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Analysis of the Application of Carrier Aggregation Combinations on the Existing LTE Network

Sri Yusnita [a, 1, *], Khalidia Igna Fillah [a], Popy Maria [a], Widya Andriani [a], Yulia Jihan SY [b]

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

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ABSTRACT

The implementation of Carrier Aggregation makes it possible to expand spectrum use by combining several bandwidth channels that work like a single spectrum. The LTE network is deployed on several bandwidth channels, namely 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz and 20MHz. Each bandwidth channel that is correlated with the implementation of carrier aggregation will occupy a different and non-adjacent frequency band, namely 900MHz, 1800MHz, 2100MHz and 2300MHz. In this research, we tested the effect of a combination of CAs that occupy non-adjacent frequency bands on uplink and downlink performance. Measuring and analyzing network performance to determine throughput using several supporting software, namely Tems Investigation, Tems Discovery and Gnet Track. There was an increase in the downlink throughput and uplink throughput values due to the implementation of CA compared to not using CA. The maximum Downlink Throughput value in the CA combination is greater than the Uplink Throughput. The maximum Downlink throughput value on CA 20+20Mhz is 9427kbps, while the Uplink value is 1133.28kbps. The maximum downlink throughput value on CA 20+15Mhz is 8272.24kbps, and the maximum uplink throughput value is 745kbps.

1. Introduction

G3PP release 10 begins to introduce Carrier Aggregation (CA) in fourth generation technology, namely LTE (Long Term Evolution). Followed by G3PP release 11 and release 12 in LTE Advanced and 3GPP release 13 and release 14 known as LTE Advanced Pro [Dalman, 2016]. The working principle of CA is related to combining several bandwidth channels that work like a single band so that it can increase the capacity of the LTE network (Sauter, 2017). Large capacity and good signal quality are important parts of the goal of deploying an LTE technology network compared to previous technologies. The 4G LTE network is deployed on varying bandwidth or carrier channels, namely 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz and 20MHz (Cox, 2014). The amount of channel bandwidth will be related to the CA applied to the LTE network. Kompas media in 2021 stated that Indonesia was deploying an LTE network in the 850MHz, 900MHz, 1800MHz, 2100MHz and 2300MHz frequency bands. Meanwhile, the channel bandwidth used in Indonesia is 5MHz, 10MHz, 15MHz and 20MHz. In recent years, research has been carried out regarding CA and channel bandwidth. The use of CA through the incorporation of new spectrum in the mmwave band and sub 6GHz can be used to increase system capacity [Adamu 2021]. The next research is how CA can improve delay performance when channel utilization is very high because the additional capacity of channel bandwidth can be used for load balancing and reducing delay [Akselrod 2020]. Research on combining bandwidth channels causes an increase in the number of resource blocks by the same amount as using a single band so that it can be used as an alternative to meet high capacity and data speed requirements. Combining 2 bands 5MHz and 15MHz provides the same number of resource blocks as using a single 20MHz band, namely 100RB [Goyal 2018].

The application of CA on band 40 frequency 2300MHz and band 5 frequency 850MHz resulted in a decrease in resource block usage from 82% to 42%, as well as an increase in the average RSRP of 12.8 dBm and SINR of 5.14dB [Putri 2021]. The same thing was also expressed by Adamu & Lopez-Benitez (2021) who explored the use of CA to increase network capacity with various radio propagation scenarios. The results obtained show that CA can be used effectively as a technique to optimize overall system performance and increase network capacity with an optimal number of carrier components depending on the radio propagation distance [5]. It is a challenge for mobile telecommunications service providers to provide optimal quality services to users both in terms of uplink and downlink. The application of CA with the aim of increasing capacity and throughput will be followed by the possibility of interference arising due to frequency differences in merging bandwidth channels which will affect the network in terms of quality. Based on the background above, this research will analyze the effect of applying a combination of CA on the uplink and downlink side so that optimal CA performance can be seen which should be applied on the uplink and downlink side.

2. Research Methodology

In the research, the analysis of the application of the Carrier Aggregation combination was carried out systematically based on the flow diagram shown in Figure 1. The regional determination was carried out based on the results of experiments at several existing sites that implemented CA.

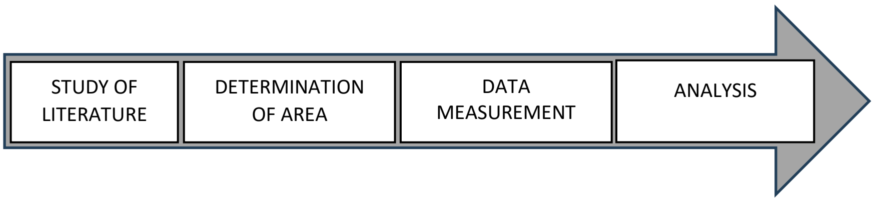

Figure 1. Research Flow

The site where data will be collected has 3 bands, namely the 900 MHz, 1800 MHz, 2100 MHz and 2300 MHz bands. Measurements were carried out using NetMonster software to view Carrier Component, Gnat Track and TEMS Pocket to measure uplink and downlink throughput and Tems Discovery to carry out analysis.

