JIETA
Journal on Internet Engineering Technologies and Applications
Volume 1, **Number** 1, January 2024, pp. 28-36

Identification of 4G LTE Network Quality in Outdoor Conditions Using TEMS Investigation and Nemo on TRI and Telkomsel Operators in the Anak Air Area, Batipuh Panjang Village

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Article History:
Submitted: 05-03-2024
Accepted: 05-04-2024
Published: 09-04-2024

Keywords:
RSRP; RSRQ; LTE; signal quality; 4G

ABSTRACT

Many people who use 4G LTE technology both in work or in everyday life. However, 4G technology itself is still not maximally spread, one of which is Anak Air, Ex. Balai Gadang, Kec. Koto Tangah, Padang City. Some of the causes are the location that is far from the 4G LTE service tower (low coverage) and poor signal quality (Low Quality). Checking network quality on several operators such as Telkomsel and Tri needs to be done to overcome Low Coverage or Low Quality. The most widely used method to determine the quality of a network is the Drive test. The parameters taken to compare the results of Telkomsel and Tri operators are RSRP, RSRQ, SINR, Throughput. The final results of the drive test process prove that the quality of the Telkomsel network produced in the drive test in the Anak Air area, Ex. Balai Gadang, Kec. Koto Tangah, Padang City is better than Tri quality according to the parameters on the 4G LTE network.

INTRODUCTION

The mobile communication system in Indonesia continues to develop from the first generation to the fourth generation Long Term Evolution (4G LTE). 4G LTE is a development of 2G and 3G networks that is more advanced than the previous generations in terms of downlink speed. For 4G LTE technology, there are still some weaknesses in terms of distribution area. Several areas are still not covered by this technology. Some of the causes are locations far from 4G LTE service towers or location/building constructions that do not support 4G LTE signal distribution. In addition to less than optimal distribution, the increase in the number of Internet network users, especially data packages, impacts the decline in the quality of data package networks, namely Low Coverage and Low Quality on 4G technology.

To overcome Low Coverage and Low Quality, it is necessary to identify the network quality according to the standard parameters of the 4G network. Therefore, a re-check of the network quality is carried out on several operators. By re-checking, the provider will know the Low Coverage or Low-Quality areas and optimize them to strengthen the signal. The method that is widely used to determine the quality of a network is the Drive test.

In this final assignment, the operator used for the drive test process is Telkomsel the operator with the most users used for mobile Internet, and the Tri operator which is in fourth place in terms of the number of users using it for mobile Internet. The drive test process requires a Cluster or area to be checked. Anak Air Area, Batipuh Panjang Sub-district, Koto Tangah District, Padang City is the choice for the drive test. The parameters measured are Signal Interference Noise to Ratio (SINR), Reference Signal Received Power (RSRP), Reference Signal Received Quality (RSRQ) and throughput.

LITERATURE REVIEW

A telecommunications network is a series of telecommunications devices, and their accessories used in telecommunications so that it can connect one user to another user so that information can be exchanged by speaking, writing, drawing, or typing at that time. A telecommunications system is all elements of infrastructure, devices, facilities and infrastructure, and telecommunications providers so that long-distance communication can be carried out. The basis of the communication system is the existence of information in the form of voice, video, or data that is sent using a Transmitter (Tx) through a transmission medium so that it can be received by the Receiver (Rx).[4]

Such rapid development has an impact on the development of cellular technology. Cellular technology started from the first generation (1G) until now it has become the fourth-generation technology (4G). Cellular technology standards are divided into 2, namely the 3GPP (3rd Generation Partnership Project) and 3GPP2 (3rd Generation Partnership Project 2) standards. In the 3GPP standard, the development of technology starts from analog-based AMPS using FDMA

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(Frequency Division Multiple Access) technology.[2]

In the 3GPP2 standard, the development of cellular technology starts from digital-based CDMA-One (Code Division Multiple Access) technology by combining two multiplexing techniques, namely FDMA Frequency Division Multiple Access) and TDMA (Time Division Multiple Access). CDMA 2000 is part of the IMT-2000 specification and is an extension of the CDMAOne technology platform that uses the IS-95A/B and J-STD-008 standards. Based on its evolution, there are differences in development between 3GPP and 3GPP2 standardization. The development of 3GPP is GSM technology which is the second generation (2G) up to LTE which is the fourth generation (4G). The technology included in the development of 3GPP2 is CDMA which is the second-generation cellular technology (2G) up to CDMA EVDO (Evolution Data Optimized).[2]

