Brilliance
Research of Artificial Intelligence

E-ISSN : 2807-9035
Volume 3, **Number** 2, November 2023
https://doi.org/10.47709/brilliance.v3i2.3030

Analysis Of The Effect Of Distance Between User Equipment and *eNodeB* On Rsrp And Sinr Value In 1800 Mhz Lte Technology

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open access

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Article History:
Submitted: 25-10-2023
Accepted: 28-10-2023
Published: 03-11-2023

Keywords:
eNodeB, LTE, RSRP,SINR, User Equipment.

ABSTRACT

Technological progress is currently experiencing very rapid development where mobile communication systems are technologies that support seamless communication links. When the user equipment is within range of the eNodeB, factors such as the distance between the user equipment and the eNodeB will affect the signal performance received by the user equipment. In this study, we analyzed the effect of the distance between user equipment and eNodeB on RSRP and SINR values on LTE 1800 MHz technology. The method used is the measurement of the drive test and the calculation of the Link Budget and the Propagation Model. The results and analysis show irregular changes in RSRP and SINR values caused by varying obstacle factors in the propagation environment. According to the calculation results of the Link Budget and the Propagation Model on the research object, it was found that the RSRP and SINR values decreased for every 100 m change in distance from the eNodeB. Based on the comparison, it is obtained that the PCS Extension to Hatta propagation model is close to the drive test measurement results.

INTRODUCTION

In general, technological progress is currently experiencing very rapid development where the mobile communication system is a technology that supports unlimited communication links (A. Pengaruh et al,2015). This mobile communication system can be used anywhere if the communication system user is within the coverage area of the telecommunications service provider (S. Sutoyo,2020).

The influence of the distance between the User equipment (UE) and the eNodeB (base station) on the RSRP (Reference Signal Received Power) and SINR (Signal-to-Interference plus Noise Ratio) values in 1800 MHz LTE (Long-Term Evolution) technology is a relevant topic in the world of wireless telecommunications (W. Setiaji, and Muayyadi, 2018). LTE 1800 MHz is one of the various frequency bands used in LTE networks (F. Karo,2020).

LITERATURE REVIEW

The 1800 MHz frequency is Band 3 and is usually used by many cellular operators throughout the world (M. A. Prakoso, 2019). When the UE is within range of the eNodeB, factors such as the distance between the UE and the eNodeB will affect the signal performance received by the UE (E. Budiman and U. Hairah, 2021), which is reflected in the RSRP and SINR. RSRP is the signal level received by User equipment from eNodeB on LTE technology (A. N. Fajar and E. Devia, 2017). Where eNodeB is another term for Base Transceiver Station (BTS) in LTE technology (A. R. Nofriyanti , 2019)(M. Kamal et al, 2023), while SINR is the signal strength ratio between the main signal emitted and interference compared to the background noise that arises (N. K. A. P. Bakri, 2022)(S. G. Y. P. Putra et al,2018).

Analysis of the influence of user equipment distance was carried out to compare theoretically, the further the distance between the user equipment and the eNodeB, the lower the RSRP and SINR values will be (N. Karlina,2019), however, if proven by measurements using a drive test according to field conditions, there are several distance points with the condition of the RSRP and The varying SINR is relatively inconsistent with theory. In theory, the change in RSRP and SINR values as the user equipment is further away from the eNodeB should relatively decrease. If the RSRP value has entered the range, it means that the user equipment is already at the maximum distance from the cell coverage area [14]. Therefore, through the data obtained from the drive test results for the RSRP value, it is necessary to compare it with theoretical calculations according to the link budget and propagation model, to prove the effect of the distance between the user equipment and the eNodeB, the RSRP and SINR values are decreasing or varying and to prove that Can the link budget calculation method and propagation model be proven to be appropriate and relevant to the results of drive test measurements with the parameters used as a reference being the suitability of the RSRP and SINR values obtained.

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In this research, the author chose LTE as the analysis of the research because he saw the operator Telkomsel as one of the largest operators in Indonesia which had officially launched the LTE network in Indonesia by implementing the LTE system on the 1800 MHz frequency (Rahmatulloh, 2019). Therefore, research will be carried out regarding the analysis of the influence of the distance between the user equipment and the eNodeB on the RSRP and SINR values on LTE technology at the 1800MHz frequency.

