Handover Procedure Between Macrocell And Femtocell In Long Term Evolution (LTE) Networks

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Abstract— **Femtocell is a small base station that deployed in homes, buildings or other locations and designed to improve indoor capacity and signal coverage, and also reduce the macrocell traffic. Femtocell becomes a solution for indoor capacity and coverage issues. Frequent and unnecessary handover is another issue in femtocell network. The UEs with various velocities moving through the femtocell usually lead problem and perform some frequent and unnecessary handovers especially for high speed users. These cause the reduction of the system capacity and the QoS level. In this project, handover algorithm between macrocell and femtocell has been proposed and developed based on User Equipment (UE) velocity and Receive Signal Strength (RSS). The proposed handover algorithm divide into two parts which is handover from macrocell to femtocell (hand-in) and handover from femtocell to macrocell (hand-out). This proposed algorithm was developed and simulated to evaluate the performance of handover procedure in order to minimize an unnecessary handover, enhance the system capacity and improve the user's QoS level in the femtocell networks. Simulation results show the proposed algorithm gives the better simulation result and achievement to minimize an unnecessary handover and also decrease the number of handover failure. The handover procedures between macrocell and femtocell by using proposed scheme are efficient and reliable compared to conventional handover. The optimization of handover procedure and algorithm will improve the performance of both femtocell and LTE networks.**

Keywords- Femtocell, Macrocell, Handover, LTE, velocity.

I INTRODUCTION

Femtocell is the new emerging network technology in the Long Term Evolution (LTE). Femtocell also improve and increase coverage and capacity of a mobile networks. It allows service providers extend service coverage indoors, especially where access is limited or unavailable. Femtocell is a low-power access point in a building that combine mobile and Internet technologies.

The femtocell generates mobile phone signal indicate home and connected to the Internet through a network operator. Femtocell seems like home internet/Wi-Fi modem that offers indoor cellular coverage. It will replace Wi-Fi modem.

The femtocell is basically a personal cell phone tower as small size as Wi-Fi router and connect all cell call through an Internet connection. Discussions as standard LTE femtocell and LTE architecture lead in the Femto Forum, NGMN Alliance and 3GPP.

Several options are possible for the femtocell/macrocell network integration, and each option comes with a tradeoff in terms of scale. The overall LTE Architecture shows in figure 1. The functions supported by the HeNB shall be the same as those supported by an eNB, and the procedures run between a HeNB and the EPC shall be the same as those between an eNB and the EPC [1]. Figure 2 represents a logical architecture for the HeNB that has a set of S1 interfaces to connect the HeNB to the EPC. With the involved of Home eNB Gateway (HeNB GW), it equivalent to expanding the S1 interface between HeNB and core network, and more HeNB can be deployed. The HeNB GW appears to the MME as an eNB. The HeNB GW appears to the HeNB as an MME. The S1 interface between the HeNB and the EPC is the same whether the HeNB is connected to the EPC via a HeNB GW or not.

