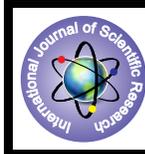


Capacity study for UMTS system in present of Femtocell Network



Engineering

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ABSTRACT

Femtocell networks and small-cells have been introduced as a solution to the indoor coverage problems, since they increase the networks coverage and capacity, and reduce both cost and power. This paper presents the study of UMTS cellular network for capacity in presence of femtocell interference. Coverage and capacity are vitally important issues in UMTS cellular Network. Capacity depends on different parameters such as, energy per bit noise spectral density ratio, voice activity factor, inter cell interference and intra-cell interference, soft handoff gain factor, etc. The coverage depends on frequency, chip rate, bit rate, mobile maximum power, MS Antenna Gain, EIRP, interference Margin, Noise figure, etc. In this paper, the outputs of simulation show the effect of the mentioned parameters on the capacity of the UMTS network. Also the present of interference from the small femtocells on overall an capacity of the UMTS Network is studied.

I. INTRODUCTION

Femtocell networks and small-cells have recently received considerable attention from industry and academia. It has been introduced as a solution to the indoor coverage problems, since it increases the networks coverage and capacity, and reduces both cost and power. Reducing the transmission distance improves the link capacity, and save the mobile battery. Moreover, they have significant potential for improving the capacity of next generation wireless communication systems due to better link qualities with the users and more efficient utilization of the spectrum resources [1], [2]. However, interference between the femtocells and the macro cell, and between neighboring femtocells, remains to be important problems that still need to be addressed for successful deployment of femtocells [3]. Due to growing demands of high speed data rate 2.5G systems were not enough to cope up the requirements of high speed internet. As the number of mobile subscribers grew tremendously and different applications (video, internet services) were developed, it was realized that the future mobile systems should provide high capacity, optimized coverage and efficient resource utilization. People also wanted high volume of data to be continuously available on their mobile phones. Thus 3G systems were launched in order to increase the capacity of existing 2G systems. For the standard customer video streaming, TV broadcasts, video calls, video clips and new music services became a reality. Similarly for a businessman high speed tele working, video conferencing and real time financial information are the added advantages of a 3G system [4, 5, 6]. Capacity in WCDMA standards of UMTS refers to maximum number of users per cell, where the area covered by RF signal from Node B or UE (User Equipment) is called coverage area of UMTS. This paper presents the performance of both capacity of UMTS considering the parameters and inter-cell and intra-cell interferences which the later one is caused by femtocell networks within a cell. In order to analysis the performance of UMTS network, dynamic parameters are considered such as energy per bit noise spectral density ratio, voice activity, inter-cell interference, intra-cell interference, soft handoff factor and data rates.

The rest of the paper is organized as follows: In Section II, we introduce background on capacity and coverage of WCDMA for UMTS. Simulation Results are given in Section III. In Section IV, paper is concluded.

II. Calculation of Capacity

Since uplink capacity is related to numbers of users, uplink capacity is considered in this paper. As in [7], for WCDMA, the chip rate is 3.84 Mcps, and the channel bandwidth is 5 MHz.

Thus the capacity for WCDMA in UMTS can be formulated as:

$$N_s = 1 + \left(\frac{W}{B} - \beta \right) \frac{1}{(1+H\beta)} \times D \times H \times A_g \quad (1)$$

where N_s , W , B , and β represent base band information bit rate, energy per bit to noise power spectral density ratio, background thermal noise and signal power respectively, $S1=UE$ power and $p(d)$ =propagation loss in distance d . It is worth noting that above formulation is obtained by considering the effects of inter-cell interference β [8], cell sectoring D [9], soft handover factor H [10], and array antenna gain [11]. As mentioned before, by the deployment of femtocell networks, we should consider the effect of interference between femtocells and (1) can be modified as follows:

$$N_s = 1 + \left(\frac{W}{B} - \beta \right) \frac{1}{(1+\beta)(1+H\beta)} \times D \times H \times A_g \quad (2)$$

One of the most famous classical propagation models for 2GHz band is Cost 231 Hata model. Cost 231 is improved version of Hata model. It is used for frequency range up to 2000 MHz It is available for urban, sub urban and rural areas.

The maximum allowable path loss for Node B can be obtained as;

$$p(d)_{\text{max}} = 46.2 + 32.9 \log(fc) - 13.82 \log(hb) - 3.2(\log(11.75hm))^2 - 4.9 + (44.9 - 6.65 \log(hb)) \log(d) + C \quad (3)$$

Where: fc is operating frequency, hb is base station height, hm is UE height, d is distance, C is constant factor for big cities is equal to 3, while $C=0$ dB is for medium sized city and suburban area with moderate tree city or $C = 3$ dB for metropolitan centers. The effective transmitting antenna height in meters is ranging from 30 m to 200 m and the effective mobile (receiver) antenna height is ranging from 1 m to 10 m, d is the separation distance in km.

III. SIMULATION RESULTS

Figure 1 shows that needs to maintain small value for increasing number of simultaneous users in different bit rate or in different services. as much as increase the number of simultaneous user will decrease this will lead us to very important fact that to design the network which offer us best quality and required capacity we need to maintain this parameter somehow to fulfill design requirements. From this figure it can be seen that for different values of N_s , the number of simultaneous data users increased or decreased. Thus the dynamic values of N_s can be the increasing or decreasing factors in UMTS capacity design.