Figure 2. Measurement route

Measurements were carried out in the Alai Parak Kopi area of Padang City on the Telkomsel network with the route as shown in Figure 2.

3. Results and Discussion

The implementation of Carrier Aggregation can be seen in the monitoring results of the NetMonster application as shown in Figure 3 and Figure 4. Measurements were carried out at the CA20+20MHz site which occupies the 1800MHz and 2300MHz bands and CA20+15 MHz which occupies the 1800MHz and 2100MHz bands. Throughput measurements are carried out using tools for CA measurements using Gnet Track and without CA using TEMS Pocket.

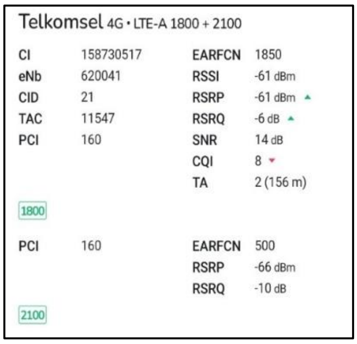

Figure 3. CA Implementation Frequency 1800 + 2100 MHz

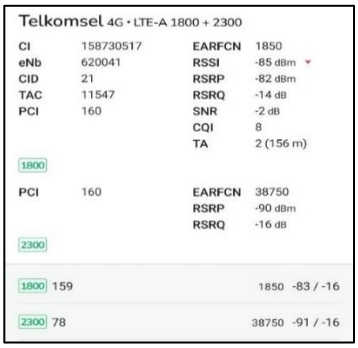

Figure 4. CA Implementation Frequency 1800 + 2300 MHz

Table 1. CA Measurement Combinations

CA Implementation	Freq (MHz)	BW (MHz)
CA	1800+2300	20+20
CA	1800+2100	20+15
Without CA	1800	20

Table 1 shows the CA combination based on frequency and channel bandwidth at the exit site taken and data retrieval according to the route in Figure 2. Tables 2 and 3 are the results of measuring uplink throughput and downlink throughput in CA and non-CA conditions. Maximum Uplink and Downlink Throughput data collection to see CA and non-CA performance is carried out at the same point for each CA combination.

Table 2. Measurement of downlink throughput and uplink throughput values for CA 1800+2300

CA Implementation	Freq (MHz)	DL Tput (kBps)	UL Tput (kBps)

CA FDD-FDD	1800+2300	9247.22	745.13
Without CA	1800	5324.13	722.22

Table 3. Measurement of downlink throughput and uplink throughput values for CA 1800+2100

CA Implementation	Freq (MHz)	DL Tput (kBps)	UL Tput (kBps)
CA FDD-FDD	1800+2100	8272.24	1133.28
Without CA	1800	5276.35	718.64

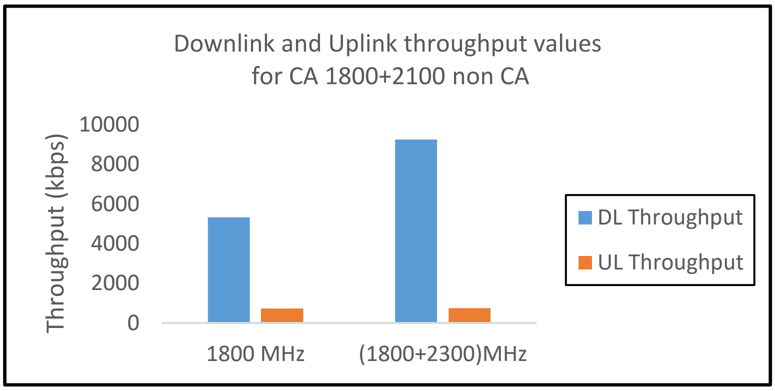

Figure 5. CA (1800+2100) and non-CA Throughput comparison Graph

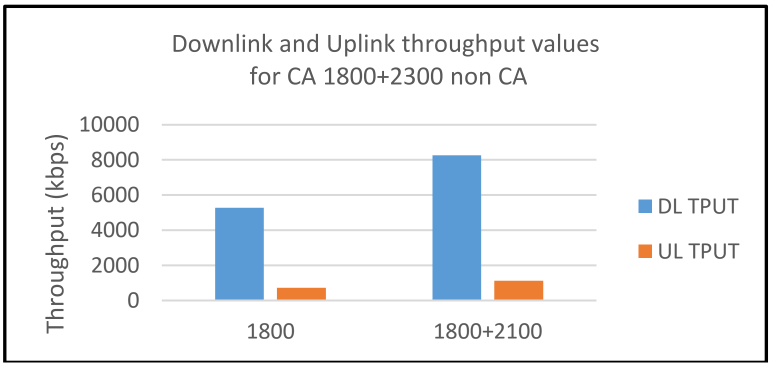

Figure 6. CA (1800+2100) and non-CA Throughput comparison Graph

4. Conclusion

There is an increase in the quality of downlink throughput and uplink throughput when using CA compared to not using CA. Measurements are carried out at the same point using tools that support CA and non-CA on sites that have CA enabled. The downlink throughput value has a higher value than the uplink throughput. Meanwhile, the combination of CA and CA band does not show any influence on the throughput value because the measurement points are carried out at different positions of the User equipment relative to the Site.

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