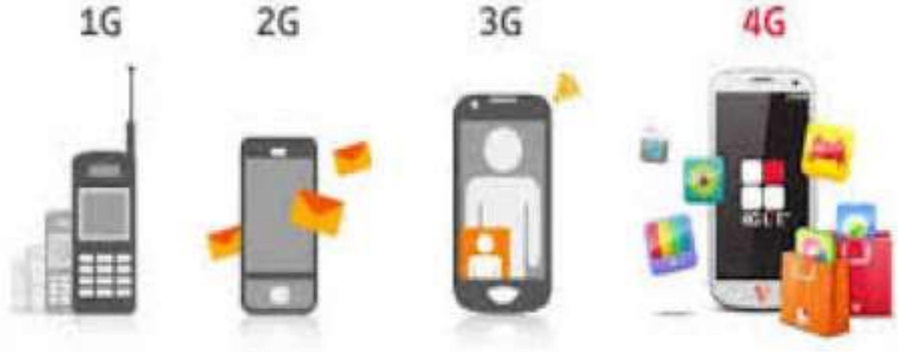

Fig. 1 The Mobile Technology Revolution

LTE (Long Terms Evolution) is a wireless data access communication standard issued by 3GGP (3rd Generation Partnership Project). LTE is based on GSM/EDGE and UMTS/HSPA networks. In UMTS, the maximum data transfer speed produced is 2Mbps, while in HSPA, the data transfer speed reaches 14Mbps on the downlink side and 5.6 Mbps on the uplink side. LTE can provide data transfer speeds of up to 100 Mbps on the downlink side and 50 Mbps on the uplink side. In addition to providing high data transfer speeds, LTE is also designed with lower latency, wide spectrum and more optimal radio access packet technology to support flexible bandwidth distribution. [7] LTE technology uses OFDMA on the downlink side and SC-FDMA (Single Carrier – Frequency Division Multiple Access) on the uplink side. SC-FDMA is technically the same as OFDMA, but its application is more suitable for handheld devices because it consumes less battery.

Each technology always has a different network architecture. LTE architecture is known as SAE (System Architecture Evolution) which means an architectural evolution compared to previous technologies. The entire fourth generation technology network is called EPS (Evolved Packet System). Figure 2 shows an architecture of the EPS (Evolved Packet System) system. There are 3 main components of the LTE architecture, namely UE (User Equipment), E-UTRAN (Evolved UMTS Terrestrial Radio Access Network), and EPC (Evolved Packet Core). Each component has a different architecture.[8]

