An Hybrid Power Control Method For Femto Cells To Mitigate Interference Caused By Macro Cells

A Dissertation Submitted in Fulfillment of the Requirement for the Award of the Degree of

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in

Wireless Communication

Submitted by

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DECLARATION

I, Sukhpreet Singh hereby declare that the work presented in this thesis entitled **" An Hybrid Power Control Method For Femto Cells To Mitigate Interference Caused By Macro Cells"** in partial fulfillment of the requirement for the award of degree of Master of Engineering (WC) submitted at Electronics and Communication department, T.I.E.T., Patiala is an authentic record of work carried our under supervision of **Dr. Surbhi Sharma** (Associate Professor), Electronics and Communication Department, T.I.E.T., Patiala from July 2016 to July 2018.

The matter presented in this thesis has not been submitted either in part or full to any other university or institute for the award of any other degree.

Date: 31/8/2018

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It is certified that the above statement made by the candidate is correct to the best of my knowledge and belief.

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ABSTRACT

The rise of new information and video services combined with an expansion in the quantity of user devices, for example, advanced cell-phones, tablets and laptops etc. has constrained mobile operating companies to inspect new ideas for expanding coverage issue, boosting data-transmission and reception rates and bringing down capital and maintenance expenditure of their mobile network. An effective method to manage these requests is the idea of Small Cell Networks (SCN). Smaller-cells have a solid potential for expanding the network coverage, efficiency and system limit of next generation mobile systems while then again the deployment costs for the network service provider is kept in to a very low level. This work is centered on effective power control in Small-Cell-Networks. Specifically, we propose a power control method for proficient power allocating in small cell networks especially the femto cells in Small cell networks. The suggested method effectively controls system-frameworks' interference along with insuring quality of service to macro users. We present the strategy of Priority based Grouping which uses one algorithm at a time among three power allocating algorithms in which first algorithm uses Fixed HeNB power setting ,second algorithm uses smart power control based on interference measurement from macro NodeB and third uses HeNB power control based on HeNB-MUE path loss, in which home clients in the topology is allocated to one of the accessible groups with different target throughput requirements as far as power necessities and to deliver the required trafficking load of the network. The system effectively refreshes the Home developed Node B (Femto node) power control setting in the favor of the effective use of the topology of the macro as well as home clients simultaneously in real time scenario. Furthermore, contingent upon the analyzed activity situation the system can give better insurance (regarding impedance) either on full scale clients or on home clients. Proposed algorithm is tested on a simulated traffic scenario in which 9 macro and 7 femto cells are simulated with 219 MUEs, 51 initial HUEs gradually distributed in time domain in which femto users (Hue) are further increased to 821 in which 770 are inserted during simulation as the iterations rises. MUE population remains constant in the simulation. It has been observed that algorithm four chosses algorithm three when femto cell is on the boundary of the macro cells, as there is least interference to the macro cell center in which little power is efficient to achieve the target throughput. When femto cell is near to center, it uses algorithm one in group 3 as it needs smaller throughput target means less power so that least interference is achieved with that of macro cell users and algorithm three is used for the first and second group as more throughput was required.

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ABBREVIATIONS

SNR	Signal To Interference and Noise Ratio
RNC	Radio Network Controller
IP	Internet Protocol
RAN	Radio Access Network
FMC	Fixed Mobile Convergence
RRM	Radio Resource Management
SON	Self- Organizing Networks
BS	Base Stations
OSS	Operation Support Subsystem
UE	User Equipment
SCN	Small Cell Network
FAP	Femto Access Point
FFR	Fractional Frequency Reuse
LTE	Long Term Evolution
HDOA	High Definition Of Anything
GAMS	General Algebraic Modeling System
MU	Macro User
CCI	Co-Channel Interference
MBS	Macro Base Station
DCC	Dual Cell Connectivity
DSL	Digital Subscriber Line
ISD	Inter-Site Distance
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality

CHAPTER 1

INTRODUCTION

1.1 Overview

LTE is the 3GPP standard releases that represent the fourth generation (4G) of mobile schemes. The data rate for its downlink can reach up to 100 Mbps [32]. There are some dead zones for LTE coverage areas. The places, indoor regions or inside tunnels are represented by these zones, wherever for very poor signals or no signal. The preeminent result to prolong the LTE coverage to embrace indoors is Femtocells' deployment. They generally share the range with the macrocells, such that the subcarriers, utilized by the macrocells, will be reused in every femtocell. This kind of spectrum assignment is known as a co-channel deployment or universal frequency reuse. Shared electromagnetic impedance may happen among the femtocells and the macrocells and among the femtocells themselves because of the task on a similar range.

This obstruction can corrupt the full scale and the femto clients' (SINR) signal to interference and noise ratio, geometry, and (bps) throughput. Figure 1.1 demonstrates the (LTE) heterogeneous (HetNet) engineering, where all Femto cells are associated with broadband system and after that gets associated with Femto portal (Femto-GW) by means of S1 interface [31]. Because of FBS, not exclusively do indoor clients appreciate high data rates, yet telecom administrators additionally advantage by saving operational expenditure (OPEX) and capital consumption (CAPEX). In spite of the fact that the association of FBSs improves indoor information rates without a doubt, it might bring about a large group of issues like cross-channel or co-channel impedance and continuous hand over. The explanation behind obstruction is that all FBSs work in a similar range to enhance the range productivity (i.e, reuse factor one). Self-assertive sending of FBS can prompt high cross and co-channel obstruction among MBSs and Femtos.

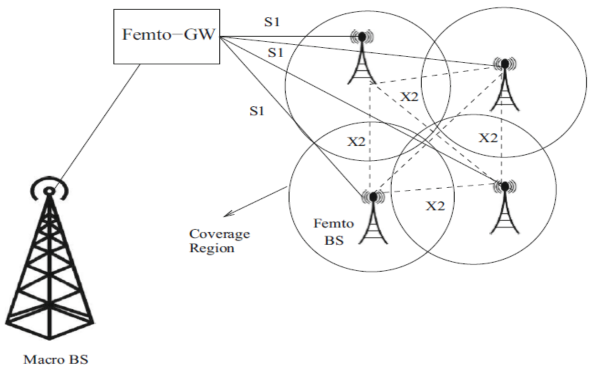

Figure 1.1: LTE architecture [30]

1.2 Femtocells

Femtocells are cellular network indoor coverage and capacity solution, designed to operate in licensed frequencies and served by access points known as Femtocell access points (Femto AP) or Home node B (HNB). Femto AP is a femtocell base station device that contains Radio Network Controller (RNC) functionality, while the femtocell is the small area covered by the Femto AP. The Femto AP is characterized by a limited number of users (5 or 16 in home or enterprise deployments, respectively), limited maximum transmission power of 125mW, a maximum range of 30 meters and low deployment cost. The core network backhaul is via internet protocol (IP), often through commercial DSL; however, some interest groups have recently proposed backhauling femtocell traffic using unlicensed spectrum [6]. Listed below are a few attractive features of the femtocell technology:

- It extends the indoor cellular coverage to places where macrocells cannot.
- In a Heterogeneous Network (HetNet), femtocells are used as traffic off-loading spots accessing network of radio to decrease congestion in macrocells and enhance QoS (when macrocells are used to provide indoor coverage, the macro Node b transmits more power to recompense for high penetration loss which results in reducing the macrocell capacity).
- Addition of femtocell layer to the HetNet, leads to efficient spectral re-use and hence the improvement of total network capacity.
- With growing demand for high data rate and high bandwidth applications, femtocells provide a promise of high QoS for indoor user through high performance radio frequency, RF; links i.e. high receive signal levels.

- Femtocells prolong battery life of user equipment, UE. This is so due to the the shorter distance between UE and Femto AP requires lesser power for the UE to transmit than transmitting to the distant Macro Node B.

1.3 Architecture

To give amenities to end clients having a femto cell base station, it is essential for the administrators to describe the design for a femto cell in light of the kind of cell network. By and large, a cell phone client can change itself deeply arrange either by associating itself to the macro or femto cell. Analysts have displayed designs for different femtocell systems. In this segment, we talk about structures for systems, for example, Cognitive Networks, UMTS, and CDMA and so on.

As appeared in Figure 1.2, the plan of femtocell arrange is with the end goal that information activity utilizes the general population web while the voice movement experiences the IMS organize [28]. The Figure demonstrates the structure of SIP (Session Initiation Protocol) and IMS (IP Multimedia Subsystem) - based femtocells. SIP and IMS based structure is utilized in light of the fact that in interworking system, IMS conventions are changed over through SIP passage. Subsequent to going IMS through MGW and MGCF, it is taken for interworking with PSTN. The system exhibited in Figure 1.2 can ensure end to end QoS call stream in the IMS and SIP compose femtocells.

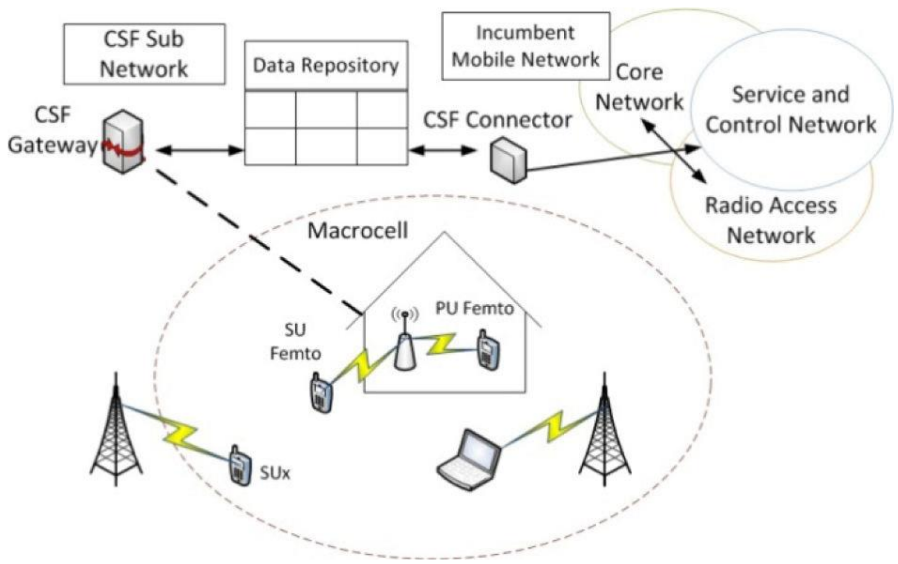

Figure 1.2: A femtocell deployment architecture

It should be remembered that IMS can deal with just voice activity; anyway it will be associated with a few femtocells. Since information does not experience the IMS organize, the supporters can benefit different administrations on less cost.

Table 1.1: A comparison between femtocell and macrocell [6]

Macrocell	Femtocell
Few number of base stations, BS.	Large number of FAP should be supported by network.
Deployed by the operator in a controlled manner.	Typically deployed by the customer in an un-controlled manner. Plug-and-Play.
The environment of each node is well known.	The environment of Femto AP is not known.
Access node is on safe locations and integral part of the network.	FAPs are on customer premises but still an integral part of the network.
Autonomous Operations, Administration, and Management (OA&M) is preferable but manual configuration is possible.	Autonomous OA&M is a mandatory.

1.3.1 Access Methods

Femtocells have the ability to discriminate between UEs through access control procedures. Users are classified in two categories:

- Subscribers are UEs that are registered to the femtocell and they are the legitimate femtocell users.

- Non-subscribers are UEs that are not femtocell registered users therefore may have none or limited access to it.

Based on the above classification, there are three access methods proposed by 3GPP in femtocells as shown in

Table 1.2: closed access, open access and hybrid access.

	Open access	**Closed access**	**Hybrid access**
Subscriber	Access	Access	Preferred Access
Non-subscriber	Access	No Access	Limited Access

In closed access mode, only subscribers who are members of the closed subscribers group (CSG) can connect to their femtocell. However, femtocells operating in open access mode are easy to get by everyone. The hybrid access was proposed to counter the drawbacks inherent in both approaches. There is a preferred access for subscriber to their femtocell, and non-subscriber can have constrained access to the femtocell assets in the hybrid mode.

Table 1.3: Features of Closed and Open Access Methods

Closed access femtocells	**Open access femtocells**
High interference	More handovers
Serves only to indoor users	Increased outdoor capacity
Lower network throughput	Higher network throughput
Easier billing	Security needs
Home market	SMEs and hotspots

1.3.2 Radio Resource Management (Rrm) in Femtocells

Femtocells are deployed as an additional layer over the existing macrocell layer in cellular networks and both layers in the multi-tier network may share the same frequency spectrum.

To build limit and furthermore because of the constrained unearthly assets, femtocells and macrocells re-utilize the aggregate dispensed frequency band incompletely or absolutely which brings about cross-level or co-channel impedance. Additionally, to ensure the required QoS to the large scale clients, femtocells ought to involve as meager data transfer capacity as could be allowed. On the off chance that RRM isn't legitimately dealt with, the throughput of the system will diminish considerably because of co-level and cross-level impedance [12].

In macro networks, extensive radio frequency planning is carried out to optimize capacity and coverage. However, in femtocells, Femto APs are deployed in an unplanned manner and hence the need for self-organizing capabilities, i.e., to negotiate resources that can be used and automatically detect and resolve clashes arising from use of overlapping resources that would cause interference. So the RRM challenge is to determine what resources should be allocated to femtocells so as to limit interference and achieve acceptable QoS.

There are two conceivable arrangement ways for the administrator as featured in the current works [14]. One approach is to set aside a piece of the range for conveying femtocells and utilize the staying for the full scale organizes. This is outstanding as the ' dedicated channel' arrangement approach, Figure 1.3. The other approach is to convey femtocells on an indistinguishable range from existing macrocells. This is outstanding as the 'co-channel' organization approach. The upside of the previous approach is that obstruction impacts of the femto system to/from the large scale system can be confined. In any case, the committed channel approach isn't a financially savvy arrangement as the authorized range isn't just rare yet in addition costly. Moreover, this additionally diminishes the range use effectiveness.

In any case, it is conceivable that administrators may consider this option given that they need to guarantee that the limit picks up encouraged by the arrangement of femtocells don't come at the cost of degradation in the full scale organize execution. Having said this, it doesn't really imply that the same can't be accomplished with the co-channel arrangement approach. The upside of cochannel approach is its cost viability and change in range use in contrast with the dedicated channel approach. Notwithstanding, sending on a co-channel may not seclude the impedance impacts of femtocell transmissions to/from the full scale cell/other femtocell transmissions. Cautious building is required to limit (if not take out) these obstruction impacts [17].

