have been proposed and investigated. In here we experience some of them:

1. **Basic settled power approach**

For all Femtocells, a preconfigured value is normal paying little respect to the encompassing RF conditions. Organize Operator regularly sets HeNB transmission power. HeNBpower stay stable and does not rely on upon the progressions showed up in the topology and the traffic situation. The advantages of this plan are its effortlessness and simplicity of usage. Drawbacks are the challenges to adjust to the encompassing RF conditions and likeliness to bring about expansive interference.

2. Self-Configuration in view of Macrocell flag

In this, the measured received signal level from Macrocell is utilized .HeNB alters its greatest DL transmit power as an element of air interface estimations to abstain from interfering with macro cell UEs. The HeNB modifies its most extreme transmit control as indicated by the accompanying equation:

$$P_{tx} = \max(\min(\alpha \times (CRS\,\hat{E}_C + 10\log(N_{RB}^{DL} \times N_{SC}^{RB})) + \beta, P_{\min}) \quad (1)$$

where:

parameters $P_{\max}$ and $P_{\min}$ is the most extreme and least HeNB transmit power settings, CRS $\hat{E}_c$ is measured in dBm, which is the RSRP per resource component present at the Home BS antenna connector got from the most grounded co-channel macro cell. N_{RB}^{DL} is the quantity of downlink resource blocks in the HeNB channel. R_{SC}^{NB} is the quantity of subcarriers in resource block (R_{SC}^{NB} =12). Parameter α is a linear scalar that permits changing the incline of power control mapping curve, β is a parameter communicated in dB that can be utilized for modifying the correct scope of CRS Êc secured by element scope of power control. Parameters $P_{\min}$, α and β are thought to be HeNB design parameters, and $P_{\max}$ relates to the HeNBs maximum transmit power capability.

3. Self-Optimization approach in light of portability of large scale clients

In this, a self-improvement of coverage as per the information on mobility occasions of passing and indoor users is utilized.HeNB modifies the downlink transmit power by considering the path loss between the HeNB and an open air neighbor MUE incorporating infiltration loss keeping in mind the end goal to give better interference mitigation to the MUE while keeping up adequate HeNB scope for HUEs. HeNB sets the transmit power of reference signal P_{tx} as takes after:

$$p_{tx} = MEDIAN(P_m + P_{offset}, P_{tx\_upp}, P_{tx\_low})[dBm] \quad (2)$$

Where:

P_m (dBm) is RSRP from the closest Macro advanced NodeB (MeNB) measured by the HeNB. P_m is reliant on path loss which incorporates the penetration loss between the closest MeNB and the HeNB. P_{offset} (dB) is the power offset portrayed in equation 3 in detail and P_{tx_upp} / P_{tx_low} (dBm) is the upper/lower limit for the transmit power of the reference signal. The most extreme and the base aggregate transmit power of HeNB ought to take after HNB in [2].

The greatest downlink transmit power can be set by the HeNB in extent to the transmit force of the reference signal. As the RSRP diminishes, which implies the HeNB is found near the edge of the macro cell, the transmit power ought to be little with a specific end goal to relieve the downlink interference to the MUE.

P_{offset} above ought to be characterized in light of path loss between the HeNB and the MUE. The path loss may comprise of indoor path loss between the HeNB and cell edge of HeNB cell and the lossdue to penetration. In this way, P_{offset} ought to be defined as in (3):

$$P_{offset} = MEDIAN(P_{offset\_o} + K * LE, P_{offset\_\max}, P_{off\_\min}) \quad (3)$$

where:

P_{offset_o} (dB) is a foreordained power offset value corresponding to the indoor path loss. Run of the mill esteem run in the vicinity of 50 and 100dB, and we can determine the value range by averaged measured value. K is a customizable positive factor which can be dictated by the need of HeNB operation. This value ought to be high to expand the aggregate transmit power (MeNB is more satisfactory to higher interference) and low to lessen the interference to MeNB operation. LE (dB) is evaluated entrance misfortune as underneath.