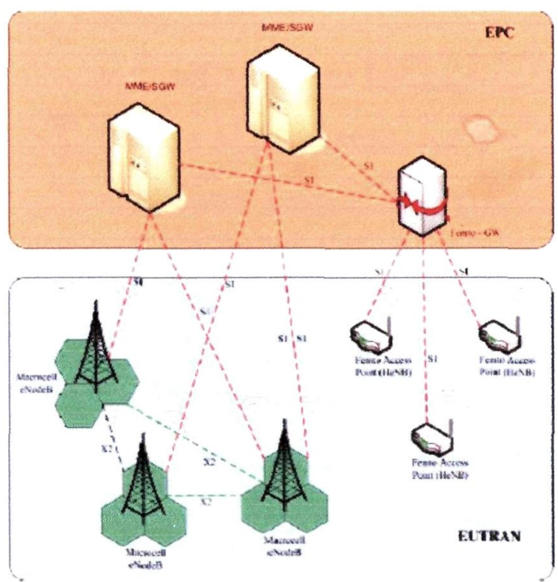


Figure 1:The overall LTE Networks Architecture

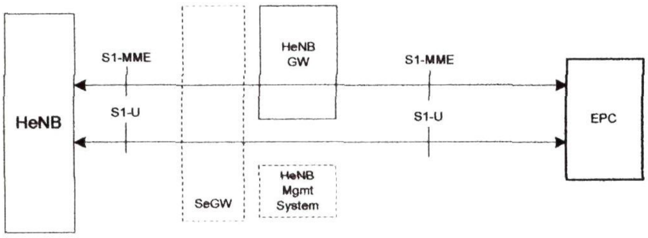


Figure 2: E-UTRAN HeNB Logical Architecture

LTE Femtocell also called as home Base Stations or Home eNode B (HeNB), with several advantages as short-range, low-cost and low-power BSs installed by the consumer give better indoor voice and data reception[2]. The user-installed device communicates with the cellular network over a broadband connection such as Digital Subscriber Line (DSL), cable/fiber to the home (FTTH/FTTx)), cable modem, or a separate Radio Frequency (RF) backhaul channel.

In order to connect standard mobile devices to a mobile operator's network, Femtocell operating in licensed spectrum. A home Femtocell delivers strong signal with fast data rates at very low cost. These targeted femtocell zone tariffs will make the mobile phone competitive not only with fixed line services, but also with television and PCs for home entertainment and information services as shown in figure 3[3].

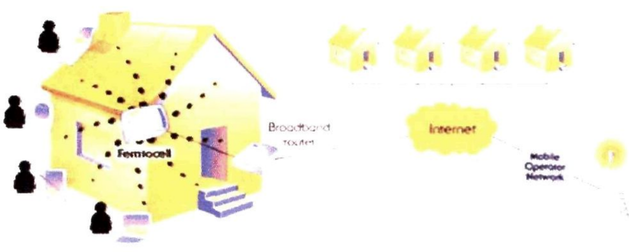


Figure 3: Femtocell concept

Handover define as a process of transferring call or data session from one to another new channel cell (new base station) in mobile communications. The transfer of current communication channel could be in terms of time slot, frequency band, or code word to a new BS [4-7]. Handover is one of the complex element in mobile systems. Basic reasons why a handover might be conducted because the user has moved out of coverage range or the base station is full.

In Femtocell, this capability is needed by users when entering or leaving the residence, office or any building. Femtocells do not support soft handover. All calls are switching directly between femtocell and the external outdoor mobile network.

This is known as "hard handover" and the caller not hear any noticeable interruption. The hard handover is essentially a 'break before make' connection.

There are three ways of scenarios for femtocell handover procedure:

Hand-In (Macrocell to femtocell):

- This is where handover occurs from the macro-cell or standard cellular network to the femtocell and vice versa is more and quite complicated due to femtocell characteristics itself together with the huge number of Femtocell base station in the Macrocell area. In hand-in procedure, the UE have to select the most suitable target Femtocell BS to handoff. The mobility prediction in handover decision is a consideration to optimize the handover procedure.

Hand-Out (femtocell to marcocell):

- This is where a handover occurs from the femtocell to the macro-cell or standard cellular network.
- Handover procedure from FAP to macrocell eNodeB is relatively uncomplicated. The UE has no option to select the target cell since there only the macrocell eNodeB. When the RSSI from eNodeB is stronger than FAP's RSSI, the UE will connect directly to Macrocell.

Inter-Femtocell (*Femtocell to femtocell*):

- There will be situations where handover will occur between one femtocell and another close by. This will be common place in offices that may have a number of femtocells to give continuous coverage within a building.
- The procedure for inter-FAP handover is similar to hand-in procedure since the UE will facing hundreds of possible target when out of its serving FAP.[8]

Figure 4 below shows the handover between macrocell and femtocell.