Radio Link Budget dan Path Loss
The formula for calculating RSL can be seen in the equation:

$$\frac{RSL}{RSRP} = RIRP - Pathlosh \quad (1)$$

EIRP = Effective Isotropic Radiate Power (dBm)
Loss = Loss konektor Tx (dB) (M. P. A. Simarmata et al, 2019)
Gt = Antenna Gain Tx (dB)
Pt = Transmit power Tx (dBm)

Pathloss is an important element in link budget design analysis and telecommunications system calculations (L. Mubarokah, 2015).

Model Propagsi PCS Extension to Hatta

$$L50\ (City) = 46.3 + 33.9\ Log\ fc - 13.82 \log hte - a(hre) + (44.9 - 6.55 \log hte) \log d + CM \quad (2)$$

In the medium city, large city formula described by [18] Nilai a (hre) ditentukan pada persamaan 3,4 dan 5.

$$a(hre) = (1.1 \log fc - 0.7)\ hre - (1.56 \log fc - 0.8) db \quad (3)$$

Big City, Fc≤300 MHz:

$$a(hre)' = 8.29\ (\log 1.54\ hre)^2 - 1.1\ dB \quad (4)$$

Big City, Fc=300 MHz:

$$a(hre) = 3.2(\log 11.54\ hre)^2 - 4.79\ dB \quad (5)$$

Where:
f= 1500 Mhz-2000 MHz
the=30 m-200 m
hre=1 m- 10 m
d=1 km -20 km

METHOD

Data collection to measure the distance between the user equipment and the 1800 MHz frequency eNodeB using the drive test method was carried out in the South Padang area, namely on Jalan Hassanuddin because this area is a densely populated urban area and is one of the areas in the city of Padang with a high center of daily activity. , such as offices, schools, hospitals, hotels and other daily activities. In the data collection process, the Telkomsel operator uses the 1800 MHz frequency band. Data collection is carried out during busy hours when the UE is being used a lot.

The drive test aims to determine the RSRP and SINR values. The drive test aims to determine the actual RSRP and SINR values in the field (F. E. Kesuma et al, 2019). Next, after the data measurement process on the LTE network, data processing is carried out and problems are observed from the drive test carried out. After the data has been managed, the distance per 100 m from the eNodeB is carved and compared with the calculation results using the propagation model, after which a data analysis process is carried out to find out the causes and solutions to the problems that arise. The block diagram below will explain the working system of this research.

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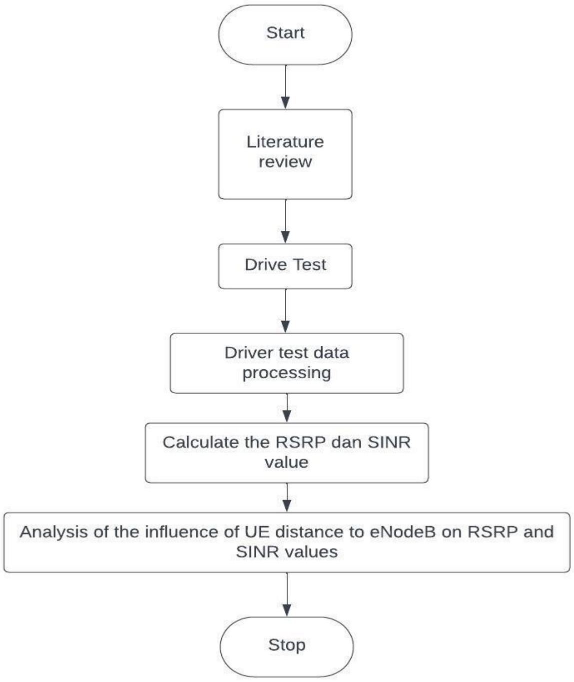

Figure 1. System Flowchart

RESULT

After the measurements were carried out for the 4G LTE 1800 MHz network, the parameters measured were RSRP (Reference Signal Receive Power) and SINR (Signal Interfence to Noise Ratio). The data from this drive test will be analyzed using TEMS Discovery and Atoll to see how the quality of the 4G LTE signal and the range of RSRP and SINR values when changing the distance between the user equipment and the eNodeB is carried out on three lines with an eNodeB height of 30 meters. The measurement results are in the form of graphs showing changes in RSRP values at distances per 100 meters to 1000 meters.

