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Enhanced Energy Efficiency in Dense Femto Cell Networks Using Modified Spreading Factor

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***Abstract*— Adding dense Femto Base Stations (FBSs) has become a common approach toward capacity and coverage enhancements in the current cellular networks. Moreover, rapidly growing demands for capacity, results in ultra dense deployment of femto base station and the energy consumption of the cellular networks. Thus increasing energy efficiency has gained great importance in small cell research to minimize the impact on the environment. The energy efficiency of dense FBS networks can be maximized; by assigning transmission power in terms of spreading factor. In the proposed method, the assignment of spreading factor is under gone using near-far effect. So that the energy efficiency of the dense FBS network can be maximized by increasing throughput of the system. Two different scenarios are used namely: indoor with closed access mode FBSs and outdoor with open access mode FBSs. The simulation results are computed using MATLAB.**

***Keywords*— *Energy Efficiency (EE); femto cell networks; transmission power*.**

I. INTRODUCTION

The main aim of mobile operators is to increase the system capacity and data transmission within a large cell coverage area, due to the popularity of wireless network service. The wireless network has taken over from wired service in terms of high data rate service and mobility it provides to end users. To achieve this aim, several standard technologies have been developed such like 3GPPs High Speed Packet Access (HSPA), Long Term Evolution (LTE), and LTE advance, 3GPP2s Evolution-Data Optimized (EVDO) and Ultra Wide Band (UWB) to provide high speed communication to end. Femtocell network has emerged as an approach to increase the capacity and coverage of mobile cellular systems by getting the transmitter and receiver closer to each other. A femtocell consists of a low power, short range access point (AP) to provide in-building coverage to home users over the internet based IP backhaul such as cable modem or digital subscriber line (DSL). In order to increase spectral efficiency per area, femtocell and existing networks use the same frequency band in an arrangement known as co-channel deployment. There are several publications on OFDMA based femtocell networks, which propose better flexibility in terms of allocation of frequency resources. The resource allocation problem as a sum rate maximization of all femtocell users in femtocell networks subject to some constraints of macrocell users and femtocell access points.

In femtocell networks, the smaller size of femtocell not only provides high spectrum efficiency by using spatial reuse of resources but also decreases the transmission range and then provides high probability of connectivity. Further, one of the most important reasons for deployment femtocells technology is to serve the remote areas with no coverage or poor signal as well as. The femtocell device can be installed to the customer's premises by the customer's themselves. Femtocells enable mobile operators to move from conventional single-macro base station with high number of users into small coverage area with limited number of users.

II. RELATED WORKS

Wang *et al.* in [1] have proposed an UE association algorithm for efficient utilization of green energy in HetNets. Green energy consumption maximization techniques minimize the use of nonrenewable energy consumption but they do not increase the EE of the system. UE association techniques are simple to study and effective in increasing EE but all the UEs cannot be assumed to follow or implement these new association techniques. Chung in [2] has proposed an efficient energy-saving transmission algorithm to minimize the power consumption of the transceivers of a BS. The proposed algorithm activates and deactivates a group of FBSs according to dynamically varying traffic load while satisfying the rate requirement of all the associated UEs. The power control algorithm which focuses on protecting macrocell user's link quality via utilizing feedbacks is introduced in [3].

The paper focuses on resource allocation for FBs in a split-spectrum setup; the non-cooperative Stackelberg game allows each user to compete for system resources; and evolutionary game theory is used to develop a self organizing algorithm for small cells in [4]. The resource allocation in open orthogonal frequency division multiple access (OFDMA) femtocell networks can be used to improve the QoS for the neighboring macrocell users. Using OFDMA, the authors in [5] proposed a multiaccess technique that allocates different users to different groups of orthogonal subchannels exploiting channel variations in both frequency and time domains. Among a few types of research proposals pertaining to the network management process, we discuss the major works related to system management and resource allocation between macro- and femtocell units. Where fair resource sharing among femtocell BS's each user and protection of macrocell users is important. A downlink power control algorithm, where femtocell BSs aim to maximize their signal quality while limiting interference they create based on the feedback received from macrocell BS is given in [6].