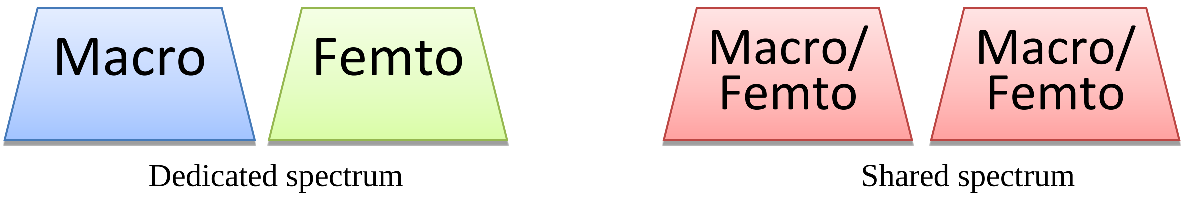

Figure 1.3: Dedicated and shared spectrum in Femtocell Radio Resource management

The purpose of RRM in femtocells is listed as follows [17]:

- Ensure that changes to individual femtocells do not cause unintended influences on overall radio network performance.
- It is important to have management control of the interference between the operator deployed macro layer and the customer deployed femtocells.

1.3.3 Self- Organizing Networks (Son) in Femtocells

A self-arranging system is characterized as a system which requires an insignificant individual contribution due to the independent and additionally programmed its working nature. It coordinates the procedures of composition, arranging and inflation in an arrangement of self-governing/programmed functionaries. These functionaries permit femto cell to filter the interface, and tune their parameter as indicated by the progressive conduct of system, traffic and channel [37]. Via independent action we mean the action does not require any human inclusion, while a programmed procedure implies that the activity is dealt with somewhat by the machine and by a person.

In order to limit the activities of RF engineers in femtocell deployment i.e., in planning and optimization, it is necessary that Femto APs have self-organizing abilities. This will allow easy adaptation of femtocells to the dynamic RF environment. There are four stages in life-cycle of a SON, Figure 1.4, i.e., self-configuration, measurements, self-healing and self-optimization [37].

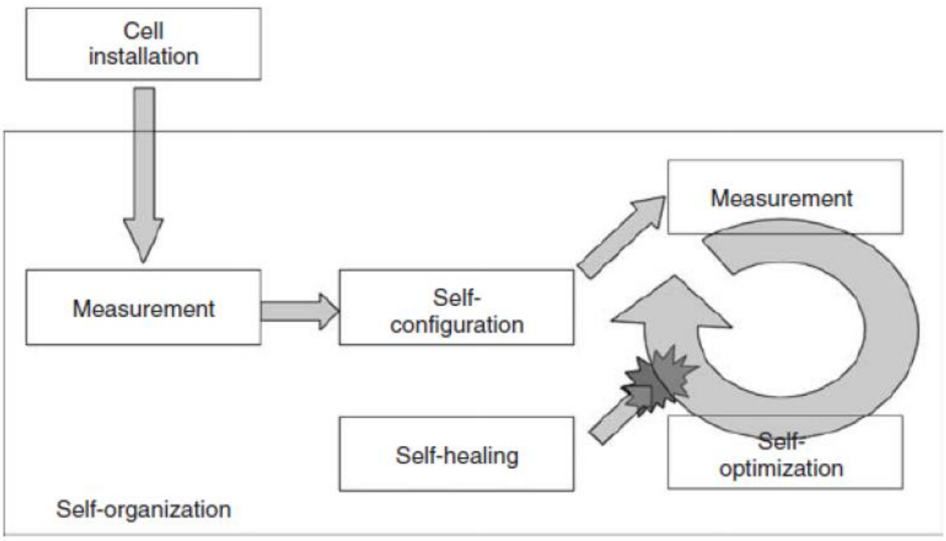

Figure 1.4: Life-cycle of a self-organizing cells [37].

A. Measurement Phase

During the estimation stage, base stations (BS) gather estimations keeping in mind the end goal to survey the conduct of the system, and trigger the satisfactory activities. These estimations are taken through different origin e.g, (OSS) Operation Support Sub-system, organize counter, estimations originating from neighboring hubs or client terminal. To give important data to the distinctive arrangement and enhancement errands, these crude information, e.g. traffic designs, client portability, impedance/blurring circumstances, must be prepared. The mandatory configuration, exactness and recurrence of the conveyed data rely upon the particular instrument to act naturally designed or advanced, and these decide the nature of the tuning [37].

B. Self-Configuration Phase

A recently included BSs arrange its product and criterion (neighboring rundown, deliver design, pilot control) utilizing self-setup. Along these lines, this BS coordinates itself into the system, while expecting to limit the effect on current BSs and User Equipment (UEs). Also, current BSs can utilize the self-arrangement stage to respond to presentation of new BSs or new highlights in the system, e.g. services, bearer, antenna. Before this new overhauls wind up agent, an underlying reconfiguration of various calculations and parameters is for the most part required [37].

C. Self-Optimization Phase

In the self-enhancement stage, the prepared estimations are utilized intermittently to alter the calculations and guideline of the BS to the alternating states of surroundings. Utilizing the information of the earth, the scope and limit of the system can be streamlined, filling scope openings and giving impedance moderation. On the off chance that the self-advancement is unequipped for meeting the execution necessities, the BS will trigger cautions with going with proposals for human intercession, e.g. sending another BS [37].

D. Self-Healing Phase

Self- curing procedures will solve the loss of scope or potentially limit because of deficit in the system e.g. hurt BSs. This is done by adjusting the calculations and its parameters in encompassing BSs Once the solution of failure has been found, all parameters are reestablished to their original setups. The requirement for self-association in femto cell arrangements is bifold:

- the installation or maintenance has not been done by administrators, because of the vast number and self-interested nature of femtocells.
- due to the non-specialized skill of the femtocell clients, femtocells can't be optimized or designed by the clients. Hence, both plug and play nature must be the key future of femtocells for both the administrator and the client. Self-association in femtocell circumstances must offer the beneath highlights among all:

- Discovery of network and neighborhood,
- physical cell identity has been select automatically,
- configuration and improvement of the neighboring cell list,
- configuration and improvement of the handover parameters
- configuration and optimization of the RF parameter (frequency and power)

This self-association can be accomplished on an event triggered or regular basis and it will permit femtocells to enhance their scope and limit, and lessen the likelihood of ID effect and impedance [37].

1.4 Shared Spectrum

The major role of 5G wireless systems is to offer both rapid availability of signal and worldwide access to clients, even the users are indoors. Certainly, one notorious difficulty related to coverage of wireless is that it may be unable to deliver high strength of signal indoors then wireless signals have concern infiltrating through walls. Then the gadgets for femtocell have been showed up as a promising keys that accompaniments and increases coverage of macrocell traditionally among positions of indoor. Furthermore, the dense organization of these cells along with small radius will deliver high capability through increased spatial reuse. Though, the mixture of both macrocells and femtocells in a license band of shared operator increases some major difficulties that are related mostly to management of interference. In this situation, the selection of the most appropriate radio resources and spectrum band to be utilized per competing entity is a main matter. To overcome this problem, algorithms of spectrum sharing have been used. The benefit of this is that they are independently organized, the allocation of these resources in an independently method has been needed and without organization between operator-managed macrocells and public femtocell devices. This becomes the issue of the difficulty allocation of resource between femtocells and macrocells.

1.4.1 Allocation procedure for resources

The Allocation procedure for resources has been placed at different layers [2]. A limited approval of band of administrator possessed range must be regular among macrocells and femtocells. At the highest level of the portion system procedure for resources, the elementary outline has been fixed: which bands of spectrum are accessible to which classes of BSs: either macrocell or femtocell. Basically, there are three structures of spectrum arrangement that has been identified as shown in figure 1.5:

1) Complete separation: Macrocells and Femtocells use separate bands of spectrum. Both macrocells and femtocells are not interfering with each other due to operating on disjoint bands. The availability of band of transmission is limited only in this case.

2) Partial sharing: Both macrocells and femtocells can by shared the portion of the total band. The remaining band is used entirely by femto or macro cells.

3) Complete sharing: The whole band is basic by femtocell and macrocell in this manner developing shots for expanded spectrum adequacy. However, explanations for justifying interference are critical and need to be calculated.

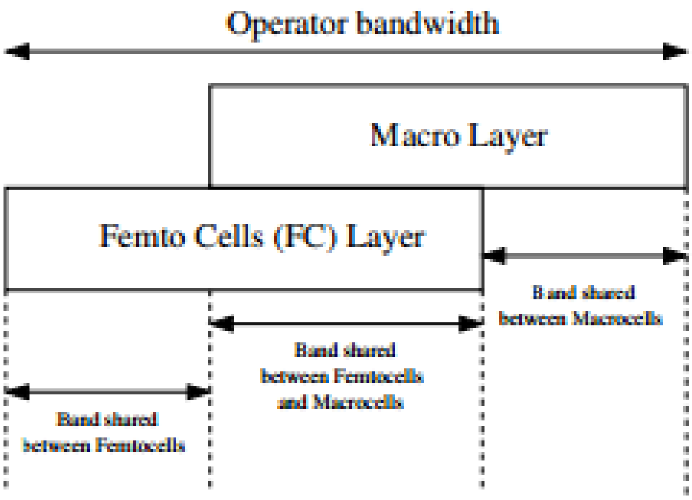

Figure 1.5: The partial sharing outline between femtos and macros [2]

1.4.2 Heterogeneous Networks in LTE

The idea behind heterogeneous networks is to overlap homogeneous ones with further organization based on the smaller low-complexity low-power base stations. The homogeneous level is typically named as the macro-layer referring to the prolonged radius of coverage of its inheritance “macro” base station. Likewise, in the second tier, the small form feature base stations are denoted to as “femto” or “pico” the coverage area of these base stations are significantly slighter. In overall system performance, the splitting of cell has been provided large gains in terms of physical level, in order to diminish the average distance both in transmitter and receiver, and the MAC level, for the normal number of linked operators per base station is likewise significantly dropped. Two situations are exceptionally compelling: Network operators connect further low-power base stations in order to generate hotzones or picocells in a proper way wherever clients have a tendency to be bunched in little spaces, for example, shopping centers, schools, or stadiums. In the coverage area, accessibility of these low-power nodes always opened to everybody and the backhaul connection has been controlled by the operator. Either Enterprise or Residential femtocells, in contrast, try to raise coverage of indoor for a somewhat small number. There are many aspects to consider in the deployment of heterogeneous networks that may differ considerably from traditional homogeneous ones. Additional low-power base stations increase the number of hand-offs in the network and a consumer-deployed Ethernet backhaul raises questions of privacy, delay, backhaul capacity, and routing. Lastly, heterogeneous networks have also attracted a lot of attention not just because of their benefits in terms of efficiency of spectral and throughput but also because of their increased energy efficacy equated to homogeneous networks [25].

In the overlapped Macrocell coverage zone: Macrocell-to-Femtocell, Femtocell-to-Femtocell and Femtocell-to-Macrocell obstructions may happen. These interferences’ frequency increases as Femtocells’ density is extended. Hence, powerful interference modification systems are basic here. In an arrangement of dense Femtocell network, a large number of Femtocells can be conveyed inside a little area of coverage and in this manner; the system must have the capacity to oversee effectively. Fig. 1.6 underneath demonstrates some organization sorts of dense Femtocell networks.

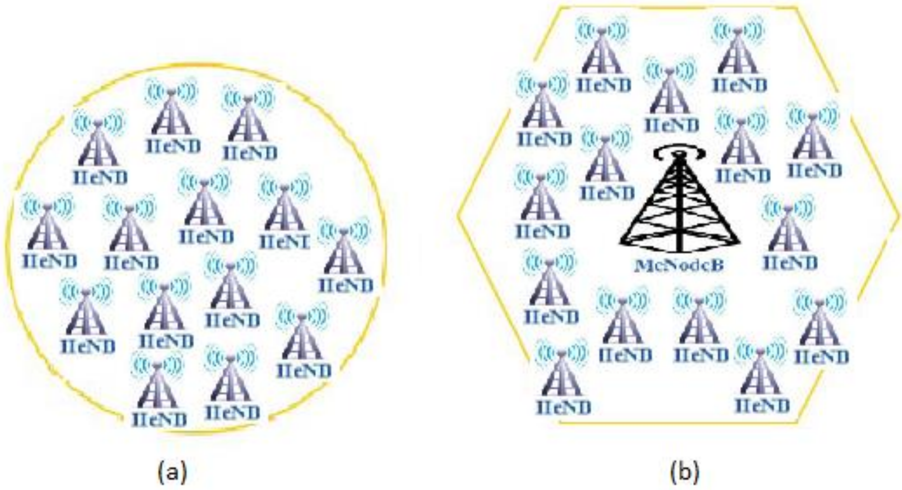

Figure 1.6: (a) Dense femto deployment without Macrocell Overlaid (b) Dense femto deployment with Macrocell Overlaid

We have significant bits of knowledge in the interference of Macro-Femto issue, while the Femto-Femto interference viewpoints endure incompletely tended to. These kind of issues are outlined in the discussion in the research and pointed towards potential arrangement methodologies.

1.5 Intra Femtocells Impedance Administration

After the establishment of another Femtocell is set very close by, the two signs of the two neighbors cells may interfere. There are different kinds of algorithms of transaction that are typically utilized to distinguish the impedance, identify run real negotiation and the interferer. The main part of these algorithms tail one of taking after various 2 methodologies:

• Centralized method: simpler to execute (based on chart and understood) like coloring in graph (NP-complete)

• Femtocell between there own (decentralized): more difficult algorithms and debates yet precise and adaptive

[1] features the most utilized methodologies to arrange properties and keep away from interference. After the hampering cell are distinguished, the following stride is team up with them in order to determine interference matters. One of the expected approaches is Power Control Transmission for example by adjusting transmits power. In the Transmit

Power Control method, contingent upon conditions, Femto cells can direct their maximum down-or uplink control levels to guarantee the most elevated conceivable signal strong for their clients with a reasonable calculation and great QoS. Furthermore, the cell phone itself may lessen its greatest communicating power when evaluated by the Femtocell to keep away from interference circumstances as when has user on its edge. Obviously, lessening the transferring power generally prompts to lower signal quality and along these lines a smaller coverage area and lower bandwidth.

