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SIGNAL STRENGTH EVALUATION ON THE BASIS OF HANDOFF PARAMETERS USING FEMTOCELL CONCEPT

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ABSTRACT

The best way to increase the system capacity of a wireless link is by getting the transmitter and receiver closer to each other, creates dual benefits of higher-quality links and more spatial reuse. A less expensive alternative is the recent concept of femto-cells. This paper includes evaluation of received signal strength at mobile user using different path loss models (indoor and outdoor) which is the main criterion for performing handoff. Also, the SINR scenarios for handoff performance and some basic handoff parameters like handoff probability, Interference for macro/femto environment.

KEYWORDS:-_SINR, Indoor and Outdoor, Handoff, Femto-cells._

INTRODUCTION

Femtocell technology has emerged as a most promising technology for home environments. It gives high coverage and capacity as well as it is very cost effective. Femtocell is a small, low-power cellular base station, typically designed for use in a home or small business [1]. It connects to the service provider's network via broadband (such as DSL or cable). It typically support two to four active mobile phones in a residential setting, and eight to 16 active mobile phones in enterprise settings. A femtocell allows service providers to extend service coverage indoors or at the cell edge, especially where access would otherwise be limited or unavailable. Although much attention is focused on WCDMA, the concept is applicable to all standards, including GSM, CDMA 2000, TD-SCDMA, WiMAX and LTE solutions. Typically the range of a standard base station may be up to 35 kilometres (22 mi), a microcell is less than two kilometers wide, a picocell is 200 meters or less, and a femtocell is on the order of 10 meters [7].

Why we use Femtocell technology?
Studies on wireless usage show that more than 50 % of all voice calls and more than 70% of data traffic originate from indoors. Voice networks are engineered to tolerate low signal quality, since the required data rate for voice signals is very low, on the order of 10 kb/s or less. Data networks, on the other hand, require much higher signal quality in order to provide the multimegabit per second data rates users have come to expect. For indoor devices, particularly at the higher carrier frequencies likely to be deployed in many wireless broadband systems, attenuation losses will make high signal quality and hence high data rates very difficult to achieve. This raises the obvious question: why not encourage the end user to install a short-range low-power link in these locations? This is the essence of the win-win of the femtocell approach. The subscriber is happy with the higher data rates and reliability; the operator reduces the amount of traffic on their expensive macrocell network, and can focus its resources on truly mobile users [8].

OUTDOOR PATH LOSS MODELS
Okumura Model
It is expressed by
$L_{50}(dB) = L_F + A_{mu}(f,d) - G(h_{te}) - G(h_{re}) - G_{area}$ (1)
where L_{50} is the 50th percentile (i.e., median) value of propagation path loss, L_F is the free space propagation loss, A_{mu} is the median attenuation relative to free space, $G(h_{te})$ is the base station antenna height gain factor, $G(h_{re})$ is the mobile antenna height gain factor, and G_{area} is the gain due to the type of environment [1].
Hata model

The Hata Model for Urban Areas is formulated as following:

$LU = 69.55 + 26.16\log(f) - 13.82\log(h_B) - CH + [44.9 - 6.55\log(h_B)]$ (2)

For small or medium sized city,

$C_H = 0.8 + (1.1\log(f) - 0.7)h_M - 1.56\log(f)$

and for large cities,

$CH = 8.29(\log(1.54h_M))^2 - 1.1$ if $150 < f < 200$

   $3.2(\log(11.75h_M))^2 - 4.97$ if $200 < f < 2000$

Cost 231 model

COST 231 Walfisch-Ikegami propagation model gives a better prediction of path loss

$P_L(dB) = 59.86 + 20\log(d) + 20\log(f) - 10\log(w) + 10\log(f) + 20\log(h_{roof} - h_{UE}) - 18(1 + (h_{Tx} - h_{roof})) + (h_{Tx} - h_{roof}) + 18\log(d) - [4 + 0.7(f/925 - 1)]\log(f) - 9\log(b)$ (3)

Where P_L is the path loss in dB, d is the distance between UE and the Transceiver in Km, f is the frequency in MHz, w is the mean value for width of the street in meters, h_{roof} is the mean value of height of the buildings in meters, h_{UE} is the height of the UE in meters, h_{Tx} is the height of the transceiver in meters, b is the mean value of building separation in meters.

