Analysis of Lte 900 Implementation to Increase Coverage and Capacity of 4g Lte Network On Telkomsel Provider

Lukman Medriavin Silalahi*[1], Imelda Uli Vistalina Simanjuntak[1], Setiyo Budiyanto[1], Freddy Artadima Silaban[1], Agus Dendi Rochendi[2], Gunawan Osman[3]

[1]*Department of Electrical Engineering Universitas Mercu Buana, Jl. Raya Meruya Selatan, Jakarta*
[2] *Department of Oceanographic Physics Lembaga Ilmu Pengetahuan Indonesia, Jl. Pasir Putih I, Jakarta*
[3] *Department of Electromedic Engineering Universitas Mohammad Husni Thamrin, Jl. Salemba Tengah, Jakarta*
[*]*Corresponding author. Email: lukman.medriavin@mercubuana.ac.id*

ABSTRACT
The growth of communication users, especially data packets, is increasing while telecommunication network facilities is not yet maximized to accommodate more and more users, especially suburban and rural areas whose population spread is uneven. So that there is a solution with the implementation of LTE900 to increase the coverage and capacity of 4G LTE network. In this final task before the implementation of LTE900, the author retrieves the data before the implementation of LTE900 through U2000 software, then performs a speed test at the site location BKS422MM1_CLEDUGBKSIST as the data before. Based on the data of LTE900 implementation results, coverage has increased. Rsrp value increased from -85dBm to -83dBm at a distance of 0.5Km, and -105dBm to -95dBm at a distance of 1.5 Km. This is influenced by the frequency used in the LTE900 implementation and the tilting design performed. Capacity absorption after LTE900 implementation affected throughput values which increased from 6.03Mbps to 28.1Mbps at 0.5Km and 3.03Mbps to 10.3Mbps at 1.5Km for sector 1, from 6.83Mbps to 31Mbps at 0.5Km and 4.83Mbps to 11.89Mbps at 1.5Km for sector 2, from 6.43Mbps to 30.04Mbps at 0.5Km and 4.23Mbps to 11.61Mbps at 1.5Km for sector 3. Therefore, in this final task it is stated that lte900 implementation runs successfully with increasing throughput and max user can be controlled.

Keywords: *Telecommunication Network, 4G LTE, Coverage and Capacity*

1. INTRODUCTION

The current pattern of communication needs [1] can be met with unlimited sources of information as well as mobility of communication anywhere through wireless communication technology called mobile broadband. Therefore, telecommunication operators are trying to implement a more reliable broadband access network so as to meet the increase and demand of consumers. [2-5].

The need for telecommunication devices has now entered the stage for the achievement of data communication. It's just that the things encountered in the application of 4G technology in Indonesia today are still constrained in maintaining network performance caused by a surge in data usage and poor coverage quality. The growth of communication users, especially data packets, is increasing while telecommunication network facilities are not yet maximized to accommodate more and more users, especially suburban and rural areas where the spread of the population is uneven. Where consumers today need a good quality mobile network and fast data speed. [6-7]

With increasing usage, the impact on bandwidth usage used today on LTE 1800 TELKOMSEL providers of 17.5 MHz is less fulfilling in terms of capacity and uneven site deployment in suburban / rural areas causing less maximum coverage of LTE 1800. This uneven network is widely complained about by the community so there needs to be a solution from providers to provide maximum service in suburban and rural areas [8-9].

Therefore, the addition of bandwidth in 4G LTE with the implementation of LTE 900 technology that has a bandwidth of 5 MHz is expected to be a solution to overcome coverage and capacity problems. So that in this research will analyze the effect of LTE900 implementation on coverage and capacity of 4G LTE network on TELKOMSEL providers in Bekasi area. With the aim that after planning to increase bandwidth capacity and coverage 4G LTE 900 until the activation process is the antenna cut over process until LTE900 service is active.

2. RESEARCH METHOD

The problem in the research that has been developed according to [10] is network performance constraints caused by a surge in data usage and poor coverage quality. The research location is in Jombang, East Java so as to produce a solution that is through a test drive can be known areas that experience bad spots and know kpi parameters so that it can be optimized. The conclusion of this research stated that the test drive results fall into the category either because the parameter value is above the KPI parameters applied and in the bad spot area has been optimized by changing the sectoral direction so that the area gets a main loob from the site.

