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Analysis of 2G and 4G Network Quality on Causeways in Gumanti Valley District

Afrizal Yuhanef [1*], Dikky Chandra[2], Muhammad Isham Musthaf[3], Herry Setiawan[4]
[1,2,4] Lecturer of Telecommunication Engineering Study Program, Department of Electrical Engineering, Padang State Polytechnic, Indonesia, [3] Students of Telecommunication Engineering Study Program, Department of Electrical Engineering, Padang State Polytechnic, Indonesia
[1]afrizal@pnp.ac.id, [2]dikky@pnp.ac.id, [3]muhammadmusthafa139@gmail.com, [4]herrysetiawan88@gmail.com

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***Corresponding Author**

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ABSTRACT

Lembah Gumanti Sub-District in Solok Regency presents a unique challenge for cellular network providers. Unlike densely populated urban areas, residents here live dispersed across a landscape dominated by hills and trees. This scattered terrain and natural obstacles significantly weaken the performance of both Telkomsel's 2G and 4G networks. To investigate this issue, a driving test was conducted on the causeway using Tems Pocket software to capture real-world signal measurements. The findings for the 2G network were mixed. Received Signal Level (RxLev) readings indicated weak overall coverage, but Received Signal Quality (RxQual) parameters were good, suggesting acceptable call quality when connected. However, occasional dropped calls (2 out of 9 attempts) hinted at potential issues during handoffs between cell towers. The 4G network fared worse, with both Received Signal Strength Indicator (RSRP) and Signal-to-interference plus noise ratio (SINR) readings showing poor results. These parameters indicate weak signal strength and significant interference, hindering overall network performance. These results highlight the need for improved network performance in Lembah Gumanti. Targeted network optimization strategies are crucial to bridge the gap and ensure reliable cellular service for residents in this geographically distinct area. This could involve deploying additional cell towers or utilizing advanced antenna technologies to enhance signal propagation and mitigate interference caused by the hilly terrain. By addressing these network limitations, Telkomsel can not only improve customer satisfaction but also bridge the digital divide for the residents of Lembah Gumanti.

INTRODUCTION

People's need for telecommunication facilities is increasing and the development of cellular networks does not stop growing. The evolution of cellular networks has created several generations with increasingly large bandwidths so that more and more users can use telecommunications services (Evalina, 2021). First generation (1G) networks are integrated into the network telekomunikasi pada sekitar tahun 1980. However, this system has been replaced by the second generation (2G) which was launched in 1991 and is still active today. 2G networks allow access to various services, such as the use of WAP to access the Internet(Salih et al., 2020). Furthermore, a third-generation (3G) network emerged that is capable of providing internet access and data transfer· Finally, there is a 4G (LTE) network that allows data transfer at very high speeds, as well as better capacity and service quality than the previous generation(Salih et al., 2020).

The Ministry of Communication and Information Technology (Kominfo) has issued a circular regarding the elimination of 3G networks throughout the region. This policy aims at network efficiency and transformation by considering that almost all regions already have 4G internet access with a larger network capacity than 3G. While the 2G network is maintained to meet the interests of the general public, where the need to make voice calls is still high(van Wel et al., 2021).

Gumanti Valley District is a highland area located in Solok Regency, West Sumatra, with an area of 456.72 km2. Geographically, this region is located at an altitude of 2,799 meters above sea level which is dominated by hills and trees. As an area with large and fertile agricultural land, this area has high-value natural potential that can be a source of livelihood for the local community. The development of the agricultural industry sector in the Gumanti Valley District area can have an impact on people's welfare and become one of the sources of regional income. This potential must be supported by the existence of quality telecommunication services so that economic development in the Gumanti Valley District area can develop rapidly. However, due to hilly geographical conditions and uneven population distribution patterns, telecommunications networks in this region experienced network weakening at some points.

To address these problems, it is necessary to carry out a Drive Test, which is a process of collecting information

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through measuring the quality of telecommunications networks directly in an area(Yulianto & , Munnik Haryanti, 2021). This measurement utilizes a smartphone that has the TEMS Pocket application installed, a software used to manage and maintain cellular telecommunications networks(Islam Kalimantan MAB et al., 2020). Therefore, this study was conducted to analyze the quality of 2G and 4G networks on the Cross Road in Gumanti Valley District.

