Hysteresis Margin for Handover in LTE Femtocell

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Abstract- **Femtocells with small radius are used in the network is one of the challenges for elimination of redundant handover. The utilization of femtocell results to more common will be initiation of a handover procedure. This paper focuses on an actual level of hysteresis margin according to the position of the UE in a cell. To elimination of redundant handovers, the hysteresis margin is commonly used as parameter. The purpose of this paper is to determine the impacts of triggering setting hysteresis margin on handover performance for different scenario which is number of user, speed and cell radius. The optimal setting for each scenario has been proposed. The result shows that the deployment of femtocell has increase the handover performance.**

Keywords- femtocell; handover; hysteresis margin;

I. INTRODUCTION

Long Term Evolution (LTE) is a new radio access technology projected by the Third Generation Partnership Project (3GPP) [1]. The goals are to provide downlink peak rates of at least 100Mbps and uplink 50Mbps. The objectives are to enhance capacity, coverage, better throughput for mobile wireless networks [1- 2]

LTE used Orthogonal Frequency Division Multiple Access (OFDMA), which is an alternative for OFDM (Orthogonal Frequency Division Multiplexing) and Single Carrier Frequency Division Multiple Access (SCFDMA) for downlink and uplink, respectively as its radio access technology [2]. Resource Block (RB) is the smallest transmission unit in downlink LTE system. It's contains 12 sub-carriers with 180 kHz total bandwidth and 1ms for duration [2]. The difference between LTE compared to UMTS is that LTE has very simple network architecture. The LTE network architecture is comprised of three elements which are evolved Node B (eNodeB), Mobility Management Entity (MME) and Serving Gateway (S-GW)/Packet Data Network Gateway (P-GW). All radio interfaces related functions such as packet scheduling and handover mechanism are implementing in eNodeB. E-UTRAN and Packet Data Network is terminated at node P-GW. [3]

According to survey of wireless usage in [4], more than 50 percent of voice calls and 70 percent of data traffic originate from indoors. Traditional macro cellular network cannot meet this demand of multimedia traffic because there is a limit of outdoor cell and capacity of existing sites. Femtocell technology is the best solution and it's introduced in LTE network to improve indoor coverage, convey high bandwidth, new services to end-users and offload traffic from the existing macro-cellular networks [4]. There are three network elements that use in any femtocell network architecture. It is Femtocell Access Point (FAP), Security Gateway (SeGW) and Femtocell Device Management System (FMS).

FAP represents femtocell that capable of connecting network to the users. The equipment will function as base station and base station controller and connects to mobile operator's network using digital subscriber Line, optical fiber or cable broadband connections. The femtocell coverage is very small in order to cover indoor environments and to produce minimum interference to its neighbor base station. The different between FAP and conventional base station is where some part of FAP can be control by user. It can be set up into a home in multiple ways and directly to the home router. Another application of FAP where it can built-in router for voice traffic over other internet traffic and include an Analog Terminal Adapter (ATA) to connect a fixed-line phone.

A network node that guarantees femtocell internet connection between users and network operators will go through the security gateway. To verify and allow femtocell and provides encryption support for all signaling and user traffic, protocol Internet security standards such as IPsec and IKEv2 are used. A large number of femtocell connect to network operators supported by the security gateway. It is similar with traditional VPNs. It is designed for use in carrier networks and meets carrier-grade requirements such as scalability, high availability, and network management.

Femtocell management systems such as TR-069, plays a key role in provisioning, activation and management operations femtocells using industry standards. The activation and provisioning of the femtocell is plug and play with no on site assistance required from mobile operator to ensure low cost deployment and easy setup for subscribers [6].

Handover is a mechanism that transfers a voice or data session from one base station to another base station. In current network environment there are two categories of handover exist which is soft handover and hard handover. When a new radio link is initiated before the old link is released, soft handover will happen. It is possible for a user equipment to connect at the same time with two or more cell or sectors during ongoing session. While for hard handover, it requires disconnecting from eNodeB source before establishing connection to a target cell. Handover in LTE is use completely hard handover. For telecommunication technology it is unique and possible since adjoining cells can operate at the same frequency and provides a better quality connection. However, the hard handover types can cause data lost. Therefore, a mechanism to prevent data loss is required for hard handovers process.

