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DEVELOPMENT OF AN ACCESS MECHANISM FOR FEMTOCELL NETWORKS

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ABSTRACT

Femtocell is a small cellular base station installed in offices and homes that can combine internet technologies and mobile within the home [1]. The two major limitations of wireless communication are range and capacity. Cellular service is far superior in areas of high population density compared to scarcely populated areas [2]. Also it provides many benefits in terms of cost, power, capacity and scalability. However, there are many challenges in the deployment of femtocells such as network architecture, allocation of spectrum resources and the avoidance of electromagnetic interference. In this paper we simulate and develop models of one of access method to create sharing between subscribers and service operator to improve the coverage of operator and reduce the cost for subscribers.

Keywords: *Femtocell, Femtocell access point (FAP), macrocell, base station, open system, closed system.*

1. INTRODUCTION

The initial cellular systems were designed for a single application, voice, but today with the advent of 3G, users expect very high data rates and reliable communication. One of most interesting trends to emerge from this cellular evolution are femtocells [3], [4]

According to [5] 2/3 of voice and 90 percent of data traffic occurs indoors, and because macrocells are not very efficient when delivering indoor coverage due to high penetration losses, providing such coverage has become a challenge for operators. This is shows why the use of femtocell access points (FAPs) seems a promising approach for coping with this coverage problem. An FAP is a low-cost low-power cellular base station are distributed by the end customer. It is expected that femtocells will enhance indoor coverage, and also provide high bandwidths, offer new services, and offload traffic from existing networks. Nevertheless these benefits can't be obtained easily; there are a lot of challenges which faces femtocell spreading such as Interference, security, resource allocation, timing synchronization, and providing emergency services.

In two tiers networks interference classified as cross tier which caused by an element of femtocell tier with macrocell tier and vice versa, and co-tier which caused by elements of the same tier, for example between neighboring femtocell [5].

The security aspects for femtocells have been studied in great detail by 3GPP TSG Service &

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System Aspects (SA) WG3. Several feasible measures were identified in order to mutually authenticate the femtocell access point and the operator's network, along with other security measures [6].

From access methods viewpoint femtocells can be configured to be either open access, closed access or hybrid access [7]. Open access allows an arbitrary nearby cellular user to use the femtocell, whereas closed access restricts the use of the femtocell to users explicitly approved by the owner, while hybrid access can be used to compromise between subscriber and nonsubscribers.

The reminder of paper is organized as follows. Explaining hybrid access method technologies in (section 2). describing the femtocell network architecture In (section 3), Simulation result In (section 4). Finally, in (section 5) there is the conclusion.

2. LITERATURE REVIEW

Research in this aria can be classified into three categories:

Access control strategy and co-channel frequency design and interference studies.

References of each of these points are described in the following:

A) Access control strategy:

A survey about Femtocell Network is done by Vikram Chandrasekhar and et. al [18]. While Guillaume de la Roche and et.al talked about access method, comparison between methods, technical challenges and solution, and describe hybrid approaches [5]. While authors focuse on access control strategy a crucial aspect for operator to give preferential access to femtocells for their subscribers [6]. David L´ opez-P´ erez proposed FDTD (Finite-Difference Time-Domain) simulation for WiMAX mobile System-Level in both case open and closed method access [19]. uplink outage analysis, with different methods of deployment femtocell, in addition to comparison between access methods has been introduced by Deepak and Venkatesh in [20]. Ping Xia and et.al has compared between open and closed access in uplink, from the viewpoint of owner and operator. And mentioned to the capacity in case orthogonal multiple access scheme, and case non-orthogonal multiple access. Lester and Holger show open access method is better than closed one, and provide better QoS and throughput, but it increase number of hand-off.

B) Co-channel frequency design and interference studies:

David López-Pérez and et.al, Naveen Arulselvan and et.al cover interference problems and how to configure the network and power effects [7,24].