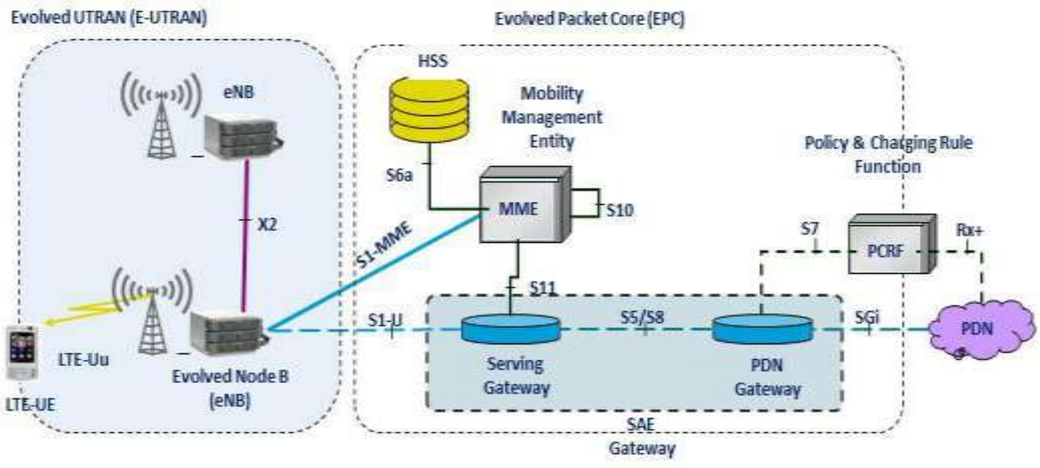

Fig 2. LTE Architecture in General

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Drive test is one part of the work in optimizing radio networks. The drive test aims to collect real network information in the field. The information collected is the actual condition of Radio Frequency (RF) in an eENodeB.[2] In general, the purpose of a drive test is to collect real Radio Frequency (RF) network information in the field. Parameters in the drive test used by the operator provider as a benchmark to determine how strong the signal obtained in the measurement is, namely Physical Cell Identity (PCI), Signal to Interference Noise Ratio (SINR), Reference Signal Received Power (RSRP), RSRQ (Reference Signal Received Quality) and throughput.

Physical Cell Identity (PCI) is the physical identity code for each cell/site used by the device to identify the cell/site. Signal to Interference Noise Ratio (SINR) is the ratio of the comparison between the main signal transmitted and the interference signal mixed with noise. Reference Signal Received Power (RSRP) is the signal strength received by the UE from the e-Node B at a certain frequency. The further the distance between the site and the user, the smaller the RSRP received by the user. Even though the RSRP value is good, the SINR value does not meet the target, the signal in that area is still said to be not up to standard. SRQ is a measurement of the quality of the received signal power from a cell. RSRQ is defined as the ratio between the number of resource blocks, RSRP to RSSI (Received Signal Strength Indicator). hroughput is the number of bits per unit of time received by a particular terminal in a network. Throughput has units of bits per second (bps). System throughput or throughput is the average number of bits received for all terminals on a network. The values of Signal to Interference Noise Ratio (SINR), Reference Signal Received Power (RSRP), RSRQ (Reference Signal Received Quality) and throughput based on Key Performance Indicator (KPI) can be seen in Tables 1, 2, 3 and 4.

In conducting a drive test, several supporting applications are needed to display the results. The following supporting applications in this final assignment are TEMS Investigation and NEMO.

Table 1.
SINR Range

Color	Range (dB)	Description
	>30	Very Good
	25 to 30	Very Good
	20 to 25	Very Good
	15 to 20	Good
	10 to 15	Quite Good
	5 to 10	Average Good
	0 to 5	Not Good
	-10 to 0	Poor
	< -10	Very Bad

Table 2.
RSRP Range

Color	Range (dB)	Description
	-80 to 0	Very Good
	-95 to -80	Good
	-100 to -95	Quite Good
	-110 to -100	Poor
	-150 to -110	Very Bad

Table 3.
RSRQ Range

Color	Range (dB)	Description
	-5 to 0	Very Good
	-9 to -5	Good
	-14 to -9	Quite Good
	-20 to -14	Poor

Table 4.
Throughput Range

Color	Range (dB)	Description
	14000 to 65000	Very Good

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	7000 to 14000	Good
	1000 to 7000	Quite Good
	512 to 1000	Poor
	0 to 512	Very Bad

METHOD

Before conducting the process of checking the 4G LTE signal in the Anak Air area, Batipuh Panjang Village, Koto Tangah District, Padang City, it is necessary to design a block diagram of the final project measurement flow where this block diagram functions as a reference in conducting the 4G LTE signal checking process.

Data collection techniques using the drive test method were carried out in the Anak Air cluster or area, Batipuh Panjang, Koto Tangah District, Padang City. The Anak Air area is an area of tsunami evacuation routes or evacuation routes where there are many houses and new housing. In addition, the area has many public facilities such as SD 54 Anak Air, Class II B Padang Prison and others. The proximity of the area to the mountain and the distance from the city center can affect the quality of the 4G signal in the area.