Along these lines, this arrangement may not generally be as satisfactory as switching channels if there should be an interference occurrence if free channel are accessible. To enhance the signal strength for contributed cell phones and in the meantime not decreasing the signal strength, the Femtocell may likewise utilize dynamic power levels, contingent upon a few components like separation between path loss, penetration and cells supporters' position, and so on. Table 1.4 underneath demonstrates the fundamental Challenges and Gains of dense/neighborhood Femtoce33lls arrangements:

Table 1.4: Advantages and Corresponding Problems oF Using Dense Femtocells

Advantages	**Problems**
Cell Splitting	Unplanned deployment
Higher Coverage	Mobility of users
Signal to noise ratio Improvement as user comes near to serving cell.	Neighborhood List, Maintenance & Discovery
Saving in power as compared to Macro cells	Mitigation of the unnecessary handovers

1.6 5G Frame Format

In Time-division-duplex (TDD) based 5G small cell optimized frame format (Figure 1.7), Micro Base Station (MiBS) controls the uplink and downlink transmissions of the femto base station (FBS) in the network by suitably assigning the resources to the FBSs [23]. MiBS broadcasts the beacons in all the directions by activating its beams in all the sectors for synchronization. As shown in Figure 1.7, each 20 ms superframe is divided into 80 subframes of 0.25 ms duration which consists of control and data period. An

FBS and the MiBS exchange data transmission requests, location information, transmission power, and boresight direction during the control period. Moreover, the MiBS also determines the optimal transmit power of the FBSs during scheduling and communicates the same to the FBSs during the control period.

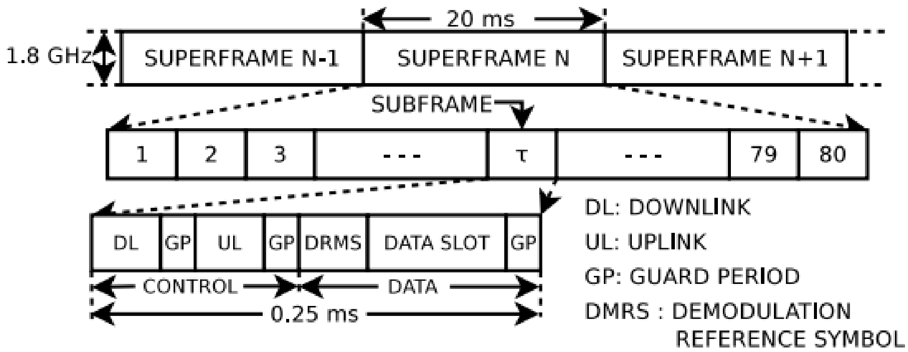

Figure 1.7: 5G Small Cell Optimized Frame Format

In the spread Macrocell broadcasting zone: Macrocell-to-Femtocell, Femtocell-to-Femtocell and Femtocell-to-Macrocell interferences may happen. The interferences frequency increments as the Femtocell's density expanded. Along these lines, great impedance frameworks of moderation are essential here. In a thick Femtocell organize game plan, a substantial number of Femtocells can be passed on inside a little scope zone and in this way, the framework must have the ability to regulate adequately. Fig. 1.8 underneath demonstrates some organization sorts of dense Femtocell networks.

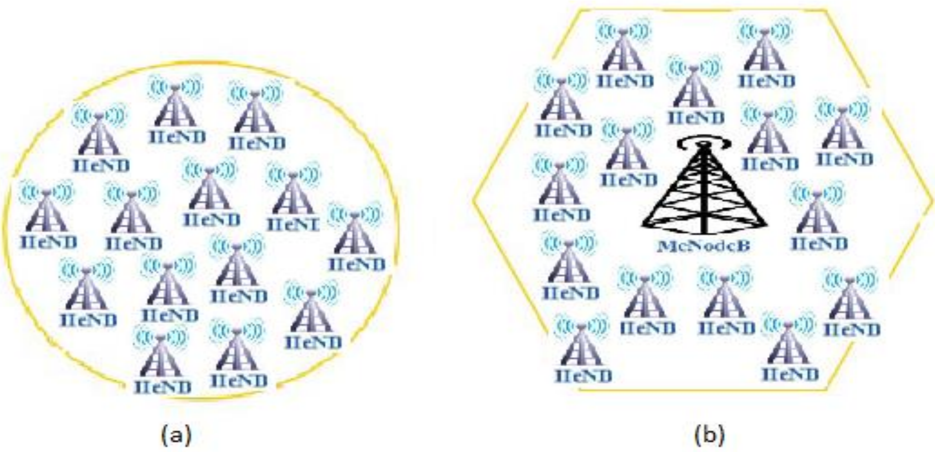

Figure 1.8: (a) Dense femto deployment without Macrocell Overlaid (b) Dense femto deployment with Macrocell Overlaid

1.7 Advantages and Disadvantages of Small Cell Networks (SCN)

1.7.1 Advantages of SCN

The benefits of SCNs come at the cost of more confounded system architecture. Following are the main features that pose great challenges to the plan and activity of a SCN.

A Large Number of Small Cell Base Stations — The quantity of SCN BSs inside a given zone is required to be considerably bigger than that of macrocell BSs. With constrained backhaul limit, it is hard to perform brought together control and coordination..

Vulnerability to Interference — Small cell BSs might be contiguous each other in a hotspot in light of little scope territory, which may effortlessly cause solid intercell obstruction. In the event that distinctive groups are alloted to neighboring cells, the accessible data transfer capacity for every phone is enormously diminished. Moreover, sending a little cell level over a current cell system may likewise cause between level obstruction if the two levels possess a similar range band.

Irregular Coverage Area — Small cell BS's coverage area is usually irregular, unlike traditional cell systems with a hexagonal scope zone for every BS. To lessen both interference and certification arrange network, it is assessed that the covering scope regions of various little cell BSs are little, and there are no scope gaps. The sending of little cell BSs has turned out to be more confused by these prerequisites..

Limited Power Budget — The power of a small cell BS is quite limited as compared to a macrocell BS. Thus, it becomes difficult to efficiently utilize the power resource. To manage the circumstance when an extensive number of clients are served by a little cell BS under a strict power imperative, advanced technologies are needed [21].

1.7.2 Disadvantages of SCN

Infrastructure needed: In order to link all base stations, a complex infrastructure is needed by Cellular systems. This comprises many location registers to find a mobile station, switches for call forwarding, antennas and many alike, which makes the whole system quite expensive (WWWF).

Handovers increased: The mobile station has to implement a handover when there is a change from one cell to another. This can happen quite often that is based on the cell size and the speed of movement.

Frequency planning: Those transmitters which use the same frequency, the interference have been avoided by distribution of frequencies carefully. On one hand, interference should be avoided on other hand only a restricted number of frequencies are available.

CHAPTER 2

LITERATURE SURVEY

2.1 Literature survey

Yang *et al.* [35] the author has talked about that small cells are seen as a assuring answer for accomplish green correspondence and manage the coverage gaps inside the macro cells. In any case, close supporter cluster of femtocells with universal frequency show solid cross-level interference in each down and uplink and in this way diminishing the general system limit. Ordinary LTE-A macrocells essentially apply control in uplink while LTE-A femtocells require both downlink and uplink control plans to successfully manage the cross-level interference circumstances. In the present work, area based independent downlink control setting and transmission fraction power management plans are projected particularly for femtocells so as to diminish the cross-level interference.

Ismail *et al.* [10] the author has examined an investigation of LTE wireless mobile system. In any case System Performance is shown and simulate for the effect of addition of shut endorser gather femto Access Points (FAPs) into the system and how it influences the general execution of the systems. At that point an investigation of the impact on the large scale cell neighboring clients for the instances of the LTE system with arbitrary resources task, and the instance of another resources task technique proposed for the shut endorser assemble FAPs in light of the Fractional Frequency Reuse (FFR) of the base station. The execution of the model is evaluated all through system tier simulations and it is demonstrated that addition of FAPs has a few advantages and a few downsides on the system, and it is additionally demonstrated that the utilizing of the proposed task strategy beats some of these disadvantages.

Jang *et al.* [15] the author has reviewed a self-change calculation for single femto-cell coverage. The objective of this function is to limited for perfect coverage modification is the aggregate of camp on (CO) and unnecessary hand over (UHO) zones that are described right away. CO issue accomplishes wasteful usage of base station with received signal strength low, and therefore causes the low information rate. UHO acquires the inefficient use of restricted resources and overhead increment because of

HO procedures. The validness of the proposed calculation by looking at the execution and the result of speculative examination is checked. In addition, the proposed calculation is developed to expand the system throughput.

Baddour *et al.* [4] the author has presented that femtocells with a specific end goal to build general LTE system performance femtocells, as a client based game plan assuring to offer far better facilitate of the client especially indoor. Their arrangement ought to enhance the total system limit observably and diminish definitely the power utilization. Then again these small indoor cells make arrange arranging procedures a great deal more unpredictable given the precariousness of their locality and their heap, femtocells are, everything considered, administered by the clients. The objective of this assignment is to give a reenactment reaches to manage opt for the consequences of heterogeneous cell organization on the pursuance of a LTE arrange. The simulation structure permits to practically look at the power utilization and throughput of the general system. The key parts are the mix of indoor and outside engendering displaying, and the expansion of femto, miniaturized scale and macro cell vitality utilization models. The model further contains complex building like structures, diverse correspondence layers (eNodeBs and femtocells) streamed over various regions while adjusting their service prerequisites. The simulation reaches brings about moderately computationally modest simulations and permits to show the normal throughput and essentialness utilization for various heterogeneous LTE situations.

Barbieri *et al.* [5] the author has examined in the present work think about a heterogeneous LTE organize wherever femto cells ar unpredictably sent in an large scale arrange. Femto cells are displayed as closed cell, to be specific simply cluster member UEs may be related to the femto cells. It is displayed that between cell interference might deflect strong activities for non-part UEs that are in closeness of closed cell, which in this manner encounter blackout. It is demonstrated that how a portion of the novel elements presented in the Rel-10 particulars of the LTE standards can be utilized by an appropriate intercell interference coordination conspire (ICIC), that depends on resource dividing among various hubs to lessen the intercell interference issue. Extra significant upgrades can be accomplished when the proposed ICIC plan is related to a+

63 basic yet compelling self-ruling force control formula, depicted in detail with the present work, and further picks up are shown for UEs utilizing interference cancelation of communicate meddling signs. An upgraded ICIC strategy is proposed, in light of a more tightly coordination amongst macrocell and femtocell hubs, whose noteworthy performance enhancements advocate for reasonable redesigns to the future LTE details.

Alexiou *et al.* [7] the author has studied that future mobile networking system taking after (LTE) Long Term Evolution will be depicted by requesting services, as far as delay and bandwidth, already prevailing in wire network, for example, High-Definition of anything (HDOA), cloud computing and extremely intelligent web games. Small Cell innovation is that the key-advancements expecting to handle the requirement for ultra-superior in future portable network. The present work is centered around able power control in Small Cell Networks (SCNs). Specifically, an influence system for effective power distribution in SCNs is projected. The proposed instrument proficiently controls systems' obstruction while then again ensures home clients QoS. The system of Priority Grouping is exibited, in which home client in the topology is allot to one of the available groups with various needs regarding power prerequisites and requested traffic load. The system progressively upgrades the Home advanced Node B control setting in light of the topology of the home and macro users in real time. Also, contingent upon the analyzed movement situation the system can give better insurance either home clients or on macro clients.

Dampage *et al.* [9] the author has studied that Femtocells are by and large customer conveyed and are related with their own specific wired broadband backhaul connection. Countless arrangements in long haul advancement (LTE) systems are extremely foreseen. one amongst the essential specific difficulties of LTE-femtocell systems is the relinquishing between a macrocell and the femtocell because of non-accessibility of direct correspondence connects between eNBs of femto and macro. attributable to little femtocell coverage ranges, visit handovers amongst macrocells and femtocells happen. In this manner, a quick handover plot utilizing small flagging overhead is necessary for LTE-femtocell systems to bolster snappy and steady handover. The S1-based handovers plot decided in the LTE standard for transfer between eNBs, that don't seem to be specifically connected through X2 interface will likewise be utilised for relinquishing between a macrocell and a femtocell..

Shokair *et al.* [33] the author has reviewed that the common electromagnetic obstruction among femto clients and macro clients is a test, when femto cells are sent in LTE and LTE propelled system. Right when the used femtocells have a closed get to, the macro clients, who are inside or near the femto cells, are slanted to an outrageous obstruction from the femto get to focuses particularly, on account of the widespread frequency employ arrangement. A power control is a viable approach to enhance the macro client's geometry to the detriment of a drop in the femto client's geometry and limit. In the present work, the possibility of an employthe large scale and femto users geometry. The system is planned, scientifically broke down, and mimicked considering that the macro clients are auxiliary users of the femto clients.

Yung *et al.* [36] the author has introduced a macro administrations ensured asset distribution conspire. which can direct extraordinary overpowering obstructions and give different administrations in expansive scale/femto overlaid 3G Partnership Project of Long Term Evolution-Advanced system. The different services resource portion plan is modelled into a multi-objective improvement issue, which is non-deterministic polynomial time (NP)- difficult issue. At that point, a low-many-sided quality calculations involving two layers in perspective of chordal chart is given. Simulation result check that the proposed plans can accomplish preferable proficiency over the past works and raise the fulfillment proportion of GBR administrations while improving the ordinary execution of non-GBR benefit.

Pal *et al.* [24] the author has discussed Fractional Frequency Reuse (FFR) conspire while Heterogeneous network (Hetnets) including of Small-cells and Macro-cells (e.g. Metro, Femto, Pico cell ,) are equipped for expanding limit and cellular coverage. This plan is in all probability utilized for forthcoming and future cellular system particularly in cell OFDM network (ex. LTE, Wimax). In two-tier networks or Hetnets of Macro-cell superimposed with Small-cell, the resource assignment can have identical licensed frequency range. In their present work, straightforward resource allocation strategy alongside power coordination conspire for the two-level Femto/Macro is proposed that grants Femto-cells to encourage and allot more resource frequency allocation by utilizing fractional frequency approach. The adapt power assignment is to boot embraced. This procedure is examined in multi-cell systems with conjunction of Macro-cells. inquiring and simulation comes regarding demonstrate that our basic resource allocation methods will reduce inter-tier interferences and to supply a modification of scope of coverage likelihood and edge user SINR within the two-level surroundings network.

