

Minimize the Inter-cell Interference in Close Proximity Cell using Dynamic Fractional Frequency Reuse Method

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Abstract— Close Proximity is emerging as a cost effective solution for satisfying the huge demands of mobile data. It can be deployed at any place where mobile traffic is required without the need for cell planning. However, coexistence of many uncontrolled small-cells using the same licensed frequency band can result in serious interference problems. In order to utilize small-cell efficiently, it is highly desirable that the small-cell can self-organize the network and mitigate interference automatically. This paper is proposing a dynamic fractional frequency reuse (DFFR) method for reducing the inter-cell interference (ICI) automatically. With reference to dynamic fractional frequency reuse (DFFR), each cell is separated into two regions identified as super region and regular region. For regular region, it is separated into three parts equivalent to the three sectors. The proposed method has evidently provided a comparable performance with Fractional Frequency Reuse (FFR) through simulation. Simulation results have verified the effectiveness of the proposed method.

Keywords—Dynamic Fractional Frequency Reuse (DFFR), Fractional Frequency Reuse (FFR), Long Term Evolution (LTE), Inter-cell Interference (ICI), Frequency Reuse (FR), Bit Error Rate (BER)

I. INTRODUCTION

In the phone system, innovation changes are on interest to give the best offering to clients. The cell system innovation was enhanced from 1 Generation (1G) that has a constrained capacity of just fit for supporting voice correspondence with the guide of simple circuit system. What's more, the most recent LTE-Advanced is competent to bolster and withstand propelled administrations and application with top information rate of 100Mbit/s for high versatility and 1Gbit/s for low portability [1]. A key component of future remote system is the utilization of little cell architectures with the potential for offloading movement from the full scale cell system and spatial reuse of assets to expand framework limit [2]. To guarantee acceptable call/ on-telephone correspondence quality, Mobile telephones are intended to work at the base force. Indeed, the mechanics of both cell telephones and portable base stations (BS) are intended to work best at the

most minimal conceivable force. Various elements constitute both cellular telephones and BS when comes to what amount is the base force level needed for them to work best. The conceivable components are the particular system, the client's nearness to BS and the radio recurrence band being utilized. With a specific end goal to maintain and keep up a dynamic call, the BS and the cell telephones will naturally triggers its sensors to direct and decrease their energy to the most reduced level needed. This instrument or procedure is alluded as versatile force control [3].

Client's separation to the closest system BS is one of the key variables that influence the operation of cellular telephone. A cellular telephone which is shut to the closest BS will for the most part oblige less energy to work than the same cell telephone that is transmitting a call from separation. By setting little's cell in a heterogeneous system, it can spare the vitality to the client. Diminishing the measure of cells, client can encounter higher limits while spending less vitality [4,5].

In LTE system, each BS utilizes the entire framework transfer speed to transmit information and there is no recurrence arranging among cells to withstand impedance from neighboring cells. Subsequently, LTE large scale cell arrangements encounter substantial impedance at the limits of the cells [6]. Every versatile client will ask for some neighboring BSs for impedance shirking, which is in view of the relative separation between the home BS and the meddling BSs, called as the obstruction coordination (IC) range. It is clear that ICI has turn into the restricting component when attempting to accomplish both high normal client fulfillment, rather a high level of fulfillment for however many clients as could reasonably be expected [7,8]. With a specific end goal to moderate ICI a few instruments between co-channel cells must be actualized. There are a few conceivable answers for minimize the ICI is utilizing Inter-cell Interference Cancellation, Inter-cell Interference Randomization and Inter-cell Interference Coordination (ICIC) [9]. ICIC assumes a key part in heterogeneous systems. ICIC systems in LTE are generally restricted to the recurrence space, e.g. just incomplete utilization of assets in recurrence bearing and/or

adjustment of force levels [10, 11, 12].