$P_{offset\_\max}, P_{off\_\min}$ (dB) is the most extreme/least value of the P_{offset} by which the assessed and figured P_{offset} can be kept from being too small or too large. This value is reliant of the genuine wall penetration loss in addition to P_{offset_o}. The normal wall penetration loss runs in the vicinity of 10 and 30dB.

IV. RESULTS AND DISCUSSIONS

Parameters used for simulation

Parameters	value
inter-site distance (ISD)	1732m
Required RSRP	-70
Maximum Macro Power	46 (dbm)
Minimum Macro Power	36 (dbm)
Maximum Femto Power	10 (dbm)
Minimum femto Power	-10 (dbm)
Antenna gain	14 db
Parameters a,b,g,k respectively	0.7,60,-30,0.1
F	2000
Carrier Bandwidth	10MHZ
Resource blocks (RB's)	50
Subcarriers	12
Ber	10^(-6)
Alpha	-1.5 / log(5 * BER)
MUE speed	3km/h
Distribution of MUS within Macrocell	Uniform

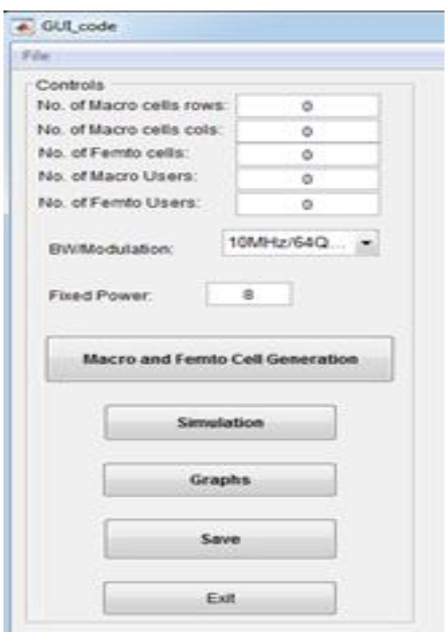

Figure 4: GUI developed in MATLAB software asking to choose various parameters

Experiment results have been taken by taking 3*3 size macro cell network. In this 5 femto cells has been considered. Total 90 macro users and total 50 femto cell users has been used in first simulation in which 'border' has been selected to localize the femto users in border location of femto cell region. In this 8 dbm fixed power forfemto cell has been used along with modulation mode of 64Qam. The carrier bandwith has been decided as 10MHZ in which 12 subcarriers has been used with 50 resource blocks size. The GUI figure asks various parameters in order to start the simulation with the asked parameters. A Gui for various parameters has been shown in figure above.As seen in figure 4, there is a choice for user to choose various parametrs according to his/her need. No. of macro cells, No. of femto cells, no. of macro users and no. of femto users can be selected from GUI, However other parameters can be changed in main code provided in main script file.

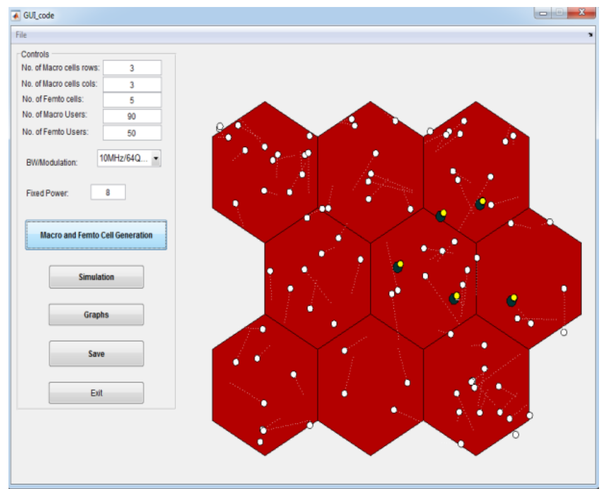

Figure 5: Image showing generation of Macro and Femto cells along with their users

Red hexagons presume macro cells wheras dark green circles resembles femto cells. Yellow circles and white circles resemblesfemto and macro users respectively. This figure comes when one pushes pushbutton named as 'Macro and Femto cell generation'.