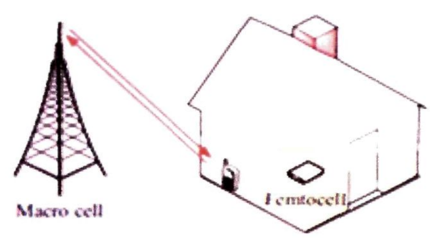


Figure 4: Macrocell and Femtocell Handover

In this paper, the handover between femtocell and macrocell is investigated. Three handover scenarios are considered. Handover procedure is based on 3GPP LTE specification.

This paper organized begins with the femtocell literature in section I. The investigates analysis of related research provides in section II. In section III, proposed handovers procedure between macrocell and femtocell are introduced. In section IV, handover algorithm scenarios based on RSS and velocity has been proposed to minimize the unnecessary handover. Analysis of the propose handover algorithm is discuss in Section V. Finally, Section VI concludes the paper.

II RELATED RESEARCH

In the femtocell network, several research works *have been published. The handover procedure in* macrocell/femtocell integrated network has been done in [9].

Some modifications on existing network and protocol architecture of Universal Mobile Telecommunication System (UMTS) based macrocell network has been proposed in order to integrate the femtocell into the system. The modifications included the change of signal flow for handover procedures and the measurement of signal-to-interference noise ratio for handover between macrocell and femtocell. The frequent and unnecessary handover is also considered. The analysis is taken on the concentrator based and without concentrator based femtocell network architecture. The result shown, the call admission control (CAC) scheme is effective to prevent the unnecessary handover.

Furthermore, handover procedures for existing networks are needed to support the macrocell/femtocell integrated network. In a large number of femtocells, there are too many prehandover and unnecessary handover processes frequently occur. In order to has seamless mobility between femtocell and macrocell, it is necessary dedicated on designing appropriate handover strategy [8, 9]. In other works, a new handover strategy between femtocell and macrocell for LTE-based network in hybrid access mode were proposed in [8]. Three scenarios after handover decision strategy procedure: hand-in (CSG and non-CSG), hand-out were analyzed. Some parameters which are interference, velocity, RSS and QoS level in handover are considered in the handover strategy. The proposed algorithm shown could avoid unnecessary handover, reduce handover failure and eliminate the cross-layer interference.

The authors in [10] overviewed the handover procedure between the HeNB and eNodeB. A new handover algorithm based on the UE's speed and Quality of Service (QoS) is proposed. Three different velocity environments have been considered in the algorithm i.e., low speed (0-15km/h), medium speed (15-30 km/h) and high speed (>30km/h). In addition, the real-time and non-real-time traffics have been considered as QoS parameters. The comparison analysis shown that the proposed algorithm has a better performance than traditional handover algorithm in order to reducing the unnecessary handovers and the number of handovers.

In paper [11], the authors pay attention to the selection of optimal target HeNB based on the measurement parameters reported by UE and the HeNB special parameters like access mode and current load acquired from the HeNBs network architecture. The researchers shown and prove that the proposed selections bring some benefits.

III METHODOLOGY

The proposed handover procedure between Macrocell and Femtocell in LTE networks proposed is shows in Figure 5. The handover procedure evaluate by consider the received signal strength (RSS) and UE velocity. The algorithm divided into two procedure which is hand in procedure (handover from macrocell to femtocell) and hand out procedure (handover from femtocell to macrocell). Inter femto (handover between femtocells) procedure haven't discuss in this strategy.