METHOD

Network quality testing for 2G and 4G in this area is conducted using the Drive Test method, which aims to assess the actual network performance and signal strength of 2G and 4G from a telecommunications provider in the field. In this study, Telkomsel is the operator conducting the test. Data collection and retrieval are done using TEMS (Test Mobile System) Pocket. Before conducting the Drive Test, a planning process determines the route/path to be covered. Subsequently, the Drive Test retrieves data to measure network quality in the area. The collected data includes 2G network quality parameters (RxLevel and RxQual) and 4G parameters (RSRP - Received Signal Reference Power and SINR - Signal to Interference and Noise Ratio). The obtained data is then analyzed using TEMS Discovery Software. The study's flowchart is depicted in Figure 1.

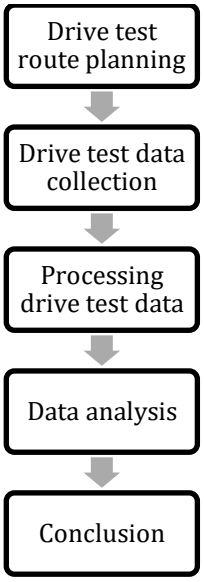


Figure 1. Research flow chart

RESULT

2G Measurement Results

RxLevel

RxLevel is the 2G signal strength of the modulated signal measured by the MS (mobile station)(Utami & Hanika, 2015). In this study, a sample of 2527 was obtained for RxLevel parameter data as can be seen in Figure 2.

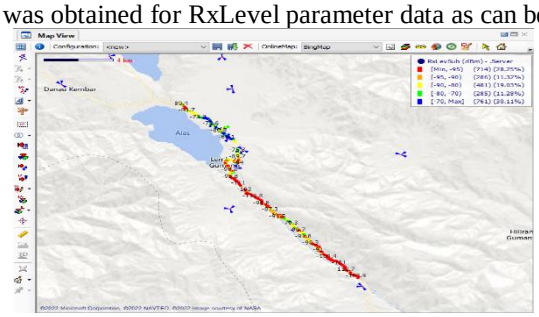


Figure 2. Display of data retrieval results from the RxLevel parameter

RxLevel is represented in 5 colors, where the signal in red which means poor, has a percentage of 28.25% or 714 samples. Orange color with fair meaning there are 11.28% or 285 samples. The yellow color means good there are 19.03% or 481 samples. The green color which means very good there are 11.32% or 286 samples. And the blue color which means excellent there are 30.11% or 761 samples. From the results of the RxLevel plot obtained, the measurement results that have the highest percentage are excellent where there are 30.11% or 761 samples (Table 1).

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Table 1. RxLevel data retrieval results

Indicator	Sample	Percentage	Information
	761	30.11%	Excellent
	285	11.28%	Very Good
	481	19.03%	Good
	286	11.32%	Fair
	714	28.25%	Poor

RxQual

RxQual is the network quality level accepted by MS (mobile station)(Sianturi & Hutauruk, 2020). This parameter is obtained after carrying out the Drive Test process with a dedicated method, which is making a call(Silalahi et al., 2021). In this study, 1847 samples were obtained for RxQual parameter data as can be seen in Figure 3.

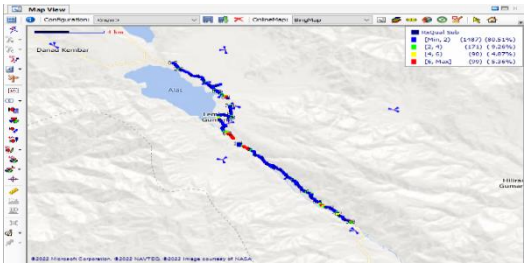


Figure 3. Display of data retrieval results from RxQual parameters

4 colors represent the quality of the received signal. Blue color means the signal is excellent, which in this study had a percentage of 80.51% or 187 samples. Then green which means the signal quality is good has a percentage of 9.26% or 171 samples. The yellow color which means that the signal is fair has a percentage of 4.87% or 90 samples. The red color which means the signal is poor has a percentage of 5.36% or 99 samples. From these results, it can be seen that the Drive Test results displayed have excellent network quality, as seen in Table 2.