Rezvy *et al.* [27] the author has studied that the femtocells may be simply sent in macrocell LTE organize while not requiring a targeted about to provide high data rate availability with a constrained coverage. Femtocell is low power, small and wise cellular station utilized as a part of indoor condition. Macrocell and Femtocell share same frequency band which cause damaging interference. With a specific end goal to keep up solid service of macro cells, it is most indispensable to alleviate dangerous femto to large scale interference. Frequency Reuse (FR) is an exertion of controlling the frequency resource allocation upon terminal area to upgrade system throughput. In the present work, a proficient technique to enhance system limit through interference service in the current Macro-Femto 2 tier network system has been projected. In projected scheme, femto user are going to be selected frequency in an exceedingly flash because it is needed. this may likewise enhance turnout of system which is able to with success management interference amongst femtocells and macro cells..

Hadda *et al.* [11] the author has presented that dense neighboring Femtocell are viewed as future minimal effort answer for altogether pick up limit contrasted with Macro-only arrangement. Dense Heterogeneous networks which requires dynamic presentation of Femtocells, offers versatile networks towards a thousand fold gain in limit according to innovation vision for 5th generation. In such dense networks, the issue of interference interferes with the Femtocell and Macrocell and also among the Femtocells themselves. Important bits of knowledge in the Macro-Femto interference are obtainable, whereas the Femto-Femto interference angles points stay usually cared-for. The present work traces this issue and directs potential arrangement techniques toward alleviate the Femto-Femto interference, increment the system limit, diminish the power utilization and in like manner decrease the CO2 footprint.

Shalaby *et al.* [32] the author as evaluated a cognitive radios, as a completely unique approach, to wholly dispense with the shared interference with the Femtocell and Macrocell. It is obvious that femtocells' deployment can stretch out the LTE coverage to incorporate indoor ranges. Lamentably, a mutual magnetic force interference will occur among the the Femtocell and Macrocell thanks to the co-channel organization.

what is more, interfarence among the femtocells themselves will happen in themselves will happen thanks to victimization similar subcarriers. the 2 forms of interference will degenerate the system execution. Femtocells base station management will cut back the obstruction, which influences the macro clients to the detriment of the femto clients' throughput and geometry. In the present work, the system is composed, scientifically compound, and reenacted considering that the femto users square measure nonmandatory users for the macro users. informative and simulation results surface demonstrate that applying the intellectual radio, to boost the system execution, is superior to something applying power management calculations..

Masek *et al.* [22] the author has presented that the operators are sending heterogeneous systems with LTE base stations covering small ranges in areas with high data transmission request to address building up customers' needs. The small cells and femto cells are regularly introduced indoor, to serve the clients of a solitary building, for example, a shopping mall or a place of business. In the present work, a viable assessment of RAN demonstrating in indoor LTE organization is given where the advantage from the full access to the genuine LTE-A (ReI. 10) arrangement and complete building documentation is taken. The deliberate estimations of Signal to Interference in addition to Noise Ratio (SINR) and throughput are contrasted and the outcomes from the radio flag spread model, actualized in Python. The acquired qualities are in result utilized for the transmission control arrangement to understand the Coverage and Capacity Optimization (CCO) in LTE networks. The outcomes indicate great connection (over 0.8) between even a fundamental model in perspective of the building maps and the measurements.

Khan *et al.* [16] the author has endeavor to diminish interference by giving a power improvement calculation that updates the estimation of the transmission force of the femto gets centers decentralizedly way so obstruction with the client and contiguous cells hardware is lessened. At the point when utilized with specific schedulers, for example, maxmin, corresponding reasonable, and resource reasonable, the typical cell throughput, the pinnacle client equipment hardware (UE) throughput, the cell edge UE throughput, and the framework sensibility and proficiency.

Lin *et al.* [19] the author has initially concentrated that provisioning the breaking point of remote networks is troublesome when load is fundamentally higher than normal load, for instance, out in the open spaces like air terminals or stations. Service providers can utilize small cells and femtocells to increase local capacity, anyway sending enough femtocells to serve peak loads requires a considerable number of femtocells that will stay sit without moving more often than not, which squanders a lot of force. To reduce the vitality use of over-provisioned femtocell systems, a femtocell particular commencement issue is formulated, which is formalized as integer nonlinear optimization issue.

Slabicki *et al.* [34] the author has given a thorough outline on live preliminary of transmission control improvement inside the full-included 3GPP LTE-An indoor organization. To convey an extensive view on the arrangement of TX power, an assessment between past outcomes gave by actualized PyLTEs programming and improved setup is performed. Keeping in mind the end goal to convey a total picture, the data from test system is supplemented with the genuine estimation in LTE-An indoor arrangement. The discoveries demonstrate that performed changes prompt to the enhanced of every deliberate system parameters as dormancy, RSRP, RSRQ, and RSSI. Over this, the dissected changes are not sustained with the specific LTE strategy - hence, the utilization isn't limited and can be executed in various indoor LTE organizations.

Sathya *et al.* [30] the author has discussed in their system model, consider the accompanying parameters: co-channel interference amongst FBS and large scale BSs, divider constriction figure and densityof user’s in the venture building condition. In this work, two blended whole number straight programming (MILP) enhancement models are detailed: ideal steady edge flag to interference in addition to clamor proportion (OptCTSINR) which ensures a specific least SINR moreover limits the amount of Femtos required for the scope of enormous business structures and ideal handover (OptHO) which decreases the measure of handovers when the customer encounters a specific segment (i.e., inside a room or entry) of the building. These MILP models are enlightened using branch and cut structure of CPLEX solver utilizing General Algebraic Modeling System (GAMS) instrument.

Rahman *et al.* [26] the author has displayed a versatile resource allocation (i.e., transmit power and bandwidth of femtocells) which attempts to direct the cross level interference amongst macrocell and femtocell, guaranteeing general decency among cell center and cell edge clients. A two player bartering diversion among macrocell and femtocell for sensible simultaneousness is proposed. Reenactment comes about demonstrate that for macrocell clients up to 80% information rate increment can be accomplished at the cost of under 10% information rate diminishment for femto users. This diminishment can be reimbursed with (5% - 9%) development in per client resource allocation. The reasonability of the plan starts from the route that with minimum sectoring of the total coverage zone and least partitioning of accessible radio resource, ideal decency around the system is accomplished.

Saadat *et al.* [29] the author has displayed a versatile resource portion plot for co-channel interference evasion in LTE heterogeneous systems with all inclusive reuse where both both intellectual femto base stations (FBSs) and macro users (MUs) inside the same macrocell can capably reuse whole range of spectrum. In particular, resource squares (RBs) are shared between intellectual scholarly FBSs in underlay mode while the asset sharing among FBSs and MUs is in overlay mode. The macrocells are separated into inward and external areas with the internal locale additionally partitioned into three divisions.. Some portion of RBs are assigned to the external locale of the macrocell with a FFR component of 1/3, while the rest of the RBs are progressively allotted to every division in the internal district of macrocell in view of MUs request to effectively use the accessible range. A fundamental macro base station (MBS) help is required by the FBS in determination of appropriate RB to maintain a strategic distance from interference with MU in every area. With the proposed arrangement, both large scale and femto users can progressively get to the entire range while having least data transmission ensure even under completely congested situations. Additionally, the proposed plot for all intents and purposes disposes of the cross-level interference and the CCI issue in heterogeneous system diminishes to inter femto cell interference.

Ichkov *et al.* [13] the author has studied that heterogeneity in cellular systems containing diverse base stations ' sorts forces new difficulties in network arranging and sending. Radio Resource Management (RRM) methods, for example, dynamic sharing of the accessible resources and propelled user affiliation procedures decide the general system limit and proficiency. The present work focuses on a two-level heterogeneous LTE organize involving vast scale and femto level. It presents randomization of the allocated resources on the femto level, novel proactive offloading plan in the customer affiliation mastermind and a novel femto level get the chance to control. System tier reproduction realizes terms of rate dissemination, i.e. the rate of users that accomplish certain rate in the system, demonstrate that an ideal RRM procedure can be intended for various system situations.

Sathya *et al.* [31] the author has reviewed that a large portion of the LTE (Long Term Evolution) organize network are conveting low power small cells in hotspots like airplane terminals, shopping centers and corporate workplaces meet growing information requests. Since customers are not respected to settled domains in such places, the system experiences uneven dissemination of movement stack over the cells which degrade the typical client throughput. This issue is substantially more extraordinary if the arrangement of little cells is unconstrained. Keeping in mind the end goal to address this, in this work, two variations of small cell placement models are proposed: a perfect Femto circumstance with full power (OPT-FP) show and an astute Femto situation with control (OPPRPC) illustrate. These models merge a limitation which helps little cells giving double cell network (DCC) for whatever number of clients as could be expected under the circumstances and after that schedule them together to improve their throughputs.

Li *et al.* [18] the author has presented that for fulfilling quickly expanding data rates at hotspots and improving coverage in structures, small cell, for example, microcells femtocells, , and picocells, are deployed in LTE-A. Femtocells are ordinarily introduced at hotspots and overlay with the macrocell to enhance vitality proficiency and information rates. In large scale femtoHetNets, the handover issue is more imperative than that in macrocell networks. On one hand, more regular handovers are activated in light of the fact that the coverage of a femtocell is small, and various femtocells are overlaid. Then again, a few plans, for example, load balancing, went for enhancing system performance, will likewise bring about incessant handover in macro femtoHetNets. In this manner, handover significantly affects the perfomance of macro femto Het Nets. In the present work, the best in class handover methods are initially overviewed that are gone for continuing progressing associations continuous or guaranteeing the nature of service of portable users. At that point stack adjust related handover plans are presented. In addition, a vitality proficient handover plan is displayed. Finally, the intriguing examination issues are brought up on handover conspires in macro femtoHetNets.

Murthy *et al.* [3] the author has 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. They also proposed an efficient concurrent backhaul link scheduling scheme that exploits spatial reuse by using directional antennas. To increase the number of concurrent links scheduled in a data slot we control transmit power of a link while satisfying the required QoS demand. They also studied the impact on the uplink throughput and on number of concurrent transmissions by varying number of backhaul link requests, beamwidth, and antenna efficiency for different scheduling schemes [3].

2.2 Inferences Drawn from Literature Survey

In this chapter, a brief survey has been done of the existed literature which works on interference mitigation caused by femto-femto, femto-macro cells etc. Different parameters has been considered by the scholars to mitigate interference i.e. Deployment method of cells, density of users, power, indoor outdoor pathlosses etc. Most of the scholars discussed the problem for heterogeneous LTE networks

CHAPTER 3

PROBLEM FORMULATION

3.1 Problem statement

Recent years have seen exponential development of worldwide mobile data traffic [8]. 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 reduced 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 [7]. 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 [7]. 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 setting out of femtocells [37]. A femtocell is an enclosed cellular base station which associates supporters at a fast as well as low power via precisely reprocessing cellular spectrum. It is associated with the inside administration organize by utilizing broadband association, for example, link modem, Digital Subscriber Line (DSL), or radio recurrence backhaul channel. The idea of femtocells has been summed up to small cells including femtocells, picocells, and metrocells. This offer ascends to the general wording of heterogeneous systems (HetNets), where heterogeneity alludes for the most part to scope and transmission control [25]. 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 small cell cost, comprising hardware and organization, is abundant lesser than macrocell base station directed 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 subsequent generation communication schemes, for example, WiMAX and LTE(- An) [25]. Femtocell base station is alluded to as Home eNB (HeNB) in LTE institutionalization. Since the backhaul HeNB association to the center system contingent on HeNB control channels, corporate Internet and information movement can't be completely planned by the administrator's radio network controller (RNC). Indeed, HeNB could get control data to its adjoining macrocell base station of macrocell. Yet, these kinds of data experiences Internet stays and can't depend upon for interference control and HeNB resource task.

Although small cell networks give a few advantages to users and administrators alike, their enormous distribution accompanies various specialized difficulties. Eminently, an essential and adverse issue confronting SCN's is the existence of interfering amongst adjacent SCN's, and among the SCN's and the full scale cell network of LTE [1].

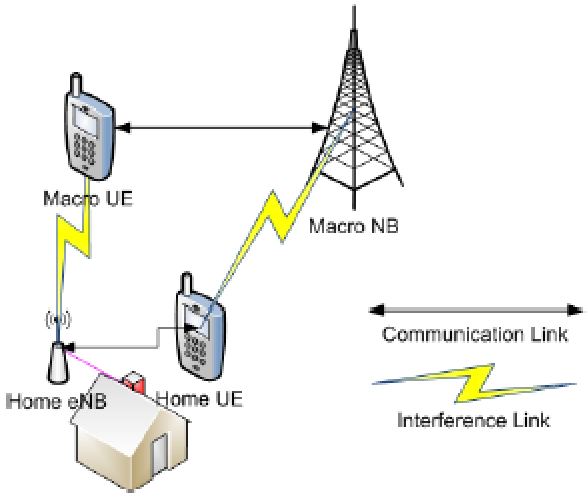

Figure 3.1: Topology of an FDD LTE Small Cell HeNB [1]

The impedance in SCNs is overseen through Power Control Optimization in our approach. The control of power primary reason is that the transfer power is to be minimized, hence eliminating interference and staying away from pointless high power levels. Through properly changing the transmission control for downlink per Resource Blocks which is mandatory to acquire an objective data rate in bit in femto cells, the general created interfernce in the SCN would be fundamentally decreased. As such, Home advanced NodeB (HeNB) modifies its transmission control in order to gratify home client (HUE) Quality of Service (QoS) though securing macrocell users (MUEs) in its region by observance the interfering underneath a limit. A noteworthy part of the current writing has explored the interference administration problems of coordinated Small Cell and LTE 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 3GPP are exhibited underneath [1]:

1.) Fixed HeNB power setting [1]

2.) Macro NodeB smart power management that relies on interference measure

3.) HeNB power management supported HeNB-MUE path loss

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

3.2 Aims and Objectives

The aim of the research is to explore how different power based interference control algorithms for small cell networks behave in which Macro, femto cells has been deployed in a network in random way. The idea is to overcome interferences caused in such networks due to three different ways.