UMi Model

This model is designed specifically for small cells with high user densities and traffic loads in city centers and dense urban areas. The path loss for the LoS condition is calculated as

$22\log_{10} d + 42 + 20\log_{10}(fc/5)$ $10m < d < d_{BP}$

$L_{UMi,LOS} = 40\log_{10} d + 9.2 - 18\log_{10} h_{eNB} - 18\log_{10} h_{UE} + 2\log10(f_c/5)$ $d_{BP} < d < 5km$

(4)

Here, the distance between transmitter and receiver is d, the effective breakpoint distance is calculated as $d_{BP} = 4h_{eNB}h_{UE}f_c/c$, where f_c is the centre frequency in Hz and h'_{eNB} and h'_{UE} are the effective antenna heights for the eNB and UE, respectively [2]. The path loss for the non-line-of-sight (nLoS) model is computed as

$L_{UMi,NLOS} = 36.7\log_{10} d + 40.9 + 26\log_{10}(f_c/5)$ $10m < d < 5km$ (5)

But in simulation for macrocell/femtocell handoff phenomenon, rather than using these models, a simplified model is used. It is given below

Path loss $L(dB) = 128.1 + 37.6\log(d)$ (6) Where d is the distance between transmitter and receiver[5].

INDOOR PATH LOSS MODELS

Indoor hotspot model

This model is used to model the channel for links lying inside the femto-cells. The LoS path loss is calculated as

$L_{InH, LoS} = 16.9\log_{10}(d) + 46.8 + 20\log_{10}(f_c/5);$ $3m < d < 100m.$ (7)

The path loss for the nLoS model is calculated as

$L_{InH, nLoS} = 43.3\log_{10}(d) + 25.5 + 20\log_{10}(f_c/5);$ $10m < d < 150m.$ (8)

ITU indoor propagation model

For indoor path loss ITU indoor path loss model is taken which is as follows [1]

$PL(dB) = \log(f) + N\log(d) + P_f(n) - 28$ (9)

where, L = the total path loss (dB).

f = frequency of transmission.(MHz).

d = Distance. Unit: meter (m).

N = The distance power loss coefficient.

n = No. of floors between transmitter and receiver.

$P_f(n)$ = the floor loss penetration factor.

For residential area N= 28 and Pf(n) = 4

RESULTS

Received power at UE from femto cell with distance

The received power decreases as the distance increases. But here we can see although femtocell radius is normally 10 meter and femtocell threshold power for handoff $s_{f,th}$ = -72 dBm, even after 20 meters of distance received power is not less than -72 dBm. So handoff doesn't occur according to the RSS algorithm.
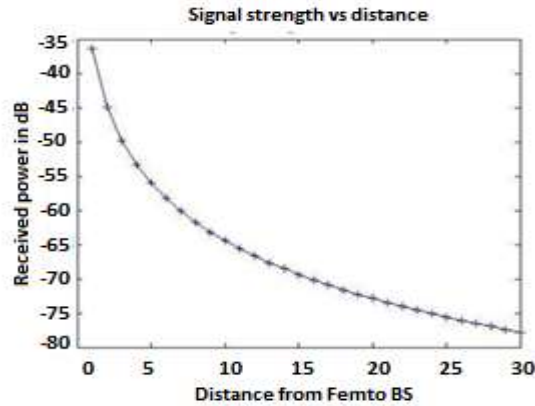
Figure 1 Received power from femtocell with distance

2. Received power at MS(dBm) vs distance(meter) from macro cell in cost 231 model and simplified outdoor path loss model.
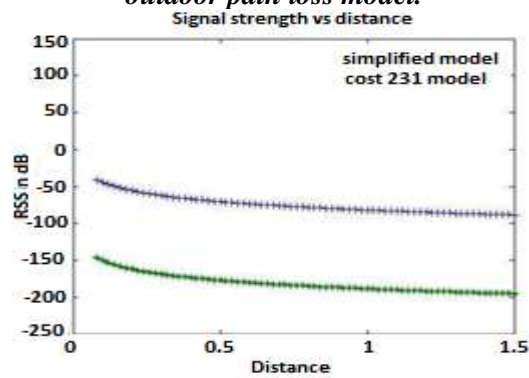

Figure 2 Received power from macrocell with distance

This graph depicts the received power at MS from macro base station with distance. Two curves are according to two different path loss models. It depends on how the macro cell and femto cells are distributed.