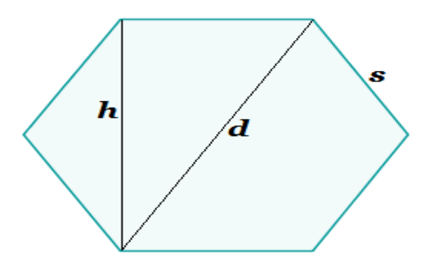

Figure 6: A figure showing various parameters that are helpful in making non-overlapinghexgon cells

As shown above, h is inter-site distance (ISD) which is taken as 1732 m. Other d and s are helpful in finding neighbouring macro cells of a cell, locating dispersed femto cells and macro users etc.

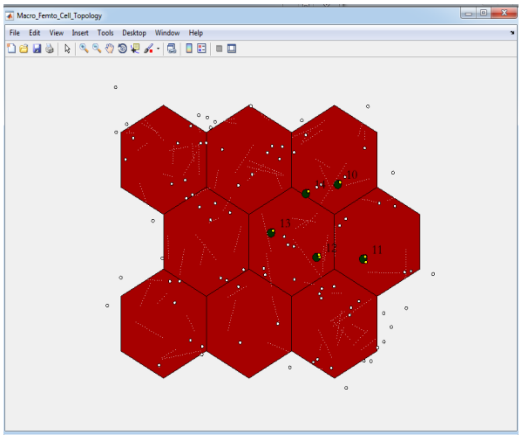

Figure 7: Location of macro users and femto cells after simulation

Figure above shows the macro users and femto cells after simulation. As seen above. Macro users have been seen moved from their original locations as mobility of macro users has been used in the simulation but femto users are kept as without movement.

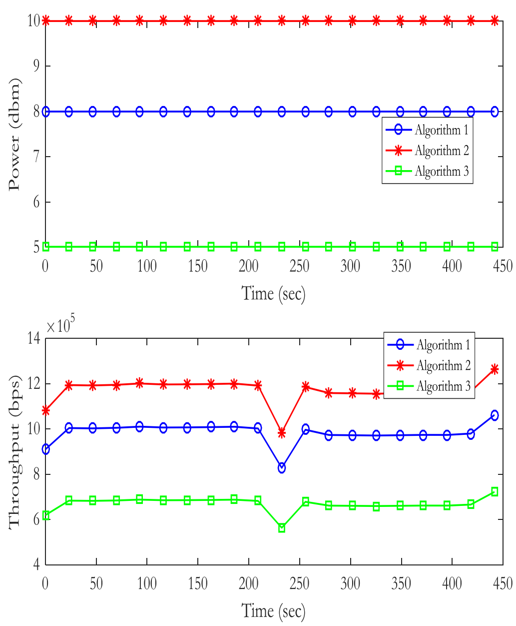

Figure 8: Femto power and throughput graphs for femto cell one (10 in topology diagram)

Similarly power results have been obtained for other femto cells. It has been found that all three algorithms provide different throughput and power consumption based on the location of the user nodes. In future a collaborative algorithm which can use all three algorithms in single communication can be developed in order to control the power and increase the throughput in a single communication

V. CONCLUSION

In this work, A GUI has been introduced in MTALAB software to generate Macro and Femto cells in a network. In this uniform distribution has been used to disperse the macro and femto users in the network. Also power control interference mitigation has been presented using three algorithms in which first algorithm can be used when operator decides the fix femto power. The second algorithm considers the femto indoor and outdoor pathloss and assists the femto user to change the power according to maximum available power of femto cell. The third algorithm uses the interference between macro cell and femto user which uses pathloss between femto cell and its macro cell as a negative function which causes reduction in sub-carrier power depending upon its distance from macro cell.

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