The objectives of the research are the following:

1. To analyze system using Basic fixed power approach in which power of Femto cell is fixed by operator [1]

2. To analyze system using Self-Configuration based on Macrocell signal (interference measurement based smart power control from macro NodeB [1]

3. To analyze system using HeNB power management supported HeNB MUE path loss [1]

4. To present an effective hybrid algorithm which can use all three algorithms in order to provide desired throughput with least power consumption

3.3 Contributions

The contribution of this research is to understand behavior three controlling power algorithm to reduce effect of diverse categories of interferences caused in LTE network

To achieve this goal, the following steps were taken:

- Presented a hexagonal Macro deployment function which localizes the macro cell in hexagonal pattern
- Presented a femto cell deployment function in which femto cells can be deployed at three different locations of a Macro cell i.e. border, center and random.
- Implemented fixed power of femto cells based behavior in which HeNB transmission power is set manually by network operator. HeNB power doesn't depend upon the changes within the topology changes and also the traffic situation. It remains stable [1].
- Implemented smart power control of femtocells in which maximum DL transmit power of HeNB is adjusted as is adjusted as perform of air interface measurements to avoiding inquisitive with macro cell UEs [1].
- Implemented HeNB-MUE path loss based power control of femto cells in which the downlink transmit influence of HeNB is balanced by considering the way loss between the HeNB and an open air neighbor MUE incorporating infiltration loss keeping in mind the end goal to give better impedance alleviation to the MUE while keeping up adequate HeNB scope for HUEs [1].
- Carried out simulation in Matlab to investigate properties of these three algorithms and presented a hybrid algorithm which uses all three algorithms to reduce the interference with macro cells.
- Carried out simulation and analysis.

CHAPTER 4

PROPOSED WORK

4.1 Parameters used for simulation

Following are the parameters that are used in simulation.

Table 4.1: Parameters used for simulation

Parameters	**Value**
inter-site distance (***ISD***)	1732m
Required Reference signal receive power (RSRP)	-70 milli decibels
Macro Power (max)	46 milli decibels
Macro Power (min)	36 milli decibels
Femto Power (max)	10 milli decibels
femto Power (min)	-10 milli decibels
Gain for Anatenna	14 decibels
Parameters a,b,g,k respectively	0.7,60,-30,0.1
Frequency	2 killo hz
Carrier Bandwidth	10 mega HZ
Number of Resource blocks	50
Number of Subcarriers	12
Bit error rate (BER)	10^(-6)
Alpha	-1.5 / log(5 * BER)
MUE speed	3km/h
Distribution of MUS within Macrocell	Uniform
Target throughput	1.2, 0.2, 0.05 megabits/s for group 1,2,3 respectively

4.2 Downlink Control Level Setting Plans

Numerous intrusion justification procedures to relieve Macro-Femto interfering issue utilizing Femtocell power level situation in DL is recommended and investigated. Here we experience some of them:

4.2.1 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 stays still and doesn't rely on upon the progressions showed up in the topology and the traffic situation [1]. The compensations of this plan are its effortlessness and simplicity of usage. Drawback is the challenges to adjust to the encompassing RF likeliness and conditions to bring about expansive interference.

4.2.2 Self-Configuration in view of Macrocell Flag

In this, the restrained acknowledged signal level from Macrocell is utilized [1]. HeNB alters its greatest transmit power of DL as an element of inflight boundary estimations to abstain from intrusive with UEs macro cell. HeNB modifies its most extreme transfer control as indicated by the accompanying equation:

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

where:

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

4.2.3 Self-Optimization Approach in Light of Portability of Large Scale Clients

In this, a self-improvement of coverage as per the evidence on motion occasions of indoor and passing users is utilized [1]. HeNB modifies the transmit power for downlink by making an allowance for the misfortune between the HeNB and an outside neighbor MUE incorporating infiltration loss keeping in mind the end goal to give improved interfering vindication to MUE although keeping up adequate HeNB scope for HUEs. HeNB sets the transmit intensity of reference motion 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) represents RSRP from closest Macro advanced NodeB (MeNB) which is computed by the HeNB. P_m gives reliant on path loss that incorporates the dissemination n the nearest MeNB and the HeNB.. P_{offset} (dB) is control offset portrayed in eqution no. 3 in fact and P_{tx_upp} / P_{tx_low} (dBm) is the lower/ upper limit for the reference signal transmit power. The most extreme and the base aggregate transmitting power of HeNB ought to take after HNB in [1].

The greatest downlink transmit power can be set by the HeNB in extent to the transmit force of mentioned signal. Because of RSRP diminishes, that implies the HeNB is found near macro cell, the transmitting power ought to with a specific end goal.

P_{offset} characterizes path loss among the MUE and the HeNB. The path loss might comprise of internal path loss among the HeNB and cell boundry of HeNB cell and the loss due to dissemination. 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 predestined power counterbalance value equivalent to the internal path loss. Run of the mill esteem run in the vicinity of 50 and 100dB, and the averaged measured value determines the value range. K is a customizable positive issue which may be determined by the necessity of HeNB operation. this is often need to be high to expand the combination transmit power (MeNB is a lot of satisfactory to higher interference) and low to reduce 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.

4.3 Hybrid Power Control Mechanism

A power control mechanism is exhibited that gives a proficient explanation for the concern of controlling power in forthcoming SCNs. Fig. 4.1 exhibits the mechanism block diagram and Fig. 4.2 exhibit the depiction of pseudo code mechanism. The traffic situation necessities and the topology is detected by this system progressively and whenever the algorithmis chosen that proper used to the existing traffic scenario and instance of topology. The system of Priority Grouping is introduced, where all HUE is allotted to individual of the existing groups with diverse priorities in terms of traffic load and power requirements. power calculations from the HeNB relying upon the traffic flow. Thus it implies HeNB plays out a more productive obstruction administration and power distribution.

Power Computation stage, Initialization stage, and Event programming stage. HeNB is that the answerable hub of the SCN engineering for the task of this element.

With respect to Initialization stage (Fig. 4.1), at initially, the system arranges the HUEs which live in topology in view of the traffic necessities to predefined number of N_G need gatherings. In every one of those gatherings, an objective mean of HUE throughput (Th_{target}) is fixed. Like, a HUE with substantial traffic necessities is classified to precedence collection through high estimation of Th_{target}, although a HUE by decreased activity prerequisites (ex. http perusing) is arranged to a need aggregate with low estimation of Th_{target}. Whatever essential to accomplish through this arrangement is to recognize the HUEs in which the activity situation necessitates expanded power assets and those HUEs that have lessened power prerequisites. What's more, we accept that the most extreme accessible power $(P_{available})$ is known to the HeNB.

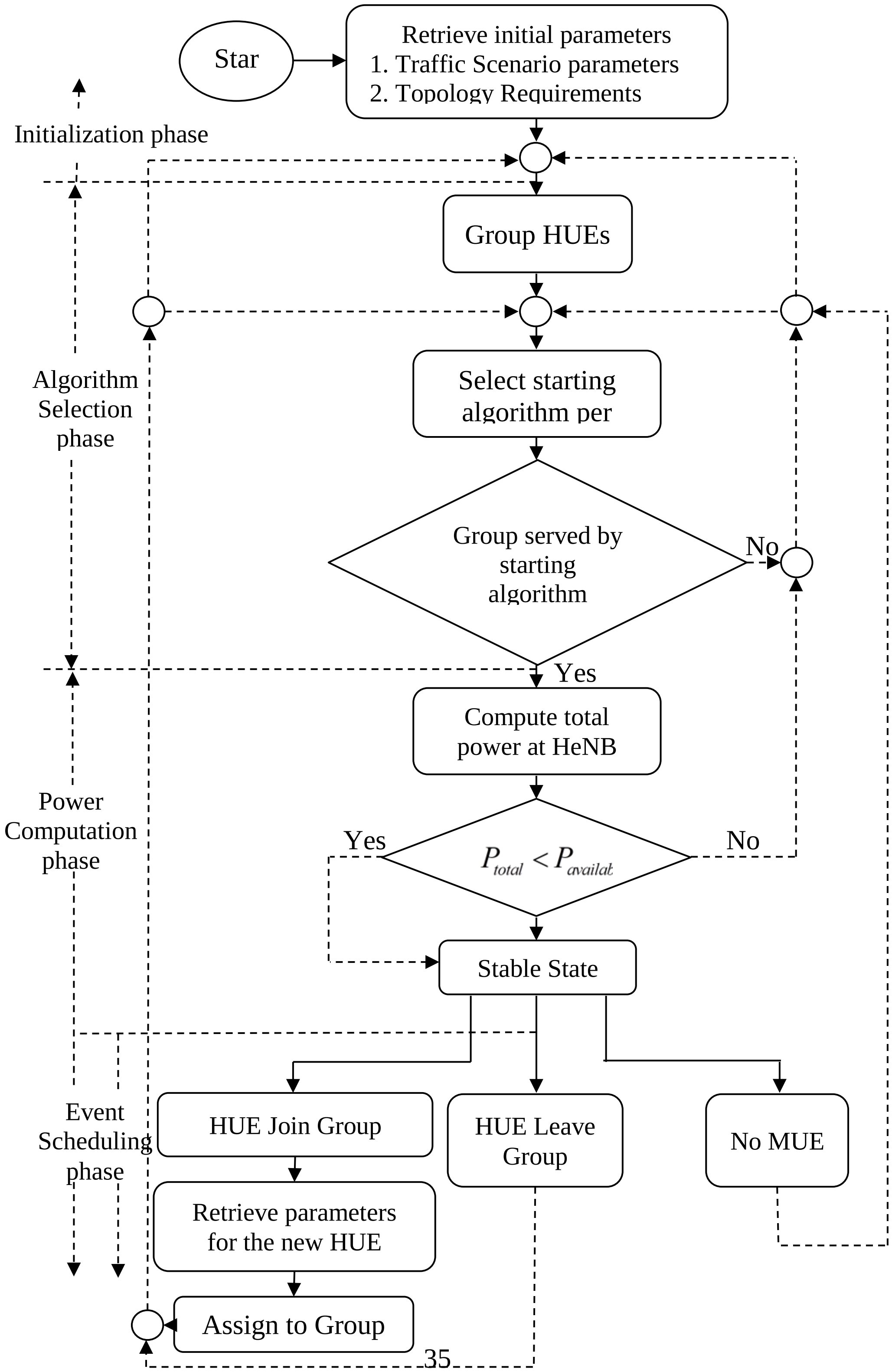

Figure 4.1: Block diagram of the proposed mechanism

The power control calculation which will initially be received by every one of N_G collections is chosen in algorithm selection stage. By this stage, the component chooses the calculation in which least introductory power is required as the starting computations of the gathering. Resulting this, the system checks in each gathering if the beginning calculation could serve the committed for the gathering movement stack, considering the mean HUE throughput per amass (Th_{target}), the quantity of HUEs in each gathering and likewise their region inside the femto cell. On the off chance that the chose calculation in each group has enough capacity to help the traffic necessities of the gathering the instrument enters the Power Computation stage. On the other hand, the component chooses another beginning calculation(s) for the group(s) their movement stack can't be served by the beforehand chosen beginning calculation(s).

Presently Power Computation arrange, the total power is determined in HeNB like whole of the requisite power in every one of the N_G priority collections. Subsequent this P_{total} is contrasted with $P_{available}$ keeping in mind the end goal to anchor that the framework's aggregate power is kept in a worthy level. On the off chance that $P_{total} < P_{available}$ the component goes into the steady state that implies that in the topology all the clients are served well concerning their traffic prerequisites. On the off chance that where $P_{total} > P_{available}$, the instrument need to decrease the framework's aggregate power

- by continuing to the rechoosing of the power control calculation per group or
- by playing out an aggregate framework regrouping (decrease no of groups or re-portray HUE keeping the NG as may be).

Now it ought to be noticed that the last technique ought to be maintained a strategic distance from since it significantly expands system's unpredictability. Nonetheless, in situations where framework's aggregate power is to a great degree high, assemble revamping is vital as this implies the selected priority grouping isn't precisely relating to the traffic necessities and framework's ability.

Define SCN topology
Retrieve topology and user parameters
Create Priority Groups N_G and **Assign** HUEs to Groups

Initialization phase

for i=1: N_G (Number of groups)

for j=1:3 (Number of algorithms)

  Calculate $P_{initial}$ (Initial Power) for algorithm **j**

  Select min $(P_{initial})$ for group **i**

end

Algorithm Selection phase

Determine Power control algorithm **j** for group **i**

if $P_{selected\,algorithm} > P_{Th\,target}$ **then**

  i++(group **i** served by algorithm **j**)

else

  switch to another algorithm for group **i**

endif

Calculate total power P_{total} (sum of all groups)

end

if $P_{total} < P_{available}$ **then**

 case HUE JOIN

  Retrieve user parameters
  Assign HUE to Groups
  Return P_{total}
  break

 case HUE LEAVE

  Return P_{total}
  break

 case NO MUE

  Return P_{total}
  break

 end else

else

  Return P_{total}
  break

endif

Event Scheduling phase

Power Computation phase

Figure 4.2: Pseudo code of the proposed mechanism

On the steady state, in each social event calculation in which outcomes is to least aggregate intensity of the HeNB is chosen as for the performed priority grouping. As it were, in each group, the chose calculation requires the base worthy power so as to assist aggregate output of the HUEs which found each group.

With respect to Scheduling of Event stage, when any one of the three unique occasions happened throughout an activity situation (leave group/ HUE join, no MUE in the topology) an alternate methodology is activated as portrayed in Fig. 4.1.

4.4 Flowchart for Initial Random Deployment of Macro and Femto Cells and Users

Step 1: Initialize parameters

Step 2: Generate Macro cells in hexagon Grid and Femto cells in circle

Step 3: Deployment selection

Step 4a: In case of Border, Generate and localize Femto users by taking .80 to 100 as radius range of Macro for deployment.

Step 4b: In case of Center, Generate and localize Femto users by taking random b/w 0 and 1 as radius range of Macro for deployment.

Step 4c: In case of Random, Generate and localize Femto users by taking .50 to .80 as radius range of Macro for deployment

Step 5: Localize macro users in random fashion by considering No overlap between them.

Step 6: Add more Femto users after few steps of running session.