In [9], the authors investigated the downlink spectrum sharing problem while applying cognitive radio (CR) technology to femtocell networks. However, the given solution did not investigate the overall network operation scenarios, nor analyze a dynamic profile for the spectrum availability. Moreover, the cross-tier interference avoidance strategy, which was developed in [10], used macrocell uplink interference in two-tier OFDMA networks to derive the distribution of macrocell uplink interference, including intercell and cross-tier interference. These analyses were conducted by assuming a homogeneous spatial Poisson point process for femtocell distribution across macrocell site.

The work in [11] developed a tractable, flexible, and accurate model for a downlink heterogeneous cellular network as a solution for two-tier networks. Even with a Poisson point process model, the outcome of this research is about as accurate as the standard grid model, when compared to an actual network. Most importantly, the authors mentioned that for a network model to be applicable and accurate, it should consider using the mathematical tools of stochastic geometry to bear on the problem of base stations locations. This helps to investigate the fundamental performance of wireless networks. The analytical model for multicell systems in [13] studied the effect of spectrum allocation in two-tier networks by considering joint subchannel allocation, in which the whole spectrum is shared by both tiers, as well as disjoint subchannel allocation, wherein disjoint sets of subchannels are assigned to both tiers. Although, joint subchannel allocation may be sensible in dense networks, it is not clear whether disjoint subchannel allocation would be necessary in lightly loaded network sites where interference incurred through subchannel sharing can be tolerated. However, there is no association between channel allocation and network structure.

III. EXISTING WORK

The EE of the femto base station network is expressed as

$$\mathrm{EE} = \frac{\text{throughput}}{\text{energy consumption}}$$

To maximize the EE, either throughput can be increased or energy consumed may be decreased. Since the throughput is related to QoS of the UEs, increasing it beyond the requirement does not give any usage. The energy efficiency can be increased effectively if energy consumed is reduced to a considerable amount. The transmit power spreading technique has been adopted to reduce the energy consumption of the FBS network. This technique set an threshold SINR and spreading factor to maximize EE of FBS by maintaining the minimum SINR and QoS requirement. By reducing the transmit power by ensuring the transmit power by ensuring the above said will consume energy thereby achieving increased EE.

IV. PROPOSED WORK

The proposed work increases the energy efficiency by updating the spreading factor with 'near-far effect'. Due to propagation characteristics the signals from mobile closer to the base station could overpower the signals from mobiles located farther away. In the proposed work the spreading factor assignment is secluded into two segment one for near field and other for far field. The spreading factor assignment is described as follows updating spreading factor for near field mobiles.

- The spreading factor for near field mobile is indicated as γ_{ni} and it should be updated by maintaining the minimum SINR threshold and QoS requirement..
- Spreading factor with less transmitting power results in link failure in UEs.
- The minimum valued SINR among all UEs is traced out and the $\gamma_n^{\min}$ is calculated, similarly $\gamma_n^{\min}$.
- Keeping $\gamma_n^{\min}$ to be the new spreading factor it check the velocity of QoS of the UE.
- If $\gamma_n^{\min}$ satisfy the QoS then $\gamma_n^{\min}$ is update otherwise the $\gamma_n^{\min}$ value is increased until $\gamma^{\max}$ until a valid Qos is achieved . In the same manner the region of cellular area covering for field is ensured with QoS and SINR by updating the spreading factor designated in the range $\left[\gamma_f^{\min}, \gamma_f^{\max}\right]$. Thus, the proposed method increased the energy efficiency of the FBS by utilizing spreading factor assignment in FBS by dividing the region in to near and far field. The time complexity involved in calculating the spreading factor by observing the response from UE can be reduced, since the step size needed to increment from $\gamma_n^{\min}$ to reach $\gamma_n^{\max}$ is different from $\gamma_f^{\min}$ to reach $\gamma_f^{\max}$. While considering far field the incremental value may be kept higher, so that communication failure does not happens which improves the throughput.