According to [11] it was found that 4G network services at this time the quality is still unstable so that it requires repair and analysis in order to obtain better services. Data retrieval quality, processing to analyze data to know the cause of the decline in service quality. Quality of Service (QoS) data retrieval can know the performance of an operator that uses 4G network including Accessability, Retainability, Mobility, Service Integrity, utilization. The conclusion of this research is a way to optimize 4G networks whose quality decreases by doing up / down power in eNodeB. According to [12] the research discussed is that the increase in the number of users of Tri's LTE network in Klaten District is not comparable to the quality of network signals that cause many consumer customers to be disappointed and potentially users will switch to other mobile operators. Network analysis is taken based on the results of drive test measurement using GENEX Probe 3.16 software. The results obtained further analyze the cause of poor throughput performance on LTE networks, then determine the necessary optimization steps.

Antenna cut-over [13] is the process of stopping the use of old devices and starting the use of new devices. This is done so that traffik sharing can be successful and also efficiency in equipment maintenance. By using one antenna, it must really do coverage analysis so that there is no blank spot or overshoot for all technology bands. Tilting antenna is an antenna tilt setting that serves to set the area that will receive signal coverage by pointing the elevation angle at the antenna. According to the type of tilting antenna divided into 2 namely Mechanical tilting is tilt antenna by changing it from the physical side of the antenna and Electrical tilt is a change in the polarization shape of antennas that are set electronically. Electrical tilt changes the character of the signal phase of each antenna element. The greater the electrical value, the smaller the coverage provided [14-16]. The RSRP parameter [17-18] is the eNodeB signal radiance level received by the User Equipment (UE) in a given frequency Table 1 is the standard RSRP parameter value in Telkomsel operators.

Table 1. KPI RSRP standard.

No	RSRP Distribution	Information
1	90% >-100%	Pass
2	<90%	Not Pass

Table 2. Max User's ideal standard table on Telkomsel providers.

No	Bandwidth	Amount
1	5	<75
2	10	<135
3	15	<185
4	17.7	<200
5	20	<235

Table 2 shows the standard KPI in MaxUser which is an indicator of the maximum number of users connected by each sector in eNodeB both being dedicated and idle.

The smallest unit in the Physical Resource block (PRB) is the Resource Element (RE). A PRB consists of 84 resource elements divided into 12 subcarriers (in frequency domains) and 7 OFDM symbols (in time domains) in normal cyclic prefix (CP) and 6 OFDM symbols in extended cyclic prefixes. Duration 1 PRB is called 1 slot with a length of 0.5 ms. Bandwidth for each subcarrier is 15 KHz, so the bandwidth of one physical resource block (PRB) is 180 KHz. Resource blocks are used to describe mapping from a specific physical channel to a resource element. Figure 1 explains that all subframes are used on downlink transmissions. The frame structure uses paired band operations (FDD), where downlink and uplink transmissions operate at different frequencies. If the bandwidth spectrum used for example 1.25 MHz, then in 1 resource block there are 72 subcarriers. LTE also supports for TDD operations, on TDD the basic structure of Resource Block (RB) and Resource Element (RE) remains the same, but in one PRB most subframes are used for downlinks and the rest is used for uplinks or as special frames (to switch between uplink and downlink transmissions). [6-9]

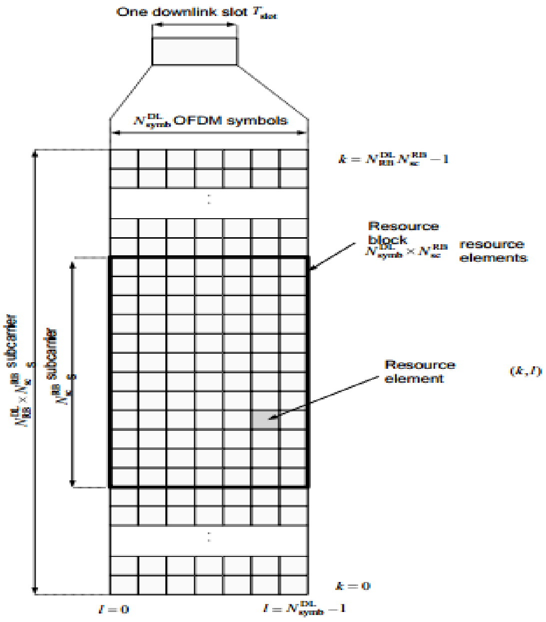

Figure 1. Grid resource structure.