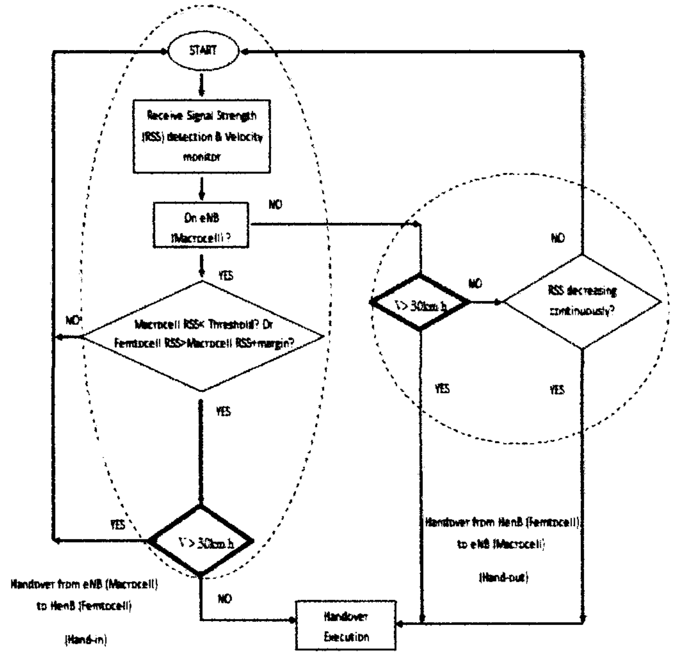


Figure 5: Flowchart of handover strategy between Macrocell and Femtocell in LTE networks

Here, the UE velocity are classified into high velocity (above 30km/h) and low velocity (below 30km/h). In hand in scenario, if the UE is attach in macrocell BS, the RSS will check and compare neither macrocell RSS less than threshold nor the femtocell RSS more than macrocell RSS + margin. Then check the UE speed/velocity (V). If V more than V1 km/h, no hand over to femtocell occurs. While if V low thanV2, handover will execute to femtocell BS.

In hand out scenario, once the UE not in macrocell, velocity of UE will be considered. If V less than V1, RSS used to decide handover. Handover from femtocell to macrocell automatically will execute when V more than V1. The femtocell characteristics set only for low-speed services.

The developing algorithm in Matlab Software is focuses in this research. The program is designed and modified to model a cellular network. The cellular network complete with 112 hexagonal macrocells as shown in figure 6, where femtocell collocated 1/3 of macrocell.

The parameters of the simulation is set as listed in the Table 1. In the simulation, fix number of UE distributed uniformly with constant velocity at the random positions and random directions.

Table 1: Simulation parameters

Parameters	Explanations
Cell Shape	Hexagon cells
Macrocell radius	1 km
Femtocell radius	30 m
Simulation time	2000s
Radio Propagation Model	Log-normal shadowing
Mobility Model	Random waypoint model 0-100km/h,
UE speed/ velocity	0km/h, 20km/h, 40km/h, 60km/h, 80km/h, 100km/h,
Threshold	-60dBm, -80dBm, -90dBm, -100dBm
Margin	3dBm, 4dBm, 5dBm, 8dBm

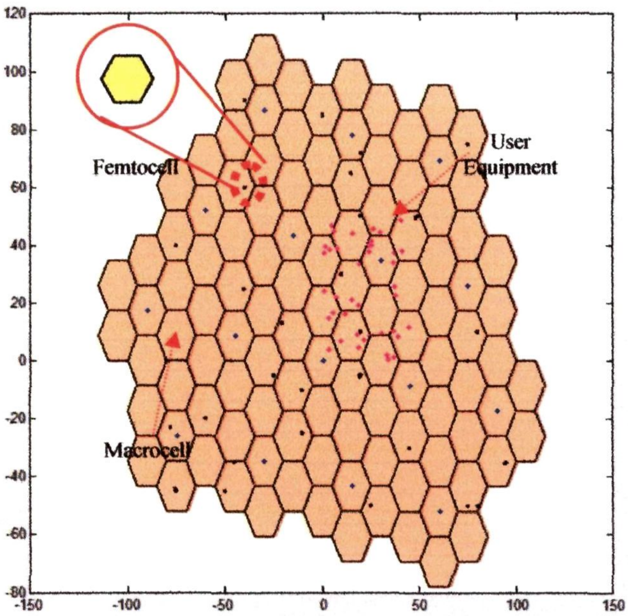


Figure 6: Simulator structure

IV RESULTS AND DISCUSSIONS

Figure 7 shows the handover execution for the algorithms with RSS= -90dBm which simulated UE speeds for both scenarios macrocell-femtocell and femtocell-macrocell.

