Analysis of Handover Priority in Intra Technology Radio Access

Afrizal Yuhanef [a.1,*], Zurnawita[a], Fitri Amalia[a], Nasrul[a], Ardi Syawaldipa[b]

[a] Department of Electronics Engineering, Politeknik Negeri Padang, West Sumatera, Indonesia
[b] Department of Information Technology, Politeknik Negeri Padang, West Sumatera, Indonesia
[1] afrizalyuhanef@pnp.ac.id
* corresponding author

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ABSTRACT

A handover strategy is required to ensure connection continuity for cellular network users due to user mobility. Handovers on the same frequency (intra-frequency) and handovers on other frequencies (inter-frequencies) are conceivable in the Intra Radio Access Technology network. The network must be able to give the best quality and optimal bandwidth so that consumers can keep their connection. Most cells have more than one bandwidth channel. A test was performed in this study to determine the influence of priority handover on intra-frequency LTE handover on signal strength and throughput. This study is based on actual measurement findings from the deployed 4G LTE network transceiver device, which contains several carriers for each eNodeB. TEMS Pocket, a mobile gadget, was used to collect data for measurements. For analysis purposes, the parameters RSRP, throughput, frequency band, serving cell identification or PCI (Physical Cell Identity), and event handover are employed. In the inter-frequency LTE handover, there are two priority handovers: handovers from lower bands to higher bands (high priority) and handovers from higher bands to lower bands (low priority). When a low-priority handover happens, the RSRP value and throughput increase, while a high-priority handover causes the RSRP value to decrease.

1. Introduction

One feature of a cellular communication system is the presence of a handover point where users can freely roam throughout the network (RRC-connected mobility) [1]. Every time entering a different cellular cell, mobile users will change the connection which is known as a handover [2][3]. A handover scenario will provide connection continuity via a handover event. The increasing demand in network usage has been proving the need for further service improvement [4][5]. The problem is ensuring that users always have the best bandwidth available when there is mobility while maintaining optimal signal quality and throughput [6]. The 4G LTE network uses a variety of bandwidth or carrier channels, including 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz, and 20MHz [7][8]. LTE networks in Indonesia use the frequency bands L900, L1800, L2100, and L2300 [9]. In intra-radio access technology 4G networks, there are two types of handovers: intra-frequency handovers and inter-frequency handovers [10]. Inter-frequency intra-LTE RATs enable cell and inter-cell handovers. Due to mobility, priority handover allows customers to be serviced by networks with higher and lower frequencies. According to 3GPP, there are numerous causes for handover on LTE networks. The event handover parameters A1, A2, A3, A4, and A5 [9] serve as the triggers.

This article will investigate handover priorities at various frequencies and how they affect coverage and throughput. The experiment was conducted on an LTE network with multiple frequency bands to fulfill the needs of low and high-frequency data. Data collection used the Drive Test tool in the form of TEMS Pocket, visualization and route creation using Google Earth, and analysis using TEMS discovery.

2. Literature Review

Many studies on mobility and handover methods have been undertaken in recent years. The work in [11] examines how to use layering to optimize intra-radio access technology handover between LTE1800 and LTE900 bands. LTE1800MHz handover priorities on higher layering and LTE 900MHz handover priorities on lower layering are optimized. The threshold values for the RSRP (Reference Signal Receive Power) parameter are -110dBm and -105dBm, respectively, based on the handover event parameters A3 and A5. Setting the layering threshold influences the covered area value. Handover settings must be optimally established for various types of user mobility conditions to limit the occurrence of handover failures [12]. The magnitude of the delay and throughput numbers vary depending on the speed of the user equipment used in the test. With changes in UE speed, simulations run by defining the handover parameter as the time to trigger (TTT) result in less latency and more throughput. User movement in a small cell will result in frequent handovers, constrained cell utilization duration because of mobility, and reduced service quality [13]. In [13], intelligent handover is used to increase handover quality while maintaining fast handover speeds. The first technique will be users who are connected to the base station and will hand over to another base station depending on the topology of the cell to be addressed, the path distance in the cell, and the distance between the base station and the cell edge. The second strategy involves utilizing a base station based on three successive cells with the assumption that the user's mobility pattern may be predicted based on trajectory and speed. Both of these techniques succeeded in reducing the rate of occurrence of HO and managed to maintain handover with good QoS during the skipping phase. Paper [14] analyzes signal strength on intra-frequency and inter-frequency using the SSV method [14]. The results of the analysis show the success rate of the handover because the signal quality meets the requirements as indicated by the signal strength (RSRP) and signal quality (SINR) values in the good category. Paper [15] analyzes the femtocell handover scenario was evaluated based on user equipment velocity and the specific stay time. The proposed algorithm gives the better result and achievement to minimize the unnecessary handover. Paper [16] discusses the best performance of the A2-A4-RSRQ and A3-RSRP algorithms when the UE has a random speed in the range of 20 to 120 KmPh. The measurement results provide the best performance on the A3-RSRP algorithm with a combination of 480 ms TTT and hysteresis of 12 dB