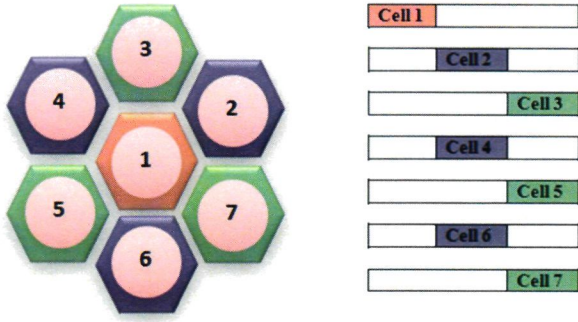


Figure 1: Different inter-cell interference coordination schemes [4]

Figure 1 illustrates a number of frequency partitioning methods. The routine techniques to moderate the obstruction of orthogonal recurrence division different access (OFDMA) framework by dodging recurrence crash can be partitioned into two primary classes: (a) recurrence division (FS) and (b) fragmentary recurrence reuse (FFR) [8], [9]. The FS system minimizes the cell impedance by isolating the entire recurrence band into littler sub band and allotting a sub band to every little cell. Be that as it may, this is frightfully wasteful in light of the fact that in little cell can't utilize the entire band. The FFR strategy minimizes the cell edge obstruction by devoting a sub band halfway, and reuses regular band for the cell focus. This makes FFR strategy more frightfully productive than FS. Also, it has been demonstrated that cell coordination in asset square distribution can decrease the intercell obstruction and additionally expand limit.

The FFR strategy, if there should arise an occurrence of little cell experiences issues in manual upgrading of sub band assignment and in cell coordination since the little cells can be haphazardly found and their number may be substantial. Moreover, the routine FFR technique will be wasteful in otherworldly use when portable stations (MSs) are congested in the cell focus in light of the fact that the saved sub band for the cell edge MS is not apportioned to the cell focus MS. Henceforth, it is attractive to outline the little cell organize as a self-arranging system (SON) [11-12] that enhances the sub-band portion naturally for impedance lessening and enhanced spectra effectiveness.

The element FFR plan the paper is proposing is in view of a dynamic methodology. Therefore, images' number per WiMAX sub-casing dispensed to cell edge clients is balanced edge by-casing as indicated by the framework load. This paper again highlights the proposed plan succeeds altogether in plunging the phone edge throughput blackout particularly for non uniform clients when contrasted with a static FFR plot in which altered portion of the sub-casing is apportioned to cell edge clients at every edge.

In this paper, we are tending to the element FFR technique to relieve obstruction close nearness cell.

II. METHODOLOGY

A. Frequency Reuse

Frequencies apportioned to the administration are reused in a normal example of ranges in cell idea called cells and each secured by one base station. At the point when cell administration suppliers fabricate their systems, their systems are intended to give scope to the range of longing with the desire of conceivable increment in populace soon. There are a few strategies to extend the current system or to include more limit and minimize the impedance to the system. One of the system that be utilized is recurrence reuse.



(a) Single reuse/reuse 1 (b) Frequency reuse/half reuse

Figure 2: Frequency Reuse Scheme

From figure 2 contrasting the base station power, separation and limit utilizing single recurrence and utilizing recurrence reuse to dissect the between cell obstruction in both systems whether the recurrence reuse or single recurrence is better in term of limit. A simpler way that evades between cell impedance is the recurrence reuse plan (figure 2b) which isolates the aggregate transfer speed between the three cells. In this circumstance, clients see no between cell obstruction at the expense of decreased data transfer capacity [8]. Subsequently, reuse 1 or single reuse (figure 2a) is suggestion where clients in every cell have entry to the whole transmission capacity however have obstruction from out of cell clients.

Consider three cells with base stations separation, l separated, each compelled by an aggregate force imperative p and framework data transmission $2W$. The separation, d client from base station lessening will expand the limit at comparison 2 and 3. The way misfortune model can be expressed as:

$$pl(d) = 133.6 + 35 \log (d) \quad (1)$$

Assume that all users in the same cell are receive the signal at the same power level, P . WN is a noise power.

$$\text{Single reuse} = 2W \cdot \log\left(1 + \frac{P \cdot pl(d)}{WN}\right) \quad (2)$$

$$\text{Frequency reuse} = 2W \cdot \log\left(1 + \frac{P \cdot pl(d)}{WN + \frac{P}{2} \cdot pl(l-d)}\right) \quad (3)$$

The limit per client shifts with the separation, d as indicated in figure 3. The green and blue surface demonstrate the limit accomplished under single reuse and recurrence reuse

individually. The separation of every client from its own base station reductions will make the aggregate force will diminishing and this is making the build the limit.

