Performance Estimation of LTE Femtocells in Various Path Models and Interference Techniques Over ICIC

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Abstract: ***In the cellular telecommunication, the use of femtocells is increasing day by day which shows that they will become backbone in the future. LTE stands for long term evolution and avails OFDM as the format of the signal. Femtocells maneuver with CDMA technology very well. To make it certain that the best operation is performed, there is a requirement to be considered that is development of LTE femtocells. Now, femtocells become an important part of the development technique for cellular telecommunications operators. FAP (Femtocell Access Points) networks are in high demand nowadays as the indoor users are increasing day by day and are in major concern in both literature and commercial applications. In the presence of macro-cell base stations FAP networks are implemented are creating interest in public mind. In new practical scenarios the communication channel capacities is investigated for development and implementing FAP and other future cellular technologies. There is interference present in inter-FAP and FAP in presence of MBS (Macro-cell Base Station). Recently many studies have been done on the various types of interferences caused on MBS due to FAP and vice versa and studies have shown that MBS's uplinks are the major cause of interference. To reduce inter-FAP interference in an OFDM system water-filling algorithm is being proposed earlier.***
Keywords: LTE Femtocells, interference, BS, MS, Channel capacity.

I. INTRODUCTION

In 3G macro layer there was a problem of indoor coverage, to overcome this femtocells came into existence. When the femtocells are placed in the home of end users, there is no problem as in 3G they provide better coverage of area. When the femtocells are deployed in the home of an end user, femtocells will provide higher performance wireless voice, higher quality videos, 3G services to the operator in and around the neighborhood of the surroundings of the home. Femtocells and Wi-Fi access points are identical to each other in many ways such as they facilitate access through an ordinary device. There are a number of criteria to be fulfilled by femtocells such as:

A. Low Impact which means for some households space may be inadequate. Therefore, femtocells must be small in size so that they can be installed easily and ideally aesthetically pleasing.
B. Silent - means to when femtocells are operated.
C. Cheap – Femtocells should be cheap.
D. Low RF power – The femtocells should have low transmit RF power output, in between 10 and 100 milli-Watts, which is a lower power level with respect to other Wi-Fi access points.

Backhaul connection is established with the help of wired broadband Internet service which is accessible in the home to the operator networks. DSL, coaxial cable, and fibre optics are examples of wired broadband internet services. In the wider cellular network no connection is needed except the Internet Protocol core, which results in relieving of the traffic to the operator otherwise that would be directly on the macro-layer onto the internet from the macrocell. The benefit of this is that it decreases the load on the whole network and also reduces the wireless traffic delivering cost compared to that of the macro network.

Femtocells create very minute cells which usually lie inside the bigger cell. Nearby macrocell base stations serve the bigger cell in which tiny cells created by femtocells is laid. As femtocells lie behind macrocells in this condition also they have to operate in a reliable way. Femtocells require to keep away from or strictly restrict the interference with the macrocells so that it can offer faultless experience to the user while roaming in and out of the coverage area of femtocell.

II. PATHLOSS MODELS

The deployment of FAP networks is observed on the basis of four different types considering two parameters i.e. frequency spectrum and services distribution:

A. Dedicated Spectrum Assignment (DSA)

Dedicated spectrum assignment is done on the basis of frequency spectrum. In dedicated spectrum assignment the dedicated spectrum is assigned to the FAP network which is different from the macro-cell spectrum. When a user calls another user than there is least interference as the frequency the FAP network is using is different from the Macro-cell's frequency. Dedicated spectrum provides high coverage so that it can handle a big number of users.

B. Shared Spectrum Assignment (CGS)

Shared spectrum assignment is done on the basis of frequency spectrum. In shared spectrum assignment both FAP network users and macro-cell users' shares the same band of frequencies. When a user calls another user than there is maximum interference as the frequency the FAP network is using is same as the Macro-cell's frequency.

C. Closed Subscriber Group (CSG)

Closed subscriber group is done on the basis of service distribution done for the subscriber. In CSG where each Femto access point is accessible only for a group of local users that are predefined.

D. Open Subscriber Group (OSG)

Open subscriber group is done on the basis of service distribution. In OSG mobile switching center request the nearest FAP for various services.

Comparison of various techniques like DSA with OSG and CSG and SSA with OSG and CSG is done.

III. CHANNEL CAPACITY FOR VARIOUS HETEROGENEOUS NETWORKS:

Channel capacity is calculated using Shannon's capacity theorem keeping into account all the cases of frequency spectrum and service distributions. All the various configurations are analyzed with Shannon's capacity theorem.