Table 2. RxQual data retrieval results

Indicator	Sample	Percentage	Information
	1487	80.51%	Excellent
	171	9.26%	Good
	90	4.87%	Fair
	99	5.36%	Poor

Call event

After retrieving data by making voice calls to the intended number, there are several successful calls and there are calls that experience drop calls. A drop call is a call that is disconnected without the user's consent(Studi et al., 2023). As seen in Figure 4, there were 9 call attempts where 7 calls ended successfully with call end and 2 calls were disconnected with marked 2 drop calls. All call events found in this study can be seen in Table 3.

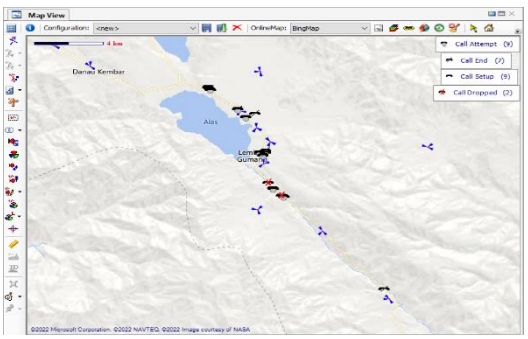


Figure 4. Display of data retrieval results from the RxLevel parameter

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Table 3. Number of call events that occur

Call Events	Sum
Call Attempt	9
Call End	7
Drop Call	2

Point 1 of drop call on 2G

It can be seen in Figure 5 that the occurrence of drop calls is caused because in that area there is no signal or what can be called a blank spot. So when the call is disconnected it can be called a drop call. Then you can see the distance of the nearest site, which is 1.41 km. Whereas in Figure 6 which shows the display of the RxQual parameter, the same thing also happens. At that point also experienced a blank spot so that the call that took place was interrupted without the user wanting.

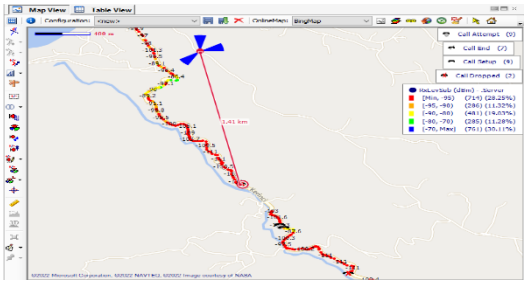


Figure 5. Drop call at point 1 with RxLevel parameter

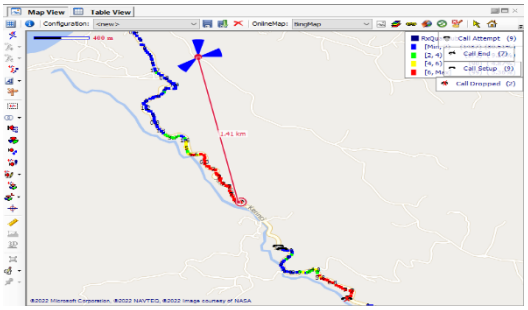


Figure 6. Drop call at point 1 of the RxQual parameter

In Figure 7 it is clear that the area experiencing the drop call is an area surrounded by hills and tall trees so that the signal at that point weakens disappearing during the call.

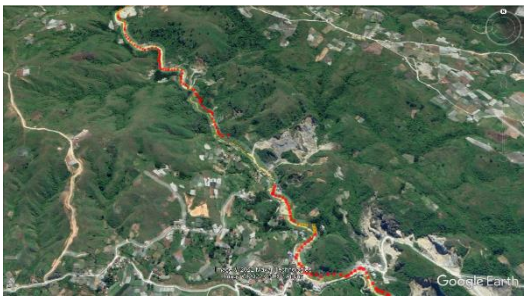


Figure 7. Areas that experience drop calls at point 1 seen from Google Earth

Point 2 of drop call occurrence on 2G

Similar to the first point, at the second point there is a drop call due to a blank spot (Figure 8). This is what causes the disconnection of voice calls without the user wanting. Similar to RxQual, the point where the drop call occurs is the point that experiences a blank spot so that the call is disconnected (Figure 9).

In the Google Earth view (Figure 10), this second point is also located between hills and trees, causing a weakening or disappearance of the signal at that point. The occurrence of drop calls is caused by coverage problems where which occur because of obstacles that hinder, namely in the form of hills and trees.