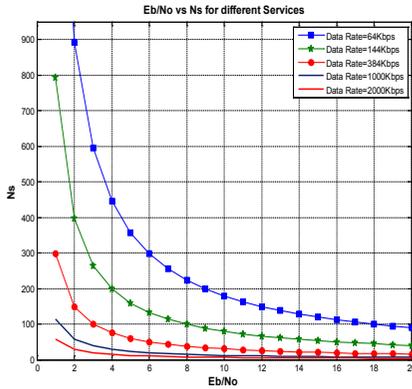


Figure (1) Eb/No Vs Ns for Different Services

Soft Handover gives an additional macro diversity gain against fast fading by reducing the required relative to a single radio link, because the fast fading from the two transmit BSs is uncorrelated. Figure 2 shows the effect of Handover factor (H) in the number of simultaneous data user for different offered services. The overlapped cell can lead an extra power thus introducing soft handover factor H in a UMTS cell. The value of H in UMTS can be a factor to increase the number of users as shows in this figure 2.

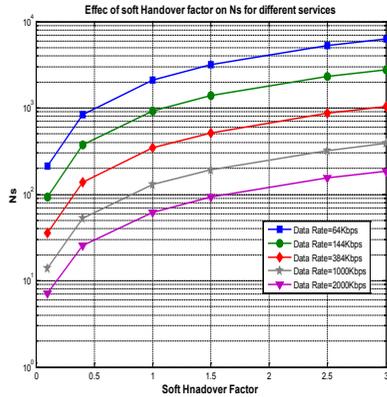


Figure (2) Ns Vs Ho for different services

The interference from other cell is known as inter-cell interference () for multi-cell configuration, the number of outer cells can reduce cell capacity in UMTS. From Figure 3 it is observed that for increasing value of β or when the air interface is not interference free the capacity of the system decreasing and the affect is more for high consumer data with higher data rates. This means we can offer the services to fewer subscribers due to interference.

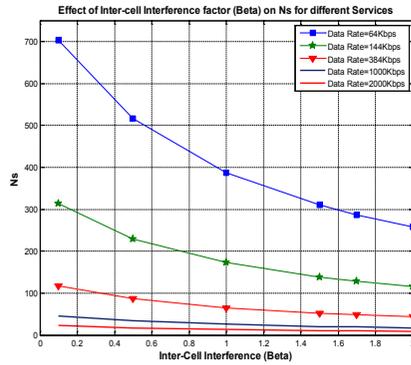


Figure (3) Inter cell Interference Vs Ns for different gamma (Data Rate=384Kbps)

Having Femtocells in the network will increase overall capacity of the network but interference generated by these small cells will affect negatively also in the number of users in UMTS. Figure 4 shows the effect of Femtocell interference on capacity with presence of inters cell interference.

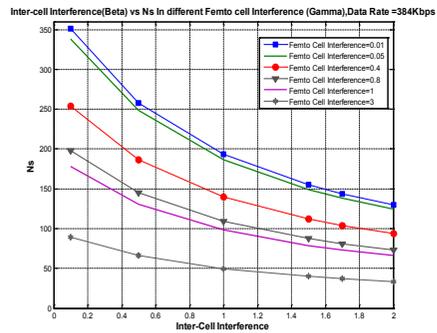


Figure (4) Beta Vs Ns for different gamma (Data Rate= 384 Kbps)

IV. CONCLUSION

In this paper we studied some factors which affect the capacity and coverage of UMTS system for different data rate offered by this system. Offered service is directly affect the capacity of the network also other parameters like soft handover and interference will also play a big roles in capacity of UMTS. Existing of Femtocell will reduce slightly the capacity however the overall capacity will increase by implementing small cells in the network. The coverage area also is depend of the type of the services offered to the UMTS Users and high data rate cells have smaller coverage area as mentioned in the results.

REFERENCE

[1] S.P Yeh, S.Talwar, S. C. Lee, and H. Kim, "WiMAX femtocells: a perspective on network architecture, capacity and coverage" IEEE Commun. Mag., vol. 46, no. 10, pp. 58-65, Oct. 2008. [2] V. Chandrasekhar, J.G. Andrews, and A. Gatherer, "Femtocell networks: A survey" IEEE Commun. Mag., vol. 46, no. 9, pp. 59-67, Sep. 2008. [3] FemtoForum, "Interference Management in UMTS femtocells" White paper [4] M. R. Karim and M. Sarraf "WCDMA and cdma2000 for 3G networks", 2002 [5] K. D. Nguyen, Haong Nam Nguyen, Hiroaki Morino and Iwao Sasase "Uplink Channel Allocation Scheme and QoS Management Mechanism for Cognitive Cellular-Femtocell Networks" International Journal of Communication Networks and Information Security (IJCNIS), Vol 6 No 1, April 2014 [6] M. Zeeshan, S. Ahmed "A Robust Carrier Frequency Offset Estimation Algorithm in Burst Mode Multicarrier CDMA based Ad Hoc Networks" International Journal of Communication Networks and Information Security (IJCNIS), Vol 4 No 3, December 2012 [7] H. Holma, and A. Toskala, "WCDMA for UMTS-radio Access third generation mobile communication" JOHN WILEY SONS. [8] J.S. Lee, I.E. Miller, "CDMA system engineering handbook" Artech House Publishers. [9] B. Sklar, "digital communication Fundamentals and Applications". Second edition prentice hall [10] S.Faruque, " Cellular Mobile System Engineering" Artech House publishers, 1996. [11] A.Skopljak, "Multiantenna CDMA system and their usage in 3G Network" University of Sarajevo, 2007.