Analysis of 4G LTE Internet Network Quality for Telkomsel, IM3, and 3 Providers in Prabumulih City

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Abstract

Indonesia is one of the countries with a high level of dependence on cellular communication systems. Along with rapid technological advancement, cellular networks in Indonesia continue to develop intensively, resulting in increasingly competitive service provision. The 4G Long Term Evolution (LTE) network is currently the most widely used mobile technology due to its superior data transmission speed and capacity, with download speeds reaching up to 300 Mbps and upload speeds up to 75 Mbps under optimal conditions. This study aims to analyze and compare the Quality of Service (QoS) of 4G LTE networks provided by Telkomsel, IM3, and 3 (Three) in Prabumulih City, Indonesia. The analysis was conducted using the OpenSignal, Google Maps, and Wireshark applications. OpenSignal was employed to identify the locations of Base Transceiver Station (BTS) towers, Google Maps was used to determine the distance between users and BTS locations, and Wireshark was utilized to measure QoS parameters, namely throughput, packet loss, delay, and jitter. The research adopted an action research approach consisting of planning, implementation, and evaluation stages based on QoS analysis. The results indicate significant variations in QoS among the three providers. These differences are primarily influenced by signal attenuation due to variations in user distance from BTS towers and by network congestion caused by high user density in specific locations.

Keywords

4G Network, OpenSignal, Google Maps, Wireshark, Quality of Service

Article History

Received 24 July 2024
Accepted 28 October 2024

How to Cite

Kanievpe, P. M., & Purwanto, T. D. (2024). Analysis of 4G LTE Internet Network Quality for Telkomsel, IM3, and 3 Providers in Prabumulih City. ***Jurnal Jaringan Komputer dan Keamanan,*** *5*(3), 113-120.

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Introduction

Indonesia is among the countries with the largest number of cellular network users, driven by the rapid evolution of information and communication technology (ICT) that has transformed how people communicate, access information, and conduct business activities (APJII, 2023; ITU, 2022). Cellular communication systems enable users to communicate over long and short distances without physical limitations, as long as they remain within the coverage area of a telecommunications provider (Rappaport, 2002; Dahlman, Parkvall, & Sköld, 2018). The widespread adoption of mobile devices has positioned cellular networks as a critical national infrastructure supporting economic growth, digital services, education, healthcare, and public administration (Kominfo, 2022; OECD, 2021).

The rapid expansion of cellular communication services has intensified competition among network providers. Each provider is therefore required to continuously improve service quality to attract and retain customers in an increasingly saturated market (Kotler & Keller, 2016; Basu & Riedel, 2013). Among the available mobile communication technologies, 4G Long Term Evolution (LTE) is currently the most widely adopted due to its substantially higher data rates, low latency, and improved spectral efficiency compared to previous generations such as 3G (Dahlman et al., 2018; Sesia, Toufik, & Baker, 2011). Under optimal network conditions, 4G LTE supports download speeds of up to 300 Mbps and upload speeds of up to 75 Mbps, enabling high-quality video streaming, online gaming, cloud computing, and Internet of Things (IoT) services (3GPP, 2020; Cisco, 2022).

To evaluate the actual performance of 4G LTE networks in real-world environments, objective field measurements based on the Quality of Service (QoS) framework are required (Stallings, 2014; ETSI, 2019). QoS represents the ability of a network to provide predictable service performance in terms of throughput, jitter, packet loss, and latency (delay), which directly affect user satisfaction (Kurose & Ross, 2021; Forouzan, 2017). In the current digital era, users increasingly prioritize stable and high-speed internet access for remote working, online education, e-commerce, and multimedia consumption (Statista, 2023; Kominfo, 2022).

Prabumulih City is one of the rapidly developing urban areas in South Sumatra with a growing demand for mobile internet services. The high mobility of users, population density differences, and geographic conditions contribute to variations in cellular network performance across different city zones (Faruk, 2018; Evstatiev et al., 2020). Despite the widespread availability of 4G LTE, users often experience inconsistent service quality depending on their location, time of access, and the operator used (Anwar & Widjaja, 2021; Hidayat & Permana, 2020). Therefore, systematic performance evaluation is essential to determine the real service quality perceived by end users.