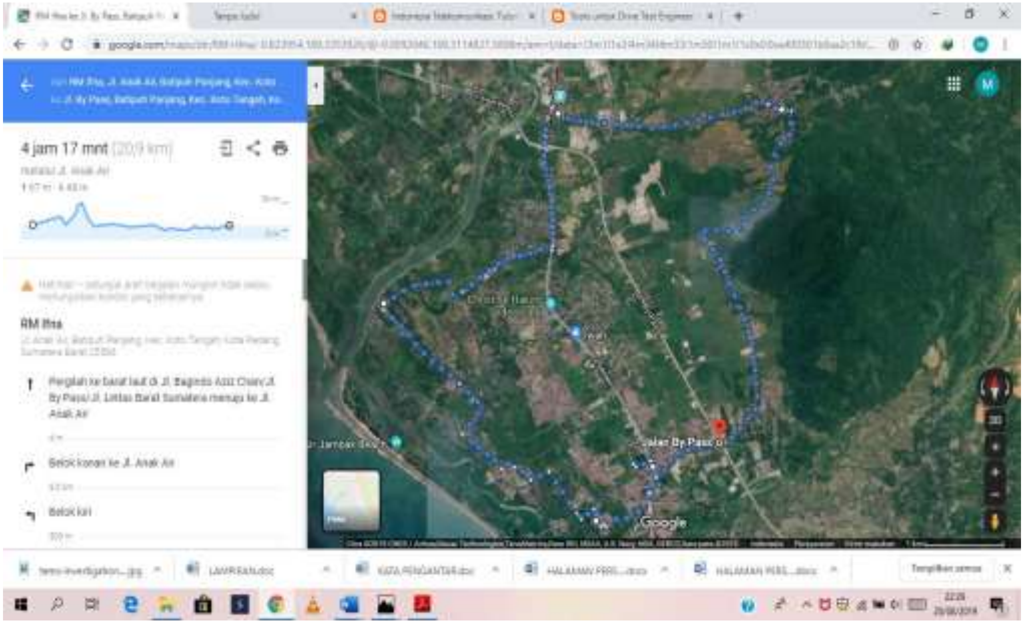

Fig. 3 Map of Anak Air Areas

After determining the cluster and area, the next step is to determine the starting point of the measurement and the small path that will be passed. The purpose of determining this point is so that the path passed does not overlap. Because the condition of the overlapping path will affect the data analysis process. As shown in Figure 4.

The instruments used for the measurements in this final project are Mobile Phones (MS) and laptops that have been installed with Tems Investigation software for laptops, Tems pocket for MS, Nemo analyze for laptops, Nemo Handy MS. Installing all the equipment needed. MS is installed via the laptop's USB port. The installation must be in accordance with the port when first installed. Here are all the devices needed. This Tems pocket application is installed on the cellphone that is taken on the road to do a drive test. Before doing the recording process, make sure the operator's sim card is installed properly. After everything is prepared, Tems pocket must be turned on in dedicated mode so that Tems pocket can record the data of the route traveled.