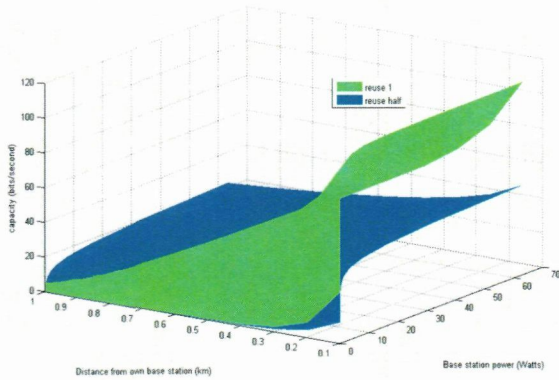


Figure 3: comparison single reuse (green) and frequency reuse (blue) based on capacity, distance and total power between 3 numbers of cells.

Based on the Shannon's theorem, the rate of the data of a user I on subcarrier n can be expressed as

$$R_{i,n} = \Delta f * \log_2 (1 + (\text{SINR})_{i,n} / \mu) \quad (4)$$

where μ called SNR gap is a constant due to the related target BER, with $\mu = -\ln(5\text{BER}) / 1.5$.

The equation for power receives of user can be expressed as

$$\text{Power rx (dBm)} = \text{Power tx (dBm)} - (133.6 + 35 * \log_{10}(d)) \quad (5)$$

B. Fractional Frequency Reuse

ICI can be lessened by dispensing contrast recurrence band to recurrence reuse however this limits the band that can be utilized by every cell. This is the motivation behind why recurrence reuse not executed in LTE frameworks. To determine this issue is a system called Fractional Frequency Reuse (FFR) is utilized. FFR system isolates the recurrence band dispensed to the range almost a base station where no sign impedance from nearby base station happens from the recurrence groups designated to the zones a long way from the base station where signal obstruction from a neighboring base station can happen [13].

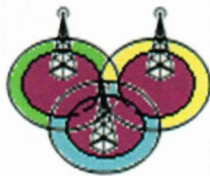


Figure 4: Fractional Frequency Reuse Scheme

Fractional Frequency Reuse is utilized to decrease the ICI that happens in the little cell. It comprises of separating the range

into two sections which will have distinctive recurrence reuse. One area of the framework range is utilized as a part of all cells, while the other piece of the range is isolated among distinctive port as in hard recurrence reuse. This technique is especially helpful for Inter-cell obstruction in the downlink, where serious impedance circumstances can happen where the client is found near to a neighbor cell.

C. Dynamic Fractional Frequency Reuse

Based from the FFR, subcarriers are firstly apportioned among the cells preceding within a cell, among the customers. Each cell is allotted into two regions: super region and predictable zone in this specific cell structure. The general social occasion is disconnected into three areas which are contrasted with the three sections. Both ranges cover the whole cell surface. Thus, all customers of a cell are virtual people from both zones. Furthermore, the subcarriers are isolated into two social affairs which are super and standard get-together. The subcarriers designated to the super and the fragments within the general get-togethers are orthogonal. Additionally, if subcarrier n is allocated to the super or general assembling in one telephone, it should be reused in all the telephones. The structure and repeat band allocation are portrayed in Fig. 5 [8]. In this paper, it is viewed as that 19-cell networks with three sections for every cell (see Fig. 5). Right when customer i is arranged in range A_n of cell 1, I consolidates all the bordering cells in the super assembling and cells numbered $\{5, 6, 13, 14, 15, 16, 17\}$ in the general social event setting.

Like [8], for course of the subcarriers to the area ranges (super and typical areas) the utility limits are used. The utility of a subcarrier n for the super assembling is typical estimations of achievable rates of every single one of customers, which can be figured from (4), on this subcarrier. Notwithstanding, in the standard assembling the utility for each portion is typical estimations of achievable rates of the present customers in the correspondence part on a subcarrier n . $R_{sup, i,n}$ and $R_{reg, i,n}$ recognize the achievable data rate of subcarrier n in the super and typical social occasion, exclusively.

