

LTE soft handover based on hysteresis and threshold combination

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Abstract. This paper proposes the combination of hysteresis and threshold based soft handover in the long-term evolution (LTE) network and presents the performance evaluation. As the simulation conducted, the observations of the generated data show that the threshold margin of -115 dBm with hysteresis margin 24 produces the highest active set, achieving 2.082. The higher the active set value results the lower the outage probability. Outage probability for threshold value of -115 dBm occurs at distance 611 m, reaching only 2.1×10^{-7} .

1. Introduction

LTE network employs hard handover [1, 2] as its architecture is flat and no centralized control. Moreover, its orthogonal modulation does not require power control so that self-interference does not exist. Hard handover employs break-before-make mechanism which radio link failure may occur. Link failure results packet losses and connection failure reducing the overall quality of service.

Some researchers proposed LTE handover improvement. Wang et al [3] proposes soft handover with make-before-break mechanism for high speed train connection to reduce number of handover and to maintain stable signal level. Haddad et al [4] proposed secure uniform handover which is uncontrolled and considering security aspect as other researchers [5, 6]. This paper proposes soft handover for TD-LTE by combining hysteresis and threshold parameters. In order to evaluate the proposed soft handover, a system model with three subsequent eNB is proposed. By using certain parameters from several sources, a mobile unit handover is evaluated. This model is discussed in next section followed by evaluation results discussion.

2. Evaluation method

2.1 System model

The proposed model contains three eNBs: eNB 1, eNB 2 and eNB 3 located in a straight line along the 2000 m line in which a mobile user moves as depicted in Figure 1. eNB1 is at distance 0, eNB2 at 600 m and eNB3 at 1600 m. UE moves from 0 to 2000 m with constant speed.

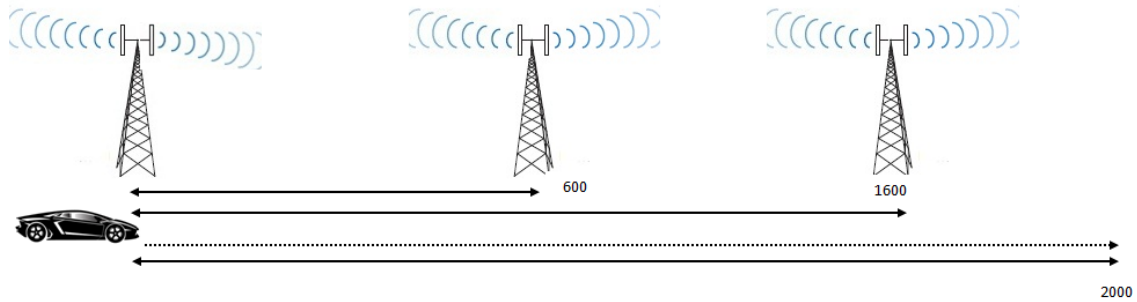


Figure 1. System model

Reference signal received power is measured every in period of t_{meas} and represented as $A_{i,k}$ where i is index of eNB and k is the measuring steps. The attenuation is calculated by using Equation 1 where d is distance from eNB and S is attenuation shadowing and n is exponential pathloss value [4,5]. The received power is denoted by Equation 2 $A_i(d)$ [6].

$$a(d, S) = d^n \cdot 10^{\frac{S}{10}} \quad (1)$$

$$A_i(d) = P_t - a(d, S) \quad (2)$$

2.2 System parameters

System parameters are shown in Table 1. Number of eNB is set 3 with travelled distance 2000 m, transmit power is 47 dBm, threshold margin has several values, hysteresis margin is set from 3 to 24. System is working on 2, 3 MHz.

Table 1. System parameters

Parameter	Nilai
Number of eNB	3
Travelled distance	2000
Transmit power	47 [7]
Threshold margin (dbm)	-90 [4] , 95 , -100, -105, -110 [8], -115 [9]
Hysteresis margin	3, 9, 12, 16, 18, 24 [10]
Carrier frequency	2,3 MHz

2.3. Handover process

Hysteresis and threshold value are set as the trigger for soft handover by following the following state. Initially, active set is for eNB1. When received power from eNB1 is higher than threshold, $RSRP1(d) > \text{Thrs}$, then the absolute differences of $RSRP1(d)$ and $RSRP2(d)$ larger than Hyst_ADD . Active set contains eNB1 and eNB2 if $RSRP1(d)$ and $RSRP2(d)$ larger than Thrs and the absolute differences of $RSRP1(d)$ and $RSRP2(d)$ smaller than Hyst_ADD . Active set is set to eNB2, only if $RSRP1(d)$, $RSRP2(d)$ larger than Thrs and the absolute difference larger than Hyst_DROP . This denotes soft handover process. Active set is none only if $RSRP1(d)$ and $RSRP2(d)$ smaller than Thrs . At this state, UE is not connected to any eNB.