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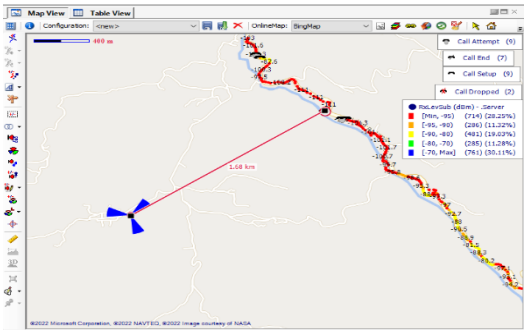


Figure 8. Drop call at point 2 with RxLevel parameter

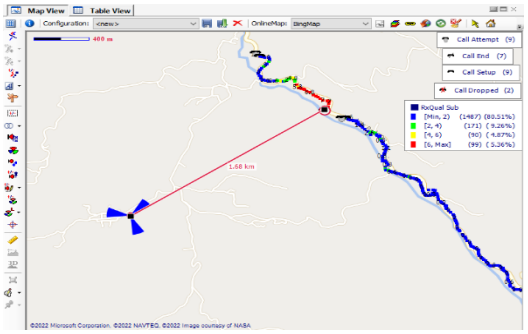


Figure 9. Drop call at point 2 of the RxQual parameter

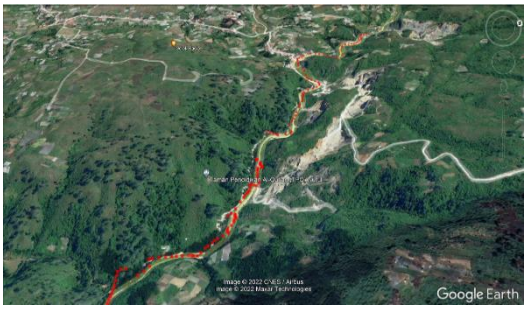


Figure 10. Areas that experience drop calls at point 2 seen from Google Earth

CSSR and DCR calculation

CSSR (Call Set Success Rate) is the percentage of successful call attempts taking into account the number of call attempts and call attempt failures, which are calculated by the formula(Dedi et al., 2012):

$$\text{CSSR (\%)} = \frac{(Call\ Attempt - Call\ Attempt\ Failure)}{Call\ Attempt} \times 100\%$$

DCR (Drop Call Ratio) is a value that shows the rate of occurrence of dropped calls, which is calculated by the formula [13]:

$$\text{DCR (\%)} = \frac{(Jumlah\ Drop\ Call)}{Call\ Attempt} \times 100\%$$

In this study, a CSSR value of 100% was obtained, which means that every call attempt does not have failures such as block calls. While on perhitungan DCR didapatkan value of 22.22%. This percentage is obtained from the comparison of calls that occur with calls that experience drop calls or dropped calls. Based on measurements, 9 call attempts were obtained, of which 2 experienced drop calls or disconnected calls that were not desired by the user.

4G Measurement Results

RSRP

Reference Signal Received Power (RSRP) is a parameter that can be used to assess network strength with measurement results expressed in dBm(Putra et al., 2021). In this study, the results of Drive Test data processing using TEMS discovery Software display a plot of RSRP parameter data results, as can be seen in Figure 11.

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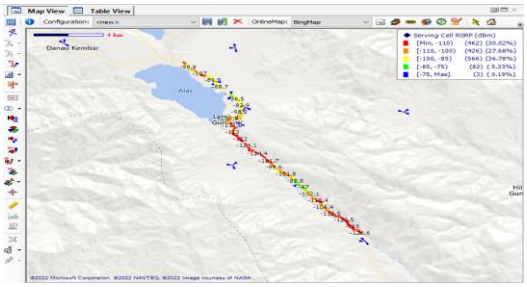


Figure 11. RSRP parameter display

Based on the results of data collection, 1539 samples were obtained and all samples were divided into 5 categories. The first category of samples with poor RSRP values was 462 samples or 30.02%. Then the sample with a fair value of 426 or 27.68%. Samples with good values have 566 samples or 36.78%. Samples with very good values of 82 or 5.33%. While samples with excellent values are only 3 or 0.19%. These results show that the RSRP value is dominated by the RSRP value of the good category.