T_{supern} and $T_{regularn,m}$ are utility of subcarrier n for the super assembling and utility of subcarrier n and part m for the standard social occasion, exclusively. At first we acknowledge that all the subcarriers are circulated to the super assembling in this way fundamental rate of a division is zero. To delegate a subcarrier to typical get-together, another utility limit is portrayed. This limit for each division procures from differential utility qualities general and super social events on a given subcarrier and mean with $U_{n,m}$, where $U_{n,m}$ is the utility limit of territory m on subcarrier n .

Consequently, to update the rate of a section showed as ϕ_m , and undertaking subcarrier to standard assembling, the going with steps are performed.

1. At choice necessities of each zone, mean as C_m , with summation data rate of the existent customers in correspondence part, are gotten.
2. In this stride, the segments that fulfilled the expression $\phi_m = C_m - \phi_n$, sort into an overwhelming area set.

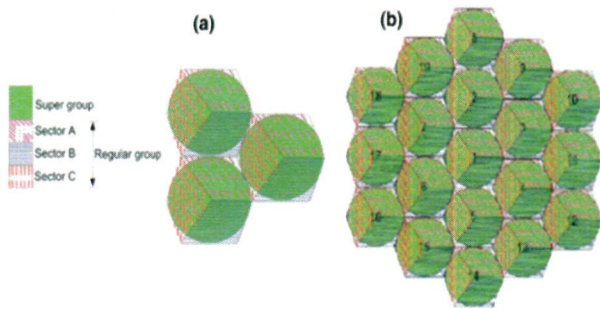


Fig. 5 a Dynamic fractional frequency reuse structure.
b 19-cell grid

3. For all subcarriers and parts fitting in with the predominant division set, $U_{n,m}$ figure and discover subcarrier section pair n, m that increase $U_{n,m}$.
4. In case $U_{n,m} < 0$, this subcarrier stays in the super assembling, in light of the fact that assignment of the subcarrier n to the predictable social affair cuts down the system data rate. Rate of a region can be overhauled as: $\phi_m = \phi_m + \lambda T_{supern}$. $\lambda < 1$ is a relentless regard.
5. Else if $U_{n,m} > 0$, subcarrier n is removed from the super assembling and assigned to division m of the predictable assembling and rate of a territory can be given by, $\phi_m = \phi_m + T_{regulam,m}$

Since the super and general social occasion subcarriers are orthogonal, in the wake of finding the subcarriers having a spot with the standard get-together, with motioned system, super pack's subcarriers can be interestingly chosen. After subcarriers undertaking to super and standard get-togethers, we use from sharp occupying for the errand subcarriers to customers in every telephone.

At the point, when there are various customers which obscure self-governingly there is a propensity that a rate of the customers will have an in number channel. By allowing only those customers to transmit, the shared direct resource is used as a piece of the most gainful way and the total system throughput is helped.

Such occupying frameworks are called guileful in light of the way that they misuse extraordinary direct conditions in distributing time openings to customers. Expecting $R_{sup,i,n,t}$ and $R_{reg,i,n,t}$ address brief achievable rates values for customer i in time opening t subcarrier n in super assembling and steady assembling, independently.

For the errand of the super assembling subcarriers to the customers, this count booking finds the customer i that increase $R_{sup,i,n,t}$ at every arranging opening t . So likewise, for the assignment of the predictable get-together subcarriers, this computation finds the customer i that intensify the $R_{reg,i,n,t}$.

III. SIMULATION RESULTS

Obstruction happens between cells when accepting information in the LTE is known as ICI. Figure 6 demonstrates that the impact of the base station power, separation and the quantity of client. Examination in the middle of FFR and the DFFR is to show the distinction between utilizing little cell when contrasted with the smaller scale cell and pico cell. Obviously, DFFR recorded more number of clients contrasted with the FFR because of the DFFR utilized separate recurrence band and clients can be situated at wherever without meddling different clients. The force of the base station is subjected to the separation of the c.

