Inter System Handoff Management in Cellular Mobile Networks

Syamil Bin Khalid
Faculty of Electrical Engineering
Universiti Teknologi MARA Malaysia,
40450 Shah Alam, Selangor, Malaysia.
Email:syamilkhalid@yahoo.com

Abstract—**This paper presents a handoff technique which supports mobility between dissimilar networks. The boundary cell of cellular network system is designed by using MATLAB design software. A simulation model is developed to study the performance of the relative signal strength with hysteresis and threshold (RSS-HT) algorithm. The theoretical analysis and simulation result are studied to evaluate the handoffs parameters.**

Keywords -cellular, signal strength, handoffs, mobility, hysteresis

I. INTRODUCTION

Next generation wireless communication is based on a global system of fixed and wireless mobile services [1]. There have several heterogeneous communication networks such as cellular networks, satellite networks, wireless local area networks (WLAN), mobile ad hoc networks (MANET) and sensor networks. Cellular network system remains as best and popular wireless access technologies in communication field nowadays and it has moved with evolution technologies begin from 1G, 2G has improved by Group Special Mobile (GSM) technology, 2.5G (GPRS, EDGE) and followed by 3G (UMTS, IMT-2000) in order to provide heterogeneous services for users to roam across various regions, networks and systems.

Handoff (also known as handover)acts as allows call in progress to the mobile station (MS) when it moves between different service areas. It also serves to minimize the handoff delay when MS across between boundary cells and accommodate mobile station (MS) roaming continuously between dissimilar networks [2]. Handoff management is the one of the main important features in mobile cellular network in order to ensure the connectivity between mobile phone users continuous and effectively.Therefore, effective handoff management is needed in cellular network to ensure the continuity roaming among users and supports mobility between types of different service areas. Figure 1 shows MS crossing from current cell to next cellin different networks called inter-system boundary cells. The BS nearest to the boundary called as boundary base station (BBS) controlled by own switch in the network.

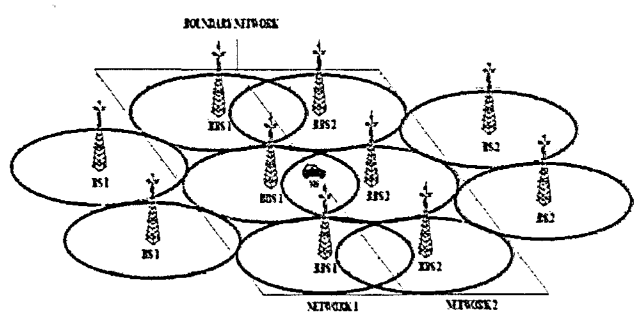

Figure 1: Inter-System Boundary Cells

II. LITERATURE REVIEWS

A. Historical Overview

The handover is the process of transferring an active call from one cell to another cellin term of time slot, frequency band and spreading code channel to the near base station (BS)[3]. BS has an ability to assign one of the channels to control handoff case. The probabilities could be occurring when all of the channels use at the same time either BS drop the call from MS or delay the call for a while to wait the available channel. The initiation of handover could be due when signal deterioration at the edge of the cell and traffic balancing in network to ease traffic congestion by moving calls from highly until lightly congested cell [4].

Handoff can be classified into two types: soft handoff and hard handoff. Soft handoff often operated in 3G technologies by releasing new resources before using the new resources called as "make before break". Hard handoff often operated in GSM technologies by releasing the current resources before new resources are used. For the roaming system, there are two types of roaming for the mobile user:intra-system roaming and inter-system roaming. Intra-system roaming refers to MS moves between different cells in same system while inter-system roaming refers to MS moves between different network in term of different backbones, protocols and service providers. In this paper, handoff technique will be focused in GSM technologies byimplementing the inter-system roaming and hard handoff in simulation model.

B. Inter-System Handoff

Each boundary cells are controlled by Boundary Base Stations (BBS) connected to switch in own network. MS moves from different network will transmit and receive the signals from either network depending on the MS's configuration. Signaling and controlled messages passed between the BBS and switch may reroute by the MS connections before the MS handoff into the new system. There are several requirements needed in inter-system handoff (ISHO): (i) MS must have ability to communicate in more than one system, (ii) technique is needed to measure and compare signals from different air interfaces and power levels, (iii) transmissions and signaling facilities must exist between the switches of each system [2]. Figure 2 shows BBS is controlled by switch in their own network when MS crossing the boundary cell in different network.

