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4G LTE Network Performance for XL Axiata provider in Lolong Belanti Area

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***Abstract*— This measurement aims to analyze the quality of the 4G LTE network and its relationship with the quality of service (QoS) parameters on the performance of TCP/IP provider XL Axiata in Lolong Belanti Village. The measurement results show that the network with the quality category "Good" to "Excellent" has a percentage value of RSRP 97.5%, SINR 75.52%, and Throughput is categorized as good (Good) based on KPI. In comparison, the network with the category "Poor" to "Fair" shows a percentage value of RSRP 2.5% and SINR 24.48%. The measurement also found that RSRP and SINR parameters significantly affect QoS, with increasing RSRP and SINR values associated with increasing Download Bandwidth, Upload Bandwidth, and Throughput. The highest quality was achieved in the "Excellent" SINR category, with a Download Bandwidth of 42.60 Mbps, an Upload Bandwidth of 28.30 Mbps, and a Throughput of 2,543 kbps. However, there was a significant decrease in the "Poor" category, especially in Download Bandwidth and Throughput. Factors such as packet loss, jitter, and delay were also analyzed, with the results showing that the highest packet loss occurred in the "Poor" category. In contrast, jitter and delay dominated the "Poor and Fair" categories. These findings indicate the importance of RSRP and SINR parameters in determining the quality of 4G LTE networks and their impact on user experience.**

***Keywords*— 4G LTE, RSRP, SINR, Throughput, QoS, Download bandwidth, upload bandwidth, packet loss, delay, and jitter.**

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I. INTRODUCTION

Telecommunication technology is increasingly developing from year to year, especially mobile phone technology. To support smooth communication with others, people need mobile telecommunication service providers that can support the operation of their mobile phones according to their needs [1]. Along with the development of information and communication technology, the use of the internet by the public has now become a necessity. Every year there is a significant increase in the number of internet users in Indonesia [2]. One of them is the community in Lolong Belanti Village.

Lolong Belanti Village is located in Padang Utara District, Padang City, West Sumatra Province. The area of the village is 1.62 square kilometers. Lolong Belanti Village consists of 7 RW and 32 RT. Lolong Belanti Village has a population of 7,875 people (2017), consisting of 3,759 men and 4,116 women [3]. One of the 4th generation (4G) technologies that offers efficiency and high-speed data access is Long Term Evolution (LTE) LTE technology. Long Term Evolution (LTE) is one of the fourth generation (4G) telecommunications network technologies that is still in the development stage by 3GPP with data transmission capabilities reaching theoretical speeds of 100 Mbps for downlink and 50 Mbps for uplink [4]. Good data communication technology must comply with established protocols, one of which is the TCP/IP protocol [5].

4G network technology also known as Long Term Evolution (LTE) is a development of 3G network technology. The data access speed for downloading on this 4G network reaches 300 Mbps while the upload speed reaches 75 Mbps[6].

4G technology provides an integrated IP solution where voice, data, and multimedia flows reach users anytime and anywhere, capable of producing speeds of up to 100 Mbps to

1Gbps. LTE is a development of previous technologies, namely UMTS (3G) and HSPA (3.5G) where LTE is called the 4th generation (4G). In UMTS the maximum data transfer speed is 2 Mbps, in HSPA the data transfer speed reaches 14 Mbps on the downlink side and 5.6 Mbps on the uplink side, in LTE the ability to provide speed in terms of data transfer can reach 100 Mbps on the downlink side and 50 Mbps on the uplink side. In addition, LTE can support all existing applications, both voice, data, video, and IPTV [7].

LTE's capabilities and advantages over previous technologies are that it provides greater service coverage and capacity, reduces operational costs, and has low delays[8].