A threshold setting is required for making a handover decision. If some conditions specified by the algorithm are satisfied, a handover will be triggered. As the consumer movement is random, the threshold value of handover algorithm may vary from time to time. Therefore, it is necessary to determine the optimal parameters to ensure efficiency and reliability of the handover algorithm. The purpose of this paper is to optimize handover in femtocell LTE based on the hysteresis margin value with focusing on decreasing the number of handover failure. Section I describes a paper introduction. A Handover procedure are discussed in Section II followed by Section III presents the principal of HM. Section IV contains simulation scenario and parameters are used. Section V includes the results of simulations. Last section present conclusions and future work plans.

II. HANDOVER PROCEDURES IN LTE

3GPP LTE handover procedure is illustrated in Figure 3 [7]. This procedure begins with the handover of a report by the event size distribution User Equipment (UE) to the serving eNB. Based on reference symbols (RS), the UE periodically performs downlink radio channel measurements namely User Equipment. UE can measure the reference symbols received power (RSRP) and the reference symbols received quality (RSRQ) [8]. UE also will send the corresponding measurement report indicating the triggered event if certain network configured are satisfied. In addition, the measurement report point to the cell which the UE has to be handover, which is namely target cell.

Based on the measurement reports; preparation of handover for serving eNB are started. Handover preparation involves the exchange of signals between serving eNB, target eNB and UE access control in target cells. X2 is a communication interface between the serving and the target eNB [9]. When the setup is successful, the results of the handover are made and consequently will be sent to the UE. The relationship between UE and cell service are released. After that by using random access channel the UE attempts to synchronize and access the target eNB. To speed up the handover procedure, the target cells may provide RACH specific preamble included in the order handover for UE [9]. When successful synchronization target ENB, this last send an uplink scheduling grants to UE. UE will reacts with handover confirm message, which will inform the handover procedure in the radio access network. It states that the specified signaling message belongs to Radio Resource Control (RRC) protocol [9]. Figure 1 show a handover procedure in LTE.

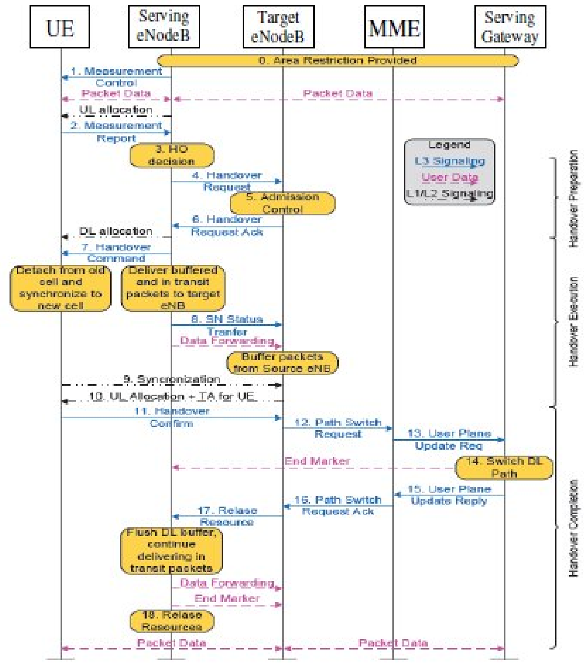


Figure 1: Handover procedure in LTE [2]

III. HYSTERESIS MARGIN

A hard handover LTE standard algorithm, as well as known as the "Power Budget Submission Algorithm", is a basic but effective handover algorithm consists of two variables, hysteresis margin (HM) and Time to Trigger (TTT) Timer [2]. This project focuses on the hysteresis margin for handover which is constant variable that represents the threshold for the difference received signal strength between serving and target cells. It identify the most appropriate target mobile cell can camp on.

Figure 2 shows the basic concept for hard handover trigger algorithm in LTE. When the mobile or user is moving from serving cell, the mobile Reference Signal Received Power (RSRP) received from the serving cell will decrease as time increase. As the mobile toward target cell, the target cell in the RSRP mobile will increase as time increases. This event is triggered if the following conditions are met as in equation 1:

$$Q(n)_{Target\ eNB} > Q(n)_{Source\ eNB} + HM (1)$$

Where HM represents a hysteresis margin to reduce unnecessary signal and ping-pong effect. The different values of hysteresis and time to trigger result in different triggering time and target cell selection. The several of handover triggering can be used to trigger handover event.

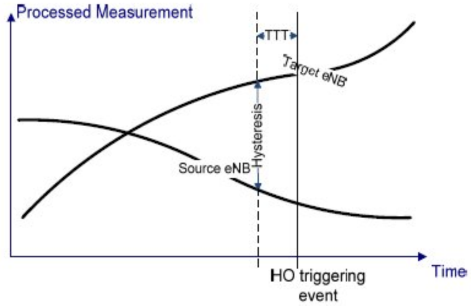


Figure 2: Triggering of hard handover in LTE [1]

IV. SIMULATION SCENARIO AND PARAMETERS

The detailed flowchart of the handover mechanism is depicted in Figure 3.