Table 4. RSRP data collection results

Indicator	Sample	Percentage	Information
	3	0.19%%	Excellent
	82	5.33%	Very Good
	566	36.78%	Good
	426	27.68%	Fair
	462	30.02%	Poor

SINR

Signal to Interference Noise Ratio (SINR) is the ratio of network strength to the sum of average interference power that can indicate the quality of the information signal received in the transmission system(Hashida et al., 2020). Interference or interference on a network can be affected by the geographical location of an area and the number of users in a cell(Ammar et al., 2022). From the Drive Test data collection of SINR parameters in this study, 1535 samples were obtained consisting of 4 categories (Figure 12).

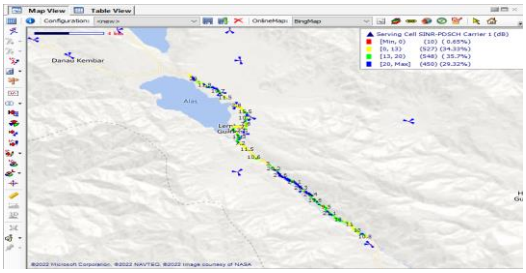


Figure 12 Display of SINR parameters.

First, signals with excellent SINR have a sample of 450 or 29.32%. Furthermore, signals with good SINR have a sample of 228 or 14.81%. Signals with SINR fair have a sample of 527 or 34.33%. Signals with poor SINR have a sample of 10 or 0.65%. From these results, it was found that the SINR parameter was dominated by the good category, as seen in Table 5.

Table 5. SINR data retrieval results

Indicator	Sample	Percentage	Information
	450	29.32%	Excellent
	548	35.7%	Good
	527	34.33%	Fair
	10	0.65%	Poor

Area 1: blank spots occur in 4G

A blank spot is a point where there is no signal at all so any network service is unavailable(Hussien et al., 2021). From the data collection results, blank spot displays were obtained based on RSRP (Figure 13) and SINR (Figure 14) parameters. From the image, it can indicate that the signal in Area 1 is a very weak or poor category.

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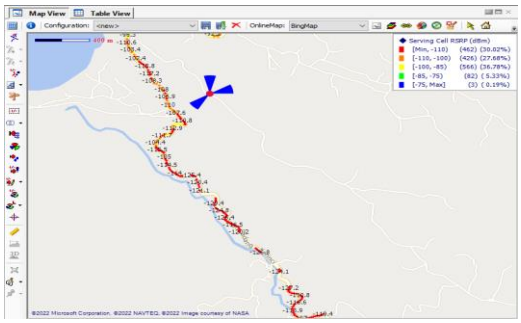


Figure 13. Display of blank spots in Area 1 seen from the RSRP parameter

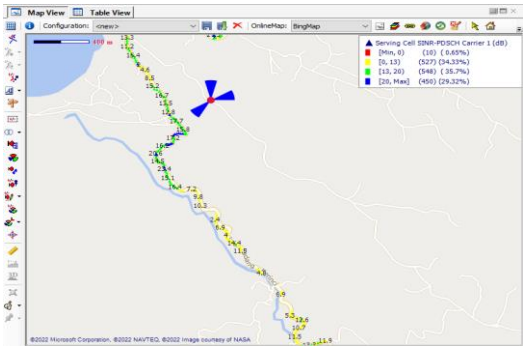


Figure 14. Display of blank spots in Area 1 seen from the SINR parameter

In the Google Earth view (Figure 15), it can be seen that in areas that experience blank spots surrounded by hilly areas and trees, as well as the point where drop calls occur.



Figure 15. Areas in Area 1 that experience blank spots

Area 2 blank spot occurrence on 4G

Figure 16 shows the display of data results in Area 2 based on the RSRP parameter. From the image, it can be observed that this area experiences many blank spots, resulting in no network access available. Meanwhile, based on the SINR parameter, there are several points with blank spots, but none fall into the poor category (see Figure 17)