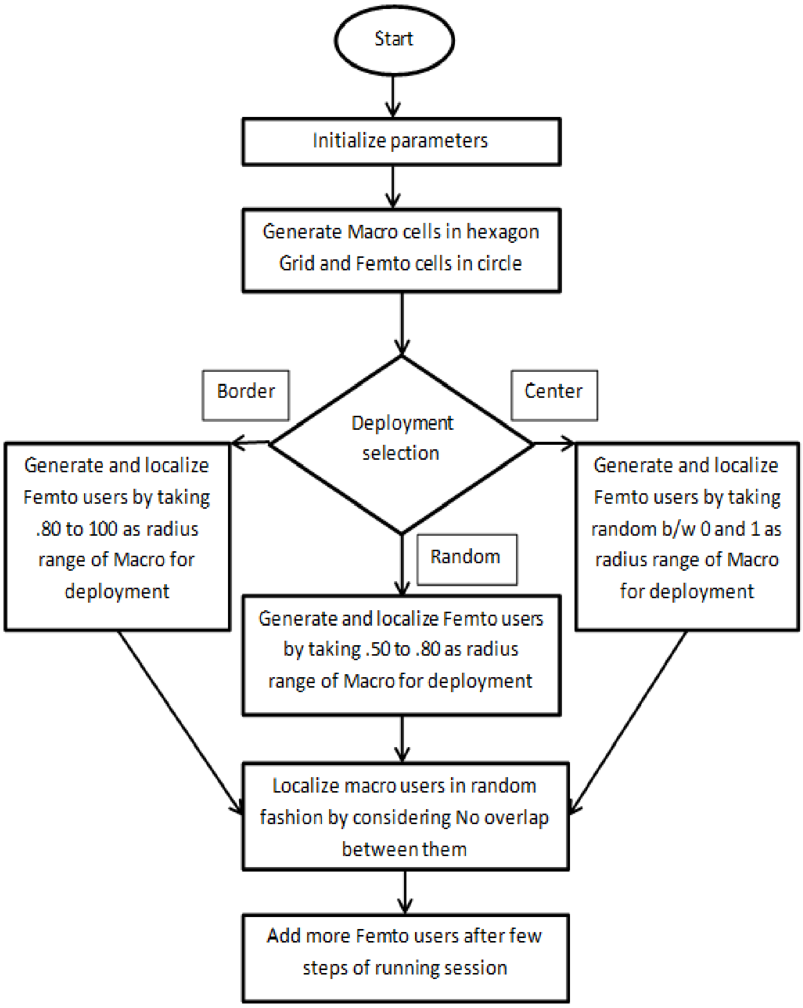

Figure 4.3: Flowchart for initial random deployment of Macro and Femto cells and users

4.5 Flowchart for Femto Power Calculation and Throughput Calculation

Step 1: Initialize parameters

Step 2: For each running step, allocate max power to Macro cell and to femto cell

Step 3: Calculate Subcarrier power using 50 RBs with 12 subcarriers each for Macro cell

Step 4: Algorithm used for femto subcarrier power

Step 4a: In Algorithm 1, Use fixed femto Power

Step 4b: In Algorithm 2, $P_{tx} = \max(\min(\alpha \times (CRS\,\hat{E}_C + 10\log(N_{RB}^{DL} \times N_{SC}^{RB})) + \beta, P_{\min})$

Step 4c: In Algorithm 3, $P_{offset} = MEDIAN(P_{offset\_o} + K * LE, P_{offset\_\max}, P_{off\_\min})$

Step 4d: In Algorithm 4, hybrid algorithm

Step 5: Calculate Subcarrier power using 50 RBs with 12 subcarriers each.

Step 6: Calculate user RSRP and user's throughput

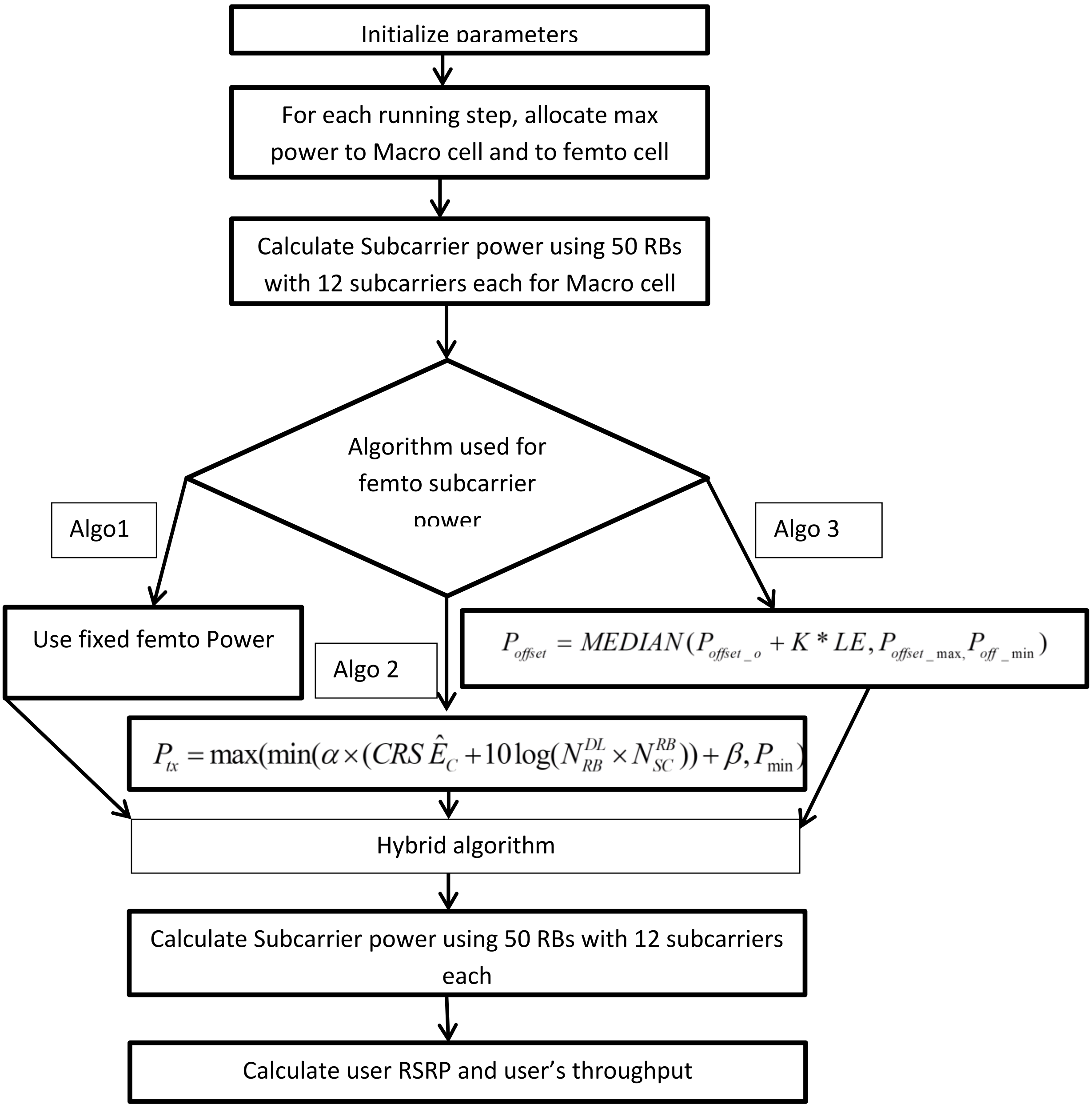

Figure 4.4: Flowchart for Femto power calculation and throughput calculation

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Results

Experiment results have been taken by taking 3*3 size macro cell networks. For the requirements of results' introduction, we directed a test in which Nine macrocell and five femto cell connect with 219 MUEs, 51 introductory HUEs continuously distributed in time domain are considered. MUE population remains constant in the simulation but HUE (femto users) are in increased to 821 in which 770 are inserted during simulation as the iterations rises. Figures beneath show the diagram of whole SCN topology. To all the more probable present the results, we focus on femto cell number 10-16 of the display the correlation of the mean throughput and SINR accomplished by every one of the HUEs that live in the same femto cell. Besides, Figure portrays the advancement of HeNB transmit control for each power control calculation in time space. The terms used in the results are defined below according to which graphs has been presented.

5.1.1. Reference Signal Received Power (RSRP)

RSRP estimation gives cell-particular flag quality metric. It quantifies normal got control over the asset components that convey cell-particular reference motion inside certain recurrence transfer speed. In the strategy of cell assurance, cell reselection out of rigging mode and handover in related mode, RSRP is used. This estimation is used essentially to rank particular LTE contender cells according to the banner quality and is used as a commitment for handover and cell reselection decisions. RSRP can be appeared differently in relation to Received Signal Strength Indication (RSSI) in GSM development and Received Signal Code Power (RSCP) in UMTS advancement.

5.1.2. Reference Signal Received Quality (RSRQ) or SINR

RSRQ is the class of the Reference signals. It's anything but a quality as for QoS or bit blunder rate or bundle rate. Be that as it may, it is quality as for clamor or obstruction. It is a Signal to Interference Noise Ratio (SINR).

5.1.3 Average Throughput

Throughput is a measure of what number of units of data a framework can process in a given measure of time. It is connected extensively to frameworks going from different parts of PC and system frameworks to associations. Related measures of framework profitability incorporate the speed with which some particular workload can be finished, and response time, the measure of time between a solitary intuitive client demand and receipt of the reaction. Before demonstrating the outcomes, Channel limit is figured and recreated for a 10MHz transfer speed and diagram is plotted for greatest channel limit that could be accomplished with it. Additionally, the outcomes demonstrate the throughput meeting the channel limit criteria. Channel limit is the most secure upper bound on the measure of data that can be dependably transmitted over an interchanges channel. Shannon– Hartley hypothesis expresses the channel limit C, which means the hypothetical most secure upper bound on the data rate of clean information that can be sent with a given normal flag control S through a simple correspondence channel subject to added substance white Gaussian commotion of intensity N, is:

$$C = B\log_2\left(1+\frac{S}{N}\right)$$

where

C - channel capacity in bits per second;

B is the bandwidth of the channel in hertz;

S/N is the signal-to-noise ratio (SNR) or the carrier-to-noise ratio (CNR)

5.2 Discussions

A graphical user face has been built in matlab software where desired number of macro and femto cells can be entered along with starting number of MUE (macro) and HUE (femto) users which is shown as below

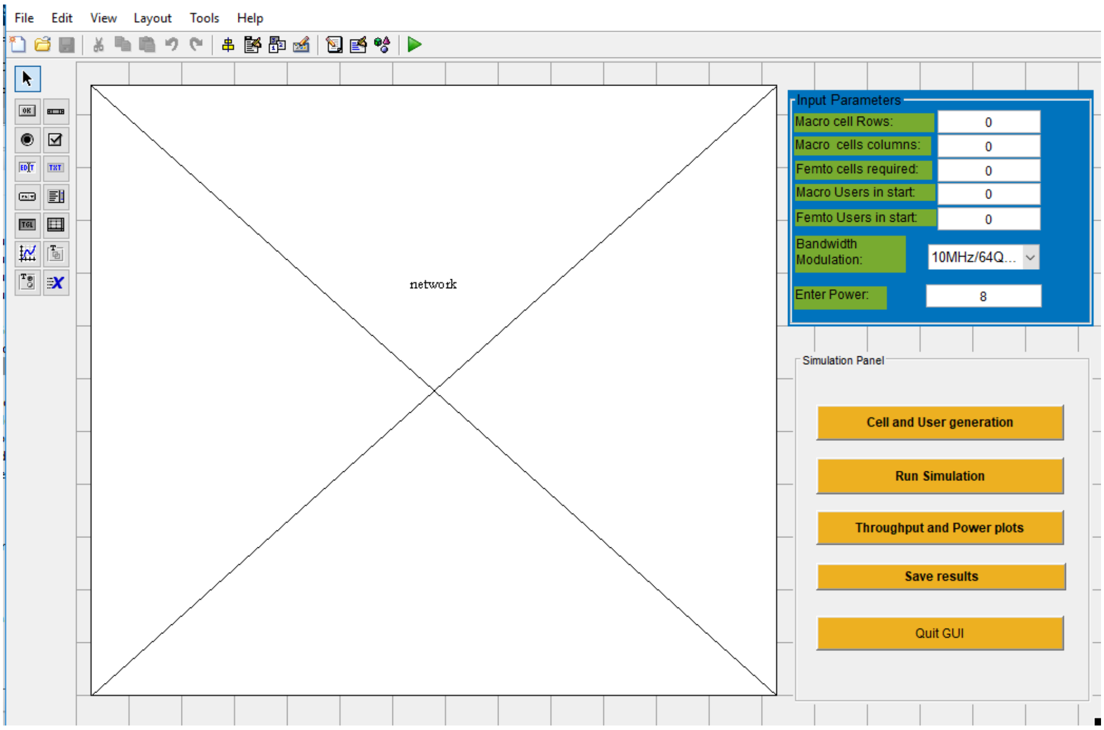

Figure 5.1: GUI developed in MATLAB software asking to choose various parameters

As seen above 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.