3. Method

The drive test method was used to assess LTE signal performance in the Lubuk Buaya area, Koto Tangah sub-district, Padang city to analyze the handover situation and its effect on RSRP parameters and throughput. The intra-LTE network was tested using multiband frequencies such as LTE 900MHz, LTE 1800MHz, LTE 2100MHz, and LTE 2300MHz. TEMS Pocket is used for testing, and the data script is run. The parameters handover events A1, A2, A3, A4, and A5, as well as RSRP values, are used to perform inter-frequency handover analysis. Figures 1 and 2 show the research flow for priority handover analysis as well as measurement paths to determine inter-frequency handover.

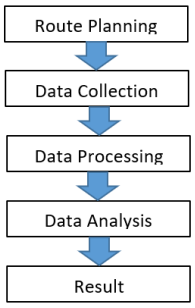

Figure 1. Research flow

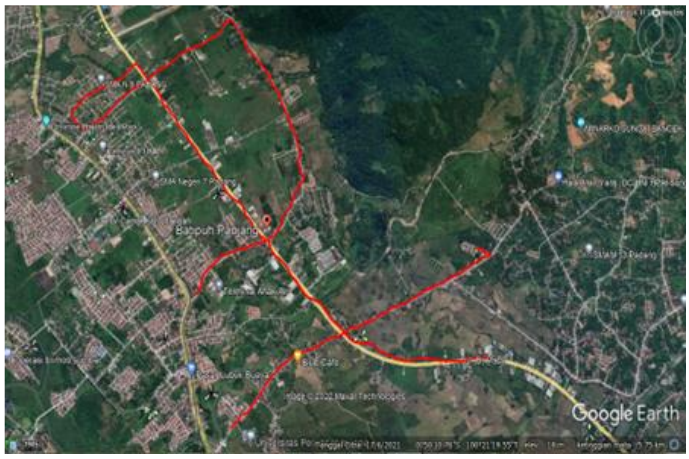

Figure 2. Inter frequency handover test route

4. Results

When there is user mobility, the test results are based on the results of the driving test via connected mode.

4.1. Plots of serving cell Identity and inter-frequency handover

Figure 3 shows serving cells and measurement routes based on the serving cell Identity parameter. There are 28 serving cells when measuring with different frequency bands and bandwidth channels.

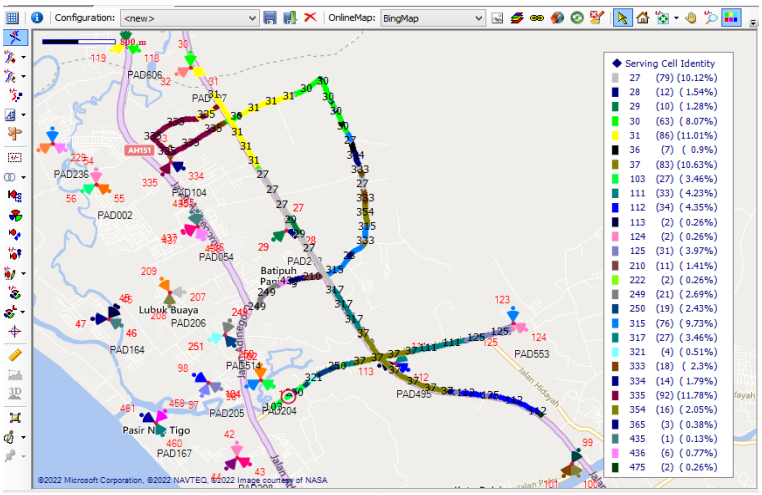

Figure 3. The serving cell and base station plots

Figure 4 is the result of the inter-frequency handover plot along the measurement route when there is user mobility. There are 18 inter-frequency handovers on the frequency bands of 900 MHz, 1800 MHz, 2100 MHz, and 2400 MHz and bandwidths of 10MHz, 15MHz, and 20MHz both on the same cell and on different cells.