Let B_t be the total spectrum assigned to Macro Base Station (MBS) and Femto Access Point (FAP) and also let the total bandwidth received by the users is same means each user receives equal portion of provided bandwidth (B_t). Assume that all the femto and macro base stations transmit together to all the users who are active to calculate the channel capacity. The four possible configurations are

A. SSA with CSG
B. SSA with OSG
C. DSA with CSG
D. DSA with OSG

When there is need to install the mobile radio architecture, we consider many of the propagation models to understand the propagation characteristics. There is need to predict the path loss models for various purposes like planning of the area to be covered, effect of multipath propagation and interference; all these are just the basis for planning the high level networking.

Normally in this planning approach, we determine the amount of received power so as to measure the attributes of BTS (Base Transreceiver Station). With the advent of services related to wireless broadband, the radio channel properties like angular speed, delay spread, etc.) are becoming necessary for the planning of network.

IV. SIMULATION DETAILS AND SCENARIOS:

We are considering the worst case scenario i.e., full buffer traffic model and cannot be implemented by scheduling techniques for our simulation. When the deployment of femtocell is done, a process occurs known as self configuration process which configures the transmission parameters such as indoor wall loss, outdoor wall loss, radius and layout of the cell, etc. It may also include femtocell resource allocation wrt ICIC schemes in macro level, traffic, or control of power transmission depending on parameters perceived by the environment. The scenarios are:

A. Co-channel Operation is the First Scenario

This is the worst case scenario of crosstier interference, in which no power control or frequency distribution is implemented. Here, the same spectrum is used by both femtocells and macrocells.

B. IFR aware is the Second Scenario

Femtocells use reference signal received power measurement to find out the sub bands having lowest priority and then schedule the transmission. This whole is done by Macro base station during the installment of Integer FR of factor 3 (IFR3). IFR3 assigns various sub bands for neighboring macrocells and femtocells.

C. SFR Aware is the Third Scenario for our Simulation

When SFR schemes, are implemented by macro base station, they operate on the sub bands that are not consumed by anyone in the cell zone in which they are installed when femtocells are capable. There is a difference between the available bandwidth in inner region of the cell, the outer radius of the cell and around the macro Base Station. The bandwidth is distributed non uniformly. This implies that in cell centre femto users and cell edge macro users the same frequencies are allocated.

D. IFR/SFR Unaware is the Fourth Scenario in Our Simulation

In this ICIC is included and this is identical to co channel operation. The femtocells are not configured properly and are unknown to the surroundings which results in transmitting to the whole bandwidth.

E. Power Control is the Fifth Scenario in Our Simulation

In this, the femtocell has the ability to configure its downlink transmit power between macro Base Station and the femtocell considering path loss, to uphold constant femtocell coverage independently of its location.

Table 1 Simulation Parameters

SR. NO.	*PARAMETER*	*VALUES*
1	Layout of Cell	Hexagonal
2	Cell Radius	250 m
3	Bandwidth (MHz)	20MHz
4	Modulation Mode	64QAM
5	Subcarriers bandwidth	15 KHz
6	Carrier frequency	2 GHz
7	Correlation distance	40 m
8	Macro BS TX power	46 dBm
9	Femto BS default TX power	11 dBm
10	Outdoor Wall loss	15 dB
11	Indoor Wall Loss	6 dB

V. SIMULATION RESULTS

The simulation is done for the various path-loss models and considering the cell power interference and other parameters. Fig 1 shows throughput w.r.t no. of femtocells.

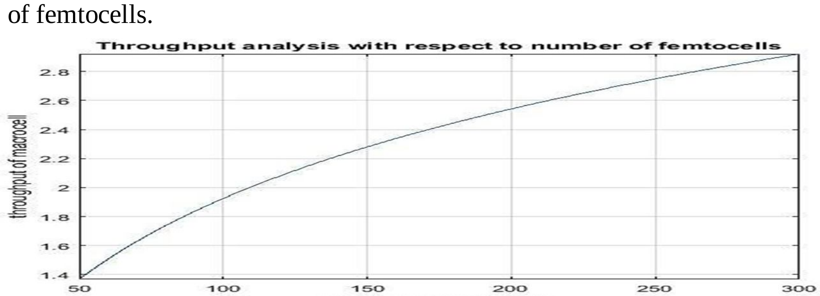

Fig 1 Throughput wrt no. of femtocells

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Fig 2 shows the throughput of femtocells when femto access point networks are implemented in the presence of existing network of macrocell and the outdoor losses are avoided.