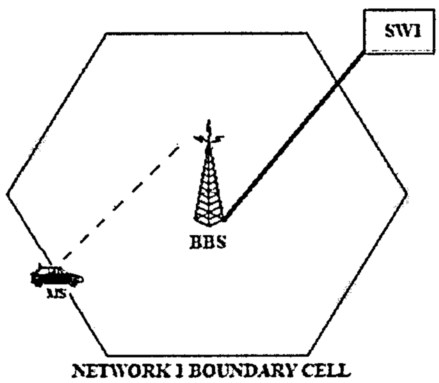

Figure 2: Boundary Cell System

The system consists of switch, boundary base station (BBS) and MS. When MS cross from previous cell to next cell in dissimilar network, MS will find new resources from nearest BS. Assume the cell has a hexagonal shape which is six sides of length. There are 3 methods can be performed in ISHO: (i) Network Controlled Handoff (NCHO), (ii) Mobile Assisted Handoff (MAHO), (iii) Mobile Controlled Handoff (MCHO).

C. Handoff Algorithm

There have several parameters involved in handoff in cellular network especially in case of hard handoff (GSM) such as relative signal strength (RSS), relative signal strength with threshold (RSS-T), relative signal strength with hysteresis (RSS-H) and relative signal strength with hysteresis and threshold (RSS-HT). RSS refers to strongest BS is selected at all time and RSS-T refers to handoff user only executed if the current signal is low or weak and the other two BS's have strong signal strength. RSS-H refers to handoff is done if new BS is sufficiently stronger by hysteresis margin. This method can prevent ping pong effect which means repeated handoffs. RSS-HT refers to user handoff to new BS occurred if current signal levels drop below than threshold value.

III. METHODOLOGY

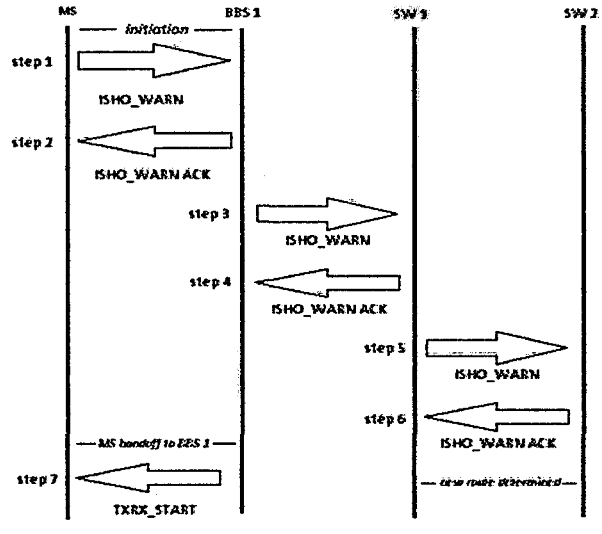

Figure 3: Signal Flow ISHO

Figure above shows the signal flow when MS approaches to the next boundary cells in different networks. The first step occurs in Inter System Handoff (ISHO), MS hears beacons from BBS1 and automatically MS will send message ISHO warning (ISHO_WARN) to BBS1. Second step, BBS1 will send back acknowledgement of ISHO warning (ISHO_WARN ACK) to MS. If wireless link error occurs, (ISHO_WARN) will retransmit by MS until BBS1 may send back the acknowledgement of warning message to MS. Step 3, BBS1 will send (ISHO_WARN) to switch (SW1) and SW1 will send back the (ISHO_WARN ACK) to BBS1 in step 4. Step 5, SW1 will transmit the (ISHO_WARN) to route message to SW2 and the message will send back to SW1 (ISHO_WARN ACK) to begin the operations such as authentication, location management, encapsulation packets and reroute the network. MS will do the ISHO at the same time and when ISHO complete, BBS1 transmit (TXRX_START) to activate or restart transmitter and receiver pairs.

IV. SIMULATION MODEL

For this simulation, the values of parameters used are assumed as follow path loss, μ = 0dB, efficiency, η = 30, distance, D = 2km, correlation distance, d = 20, averaging constant = 30 and shadow fading = 6 dB.

$$a(d) = \mu - \eta \log(d) + u(d) \quad (1)$$

$$b(d) = \mu - \log(D-d) + v(d) \quad (2)$$

$$c(d) = \mu - \eta \log \sqrt{\left(\frac{D}{2} - d\right)^2 + \left(\frac{3}{\sqrt{3}} - \frac{D}{2}\right)^2} \quad (3)$$

where D is the distance between two base stations (BS), d is the position of the MS from BS, μ and η are parameters for path loss, μ depends on transmitted power at the BS and η is equivalent to path loss slope equals 3 for the attenuation. A handoff test is performed periodically at every sampling distance equal to 1m. In this simulation, the boundary cell system of cellular mobile network is designed by using MATLAB simulation software as shown in Figure 4(a).