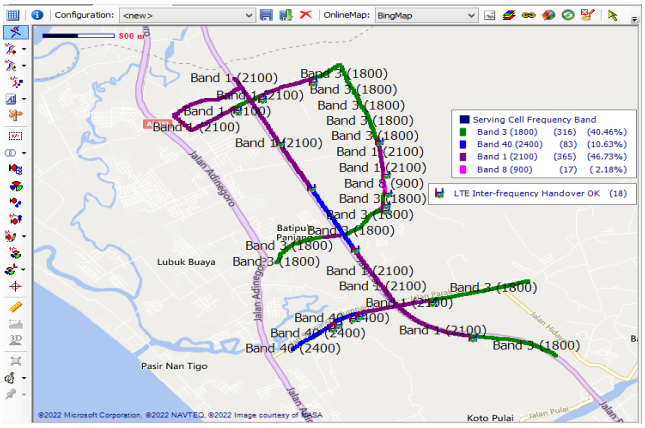

Figure 4. Inter Frequency Handover Plots

The following is serving cell data and frequency bands on the measurement route as shown in Table 1

Table 1. Frequency band in each cell (PCI)

Serving Cell Identity (PCI)	Frequncy Band (MHz)
321	L900, L2100
250	L1800, L2100, L2400
250	L1800, L2100, L2400
222	L900, L1800, L2100, L2400
111	L1800
354	L2100
333	L1800, 2100
315	L1800
27	L900, L1800, L2400
334	L1800, L2100
335	L1800, L2100
29	L1800, L2100, L2400, L2400
317	L900, L1800, L2100
125	L1800, L2100

4.2. Handover Priority Analysis

When the UE is in the Radio Resource Control connected (RRC Connected) state, handover happens. Handover is triggered by UE mobility and load balance technique so that UE can have the optimal network quality. Table 2 shows the handover priority depending on the RSRP value, cell identification, handover event, band frequency, and bandwidth on the serving cell source and serving cell destination as determined by the A5 event trigger.

Table 2. Serving cell RSRP on inter-frequency handover

Serving Cell Identity	Serving Cell Target Identity	Serving Cell RSRP (dBm)	Serving Cell Target RSRP (dBm)	Serving Cell Freq Band (MHz)	Serving Cell Target Freq Band (MHz)	Serving Cell BW (MHz)	Serving Cell Target Band (MHz)
103	321	-113.8	-88.9	2400	2100	20	10

321	250	-96.5	-101.4	2100	2400	10	10
250	250	-114.0	-112.4	2400	2400	10	20
250	222	-116.6	-110.0	2400	2100	20	15
37	111	-94.3	-72.6	2100	1800	10	20
315	354	-105.2	-105.6	1800	900	20	10
354	333	-105.6	-111.4	900	2100	10	10
27	315	-109.0	-102.7	2100	1800	10	20
315	354	-98.5	-97.9	1800	900	20	10
354	333	-104.5	-109.3	900	2100	10	20
27	334	-98.0	-90.8	2100	1800	20	20
333	335	-90.9	-94.9	1800	2100	20	10
27	317	-110.2	-92.3	2400	2100	10	20
365	365	-88.8	-85.1	2100	1800	15	20
27	29	-90.6	-96.9	2100	2400	20	10

Based on the A5 event parameter, the inter-frequency handover has 15 handover occurrences. On the LTE 900MHz, LTE 1800MHz, LTE 2100MHz, and LTE 2400MHz bands, there was a handover. Based on RSRP settings and serving cell identification, inter-frequency handover happens in 14 separate cells and the same cell.

Table 3 shows the throughput numbers for 15 different handover events based on cell identification, band frequency, bandwidth on the serving cell source, and bandwidth on the serving cell destination. When an inter-frequency handover occurs, the throughput value varies depending on the serving cell identity value in both the source and target cells.