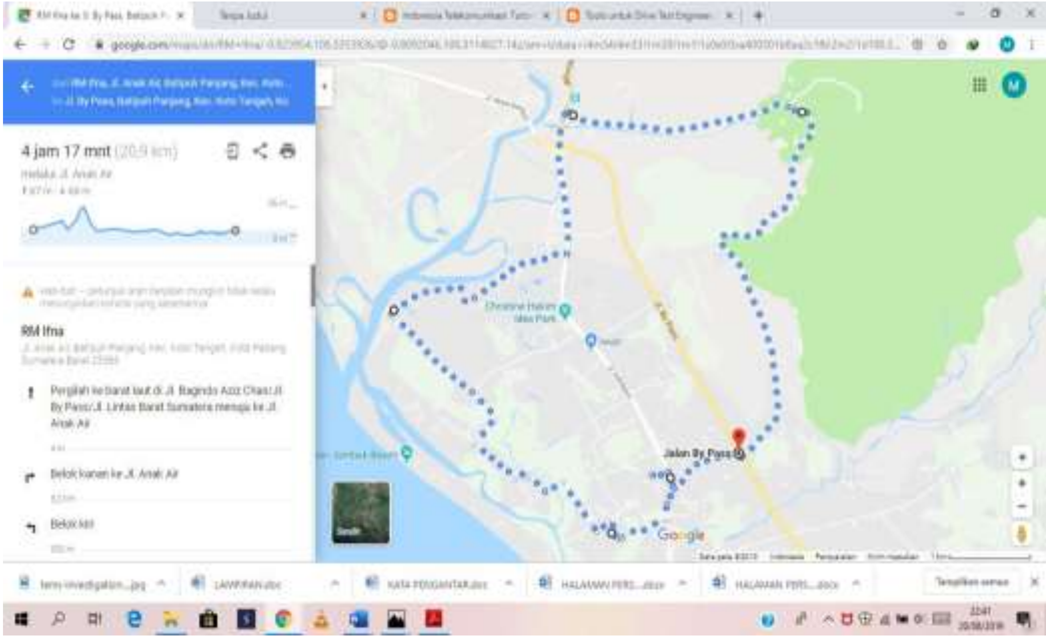

Fig. 4 Starting Point of Measurement

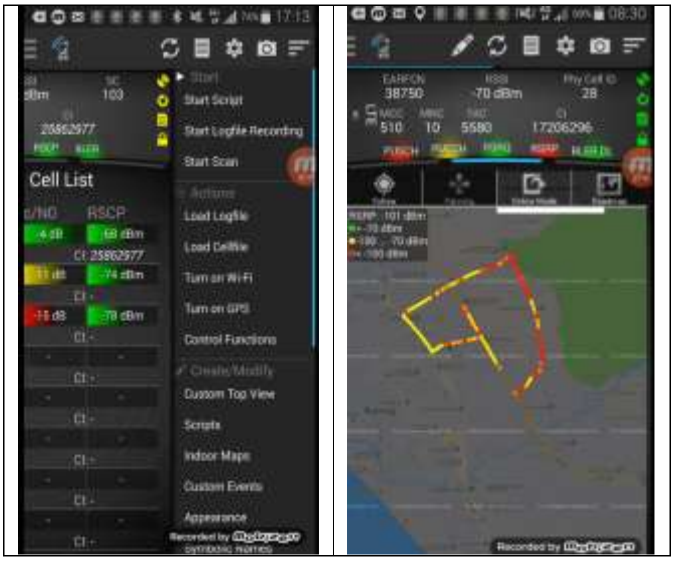

Fig. 5 Control Functions View display on Tems

After the data collection process is carried out, the next step is to see the results of the data that has been recorded in the form of a log file. This log file will later be processed using tems software, this process is called the plotting process. The plotting results will be in the form of paths that have colors according to the range of parameters contained in the tems discovery application for tems pocket, while for nemo handy it is nemo analyze. After the plotting process is successful, the results can be exported or saved in two forms. The form of map info that will be opened in the map info application and the form of google earth that will be displayed in google earth. The use of the map info or google earth application has the same function, namely viewing the results of the drive test with map contours. Displaying the range in the map info application is done manually. The results of the plotting process in the TEMS and NEMO applications can be seen in Figure 8.

The data that has been plotted in the TEMS and NEMO applications will later be exported to the Map Info application. Map Info application is a software used as a means to display or implement geographic information systems. The advantage of Map Info software is that it can be operated easily. This application is widely used to display drive test results by displaying maps and drivetest paths simultaneously. To open the results of a drive test that has been processed in the tems application or nemo application, the data is in the map info tab file type.