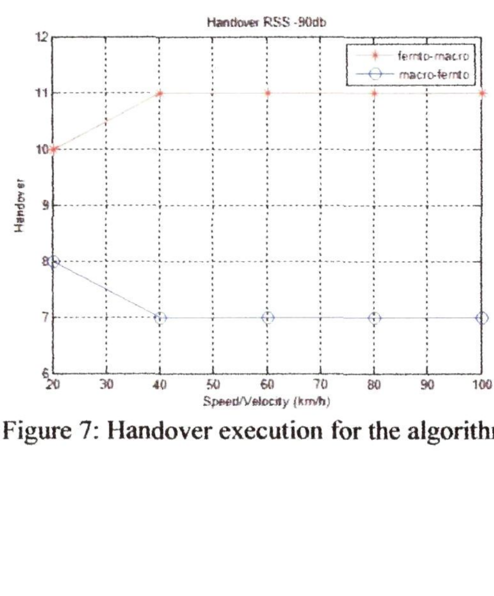
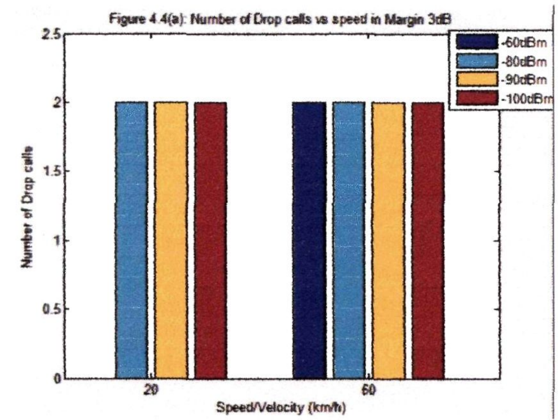


Figure 7: Handover execution for the algorithms

The numbers of handover is less when the UE speeds increased. Referring to the algorithm ,the handover from macro to femto occurs only when the UE velocity is less than 30km/h (low speed) . It shows the handover execute more from macrocell to femtocell during low speed (0km/h until 30km/h). However, the numbers of handover increase when the UE speeds increase for femto-macro case. Handover execute from femtocell to macrocell when the speeds reach high speed zone (more than 30km/h).



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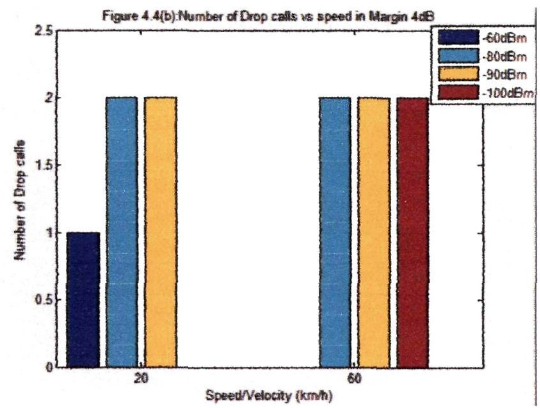

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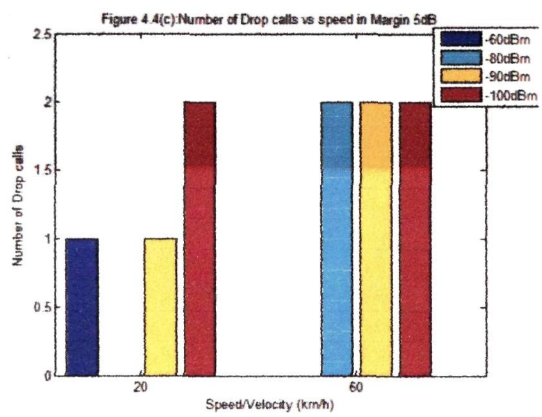