Table 3. Serving cell throughput in inter frequency handover

HANDOVER PRIORITY	Serving Cell Identity	Serving Cell Target Identity	Serving Cell RSRP (dBm)	Serving Cell Target RSRP (dBm)	Serving Cell Throughput (kbps)	Serving Cell Target Throughput (kbps)
L2400 to L2100	103	321	-113.8	-88.9	8057.33	18052.60
L2100 to L2400	321	250	-96.5	-101.4	8980.00	9866.45
L2400 to L2400	250	250	-114.0	-112.4	2173.70	3745.10
L2400 to L2100	250	222	-116.6	-110.0	1047.70	2368.67
L2100 to L1800	37	111	-94.3	-72.6	1016.50	8314.90
L1800 to L900	315	354	-105.2	-105.6	8514.30	3289.30
L900 to L2100	354	333	-105.6	-111.4	3289.30	585.33
L2100 to L1800	27	315	-109.0	-102.7	1590.27	5340.11
L1800 to L900	315	354	-98.5	-97.9	10656.00	7916.40
L900 to L2100	354	333	-104.5	-109.3	500.00	837.17
L2100 to L1800	27	334	-98.0	-90.8	1251.90	4610.40
L1800 to L2100	333	335	-90.9	-94.9	2459.33	1587.60
L2400 to L2100	27	317	-110.2	-92.3	7277.10	17045.10
L2100 to L1800	365	365	-88.8	-85.1	11410.20	16388.90
L2100 to L2400	27	29	-90.6	-96.9	3615.70	8613.90

4.3. The Effect of Inter-Frequency Handover on Coverage

In Inter Frequency Handover intra LTE, there are two types of priority handover: handover from a higher frequency band to a lower frequency band or low priority, and handover from a lower frequency band to a higher frequency band or high priority, both on the same cell or separate cells. Figure 5 depicts an increase in the RSRP value when switching from a higher frequency band to a lower frequency band or from high priority to low priority. When switching from a lower frequency band to a higher frequency band or a high priority, the RSRP decreases.

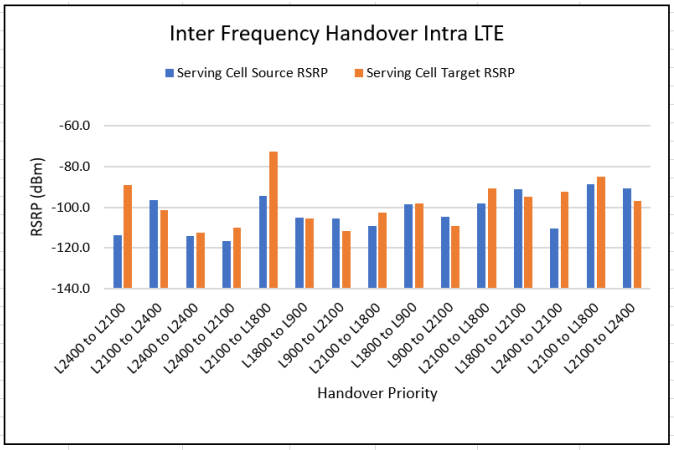

Figure 5. Effect of Inter frequency Handover on Coverage

4.4. The Effect of Inter-Frequency Handover on Throughput

According to the graph in Figure 6, the dominating rise in throughput happens when a handover occurs on low priority and a decrease in throughput occurs when a changeover occurs on high priority. The decreased RSRP value affects the decreased throughput value.

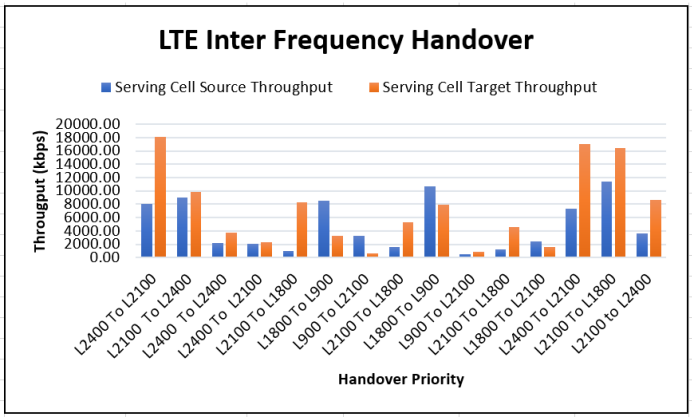

Figure 6. Effect of Inter frequency Handover on Throughput

5. Conclusions

Based on the findings of testing and analysis of handover priority on the Intra Technology Radio Access Network LTE 4G in the Lubuk Buaya area of the Koto Tangah Sub District, Padang City, it is possible to conclude that handover priority occurs through the A5 event, which affects the quality of servicing cells. The RSRP and throughput numbers increase at Low priority. According to KPI criteria, there is a drop in RSRP and throughput while on high priority. The RSRP value influences the inter-frequency handover throughput.

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