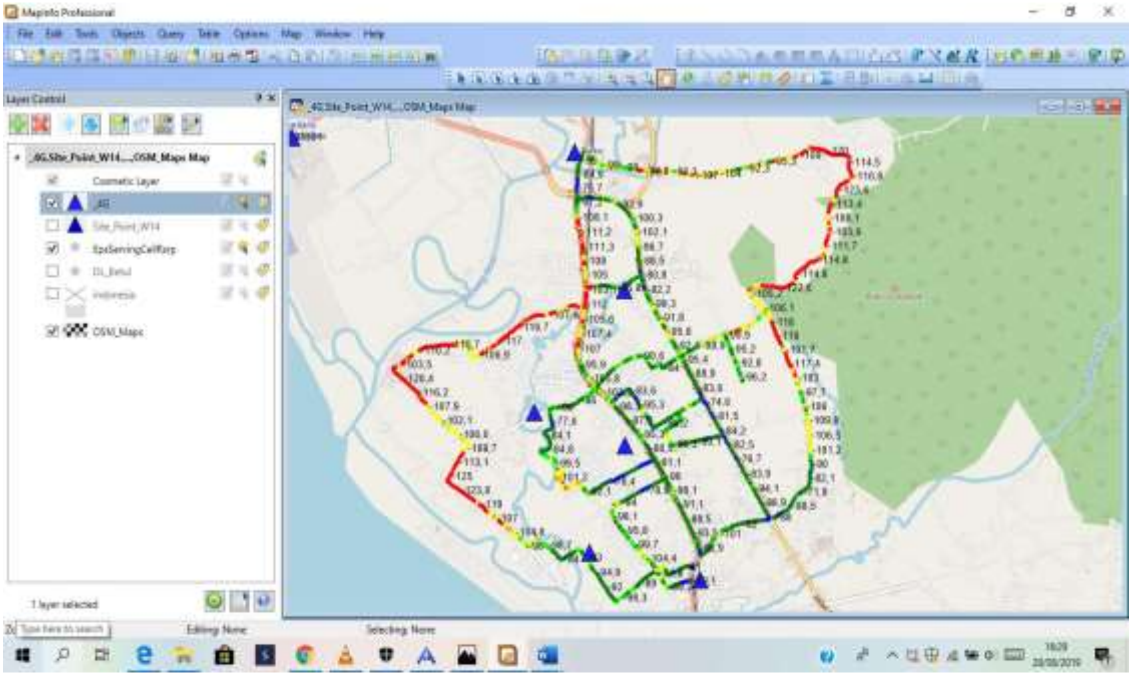

Fig. 6 Display Drive Test Results on Map Info

RESULT

Drive test is done to find out the real conditions in the field. There are several parameters that can be measured in the drive test process such as Reference Signal Received Power (RSRP), Reference Signal Received Quality (RSRQ), Signal to Interference Noise Ratio (SINR), Throughput. In this drive test, it was carried out in the Anak Air area, Batipuh Panjang Village, Koto Tangah District, Padang City with coordinates -0.8242037 100.335643 on the Telkomsel and Tri operators. The drive test process involves two applications to strengthen the data to be discussed. The supporting applications used are Tems discovery and Nemo Analyze in the same conditions and at the same time. The condition of the cellphone when conducting the drive test is in dedicated mode, which means the cellphone is in a silent state without doing any other processes. In figures 9 and 10 is the form of the result of plotting the Tri and Telkomsel operator logfile on the RSRP parameter that is processed in map info software. The tems discovery application does not display the map form. So, this result only shows the parameter value of the measured data.

From the information in Tabel 5, the blue color has a very good description. With a large range from -80 dBm to 0 dBm. This very good condition has a percentage of 8.1% with a lot of points 296 points on the Telkomsel operator, and on the Tri operator as much as 6.05% with a lot of data samples 221 points. Excellent signal quality is influenced by the location of the ENodeB which is close to the area. In addition, the condition of the land in the area around ENodeB. The flatter the area, the better the transmission emitted by the ENodeB. Good condition Described by dark green color that has a range of -95 dBm to -80 dBm. On the Tri operator, a large percentage result was obtained, namely 38.13% with a sample number of 1393 points. Meanwhile, the Telkomsel operator has a large percentage, namely 39.0% with 1448 points. In fairly good condition (light green) Tri operator gets RSRP value with percentage of 12.84% with 469 points. While Telkomsel operator has RSRP value of 16.7% with 608 points. This amount is more compared to Tri operator parameter legend. Bad conditions are marked in yellow. In the range of -110 dBm to -100 dBm. In the driving test results, this condition has the second largest number after good conditions. Where the percentage of bad conditions is 27.3% with a total of 993 points for the Telkomsel operator, while the Tri operator Where the percentage of bad conditions is 23.16% with a total of 846 data samples. While the worst condition is Bad condition. This condition is in the range of -150 dBm to -110 dBm and has a percentage of 8.8% with 318 points. In this condition it is better because compared to the Tri operator which reaches 19% more reinforcement is needed or a new ENodeB is formed. In this condition, strengthening or the creation of a new ENodeB is required which is able to strengthen the signal.