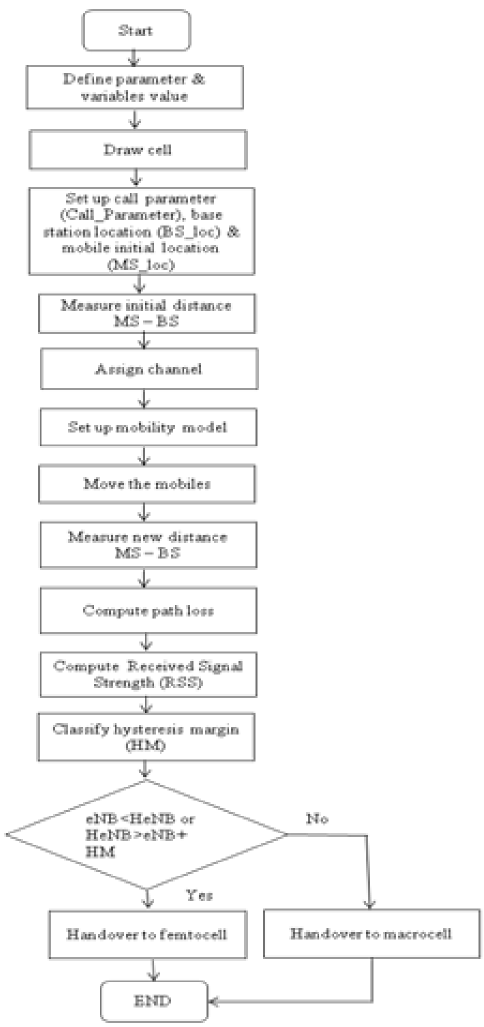
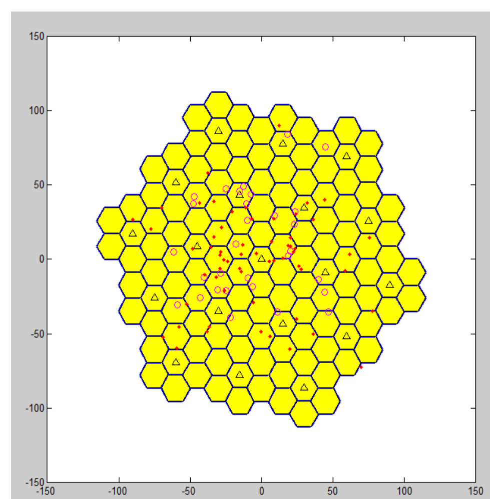


Figure 3: Flowchart of handover algorithm

The performance of handover is evaluated and compared using 133 hexagonal cell scenario and UE generated randomly with a normal distribution within in rectangular area. The simulation was performed in MATLAB software as indicated in Figure 4. UE is moving on constant speed of 3km/h, 30km/h, 120km/h and 250km/h depending on the scenario. Each of the users is move randomly and remained constant throughout the simulation. The system parameters used in the simulation are given in Table 1.

Table 1: System Parameters

	Parameter	Value
Cell Plan	Cell Layout	133 hexagonal
	Cell Radius	{288,2000}m
System Assumption	Propagation Model	Okumura-Hata model
	Traffic Load, Voice Traffic	{1,50}UE
	Carrier frequency	2 GHz
	System bandwidth	5 MHz
	Tx power of macro cell	46 dBm
	Tx power of femto cell	20 dBm
	Wall Loss	10dB
	BS Path Loss(Macro)	
	BS Path Loss(Femto)	15.34+37.6log(d[m])
	Simulation Time	2000s
	Hysteresis Margin	{0,0.5,1,2, 4,4.5}dB
	Mobile Velocity/UE Speed	{3,50,120,250}km/hr



Δ : Macrocell/Node B O: Femtocell/HeNodeB •: Mobile station

Figure 4: Simulator structure

V. SIMULATION RESULT

The simulation is done based on the scenario and the parameter was mentioned above. Only voice calls services to be considered. Figure 5 and Figure 6 is the simulation results from a single simulation scenario. Graph from figure 7 shows that there is no handover failure in the cells when it moves in all speed and radius. This situation occurs because the cell radius is too small for the UE when moving to complete the handover [10].