V. SIMULATION RESULTS

TABLE I. SIMULATION PARAMETEER

PARAMTER	VALUE
FBS Bandwidth	5MHz
Number of UEs per FBS	2 – 9
MBS Bandwidth	60MHz
FBS Coverage area	30 Meters
FBS transmit power	0.1 Watt
Carrier frequency	2 Ghz

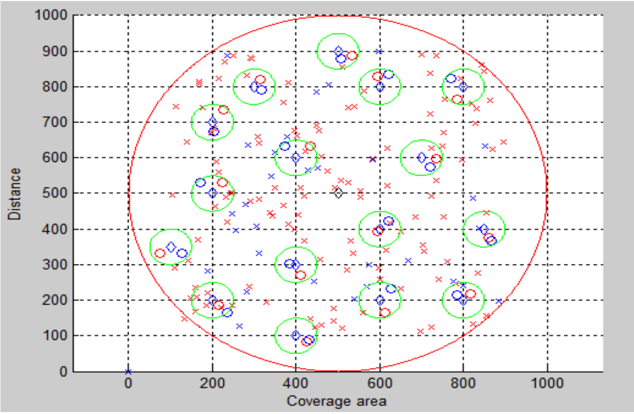

Fig .1. Distance versus Coverage area.

Fig.1. shows the macro base station versus coverage area of 1000m × 1000m. The macro cell is deployed with dense femto base stations. 'x' mark represent users of the femto base station.

A. User Power Transmission

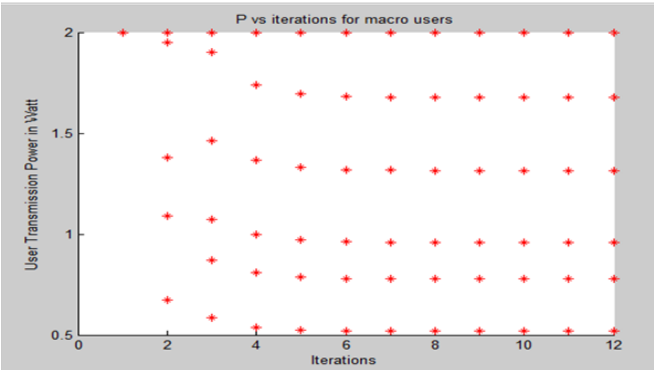

Fig. 2(a) . User power transmission Versus Iteration for macro users.

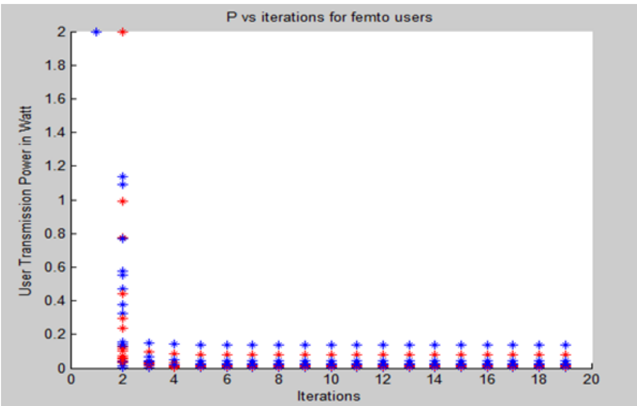

Fig. 2(b). User power transmission Versus Iterations for femto users.

Fig. 2(a) and Fig. 2(b) shows the allocation of transmission power for macro users and femto users respectively.

B. Utilization

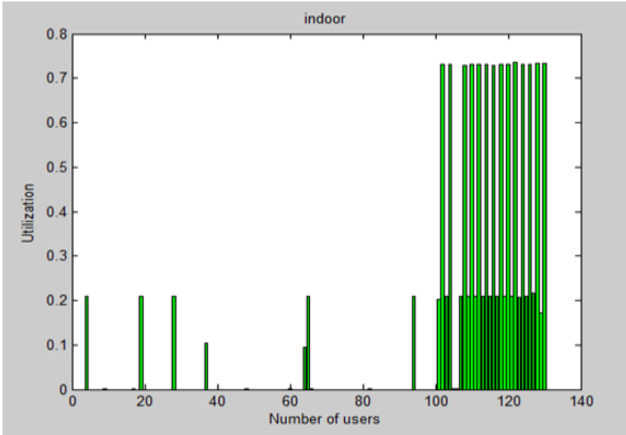

Fig .3(a). Utilization versus Number of Users in Indoor

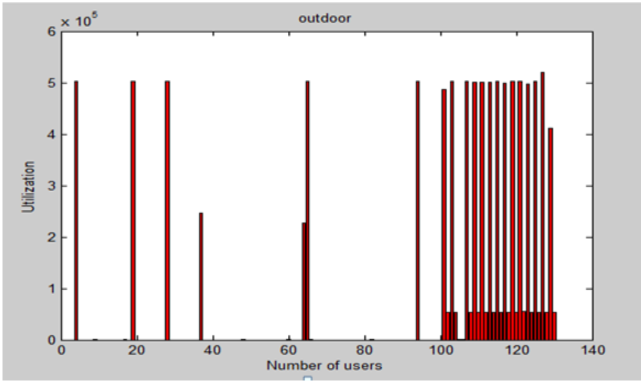

Fig. 3(b). Utilization versus Number of Users in Outdoor.