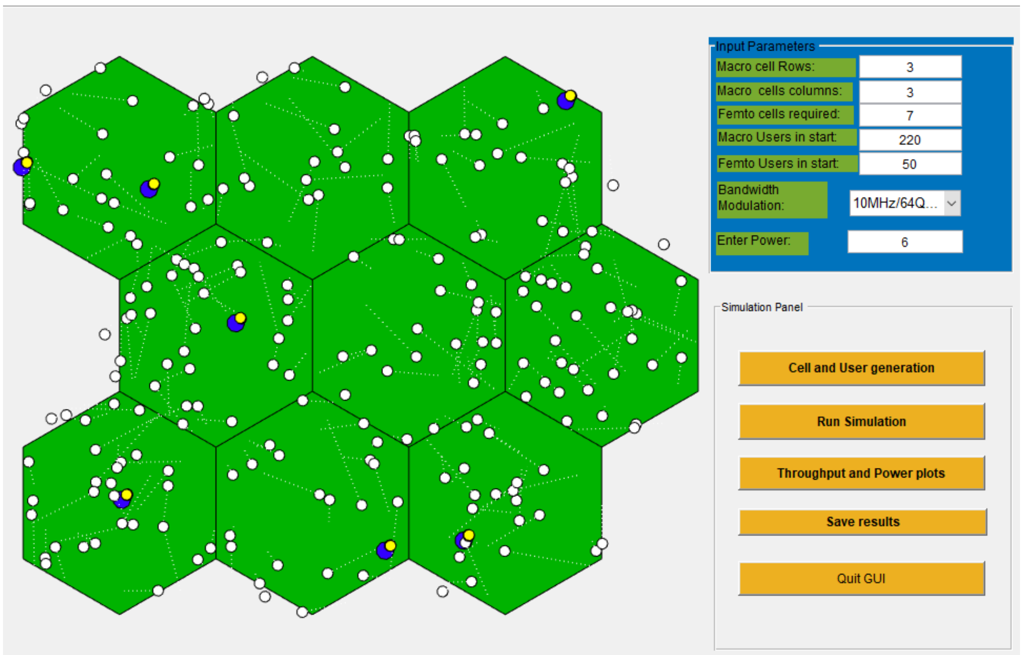

Figure 5.2: Image showing generation of Macro and Femto cells along with their users

Green hexagons presume macro cells whearas dark blue circles resembles femto cells. Yellow circles and white circles resembles femto and macro users respectively. This figure comes when one pushes pushbutton named as ‘Macro and Femto cell generation’.

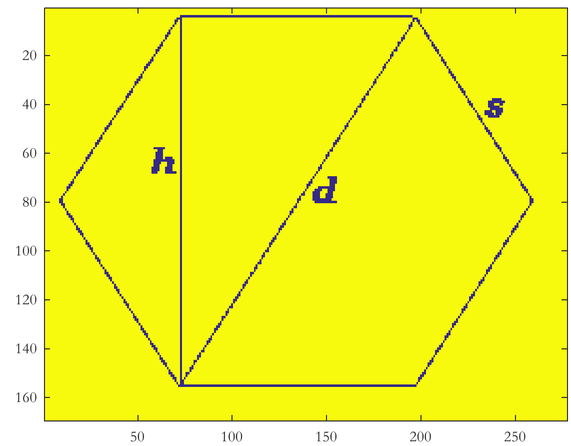

Figure 5.3: A figure showing various parameters that are helpful in making non-overlaping hexgon cells

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.

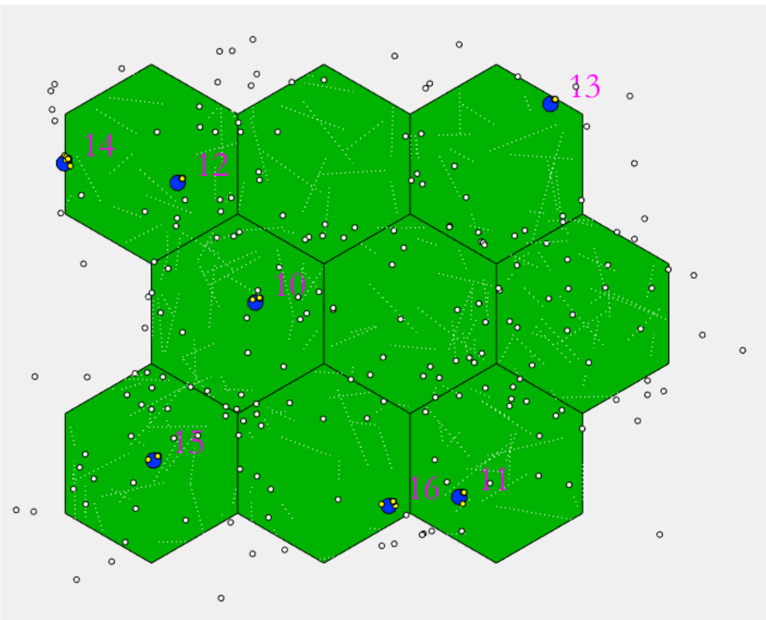

Figure 5.4: Location of macro users and femto cell users after simulation

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. Below are the throughput and power line graphs by considering four algorithms used for power control in the simulation.

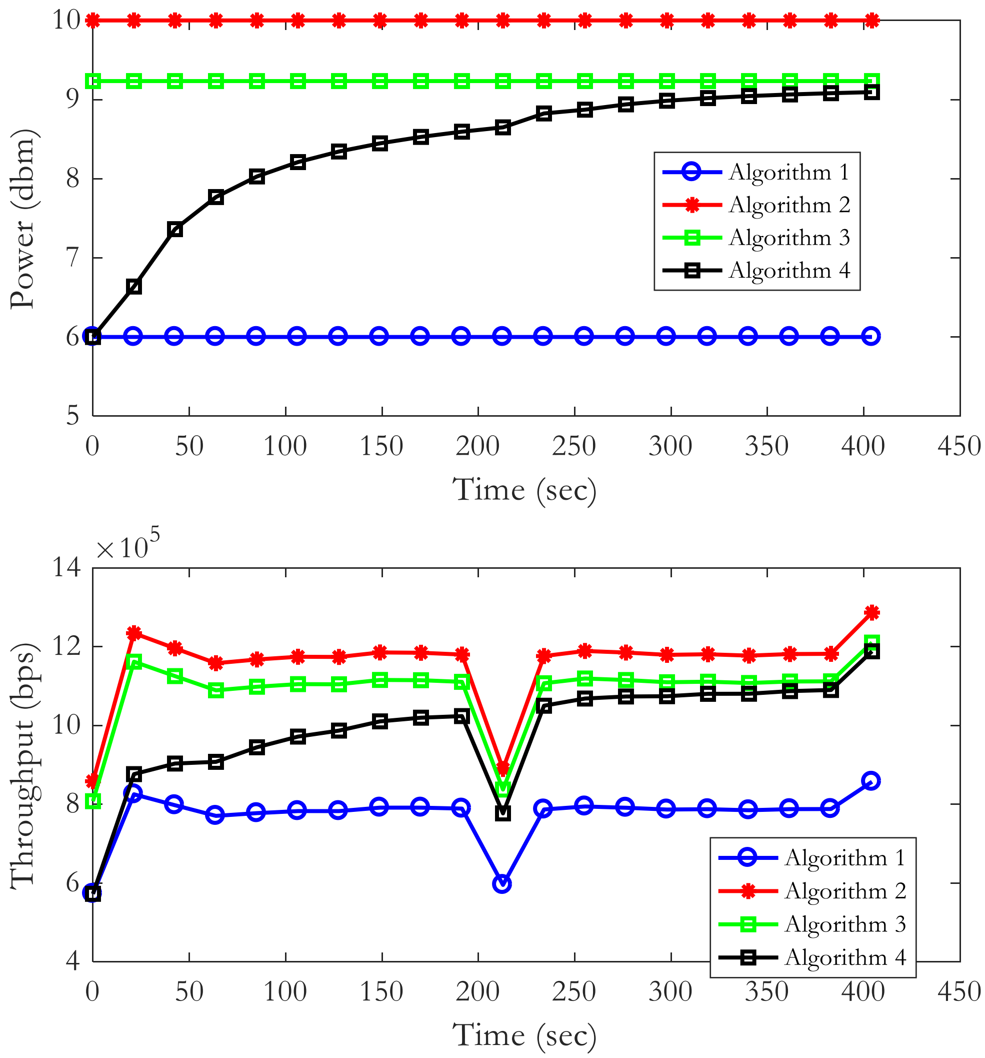

Figure 5.5: Femto power and throughput graphs for femto cell one (10 in topology diagram)

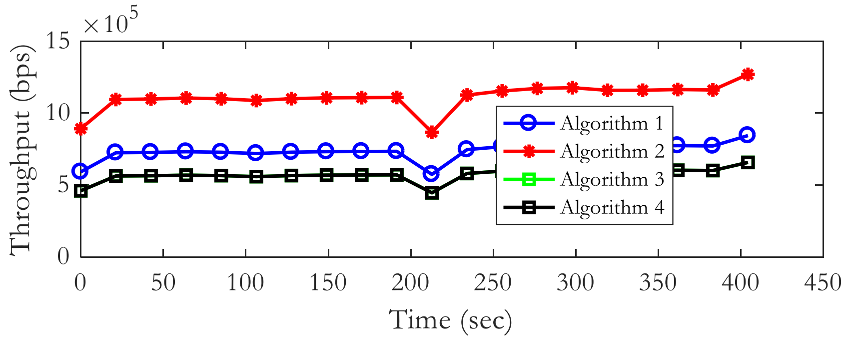

Figure 5.6: Femto power and throughput graphs for femto cell two (11 in topology diagram)

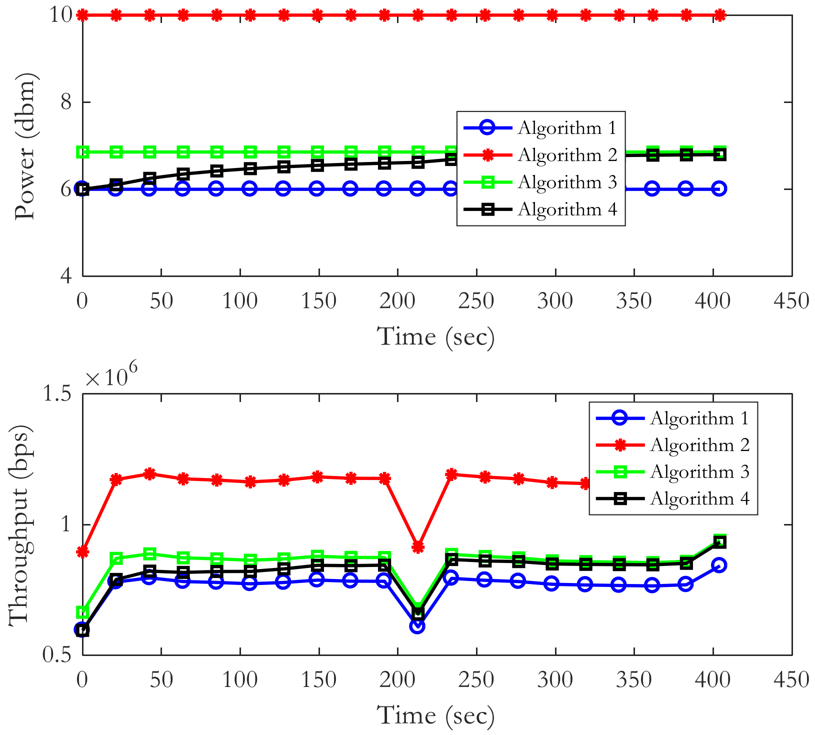

Figure 5.7: Femto power and throughput graphs for femto cell three (12 in topology diagram)

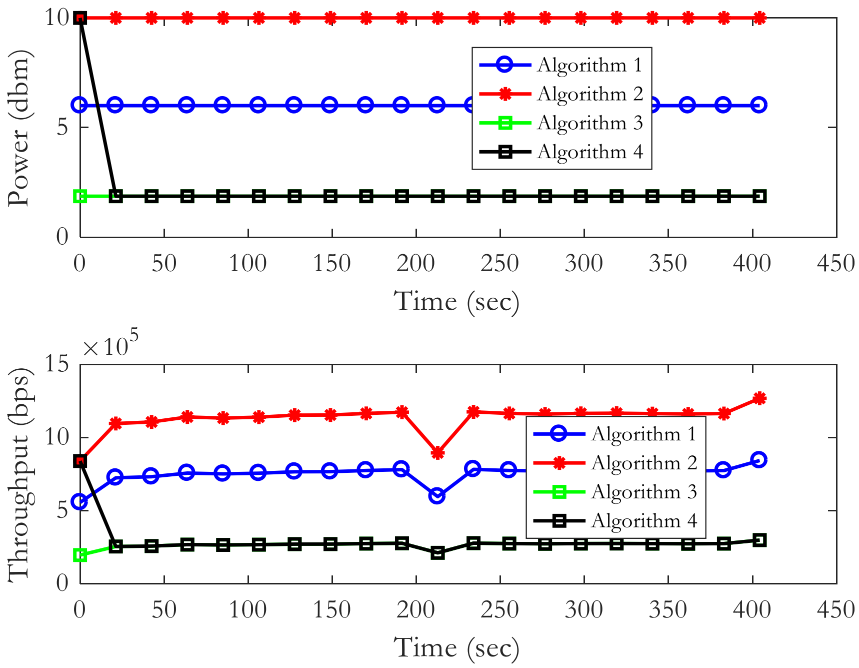

Figure 5.8: Femto power and throughput graphs for femto cell four (13 in topology diagram)

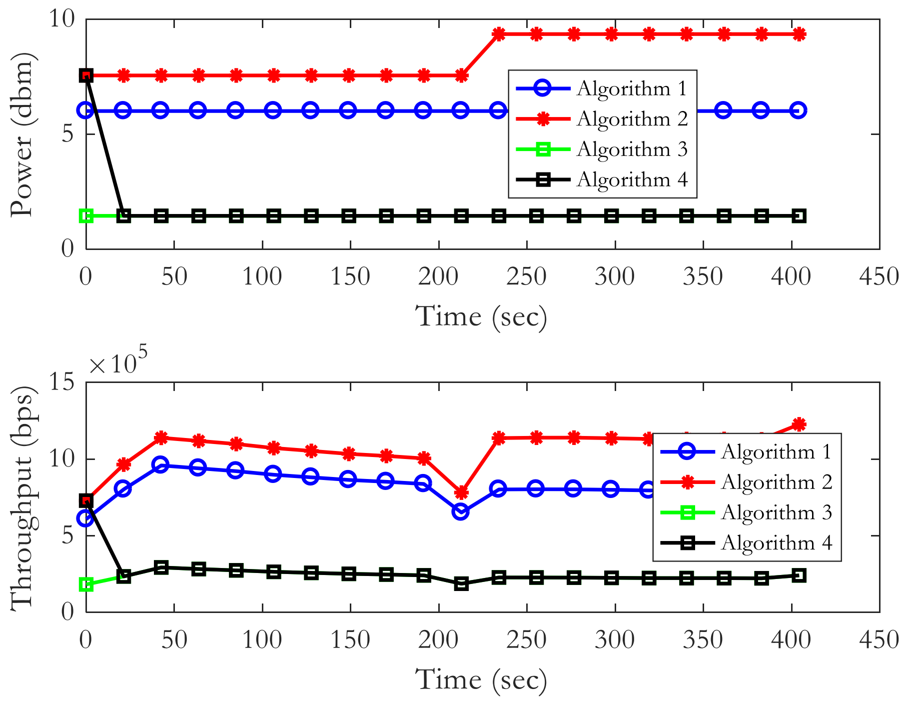

Figure 5.9: Femto power and throughput graphs for femto cell five (14 in topology diagram)