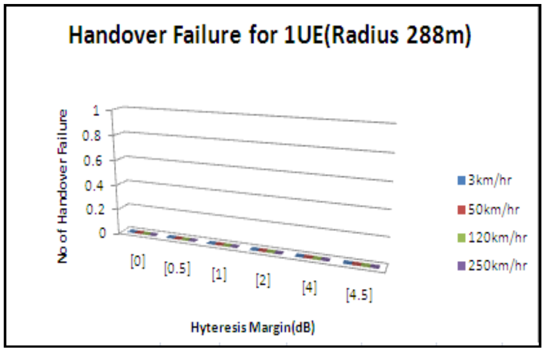


Figure 5: HO failure for 1 UE in radius 288 m

Figure 6 presents for 1UE system with larger cell which is 2km radius. It also shows no handover failure occurs. This result achieved the objective because radio resources seems inadequate and user has sufficient channel when it handover from one cell to another cell.

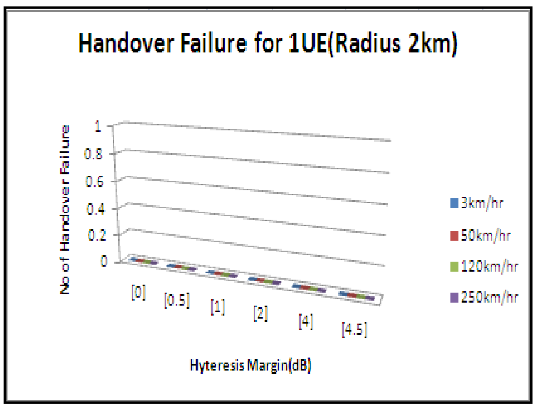


Figure 6: Handover failure for 1 UE in radius 2 km

Figure 7 and Figure 8 illustrates the handover failure for 50 UE in different radius. There are handover failures for each speed for both radiuses. Theoretically, more handover will be executed at higher speed because it will move farther at a constant simulation time. In the other hand, when cell size is reduced, the total of handover failure also reduced. Reduction of cell size is equal to cell splitting. In order to increase capacity, cell splitting increase the number of base station.

In high hysteresis margin for each case which is in range between 4dB-4.5dB, UE will have enough time to make handover decision. Then, it transmits a handover request to the eNB target to begin the handover process, and this will reduce the probability of handover failure [8].

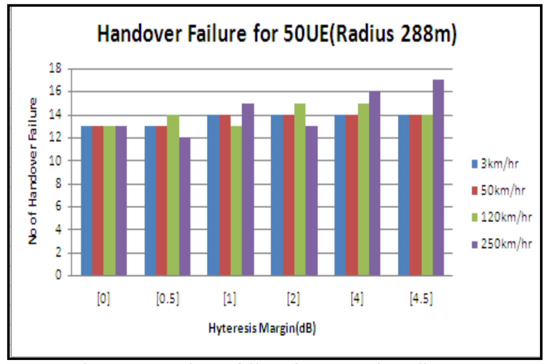


Figure 7: Handover failure for 50 UE in radius 288m

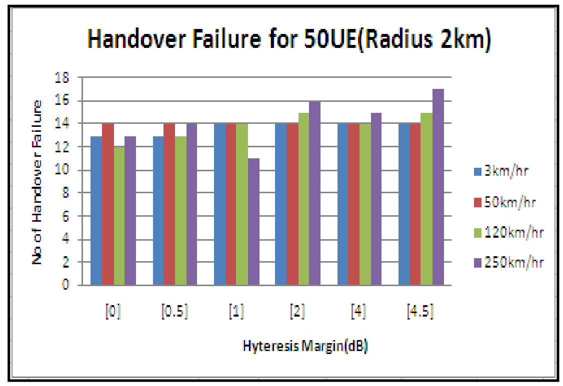


Figure 8: Handover failure for 50 UE in radius 2 km

VI. CONCLUSION

In this paper, the performance of handover triggering based on hysteresis margin has been studied. A different value of HM is analyzed for each of the service with a different user speeds during simulation. The increase in mobile velocity will disproportionate number of handover occurs. Simulation results show that reducing the cells size will lead to decreasing handover failure, which has an impact on channel capacity. Also, it can be demonstrated that the good setting on hysteresis margin for different speed will reduce the number of redundant handover.

The future work will be focused on the optimal value setting for HM based on different speed for handover triggering. Other performance analysis such as time not in best cell, handover overall delay and VoIP services can be further investigated on LTE network.

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