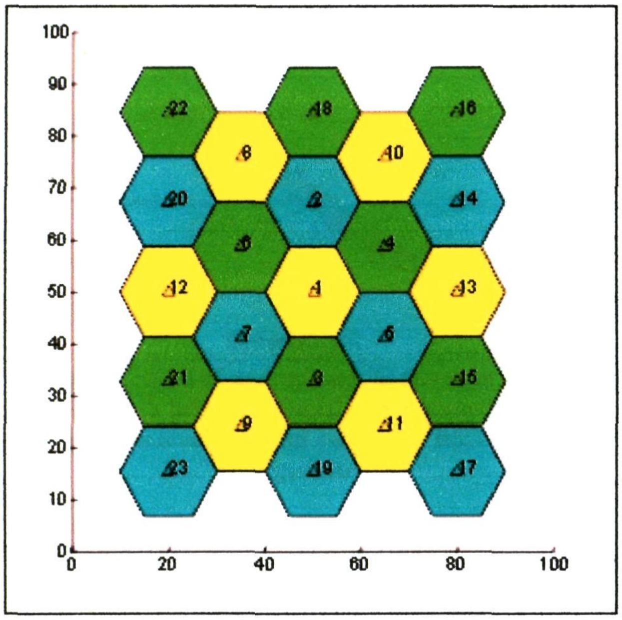

Figure 4(a): Boundary Cell System of Cellular Mobile Networks by using MATLAB Simulation

According to the Figure 4(a), there have many cells in this cellular network. The number of cells increasing often occurs in urban area because the number of subscriber increasing in order to provide best coverage to users. The performance evaluated of the algorithm are mean number of handoffs, mean number of wrong handoffs and expected average signal strength (EASS) of the serving BS to indicate delay. Signal strength received by MS form BS measured in dB as shown in equation (1),(2) and (3). The problem about fading (Raleigh fading) in this case, the value of fading assume neglected because it has shorter correlation distance. The simulation analyzed based on the three BS model and this BS separated by distance, D as shown in Figure 4(b).

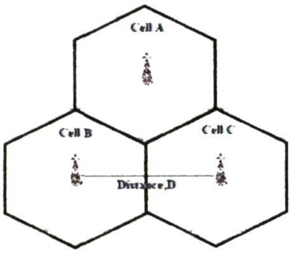

Figure 4(b): A Three BS Model

V. RESULTS

The performance of the relative signal strength (RSS) with hysteresis and threshold (HT) algorithm for varying the HT parameters are evaluated.

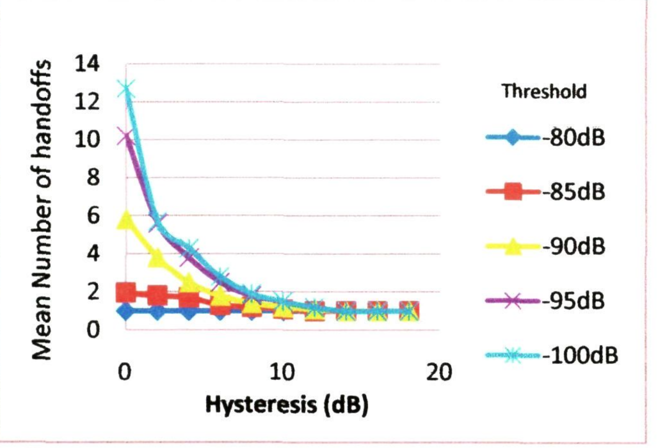

Figure 5: Mean Number of handoffs versus hysteresis levels in 3BS model in RSS-HT new algorithm.

Figure 5 shows the mean number of handoffs versus hysteresis margin for different values of threshold. It can be seem when higher threshold value while the mean number of handoffs are become lower. The reasons when threshold decreasing, signal strength between BS and MS will become lower (weak) and causing the handoff process repeated several times.

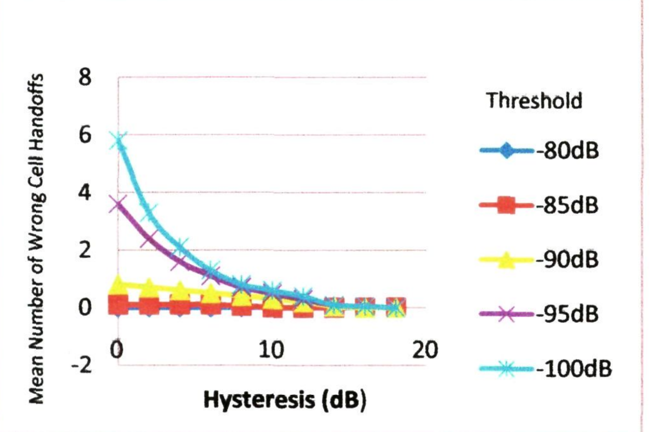

Figure 6: Mean Number of Handoffs versus hysteresis levels in 3BS model for RSS-HT new algorithm