Fig. 3(a) & (b) represent utilization of users in indoor and outdoor. The utilization of femto base station varies with different types of users. In indoor large number of users utilizes the femto base station Fig. 3(a). But outdoor less number of users utilizes the femto base station Fig .3(b).

C. Energy Efficiency

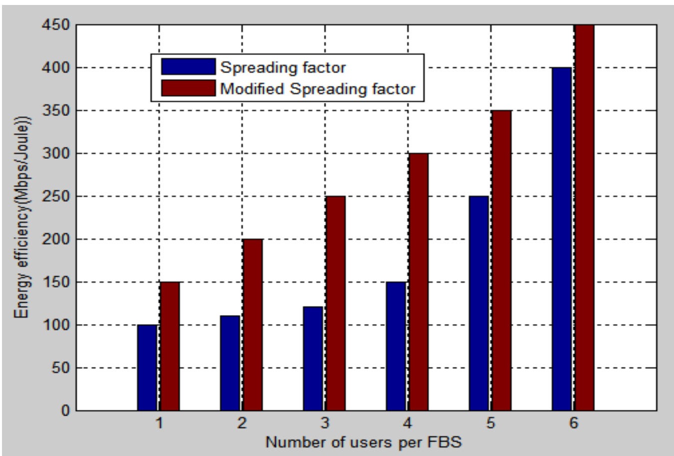

Fig. 4. Energy Efficiency (Mbps/Joule) versus Number of Users

The energy efficiency of the femto cell is shown in Fig. 4. The result shows that there is an increase in energy efficiency due to the increase in throughput of the femtocell.

D. Throughput

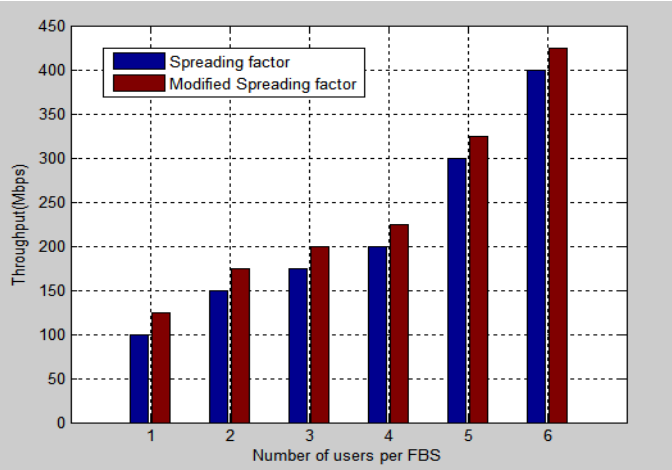

Fig. 5. Throughput (Mbps) Versus Number of users.

The fig. 5 shows the simulation result of throughput with spreading factor Vs modified spreading factor the throughput of MSF is higher than SP; since power allocation utilizes near- far field effect, thereby incrementing factor of spreading factor is separated in to two region for MSP. So that the time required for the UE to send its feedback about the QoS is reduced, which in turn avoid call drops, thereby increasing the throughput of the dense femto cell. In turn an increase in EE is realized.

VI. CONCLUSION AND FUTURE SCOPE

The proposed work enhance the energy efficiency in dense femto cell networks by modified spreading factor . By using this algorithm the energy efficiency is increased in femto cell networks. And also simulated in two different scenarios namely: indoor with closed access mode FBSs and outdoor with open access mode FBS. The simulation results conclusively demonstrated the effectiveness of the proposed heuristic approach in improving the Energy efficiency. The future increase the number of users in femto cell, increase the coverage area and reduce interference in femto cell networks.

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