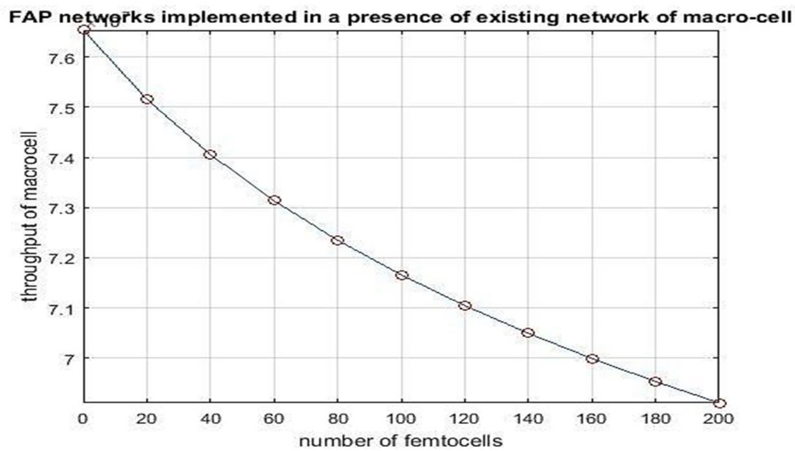

Fig 2 Femto Acess Point networks are implemented in presence of existing network of macrocell

Fig 3 shows a comparative study of femtocells for outdoor and indoor scenarios. The coverage radius is higher for indoor models than outdoor model.

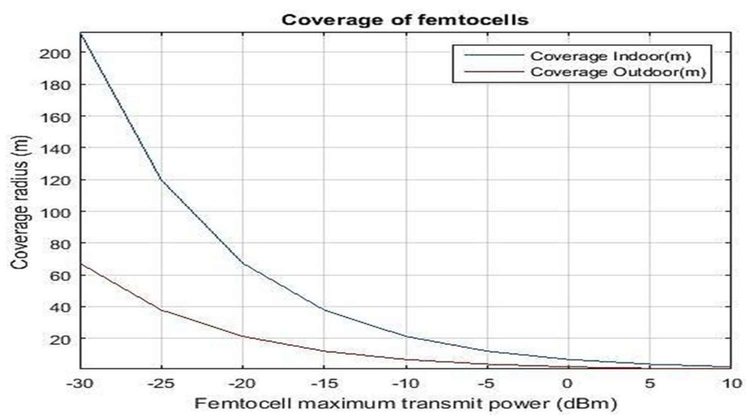

Fig 3 Coverage of femtocells

Fig 4 shows a comparison between capacities when there are shared and dedicated CSG and OSG are presented.

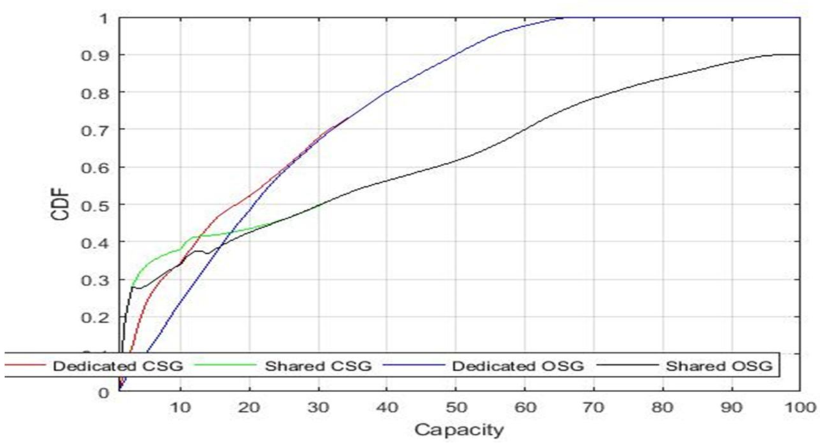

Fig 4 Capacity Comparison

Fig 5 and Fig 6 presents comparison of all the scenarios taken in our simulation wrt number of femtocells. The best performance among all methods is shown by simple power control as the fragmentation of bandwidth doesn't take place in it. As the number of femtocells increases, the edge decreases and at last becomes negligible when femtocells are beyond 35 in number. When the number of femtocells go beyond 22, co channel operation becomes worse.