An issue is emerged if the active set change frequently which means handover repeated many times. Other issue is when no eNB registered in active set which result an outage. This is measured by using the outage probability. Theoretically, it is approximated by Equation 3 [8]

where A_{best} is the highest RSRP value, A_{min} is the lowest RSRP, and σ is standard deviation.

$$P_o(d) = Q(A_{best} - A_{min} / \sigma) \quad (3)$$

3. Simulation results

Received power level from all eNBs to travelled distance is shown in Figure 2. By varying the hysteresis and threshold values of 3, 9, 12, 16, 18, 24 and -90 dBm, -95 dBm, -100 dBm, -110 dBm, -115 dBm, the active set changes as plotted in Table 2.

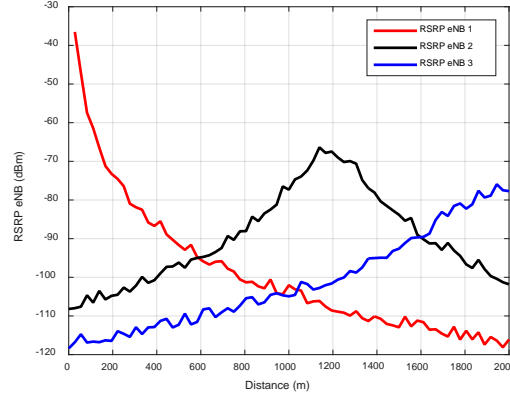


Figure 2. Signal level of three eNBs

Table 2. Active set value versus threshold and hysteresis margins

Threshold margin(dBm)	Hysteresis margin(dBm)					
	3	9	12	16	18	24
-90	0.89	0.877	0.836	0.877	0.877	0.89
-95	1.082	1.11	1.151	1.178	1.192	1.192
-100	1.082	1.26	1.301	1.397	1.452	1.479
-110	1.082	1.26	1.301	1.466	1.562	1.808
-115	1.082	1.26	1.301	1.534	1.712	2.082

Active set values reflect the number of eNB that is able to serve UE. The higher active set, the better the performances. Table 2 shows that threshold of -115 dBm and hysteresis of 24 produce the highest active set of 2.082 which means there are 2 eNB exist in the distance travelled. The higher the active set value results the lower the outage probability. Figure 3 shows the outage probability for threshold value of -115 dBm. At this threshold, the maximum outage occurs at distance 611 m, reaching only 2.1×10^{-7} .

4. Conclusion

This paper has examined the soft handover for LTE by considering the threshold and hysteresis margin. By using these two parameters, the highest active set occurs only when the threshold is -115 dBm and hysteresis is 24. At this point, active set reaches 2.082.

The highest active set produces lower outage probability. With the proposed model, highest outage happens at 611 m distance from the initial zero position. With maximum outage probability of 2.1×10^{-7} , system performance is excellent.

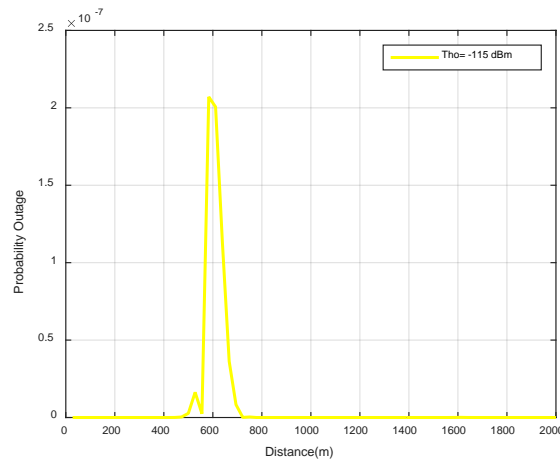


Figure 3. Outage probability for threshold margin -115dBm.

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