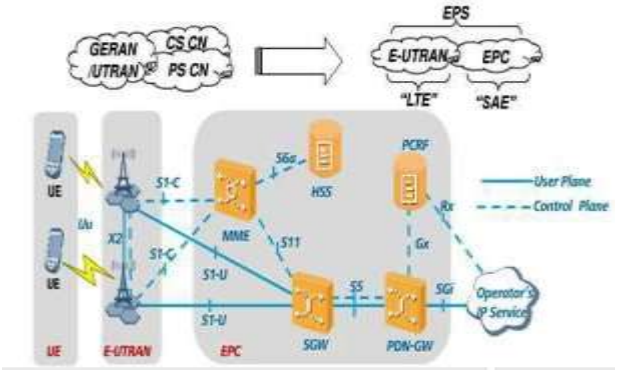

Fig. 1 LTE Network Architecture

User equipment is a device in LTE that is located at the very end and closest to the user. E-UTRAN system there is only one component, namely the Evolved Node B (eNodeB) which has combined the functions of both. EPC is a new system in the evolution of cellular communication architecture where the core network uses all-IP (Internet Protocol). EPC consists of MME (Mobility Management Entity), SGW (Serving Gateway), HSS (Home Subscription Service), PCRF (Policy and Charging Rules Function) and PDN-GW (Packet Data Network Gateway) [9].

II. MATERIALS AND METHOD

A. *Drive Test Design and Sign up*

The study employed a drive test methodology to capture real-time data on signal strength, interference, and throughput across multiple locations in the Lolong Belanti area. The test was conducted using the following tools:

1) *G-NetTrack Pro*: To capture and log signal strength (RSRP), SINR, and Throughput readings in real time.

2) *MapInfo Pro:* Used for geographic mapping and spatial analysis of the collected data.

3) *Speedtest by Ookla*: To measure upload, download, and latency performance.

4) *Wireshark:* For analyzing packet loss, jitter, and delay.

The test route covered key streets such as Jalan Ahmad Dahlan, Jalan Raden Saleh, and other nearby residential and commercial areas. The drive test was conducted during peak traffic hours to capture realistic network performance under typical load conditions.

B. *Key Performance Indicators (KPIs)*

Three primary KPIs were measured during the drive test to assess the overall network performance:

1) *RSRP (Reference Signal Received Power)*

RSRP is a measure of the received power of the LTE reference signal and is used to determine the signal coverage and strength in different areas. Stronger RSRP values indicate better coverage, essential for maintaining a stable connection.

Fig. 2 User Equipment Receives Signal From Site

2) *SINR (Signal to Interference Noise Ratio)*

SINR quantifies the quality of the signal received relative to background noise and interference. Higher SINR values suggest better signal quality and less interference, which results in higher data throughput and fewer connection issues.

3) *Throughput*

Throughput is the effective data transfer rate measured in bps. Throughput is the total number of successful packet arrivals from the destination, which are successfully observed during a time interval adjusted to the duration of the time interval.

C. *QoS Metrics*

The study also evaluated additional Quality of Service (QoS) metrics to understand the broader user experience:

1) Packet Loss: The percentage of packets lost during data transmission, which affects the reliability of real-time services like voice over IP (VoIP) and video streaming.

2) Latency (Delay): The round-trip time for data packets, is a critical factor for interactive services like video calls.

3) Jitter: The variation in packet arrival times, which can cause disruptions in real-time communications.

III. RESULT AND DISCUSSION

A. *RSRP (Reference Signal Received Power)*

RSRP measurement results(Reference Signal Received Power) provider XL Axiata are obtained from the Drive Test conducted at various points in the test area. This data shows

the strength of the signal received and is used for network performance analysis.

The RSRP measurements show that the XL Axiata 4G LTE network provides solid coverage in the Lolong Belanti area, with 97.5% of the region experiencing signal strength above -100 dBm. This performance places most of the area in the "Good" to "Excellent" categories, with only a small fraction (2.50%) falling into the "Poor" category, indicating weak coverage in certain pockets.

Fig. 3 RSRP Measurement Results

TABLE 1

RSRP MEASUREMENT RESULT DISPLAY

No	Color	Value Range (dbm)	Amount Point	Presentation Amount of Data
	Excellent	RSRP ≥ -75 dBm	360	14.28%
2	Very Good	-85 dBm ≤ RSRP < -75 dBm	525	20.82%
3	Good	-100 dBm ≤ RSRP < -85 dBm	1370	54.34%
4	Fair	-110 dBm ≤ RSRP < -100 dBm	203	8.05%
5	Poor	RSRP <-110 dBm	63	2.50%

B. SiNR (Signal to Interference Noise Ratio)

The significant number of areas with low SINR indicates interference from nearby buildings, other cellular signals, and environmental factors. This affects the overall signal quality and throughput, reducing the network's capacity to deliver consistent high-speed data in congested areas.