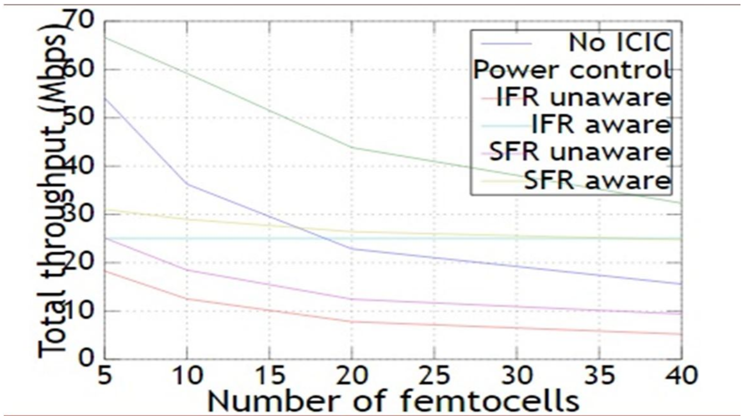

Fig 5 Throughput performance for macrocells

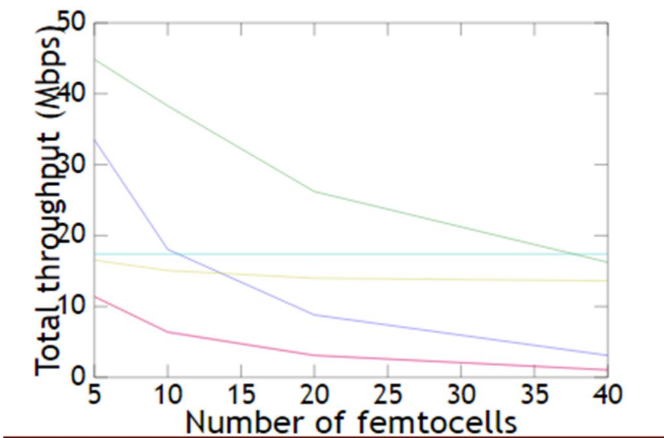

Fig 6 Average Throughput performance for macrocells

Fig.7 shows the average throughput performance for macro users. The SFR and IFR are the best throughput.

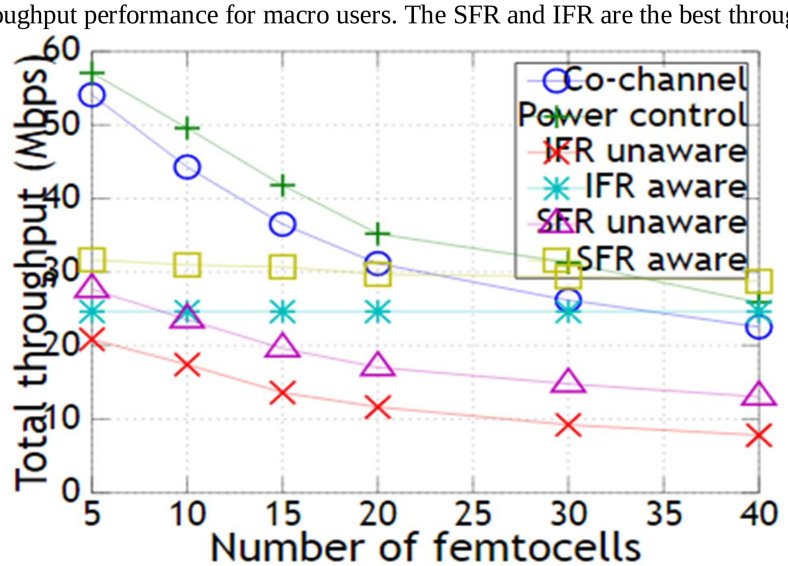

Fig 7 Average throughput performance for macro users

Fig. 8 shows the throughput for macro users at the cell's borders. The SFR and IFR are the best throughput when the number of femtocells is more than 25.

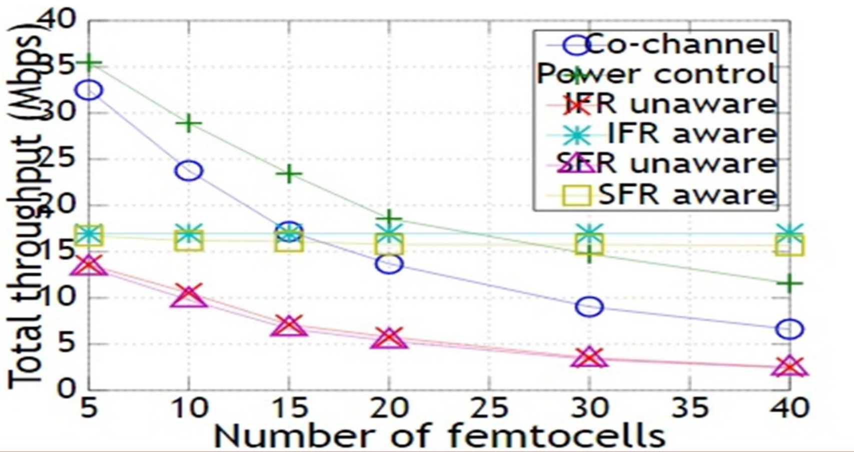

Fig 8 Throughput for macro users at cell's borders

VI. CONCLUSION

As there is a lot to come in LTE techniques so there is a lot of possibility for the researcher to work on femtocells so that this framework can help the mankind towards easing its social life.

With the help of proposed method we are able to perform different throughput and interference calculations. The proposed method has been implemented and designed in such a manner that it easily allows others to work with it and make changes as they needed.

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