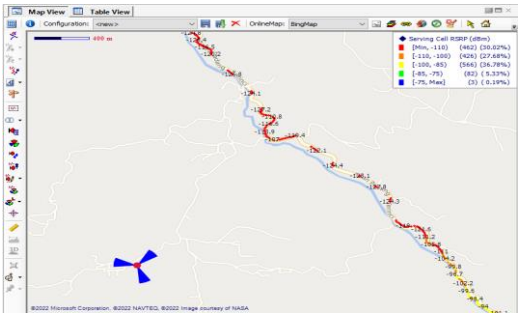


Figure 16. Display of blank spots in Area 2 seen from the RSRP parameter

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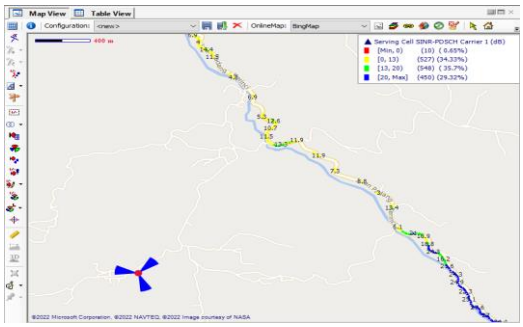


Figure 17. Display of blank spots in Area 2 seen from the SINR parameter.

Figure 18 shows how Google Earth looks in the second Area. It can be seen that the point that experiences this blank spot is an area that surrounds hilly areas and trees so it is difficult to cover the network and has an impact on signal weakness.



Figure 18. Areas in Area 2 that experience blank spots

DISCUSSION

The evaluation of Telkomsel's network performance in Gumanti Valley District reveals significant insights into the quality and coverage of both 2G and 4G networks. The measurement results highlight key areas where the network excels and where improvements are necessary to optimize service for users.

2G Network Performance Coverage and Signal Quality

The 2G network's coverage, assessed through the RxLevel parameter, demonstrates a commendable performance, with 30.11% of measurements indicating excellent signal strength. This suggests that in terms of signal reach, the 2G network is robust in certain areas of the district. Moreover, the quality of the 2G network, measured using the RxQual parameter, is overwhelmingly positive, with 80.51% of the results falling into the excellent category. This indicates that where the 2G signal is available, it is largely reliable and clear for users, ensuring good call quality and data transmission for basic services.

4G Network Performance Coverage and Signal Quality

In contrast, the 4G network shows room for improvement. Coverage based on the RSRP (Reference Signal Received Power) parameter is predominantly fair, at 36.78%. This suggests that while 4G coverage exists, it may not be as extensive or strong as required for optimal user experience. The quality of the 4G network, as indicated by the SINR (Signal-to-Interference-plus-Noise Ratio) parameter, also falls into the fair category at 66.28%. This implies that users might experience inconsistent performance, with potential issues such as slower data speeds or interruptions in service, particularly in areas with high interference or physical obstructions.

Optimization Strategies

To enhance the network quality and coverage for both 2G and 4G services, several optimization strategies can be implemented. Adjustments to site configuration, such as changing the azimuth and tilt of antennas, and modifying the height of antennas, can significantly improve signal distribution and strength. By realigning antennas, operators can better direct signals to underserved areas and mitigate the impact of physical obstructions. Additionally, optimizing antenna height can enhance coverage by reducing shadowing effects caused by terrain. while Telkomsel's 2G network in Gumanti Valley District shows strong performance in terms of both coverage and quality, the 4G network requires targeted improvements to meet user expectations. Addressing the identified issues through strategic site configuration changes can enhance overall network reliability and user satisfaction. Continued monitoring and adjustments will be

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essential to ensure that both networks provide robust and consistent service across the district.

CONCLUSION

The signal quality of Telkomsel operator Jalan Lintar in Gumanti Valley District from the measurement results on the 2G network in terms of coverage based on RxLevel parameters with dominant results is excellent which reaches 30.11% and from quality based on RxQual parameters, the dominant signal quality is excellent, reaching 80.51%.

The measurement results on the 4G network from coverage based on RSRP parameters found the dominant measurement was fair reaching 36.78% and the quality of the 4G network from quality based on SINR parameters obtained the dominant signal quality fair reaching 66.28%. From the measurements made, several drop calls and blank spot areas were obtained due to coverage problems due to obstacles in the form of hills and trees around the point.

To optimize the quality of 2G and 4G networks in the region, it is necessary to do Site Configuration Changes, such as by adjusting the azimuth antenna, tilt change, adjusting the height of the antenna, and others.

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