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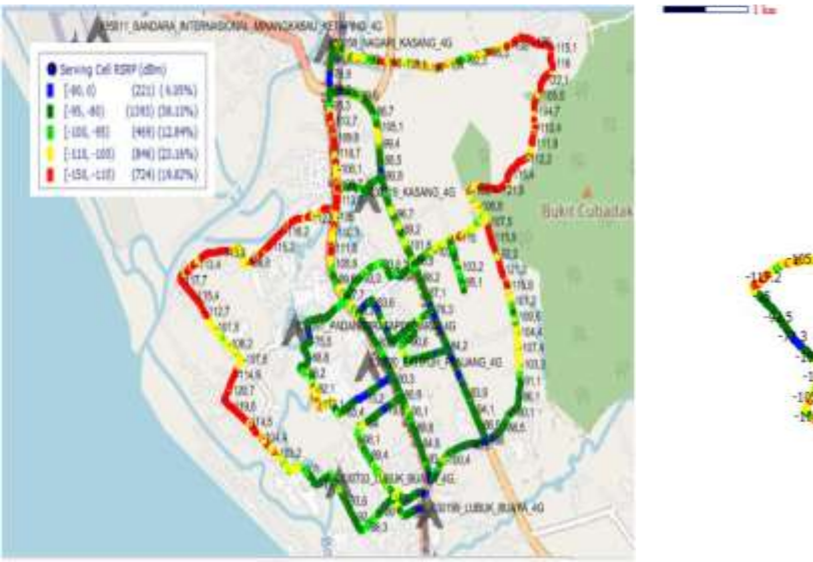
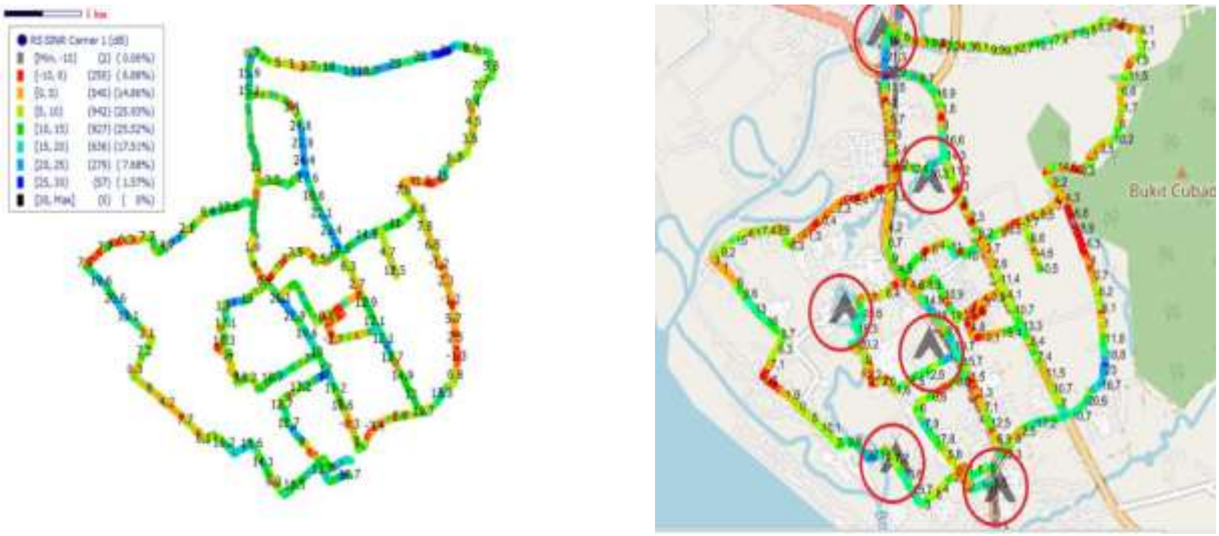


(a) (b)

Fig. 9 (a) RSRP operator Tri, (b) RSRP operator Telkomsel

The next measurement on the Telkomsel operator with the SINR parameter on the 4G LTE network. Unlike the Tri operator for the SINR parameter on Telkomsel, the display results are as shown in Figure 11 which is predominantly light green. The good quality obtained from the drive test results on the SINR parameter is influenced by the previous parameter value, namely RSRP, so it will affect the quality of SINR. The range in Figure 11 is the same as the range on the Tri operator with the same range value, the quality of the network that has been measured between the Telkomsel operator and operator tri. The process is also the same as using two different drive test applications so that you can see the best quality between them. The strength of the transmit power at each ENodeB site will affect the value of the SINR parameter. On the Tri operator, there are six ENodeBs spread across the Anak Air area, Batipuh Panjang Village, Koto Tangah District, Padang City. So, the area close to the Site coverage will have good SINR quality as shown in Figure 10. Each ENodeB will transmit a signal in the form of a frequency that will be received by the ME (Mobile Equatment). Good quality is indicated by good serving cells because the ENodeB is able to transmit signals well without any noise or interference between the surrounding ENodeBs.