From measuring the distance between the user equipment and the eNodeB, the following results were obtained.

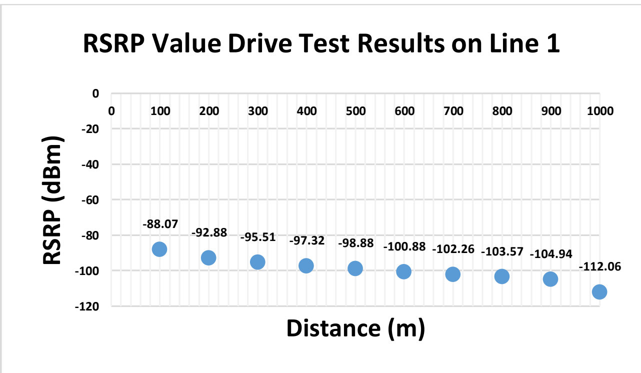

Figure 2. Graph of RSRP Values from Drive Test Results on line 1

In Figure 2 is a display of the RSRP value from the drive test on lane 1 on Jalan Nipah and ends at Jalan Sangatgam. At a distance of 100 meters you get a result of -88.07 dBm, at a distance of 200 meters you get a result of -92.88 dBm, at a distance of 300 meters you get a result of -95.51 dBm, at a distance of 400 meters you get a result of -97.32 dBm, at a distance of 500 meters get a result of -98.8 dBm, at a distance of 600 get a result of -100.88 dBm, at a distance of 700 meters you get a result of -102.26 dBm, at a distance of 800 meters you get a result of -103.57 dBm, at a distance of 900 meters you get a result the result is -104.94 dBm, at a distance of 1000 meters the result is -112.06 dBm. There is a change in the RSRP value which is getting lower as the distance between the user equipment is getting farther and farther from the eNodeB.

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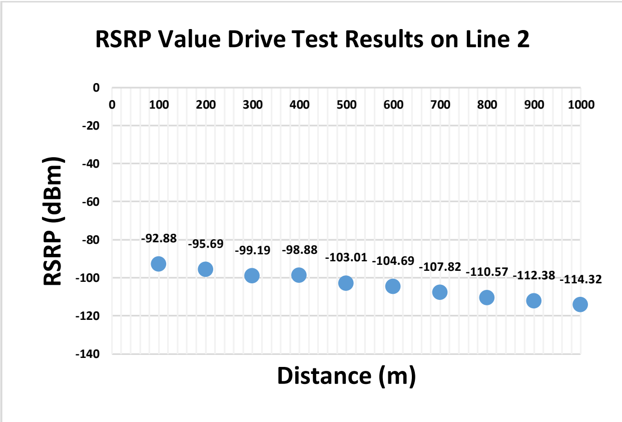

Figure 3. Graph of RSRP Values from Drive Test Results on line 2

Figure 3 shows the RSRP value from the drive test results on lane 2 on Jalan Hassanuddin and ends at Jalan Church. At a distance of 100 m the value is -92.88, at a distance of 200 meters the result is -95.69 dBm, at a distance of 300 meters the result is -99.19 dBm, at a distance of 400 meters the result is -98.88 dBm, at a distance of 500 meters get a result of -103.01 dBm, at a distance of 600 get a result of -104.69 dBm, at a distance of 700 meters get a result of -107.82 dBm, at a distance of 800 meters get a result of -110.57 dBm, at a distance of 900 meters get a result of - 112.38 dBm, at a distance of 1000 meters the result is -114.32 dBm. There is a change in the RSRP value which is getting lower as the distance between the user equipment is getting farther and farther from the eNodeB.