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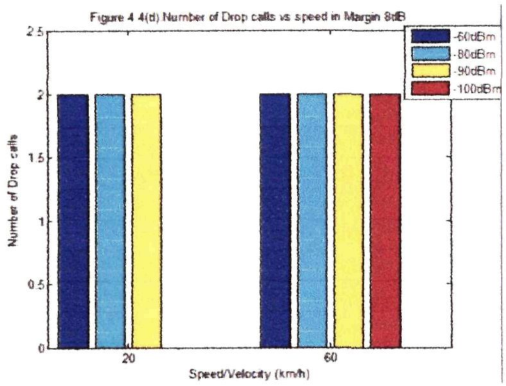
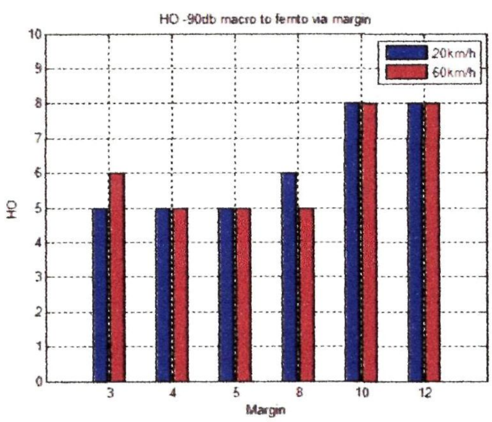


(d)

Figure 8: Comparison drop calls for femto-macro scenario vary speeds with Threshold=- 90dBm and margins

Figure 8 above shows comparison drop calls for femto-macro scenario vary speeds with RSS Threshold value based on different margins. From the result, 5dBm margin with RSS threshold -80dBm is selected for 20km/h. If the speed is 60km/h, the margins of 4dBm and 5dBm with RSS threshold -60dBm would be the best to be selected.

The algorithm proposed for the handover strategy have a best performance in dropcalls for both scenario especially in macro-femto scenario. Dropcalls have been avoided and no dropcalls occurs from macrocell BS to femtocell BS.



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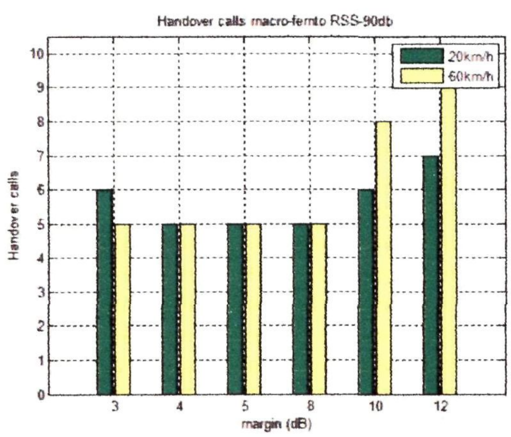
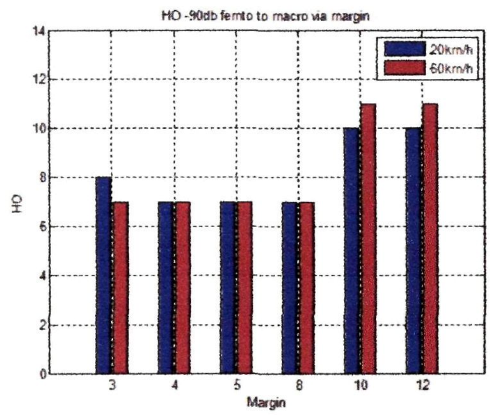


(b)