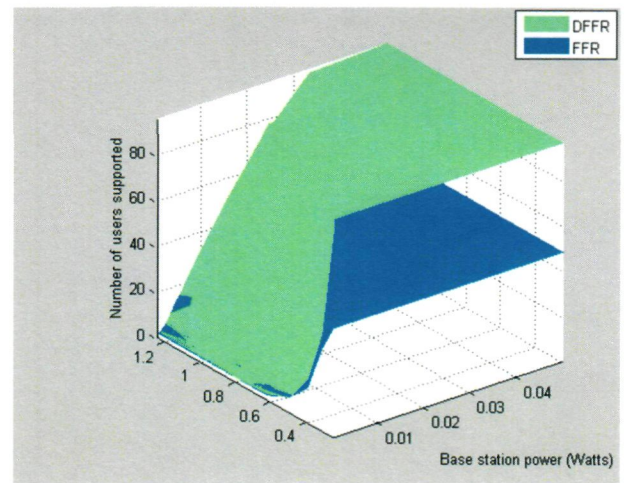


Figure 6: comparison of DFFR (green) and FFR (blue) based on the number of users supported

Figure 6 contrasts DFFR with partial recurrence reuse and demonstrate the subtle element of chart from Figure 5 in light of the quantity of client, separation and BS power. It shows that the DFFR is proper to quantify this and further points of interest as cuts of figure 6 can be allude in figure 7.

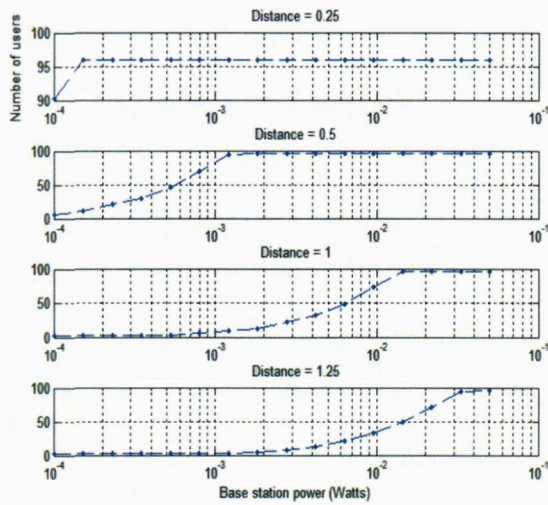


Figure 7: Dynamic FFR with varying power and distance from BS. Figure 7 brings up the separation client to the base station is increment with the expanding of the force on the base station. Figure 8 demonstrates that when separation build, base station force will augment and reason a higher obstruction. It demonstrates that the closer the cell, it will disservice the force of the base station. The procedure of diminishing the force will spare the vitality and minimize the radiation.

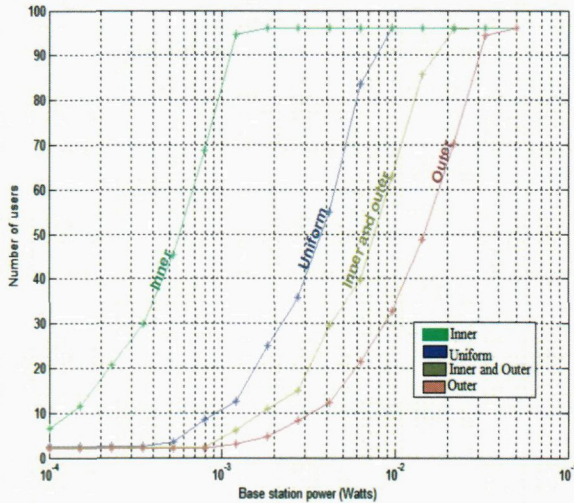


Figure 8: the variant power and distance from BS effect of user distribution of the Dynamic FFR

Figure 8 demonstrates the Dynamic FFR with shifting power and separation from BS impact of client dissemination. Figure shows the backing of the DFFR gave an effect on the client area inside of the cell and aggregate force imperatives. "Internal" surmise to the circumstance where the gathering of clients are precisely 0.5 km from their individual base station though for the situation "external" these gatherings are at 1.25 km. "inward and Outer" is the common mix of these two circumstances (50% of the clients are at 0.5 km and half are at 1.25 km). The "Uniform" spots clients arbitrarily between

their base station and the cell edge.