Throughput is a parameter that indicates the maximum transfer speed when transferring uploaded or downloaded data to a file server. [6] Eq. 1 is a calculation formula to find out the throughput value:

$$Throughput = \frac{Number\ of\ Bits}{Interval\ Time} = \frac{RB\ Amount \times 84 \times Modulation\ Factor}{0.5\ ms} \quad (1)$$

Table 3. Standard Throughput on busy hour.

No	Criteria	Throughput	Information
1	Throughput LTE1800	>20 Mbps	Pass
2		<20 Mbps	Not Pass
3	Throughput LTE1800	>10 Mbps	Pass
4		<10 Mbps	Not Pass

Speed test is an application from Ookla that is used to find out the download and upload speed. Here is the standard throughput value of telkomsel operator can be seen in Table 3.

3. RESULTS AND DISCUSSION

The research location is focused on suburban or rural areas located in bekasi area. The process of determining the location of research aims to determine the site to be implemented based on coverage conditions and capacity that has not been maximized. Figure 2 is a map of the location of the site to be implemented that is site BKS422MM1_CLEDUGBKSIST. This location is chosen based on the distance of the site with a neighboring site far enough about 2 Km so that the coverage is not maximal, the spread of the population is uneven and this site is included in the suburban area.

Figure 2. **S**ector 1-site area coverage direction to BKS422MM1_CLEDUGBKSIST.

Data collection is used for primary data research purposes and outside it produces Measurement Report (MR) by RSRP data as an indicator of change in coverage, Max User and Resource block (RB) Utilization as the next capacity indicator used as a comparison before and after lte900 implementation.

3.1 Measurement report reference signal received power (MR-RSRP)

In retrieving measurement report (MR) RSRP data before and after LTE900 implementation of U2000 software that has been converted in Mapinfo Professional software.

The following Measurement Report (MR) RSRP before LTE900 implementation and after LTE900 implementation on site BKS422MM1_CLEDUGBKSIST, can be seen in Figure 3 and 4 and the results can be seen in Table 4.

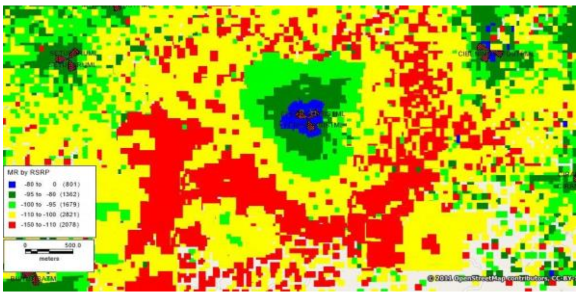

Table 4. Measurement Report Reference Signal Received Power.

No	Coverage Colour	RSRP (dBm)	Indicator	Before		After		Delta
				Sample	Percentage	Sample	Percentage	
1	(blue)	-80 to 0	Excellent	801	9.16%	1101	12.59%	↑3.43%
2	(dark green)	-95 to -81	Very Good	1362	15.58%	1862	21.30%	↑5.72%
3	(green)	-100 to -95	Good	1679	19.21%	2970	33.97%	↑14.77%
4	(yellow)	-110 to -100	Fair	2821	32.27%	2021	23.12%	↓-9.15%
5	(red)	>-110	Poor	2078	23.77%	788	9.01%	↓-14.76%

Figure 3. Measurement Report Reference Signal Received Power after LTE900 implementation.

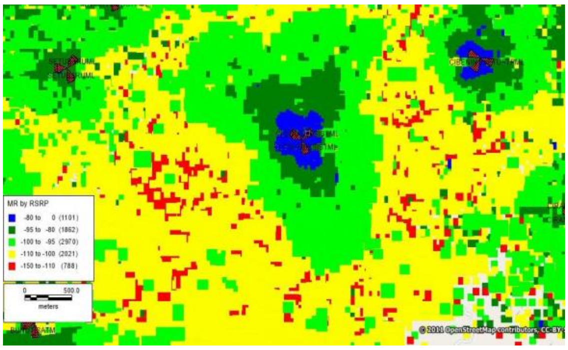

Figure 4. Measurement Report Reference Signal Received Power after LTE900 implementation