David López-Pérez and et.al show that OFDMA femtocell as solution better than CDMA to avoid interference, also introduce some challenges as time synchronization between uplink and downlink, physical cell identity, mobility management and solution for each one [7]. While Authors concentrates on OFDMA based co-channel femtocell, that cause minimum interference because of the sharing by the spectrum with macrocell and femtocell [25]. While [26] shows that there are two types of deployment operator first one called dedicated channel in this case it specified part of the spectrum for femtocell and the remaining for macrocell, second one called co-channel deployment in this case femtocell lie on same frequency of macrocell. Parag and Tim explain how to manage radio resource in consideration of LTE femtocell, and introduce two approach for allocate resource according to application

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requirement first approach by identify the loud transmissions and avoid using their frequencies, the second approach by allocate to any resource block which not used by any somebody else. Also introduce several method to negotiate resource for avoiding or mitigating interference such as transmit power control, randomize frequency, etc…

Developing an uplink capacity analysis and interference avoidance strategy in two tier CDMA network is proposed by Vikram and Jeffrey [28], where the avoidance was by way of antenna sectoring and time hopped CDMA (TH-CDMA) in each tier.

In [29] two strategies to adjust maximum transmit power in both case closed loop and open loop technique, where in open loop femtocell user adjust the maximum transmit power to stop cross tier interference to make the interference less than fixed threshold, in closed loop femtocell user adjust maximum transmit power to satisfy an adaptive interference threshold based on the level of noise and uplink interference at macrocell BS.

Sam and et.al explains two methods of power configuration; first one is fixed power, second one auto power configuration according to macrocell power. Then introduce new method dynamic power control which adjusts the femtocell coverage according to usage of femtocell UEs [30].

3. HYBRID ACCESS METHOD TECHNOLOGIES

There are three different access modes for spectrum sharing between the macro and femto tiers, namely closed, open, and hybrid access. In general, open access is more effective in mitigating cross-tier interference compared to the closed access while it may result in uncontrollable performance degradation for macro users [17]. The hybrid access scheme can balance between advantages and disadvantages of the other two access modes are an interesting and important research topic.

In this paper we constraint in hybrids access methods. There are many technologies used in hybrid access methods, but the most common are [5]:

A) Orthogonal Frequency Division Multiple Access (OFDMA):

The hybrid access method in OFDMA femtocell networks consists of managing the sharing of the OFDMA resources (frequency and time) between subscribers and nonsubscribers. Therefore and first of all, these resources have to be defined. In OFDMA systems sub channels contain a series of subcarriers, which can be adjacent or pseudo randomly distributed across the spectrum in order to exploit either multi-user or frequency diversity. A nonsubscriber allowed access to a given sub channel can use it, for instance, during the whole transmission frame. However, if the network operator owns only a little bandwidth for its femtocells, one sub channel might seem a large resource to be shared. In such cases it is necessary to increase the granularity of the resource allocation, subdividing sub channels over the time domain (OFDM symbols). In general, it can be said that the smaller the resource, the better the approximation to the solicited throughput of a nonsubscriber [5].

Since the amount of resources to share N nonsubscriber is limited, different sharing strategies can be considered for the hybrid access algorithm. The simplest approach is FIFO until N nonsubscriber, then any incoming one will be rejected. Another

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solution, more suitable for residential femtocells, would be to use an approach of granting resources first to those users that request real-time traffic or lower data rates, etc.

There are many drawbacks for this technique, but most important one is interference. Several papers have considered interference coordination in OFDMA based networks, including co-channel interference [9], interference management [10], and interference avoidance strategies [11].

B) Code Division Multiple Access (CDMA):

This method allows a limited number of nonsubscribers to access to femtocell, the number is a fraction of factors such as traffic load at a given location and time.

In code-division multiple access (CDMA) systems, transmissions from other users are seen as interference by the users already in the network. In this case, when a nonsubscriber is granted access to the femtocell, the noise rise deteriorates the instantaneous throughput of subscribers. Moreover, this scheme treats allowed nonsubscribers and subscribers equally (i.e., no data rate restrictions are imposed). Therefore, the incorporation of nonsubscribers degrades the performance of connected subscribers in an uncontrolled way. In the CDMA components (uplink, downlink) many drawbacks, discussed earlier in many papers, Uplink interference problem in CDMA-based networks with closed access [12], [13]. This model and approach was adapted to the downlink and with multiple antennas in [14].

4. SIMULATING AND RESULTS

A) System model:

In this system there is one femtocell with capacity up to M channel, time is slotted, arrivals are Poisson, average service time is equal to slot time, probability to transmit is P, and there is finite number of user with no queuing and blocking probability "block". Also there are two groups of users: first group are subscriber users, and the other one are nonsubscriber users. Subscriber users can use any available channel, whereas nonsubscriber can use only specific part of channels.