Figure 9 : Macro-Femto scenario varying margin with Threshold = -90dBm and UE speeds= 20km/h ,60km/h (a)Conventional handover (b) propose handover algorithm

Figure 9 shows the conventional and propose handover in macrocell-femtocell scenario respectively according to Margin values for 20km/h (low speed) and 60km/h (high speed) UE speeds. The number of handover increase for both algorithm and for both selected speeds when the Margin values increases. The number of handover calls for proposed algorithm less than the traditional procedure. For the proposed algorithm, in the macro-femto HO case, 4dBm to 8dBm selected as the proper margins for speed 20km/h and 3dBm to 8dBm for 60km/h base on the result.



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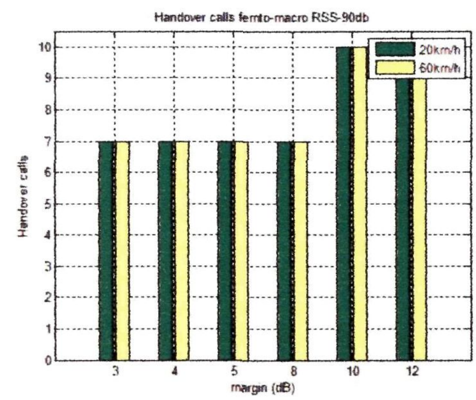

(b)

Figure 10: Femto-Macro scenario varying margins with Threshold = -90dB and UE speeds= 20km/h and 60km/h (a) Conventional handover procedure (b) propose handover algorithm

Figure 10 present the conventional and propose handover femtocell-macrocell scenario also according to Margin values for 20km/h (low speed) and 60km/h (high speed) UE speeds. The number of handover increase for both algorithm and for both selected speeds when the Margin values increases. The number of handover calls for proposed algorithm less than the traditional procedure.For femto-macro scenario proposed handover, margin 3dBm to 8dBm is suggested at 20km/h while 3dBm to 8dBm at 60km/h UE velocity.

TABLE II. SELECTED RSS & HANDOVER MARGIN VALUES

	20km/h	60km/h
TH	-80dBm	-60dBm
HM_macro-femto	5dBm	4dBm
HM_femto-macro	5dBm	5dBm

Table II is the summarization and selection for RSS and margin values for 20km/h and 60km/h. From all Threshold (-60dBm,-80dBm,-90dBm & -100dBm) and margin (3dBm,4dBm,5dBm & 8dBm), -80dBm and 5dBm selected for most good performance for both macro-femto scenario and femto-macro scenario in low speed. While -60dBm and 5dBm for high speed UE after considering handover and dropcalls from the simulation result. The simulation result shows improvement compared others parameters. When velocity is fast and it initiate early, more handover will execute. While if initiate to late, it will make a drop call.

The proposed handover strategy is better to optimize the unnecessary handovers and also reduce the drop calls for both scenarios either for handover from macrocell to femtocell or vise verse.

VI CONCLUSION

In this paper, the femtocell handover procedure and concept were introduced and over viewed. The handover techniques were evaluate based on the RSS and UE velocity. The research focus on modification and analyzation Handover Algorithm in Femtocell networks by using MATLAB software. User Equipments in the movability are categorized into vary scenarios base on vary UE speeds to keep off the handover from the speedy users (high speed) in femtocell network. The speedy users will not execute handover to femtocell due to the small scale coverage. These propose procedure and algorithm in this proposal avoid unnecessary handover and reduce handover failure.

In an effort to enhance the system capacity in femtocell and the user's QoS level in the femtocell network, the minimization of unnecessary handover is very essential. The simulation result shows that proposed algorithm give the better result and achievement to minimize an unnecessary handover and decrease the handover failure (drop calls). Handover procedures between macrocell and femtocell by using proposed scheme are efficient and reliable compared to conventional handover.

For the future project planning, the handover procedure by consider the interference and access control management will analyze.

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