Based on Table 4 can be done calculation of KPI values that have been determined by telkomsel operator as a whole, so that it is known the percentage of RSRP value that meets the target of KPI. Eq 2 shows the calculation of RSRP before LTE900 implementation:

$$RSRP = \frac{801 + 1362 + 1679 + 2921}{8742} \times 100\% = \frac{6663}{8742} \times 100\% = 76.23\% \quad (2)$$

Eq 3 shows the calculation of RSRP values that have met kpi targets after LTE900 implementation:

$$RSRP = \frac{1101 + 1862 + 2970 + 2021}{8742} \times 100\% = \frac{7954}{8742} \times 100\% = 90.99\% \quad (3)$$

From PT KPI standard. Telkomsel that the rsrp value increased by 14.76%, so that on the site BKS422MM1_CLEDUGBKSIST coverage looks to be better. This is influenced by several factors, namely from the implementation of LTE900 which is lower frequency, namely at the frequency of 900 so as to affect the coverage that is getting farther, then influenced by tilting design done, so that the coverage emitted by the site

BKS422MM1_CLEDUGBKSIST can reach the maximum, but also influenced by the surrounding site when data retrieval after the implementation of LTE900 performance in good condition.

3.2 Max User

Max user is an indicator of the maximum number of users connected by each sector in eNodeB both dedicated and idle. The more users served by eNodeB will reduce the throughput value that can be seen in Figure 5.

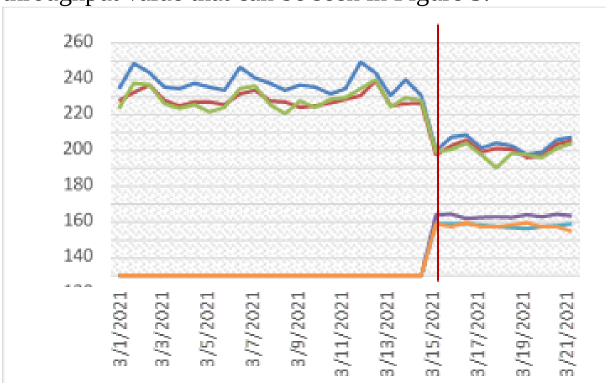

Figure 5. Max User LTE900 implementation.

From Figure 5 can be seen on March 22, 2021 LTE900 is N_BKS422MT1_CLEDUGBKSISTMT1, N_BKS422MT1_CLEDUGBK-SISTMT2,N_BKS422MT1_CLEDUGBKSISTMT3 newly activated and new max user visible about 50-60 users in each sector that indicates that LTE900 is active. At the same time there is a decrease in max user in LTE 1800, namely in cell BKS422ML1_CLEDUGBK-SISTML1,BKS422ML1_CLEDUGBK-SISTML2,BKS422ML1_CLEDUGBKSISTML3 that previously max user exceeded 200 User which exceeds its ideal capacity, to about 135-160 Users. So it can be analyzed that the effectiveness of user absorption previously served by LTE1800 switches to LTE900 about 50-60 users. After the implementation of LTE900 has reached its ideal target which means it will affect the value of throughput in the Customer Experience Test (CET).

3.3 Resource Block

The amount of resource block depends on the bandwidth used. The greater the bandwidth, the greater the resource block available. That way, the bigger the system has resource block, the greater the maximum throughput generated. Resource block (RB) Utilization is still said to be normal if usage is still < 80% of the maximum capacity limit. But it would be better if savings can be made in the use of PRB. Can be seen in the figure 6 show percentage graph resource block (RB) Utilization before and after lte900 implementation.

From Figure 6 can be analyzed that there is a decrease in Resource block (RB) Utilization on March 22, 2021. The decrease in Resource block (RB) Utilization LTE1800 before lte900 implementation from 80-90% to about 60-65%. As for LTE900 active with a Resource block (RB) Utilization value of about 40-45%. With the decrease in Resource block (RB) Utilization LTE1800 and the active LTE900 this makes the value of Resource block (RB) Utilization become normal so that it can maximize throughput in customer experience test (CET) with LTE1800 division to serve coverage 0-700 Meters and LTE900 in coverage area 800-1500 Meters.

Figure 6. Resource block (RB) Utilization Graph Before and after LTE900 Implementation.