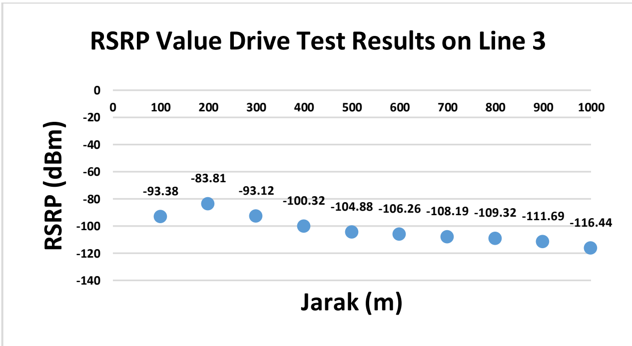

Figure 4. Graph of RSRP Values from Drive Test Results on line 3

Figure 4 shows the RSRP value from the drive test on lane 1 on Jalan Ahmad Yani and ends at Jalan Hassanuddin. At a distance of 100 meters you get a result of -93.38 dBm, at a distance of 200 meters you get a result of -83.81 dBm, at a distance of 300 meters you get a result of -99.19 dBm, at a distance of 400 meters you get a result of -98.88 dBm, at a distance of 500 meters get a result of -103.01 dBm, at a distance of 600 get a result of -104.69 dBm, at a distance of 700 meters you get a result of -107.82 dBm, at a distance of 800 meters you get a result of -110.57 dBm, at a distance of 900 meters you get a result the result is -112.38 dBm, at a distance of 1000 meters the result is -114.32. There is a change in the RSRP value which is getting lower as the distance between the user equipment is getting farther and farther from the eNodeB.

From the three RSRP Value Lines resulting from the drive test, it is known that changes in the RSRP value resulting from the drive test correspond to actual conditions in the field, apart from being influenced by the distance function, they are also influenced by propagation environmental conditions, namely the presence of varying obstacles causing signal fluctuations, resulting in attenuation and affecting the RSRP value received by user equipment.

The RSRP value tends to decrease as the distance between the user equipment and the eNodeB increases. The strength of the reference signal received by the User equipment will weaken, and this is reflected in a lower RSRP value.

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SINR Measurement Results

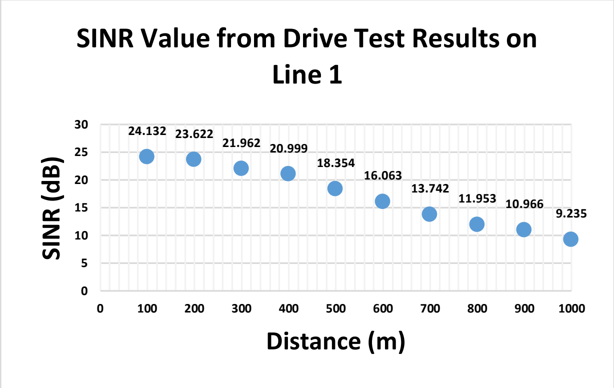

Figure 5. Graph of SINR Values from Drive Test Results on line 1

Figure 5 shows the SINR value from the drive test on lane 1 on Jalan Ahmad Yani and ends at Jalan Hassanuddin. There is a decrease in the graph at a distance of 800 meters where the UE is getting further away from the eNodeB.

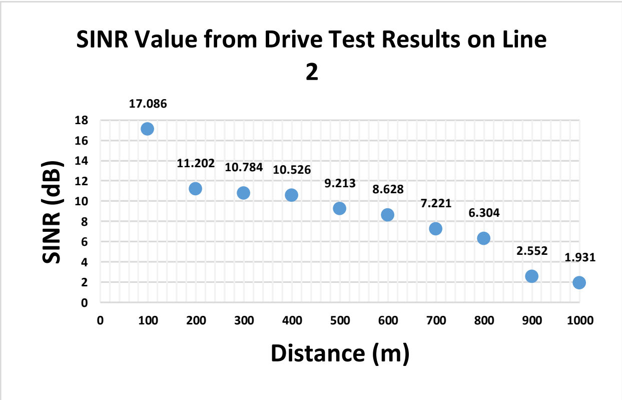

Figure 6. Graph of SINR Values from Drive Test Results on line 2

Figure 6 shows the SINR value from the drive test on lane 2 on Jalan Hassanuddin and ends at Jalan Church. At a distance of 100 meters you get a result of 17.086 dBm, at a distance of 200 meters you get a result of 11.202. There is a change in the SINR value at a distance of 200 meters where the user equipment is further away from the eNodeB.