	Base Station Power	Numbers of Users
Inner	0.00035	30
	0.00081	70
	0.00182	96
Uniform	0.00252	30
	0.00522	70
	0.01534	96
Inner and outer	0.00513	30
	0.02311	70
	0.02254	96
Outer	0.00895	30
	0.02356	70
	0.05112	96

Table 1: data that collected from effect of user within the power for DFFR

From the information in table 1, clients in internal cell have a low get base station force contrasted with the client in other area. This demonstrates that the client get low power when client close nearness to the cell. At the point when client at external, the base station power recipient to client is increment in light of the client a long way from the base station. Equation 5 demonstrates that the forces get and set the irregular for transmit power and believer to dBm. Proselyte get energy to Watt. Change the separation in the middle of client and base station will change the outcome and it will influence the force.

Between cell impedance is one of the obstruction that happens in the LTE. In this paper, to demonstrate that the utilizing DFFR technique will decrease the between cell impedance is contrast bit lapse rate and the force due to misfortunes and high different access obstruction. Figure 9 demonstrates that the bit mistake rate contrasts with the base station power.

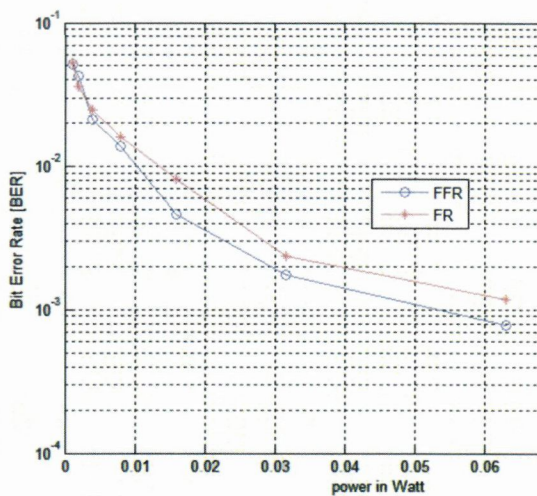


Figure 9: comparison BER versus power in watt

In view of figure 9, utilizing technique Fractional Frequency Reuse will diminish the impedance utilizing mathematical statement 4 taking into account the bit slip rates.

In conclusion, figure 10 is centered around the impacts of subgroups on the supportable number of clients. From the figure, it can be determined that there is one subcarrier per sub-band, the obstruction is profoundly used so client gets the opportunity to hand-pick his meddle however when there are forty-eight subcarriers for every sub-band, the commotion is consolidated and every client confronts the impedance from the greater part of the clients in the other cell.

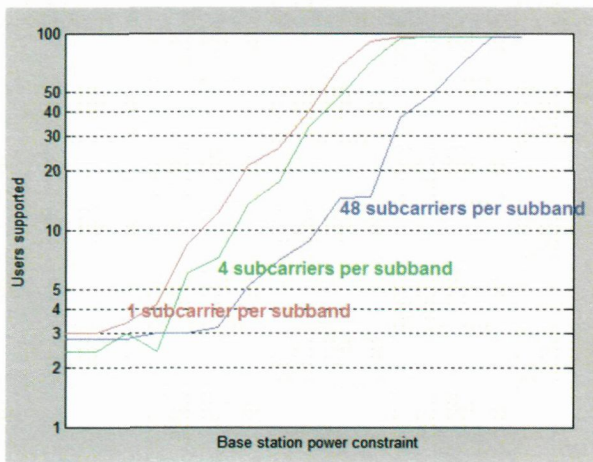


Figure 10 effect of subbands on the number of users the system can support

From the figure 10, the higher the quantity of subcarriers per subband the most reduced the base station power limitations and will be minimize the between cell obstruction.

IV. CONCLUSION

Inter-cell interference is a principle issue in LTE. One of ordinary between cell obstruction moderation system is IC.

most normally IC strategy is the recurrence reuse design. As the conclusion for this venture, the strategy that used to assess the obstruction is Dynamic Fractional Frequency Reuse (FFR). In light of the outcome, the Dynamic Fractional Frequency reuse was effectively to minimize the between cell obstruction with diminishes impedance. Impact of shut nearness cell will lessen the cellular telephone power. Diminished the separation of client to base station will lessen the force recipient. At the point when the force gets is diminish, cell telephone will spare the battery.

V. RECOMMENDATION

For the future work to minimize the between cell obstruction is utilizing strategy that can be manage changing client movement of client areas. Other change that ought to do in the LTE is enhancing the transmission speed at the cell edges.

VI. ACKNOWLEDGEMENT

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