(a) (b)

Fig. 10 (a) Drive test results on SINR Operator Telkomsel, (b) Drive test results on SINR Operator Tri

There are 13 ENodeBs spread across the Anak Air area, Batipuh Panjang Village, Koto Tangah District, Padang City. This is different from the Tri operator which only has six ENodeBs. This difference has an effect on the signal transmission in the area. It can be seen in Figure 12 that good signal quality will be in an area surrounded by many ENodeBs. Because each ENodeB will transmit its own frequency, and the UE (User Equipment) will capture the signal given. Figure 12 illustrates the signal quality of the SINR parameters on the Tri and Telkomsel operators. There are very different range conditions where when the Tri operator has a SINR value of 15 dB to 20 Db it has a sample percentage of 10.87% while the Telkomsel operator is 17.51%. Figure 11 explains that the quality of the 4G LTE network on the Telkomsel SINR parameter is better than the Tri operator. It can be seen from the value of each percentage. The SINR value of Telkomsel operators tends to have a good SINR value because the ENodeB owned by Telkomsel operators is well distributed in the Anak Air area, Batipuh Panjang Village, Koto Tangah District, Padang City. The signal transmission process will be smooth because each area has an ENodeB.

Tabel 5 Serving cell SINR Operator Telkomsel and Tri

Color	Range (dB)	Description	Tri		Telkomsel	
			Persentase	$\sum Sample$	Persentase	$\sum Sample$
	>30	Very Good	0 %	0	0 %	0
	25 to 30	Very Good	0,99 %	36	1.57 %	57
	20 to 25	Very Good	4,74 %	173	7.68 %	279
	15 to 20	Good	10,87 %	397	17.51 %	636
	10 to 15	Quite Good	17,57 %	642	25.52 %	927
	5 to 10	Average Good	28,03 %	1024	25.93 %	942
	0 to 5	Not Good	26,85 %	981	14.86 %	540
	-10 to 0	Poor	10,87 %	397	6.88 %	250
	< -10	Very Bad	0.08 %	3	0.06 %	2

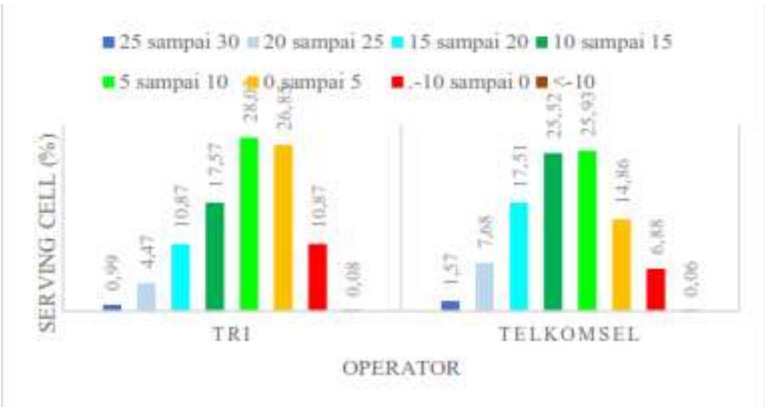


Fig.11 SIN Values for Telkomsel and Tri Operators in Text

CONCLUSION

Based on the analysis of the final assignment carried out from the results of the drive test measurements on two operators using two applications, it can be concluded:

1. The RSRP parameter on the Tri operator has a linear average of -86.41 dBm while the Telkomsel operator has a linear average of -81.2 dBm with a difference of 5.21 dBm. The best SINR parameter is owned by the Telkomsel operator with a linear average of 15.7 dB while the Tri operator only has a linear average of 13.73 dB. With a difference of 1.97 dB. The best RSRQ parameter is owned by the Telkomsel operator with a linear average value of -10.7 dB while the Tri operator only has a linear average of -11.19 dB. With a difference of 0.49 dB. Where the relationship between RSRQ and RSRP. The best quality of throughput parameters is also owned by the Telkomsel operator with a linear average value of 15072.2 Kbit/s while the Tri operator is 6129 Kbit/s.
2. The quality of the Telkomsel network produced in the drive test in the Anak Air area, Batipuh Panjang Village, Koto Tangah District, Padang City is better than the Tri quality according to the parameters on the 4G LTE network

3. The Tems application's reception power is better than the Nemo application. The number of ENodeB transmit power samples captured by the application's mobile phone

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