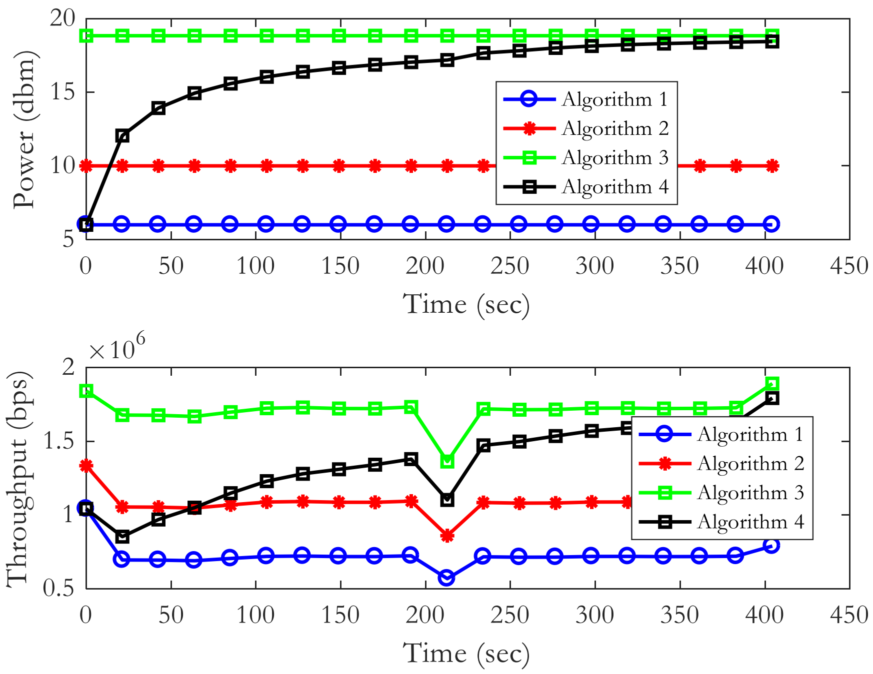

Figure 5.10: Femto power and throughput graphs for femto cell six (15 in topology diagram)

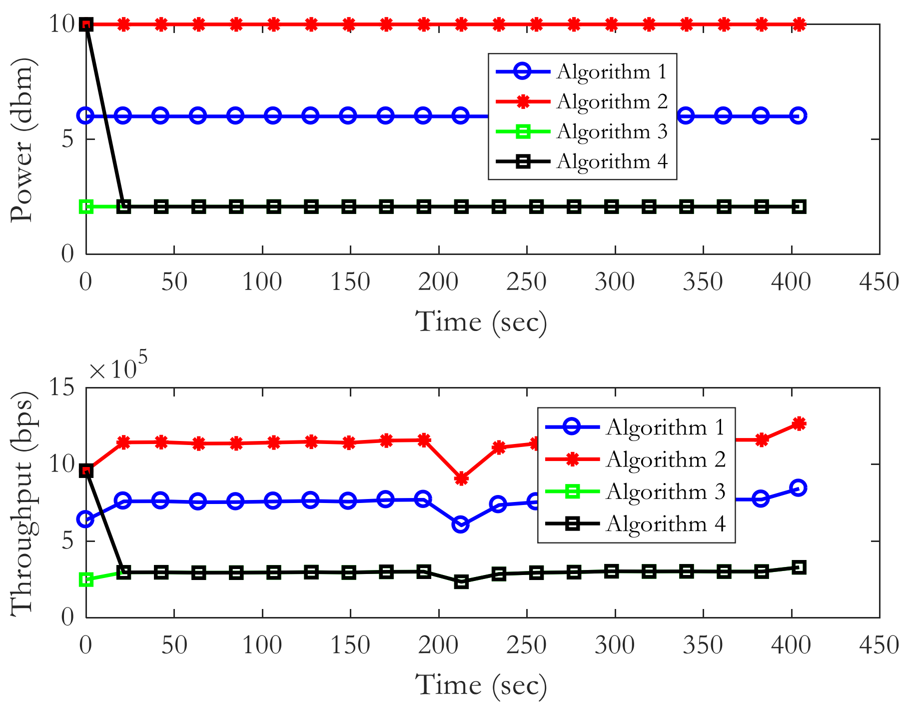

Figure 5.11: Femto power and throughput graphs for femto cell seven (16 in topology diagram)

As seen above, for first algorithm fixed power of 6 dbm has been kept and its has been used by 12 subcarriers. The total throughput is more in first algorithm than the second and less than the third algorithm. It comes as throughput of users depends upon RSRP (Reference Signal Received Power) which in turn uses femto subcarrier power+ antenna gain and negative of pathloss. As subcarrier power in second algorithm is less than the other two it has low throughput. For algorithm three there is less power among all. It causes due to pathloss factor which in turn vary from one femto cell location to another and hence variable power for all five femto cells. For algorithm two it uses the max function from max femto power, power considers indoor femto pathloss and outdoor macro pathos. Hence it chooses the max value which comes to be maximum femto power supplied which is 10dbm.

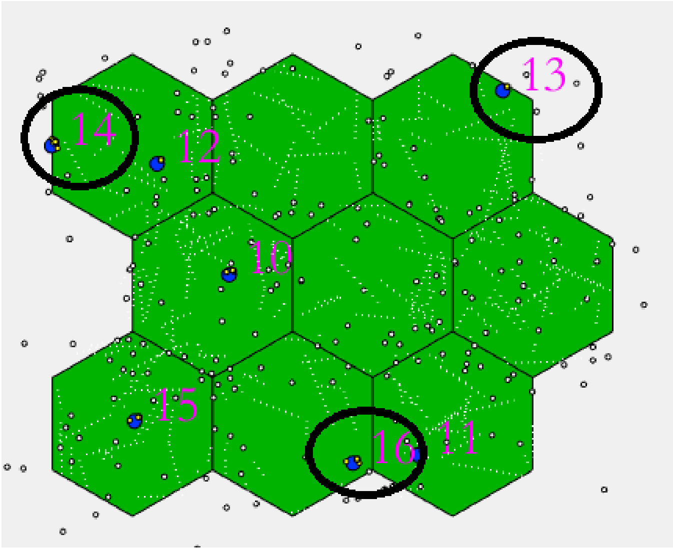

Figure 5.12: Image showing femto cells away from macro cell centers

Figure above shows that there is more path loss when femto cells are away from its main macro cell. As shown above, cell 14 is more away and near to border area and hence more path loss which results in fewer throughputs as it depends on it.

Table 5.1: Algorithm selection by hybrid algorithm for femto cell 10

Algorithm selection by hybrid algorithm		
Group 1	Group 2	Group 3
1	1	1
1	3	1

1	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1
3	3	1

Table 5.2: Power consumed at each time step by different algorithms for femto cell number 10

Power consumed at each time step by different algorithms for femto cell number 10			
Algo1	Algo2	Algo3	Algo4
6	10	9.234291	6
6	10	9.234291	6.63701
6	10	9.234291	7.362827
6	10	9.234291	7.768616
6	10	9.234291	8.028865
6	10	9.234291	8.210267
6	10	9.234291	8.344047
6	10	9.234291	8.446827

6	10	9.234291	8.528285
6	10	9.234291	8.594442
6	10	9.234291	8.649246
6	10	9.234291	8.824596
6	10	9.234291	8.872586
6	10	9.234291	8.939426
6	10	9.234291	8.98541
6	10	9.234291	9.018984
6	10	9.234291	9.044575
6	10	9.234291	9.064728
6	10	9.234291	9.08101
6	10	9.234291	9.09444

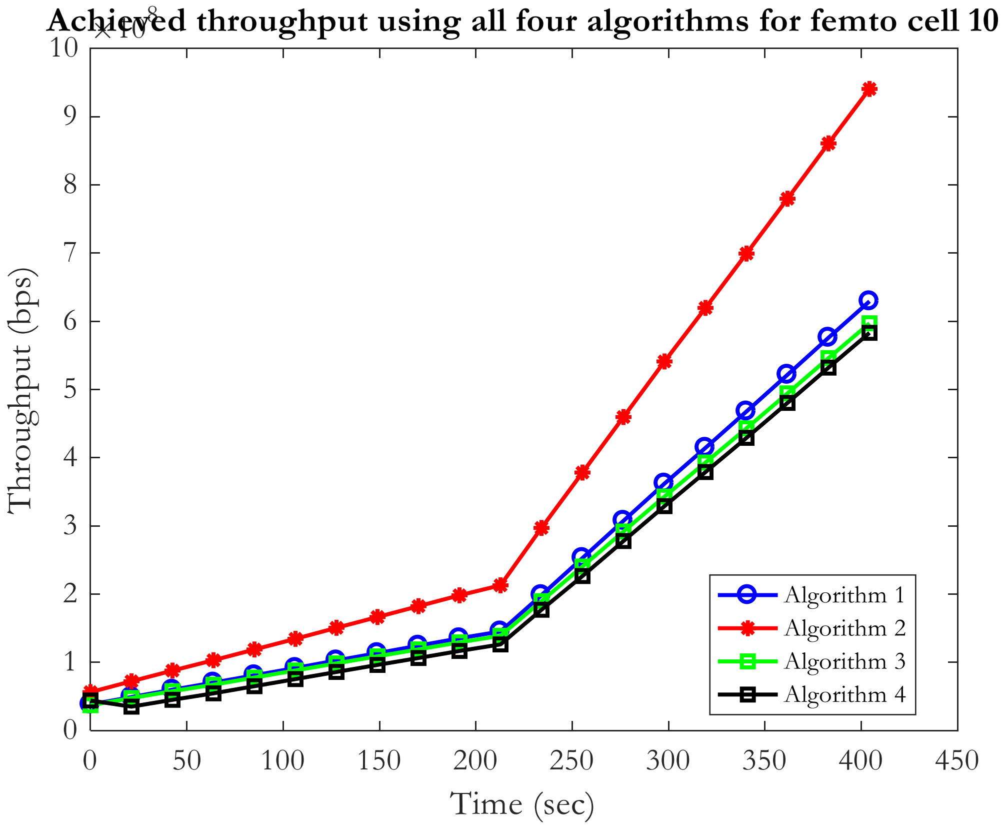

Figure 5.13: Achieved throughput using all four algorithms for femto cell 10

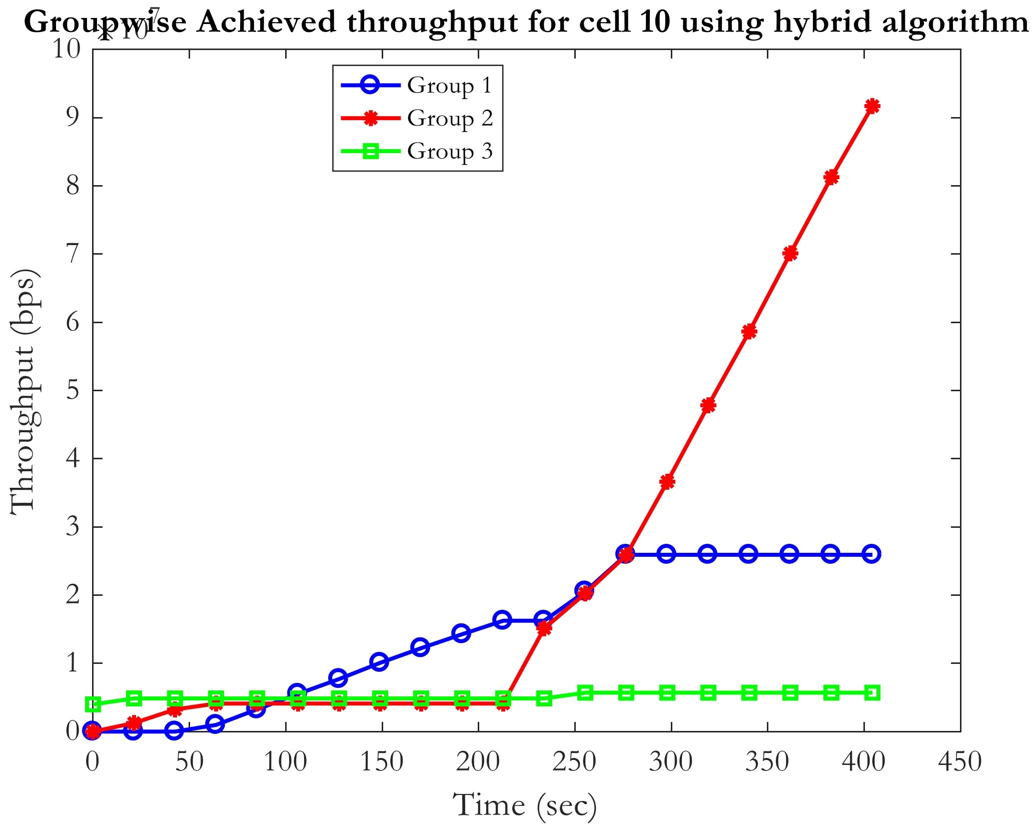

Figure 5.14: Groupwise achieved throughput for cell 10 using hybrid algorithm

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 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. In the end, a fourth algorithm has been presented which selects on algorithm from all three for a particular group based on the required target throughput of the group. As different algorithms has its advantages and drawbacks, a combination of these has been observed and effectively utilized in fourth algorithm so that each femto cell choose one of the algorithm according to its users and its location from corresponding macro cell. Algorithm 3 is best in interference reduction from macro cell which uses about 9.23 dbm of power. If cell 10 is compared where femto cell is located in center of the macro cell, Proposed algorithm uses 8.374 dbm of power on average which gives 9.3 % of power saving and by achieving the desired target throughput for all three groups.It has been observed that algorithm four chosses algorithm three when femto cell is on the boundary of the macro cells, as there is least interference to the macro cell center in which little power is efficient to achieve the target throughput. When femto cell is near to center, it uses algorithm one in group 3 as it needs smaller throughput target means less power so that least interference is achieved with that of macro cell users and algorithm three is used for the first and second group as more throughput was required.

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