B) Results:

This simulation has been done in three cases: first case when system use closed access method (i.e. only subscriber has permeation to access the FAP.

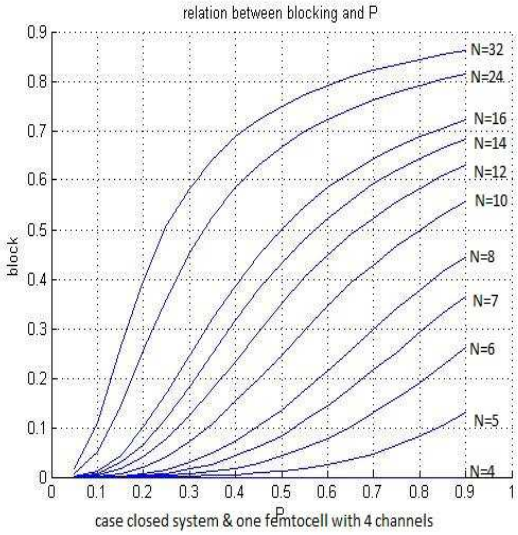

Fig-1 closed system

P: probability of transmitting.

N: maximum number of users that can served with one femtocell.

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M: 4 channels.

block: is probability of blocking.

As shown in the figure 1 whenever the number of user is increased the probability of blocking will increase.

The second case hybrid access method with 1 probability (i.e. for both subscribers and nonsubscribers) if they have call and there is any free channel they will make their call.

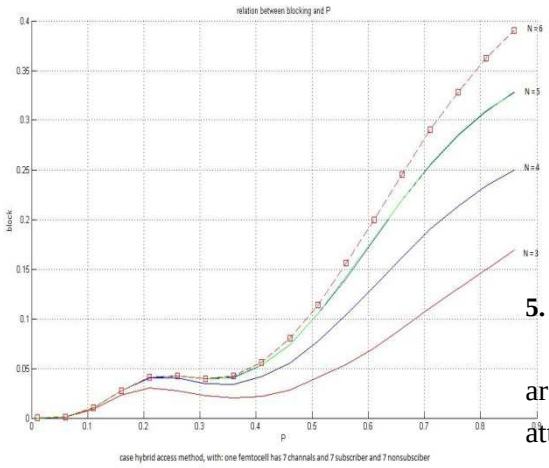

Fig-2 Hybrid System With Different Fragmentations

As shown in the figure 2 when number of nonsubscriber is increased the blocking probability is a little bit increased especially in rang [0.1-0.4], which means nonsubscriber calls are have small effect on subscriber.

The third case hybrid access method with p-probability (i.e. for nonsubscribers if they have call and there is any free channel they will make their call with probability p or they will be ignored by that FAP, while in same time for subscriber it will be with 1 probability.

As shown in figure 3 when P is small that mean the system is more near to closed system and blocking probability will be less than second method, as special case when P=1 this will be exactly second method.

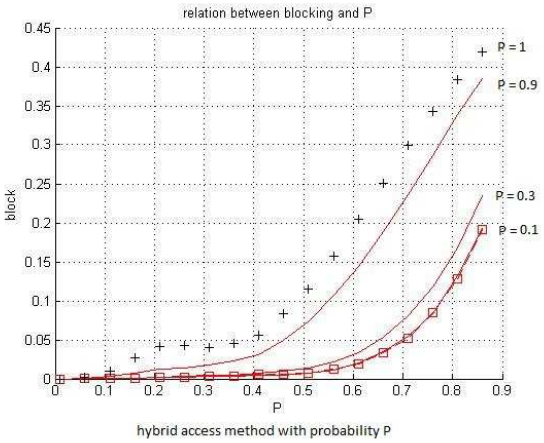

Fig-3, Hybrid Access Method With Probability P.

5. CONCLUSION

Nowadays, femtocells, which cover a cell area of several tens of meters, have been attracting considerable attention in mobile communications.[16]

Femtocells use common cellular air access technologies [15].

Femtocells have the potential to provide high quality network access to indoor users at low cost, while reducing the load on the macrocells.

In our paper we present that using hybrid access method will increase a bit blocking probability which is disadvantage for subscriber, but in the other hand will increase the efficiency of the network. In addition to noticing that Using of hybrid access method with probability P will decrease the blocking probability.

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