Figure 6 shows the higher threshold values reduces the number of handoffs but the delay in handoffs increasing. Inspection of this result for -90dB threshold and hysteresis of 2dB, the mean number of wrong cell handoffs to cell A is 0.5. It can be reduced to 0.075 by increasing the threshold to -85dB. It decreases the mean number of handoffs from 3.6 to 0.5 but results in increased handoff delay. The reason is lower threshold causing the signal strength at nearest BS become lower and other BS at different cells will cover the handoff process. Therefore, the number of wrong cell handoff increasing when threshold become lower.

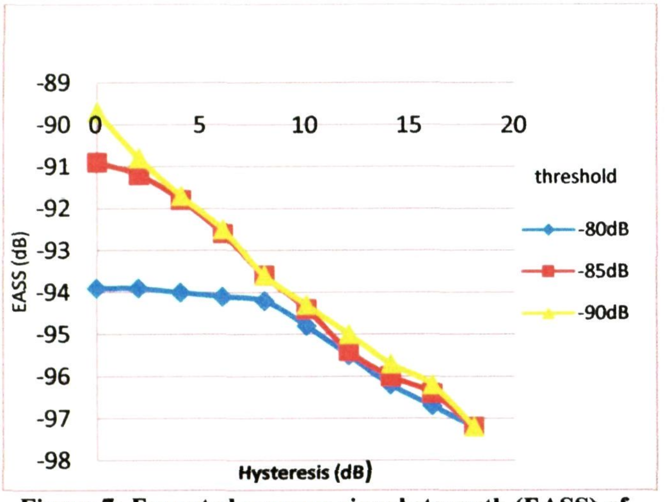

Figure 7: Expected average signal strength (EASS) of BS1 at which handoff initiation occurs to BS2 versus hysteresis levels in 3 BS model for RSS-HT new algorithm.

Figure 7 shows the EASS in dB versus hysteresis for different threshold levels. For hysteresis of 2 dB and increasing threshold level for -90dB to -85dB the EASS decreases from -89.4dB to -91.3dB. This is achieved at the cost of increased handoff delay. Higher threshold causing the EASS become lower at lower hysteresis. It will become stable from 8db and above. The reasons is higher threshold is slowly to initiate the signal strength between 2 BS.

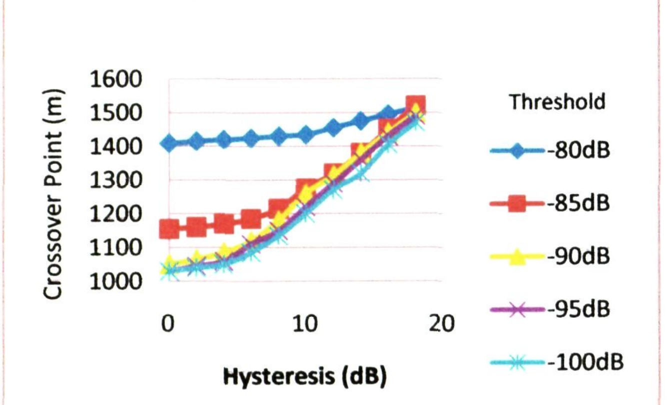

Figure 8: Crossover point versus hysteresis levels in 3BS model for RSS-HT new algorithm

Figure 8 shows crossover point from current cell to new cell versus hysteresis values for different threshold level. For hysteresis of 2 dB at -90dB threshold the crossover point is at 1060m and at -85dB threshold is 1150m. Therefore, crossover distance increases for certain values of hysteresis with increasing threshold level causing handoff delay.

VI. CONCLUSIONS

Handoff occurs when MS moves from the existing cell to the adjacent cell when signal strength received by MS is higher than the signal strength from the original cell by certain value (hysteresis value). When the hysteresis values increasing in results, the delay in handoffs and crossover points will increase but the average number of handoff will decreasing. Therefore, crossover point and EASS causing delay in handoffs decreasing.

VII. RECOMMENDATIONS

The proposed ways to improve the performance of the parameters are introduce proper new BS threshold setting which is minimize the number of unnecessary handoff to new BS when BS signal strength is not sufficient to serve the call. The another ways is introduce the new appropriate higher threshold setting which is number of handoff occurring to the neighboring cell are not intended for handoff can be minimized.

VIII. ACKNOWLEDGEMENT

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