SINR analysis reveals more varied results, with only 1.51% of the measured locations falling into the "Excellent" category (SINR > 20 dB). The majority (66.30%) of the area exhibits "Fair" SINR values (0 dB ≤ SINR < 13 dB), while 24.48% falls into the "Poor" category, where SINR values are less than 0 dB.

The results of the SINR parameter measurements of the XL Axiata provider on weekdays obtained from the Drive test measurement results can be seen in Figure 4:

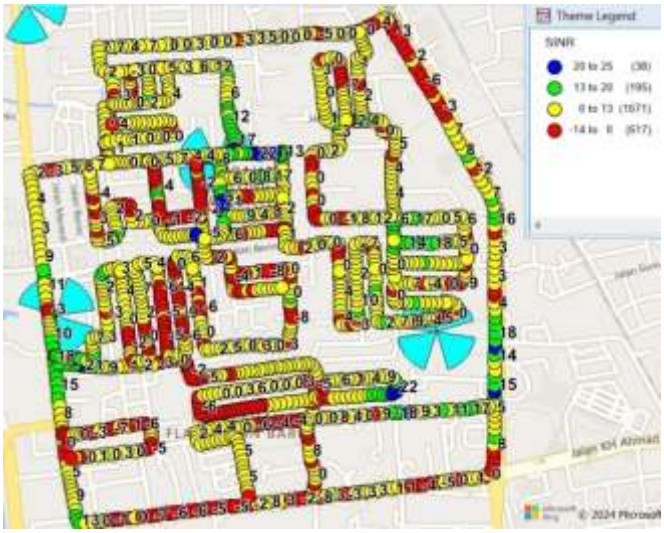

Fig. 4 SiNR Measurement Results

TABLE II

SINR MEASUREMENT RESULT DISPLAY

No	Color	Value Range (dB)	Number of Points	Percentage of Data Amount
1	Excellent	SINR >20 dB	38	1.51%
2	Good	13 dB≤ SINR < 20 dB	195	7.73%
3	Fair	0 dB ≤ SINR < 13 dB	1671	66.30%
4	Poor	SINR <0 dB	617	24.48%

C. Throughput

The throughput analysis demonstrates variability across different locations, with 26.93% of the area achieving "Excellent" throughput (≥14,000 kbps). However, 17.25% of the region exhibits "Poor" throughput (≤512 kbps), indicating slower data speeds in some parts of the area. These low throughput areas overlap with regions where SINR values are lower, confirming the impact of interference on data speeds.

Fig. 5 Throughput Measurement Results

TABLE III

THROUGHPUT MEASUREMENT RESULT DISPLAY

No	Color	Range Value (kbps)	Number of Points	Percentage of Data Amount
1	Excellent	Throughput≥ 14000 kbps	679	26.93%
2	Very Good	7000 kbps ≤ Throughput ≤ 14000 kbps	529	20.98%
3	Good	1000 kbps ≤ Throughput ≤ 7000 kbps	761	30.19%
4	Fair	512 kbps ≤Throughput ≤1000 kbps	117	4.64%
5	Poor	Throughput≤ 512 kbps	435	17.25%

Further analysis of packet loss, delay, and jitter reveals that areas with low SINR are more prone to higher packet loss (over 25%) and latency exceeding 450 ms. This impacts user experience for real-time applications such as video streaming, VoIP, and online gaming.

IV. RESULT AND DISCUSSION

This study has provided a comprehensive assessment of the XL Axiata 4G LTE network in Lolong Belanti, focusing on key performance indicators such as RSRP, SINR, and Throughput. While the network demonstrates good coverage (97.5% of the area having adequate RSRP), the presence of low SINR values in 24.48% of the area poses challenges for maintaining consistent service quality. These areas, particularly those with poor throughput and increased packet loss, require targeted improvements, such as reducing interference and upgrading base stations.

The findings suggest that XL Axiata should focus on enhancing SINR and mitigating interference to provide better service, especially in high-traffic urban zones. With these improvements, the network will be better equipped to meet growing demand and deliver a more reliable and high-quality user experience.

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