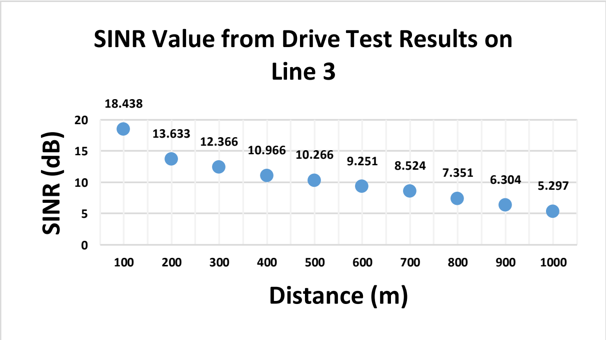

Figure 7. Graph of SINR Values from Drive Test Results on line 3

Figure 7 shows the SINR value of the drive test results on lane 1 on Jalan Ahmad Yani and ends at Jalan Hassanuddin. At a distance of 100 meters the result is 18,438 dBm, at a distance of 200 meters the result is 13,633 dBm.

From the three graphs, the SINR drive test results are decreasing, the signal strength received by the user equipment tends to weaken. This can result in a decrease in the SINR value because the ratio between signal strength and interference or noise becomes smaller. Therefore, SINR tends to decrease as distance increases.

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Drive Test Measurement Results Compared with Link Budget Calculations and Propagation Models

Link Budget Calculation

$$\frac{RSL}{RSRP} = EIRP - Pathloss = 52{,}43 - 112{,}72\ dB = -61{,}29$$

In the link budget calculation, the results obtained are negative. A negative value indicates that the signal power received by the receiver is lower than that produced by the sender. This occurs due to signal attenuation caused by distance, obstacles and interference.

Propagation Model Calculation

Table 1. Measurement and Calculation Results

Distance (m)	RSL (dBm)	Model PCS Extension to hatta
100	-88,07	-80,61
200	-92,88	-88,93
300	-95,51	-93,79
400	-97,32	-97,24
500	-98,88	-99,92
600	-100,88	-102,11
700	-102,26	-103,96
800	-103,57	-105,56
900	-104,94	-106,97
1000	-112,06	-108,24

Table 1 is the result of measurements and calculations between RSRP measurements and the PCS Extension to Hatta propagation model shown in Figure 8 to make comparisons easier.

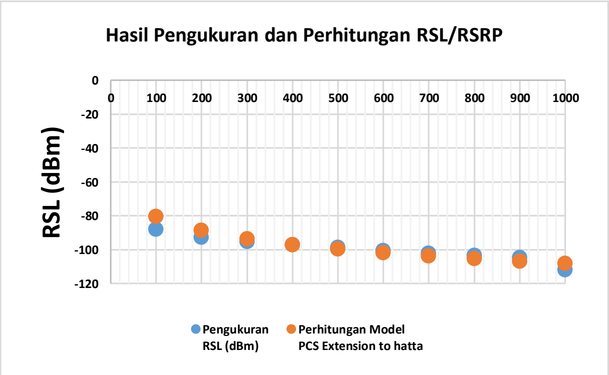

Figure 8. Measurement and Calculation RSL/RSRP

Figure 8 is a graph comparing the results of measurements and calculations with the PCS Extension to Hatta propagation model. It can be concluded that from the location where the PCS Extension to Hatta propagation model was researched, the value is close to the measurement results using the drive test.

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DISCUSSION

Analysis of the influence of user equipment distance was carried out to compare theoretically, the further the distance between the user equipment and the eNodeB, the lower the RSRP and SINR values will be, however, if proven by drive test measurements according to field conditions, there are several distance points with different RSRP and SINR value conditions. vary relatively inconsistent with theory. In theory, the change in RSRP and SINR values as the distance between the user equipment and the eNodeB increases is relatively reduced.

CONCLUSION

From the results of this final assignment it can be concluded that:

1. The quality of the 4G LTE network on Jalan Hassanuddin, Padang City, West Sumatra, based on the RSRP and SINR values, changes in the distance between the user equipment of 100m and the eNodeB, experiencing changes in value, namely decreasing.
2. Comparison of the RSRP values from the calculation results shows that the PCS Extension to Hatta propagation model is close to the measurement results. This is because the standardization used in the Extension to Hatta propagation model equation formula is closer to the Telkomsel eNodeB specifications and regional characteristics and propagation environment in the drive test data collection area.

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E-ISSN : 2807-9035
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