3. SINR at MS(dB) which moves from a macrocell towards femtocell.

This figure shows SINR values at user equipment when it moves from macro cell towards a femto cell when the distance between them is 1km.
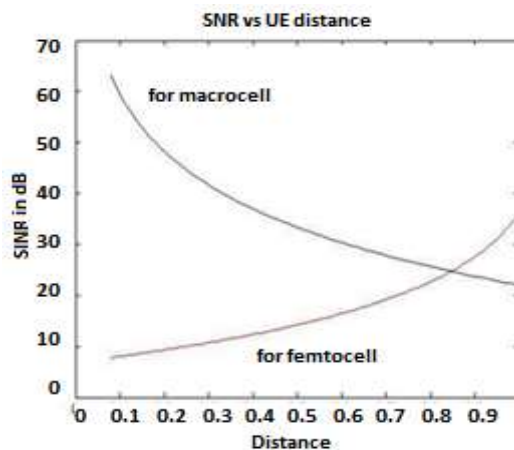

Figure 3 SINR from macrocell/femtocell with distance
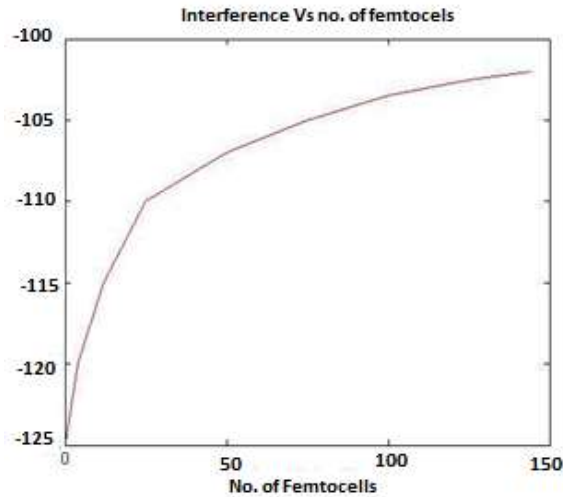
4. Interference

Figure 4 Interference Vs no. of Femtocells

Result clearly shows that as number of femtocells increases, magnitude of interference to the target femtocell increases gradually. The reason being the number of interfering femtocells is increasing.

5. SINR

This figure depicts the signal-to-interference and noise ratio SINR, which is calculated by the main signal that transmitted from the served FMC to the target UE, and the interference that are accumulated from all the neighbouring FMCs to the target UE. The SINR increases slightly with the increase of FMCs number.
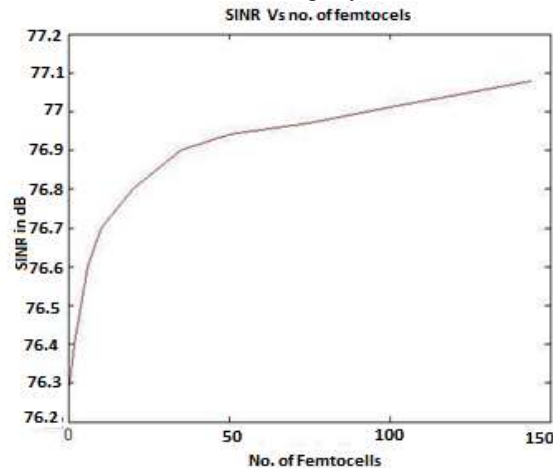

Figure 5 SINR vs No. of femtocell

CONCLUSION

First handoff scenarios in macro cell/femto cell coexisting network based on received signal strength and SINR are observed using different indoor and outdoor path loss models.Interference and SINR are calculated in dense femto cell environment and their effects on handover are obtained. With the increase in the number of femtocells in a fixed area saw the effect on the interference and SINR considering no macrocell interference to users. Interference increases with number of femtocells. Probability of connection also increases. The desired FMC coverage distance is suggested to be 10 m in each direction and 10 m by 10 m area will be covered by the individual FMC, here for the whole area used 144 FMCs. The interference of the target UE is evaluated in the grids of the X and Y axis's by substituting the target UE location and calculates the average interference. The simulation evaluates the interference and SINR

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