3.4 Customer Experience Test (CET) LTE900 Implementation

Customer Experience Test (CET) collection after LTE900 implementation is sampled from three locations according to the number of existing sectors and locations that are indeed crowded with residents. Each location is taken 2 times sample speed test, namely when served at a distance of 0.5 Km and 1.5 Km. The first test conducted testing at a distance of 0.5 Km, at this distance the test results were served by LTE1800 according to the direction of the sector from each location. For the results of speed test before and after implementation of LTE900 at a distance of 0.5 Km sequentially from sector 1, sector 2, and sector 3 can be seen in Figure 8 and Figure 9.

Figure 8. Speed test LTE1800 before LTE900 implementation at a distance of 0.5Km.

Figure 9. Speed test LTE1800 after LTE900 implementation at a distance of 0.5Km.

Furthermore, the second test was conducted at a distance of 1.5 Km, at this distance the testing was served by LTE900. For the results of speed test before and after implementation of LTE900 at a distance of 1.5 Km sequentially from sector 1, sector 2, and sector 3 can be seen in Figure 10 and Figure 11.

Figure 10. Speed test LTE1800 before LTE900 implementation at a distance of 1.5Km.

Figure 11. Speed test LTE1800 after LTE900 implementation at a distance of 1.5Km.

Figure 11 shows that there is an increase in throughput both from a distance of 0.5 Km and a distance of 1.5 Km for all sectors. Refers to Eq. 4 assuming that the site only serves single users, for LTE1800 is as follows

$$Throughput = \frac{95 \times 84 \times 6 \times 1000}{0.5\ ms} = 95.76\ Mbps \quad (4)$$

Where, on LTE1800 site BKS422MM1_CLEDUGBKSIST bandwidth used is 17.7 MHz with the number of RB is 95, resource elements 84 and 6 are modulation used that is 64-QAM. From the criteria of this site the maximum throughput that can be on LTE1800 is 95.76 Mbps. For LTE900 refers to Eq. 5 are:

$$Throughput = \frac{25 \times 84 \times 6 \times 1000}{0.5\ ms} = 25.2\ Mbps \quad (5)$$

Where, on LTE900 site BKS422MM1_CLEDUGBKSIST bandwidth used is 5 MHz with the number of RB is 25, resource elements 84 and 6 are modulation used that is 64-QAM. From the criteria of this site the maximum throughput that can be on LTE1800 is 25.2 Mbps. When compared theoretically from calculations with the results of speed test throughput obtained on both LTE1800 and LTE900 has a fairly far difference, this is because the calculation is assumed with a single user while in the results of speed tests performed it appears that the denseness of users served by the site BKS422MM1_CLEDUGBKSIST.

4. CONCLUSION

Based on the analysis and data collection that has been done, it can be concluded that the implementation of LTE 900 is able to improve the performance quality of RSRP, Throughput, PRB and max users. Furthermore, based on the data from LTE900 implementation, coverage has increased. RSRP value increased from -85 dBm to -83 dBm for distance 0.5 Km and -105 dBm to -95 dBm for a distance of 1.5 Km it is the influence of the frequency used LTE900 which is lower frequency that is at frequency 900 so as to affect coverage further, then influenced by tilting design done, so that the coverage emitted site BKS422MM1_CLEDUGBKSIST can reach optimally. In addition, with the active LTE900 there is a very effective absorption in terms of capacity in both PRB and Max users from LTE1800 to LTE900. With such absorption affecting throughput values that have increased from 6.03 Mbps to 28.1 Mbps at a distance of 0.5 Km and 3.03 Mbps to 10.3 Mbps at a distance of 1.5 Km for sector 1, from 6.83 Mbps to 31 Mbps at 0.5 Km and 4.83 Mbps to 11.89 Mbps at 1.5 Km for sector 2 , from 6.43 Mbps to 30.04 Mbps at 0.5 Km and 4.23 Mbps to 11.61 Mbps at 1.5 Km for sector 3. And lastly to the research problem studied is coverage and capacity in suburban areas can be solved. This is characterized by increased coverage and throughput generated by site BKS422MM1_CLEDUGBKSIST after lte900 implementation.

ACKNOWLEDGMENT

The first special thanks to Universitas Mohammad Husni Thamrin which has supported in domestic collaborative research and the second to Universitas Mercu Buana, for his assistance and cooperation during this research. Hopefully there will always be papers with in future research.

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