To measure the real performance of 4G LTE services in Prabumulih City, a drive test was conducted using specialized network measurement software to collect real-time performance data (Zhang & Feng, 2019; 3GPP, 2020). Drive test methods allow direct observation of Key Performance Indicators (KPIs) such as signal strength, data rate, and delay while moving through predetermined routes (Nugroho, Wibisono, & Putri, 2020). This method provides more realistic results compared to laboratory-based simulations because it captures actual environmental and traffic conditions (Faruk, 2018; ETSI, 2019).

Based on this background, this study focuses on measuring and comparing the QoS of 4G LTE networks operated by Telkomsel, IM3 (Indosat Ooredoo), and 3 (Three) in several strategic locations in Prabumulih City. The results of this study are expected to provide objective information for the public regarding the best-performing network operator and to serve as input for cellular providers to improve network planning and optimization strategies (Anwar & Widjaja, 2021; Cisco, 2022; Kurose & Ross, 2021).

Research Method

This study employed an Action Research approach, in which the researcher directly tested and evaluated network performance in real operational environments. The objective of this method was to obtain valid empirical data related to the QoS of the observed 4G LTE networks. The stages of the action research applied in this study consisted of the following steps:

1. Diagnosing
   At this stage, initial identification of network quality problems for Telkomsel, IM3, and 3 was conducted. QoS measurements were based on throughput, jitter, packet loss, and delay parameters using the Wireshark application.
2. Action Planning
   A systematic measurement plan for the 4G LTE network in Prabumulih City was formulated. OpenSignal was used to identify the nearest BTS for each provider, while Google Maps was utilized to calculate the distance between the observation points and the BTS locations.
3. Action Taking
   The drive test was carried out at several predetermined locations using a laptop and a smartphone equipped with the Wireshark application. Measurements generated data on throughput, packet loss, delay, and jitter for each provider.
4. Evaluating
   The collected data were evaluated and analyzed to identify performance differences among the three providers. The analysis was conducted with reference to the ETSI TIPHON (Telecommunications and Internet Protocol Harmonization Over Networks) standard.

Research Tools

1. OpenSignal
   OpenSignal is an application that provides information on signal strength, BTS locations, upload and download speeds, and network coverage. It was used to identify and locate the serving BTS of each provider.
2. Google Maps
   Google Maps was used to determine the geographical distance between the measurement points and the BTS towers serving each provider.
3. Wireshark
   Wireshark is a network protocol analyzer used to capture and analyze packet-level network traffic. It was utilized to measure throughput, packet loss, delay, and jitter during the drive test.

Results

Measurement at Prabumulih Traditional Market

Measurements at the Prabumulih Traditional Market were conducted between 13:00 and 16:00 WIB.

1. IM3:
    - Distance to BTS: approximately 500 m
    - Throughput: 1,717 kbps (Very Good – TIPHON)
    - Packet Loss: 1.6% (Good)Delay: 5.278 ms (Very Good)
    - Jitter: 5.193 ms (Good)
2. Telkomsel:
    - Distance to BTS: approximately 350 m
    - Throughput: 708 kbps (Very Good)
    - Packet Loss: 0% (Very Good)
    - Delay: 8.058 ms (Very Good)
    - Jitter: 8.080 ms (Good)
3. 3(Three):
    - Distance to BTS: approximately 250 m
    - Throughput: 718 kbps (Good)
    - Packet Loss: 0% (Very Good)
    - Delay: 8.419 ms (Very Good)Jitter: 8.425 ms (Good)

The results indicate that all three providers demonstrated good overall performance at this location. However, IM3 experienced packet loss, while Telkomsel and 3 recorded zero packet loss.

Measurement at City Mall Prabumulih

1. IM3:
    - Distance to BTS: approximately 6.3 km
    - Throughput: 782 kbps (Good)
    - Packet Loss: 5.0% (Good)Delay: 8.655 ms (Very Good)
    - Jitter: 8.664 ms (Good)
2. Telkomsel:
    - Distance to BTS: approximately 80 m
    - Throughput: 318 kbps (Very Good)
    - Packet Loss: 0% (Very Good)Delay: 23.176 ms (Very Good)
    - Jitter: 23.168 ms (Good)
3. 3 (Three):
    - Distance to BTS: approximately 1.6 km
    - Throughput: 401 kbps (Moderate)
    - Packet Loss: 0% (Very Good)
    - Delay: 16.676 ms (Very Good)

- Jitter: 16.704 ms (Good)

At this location, 3 (Three) demonstrated the most stable performance due to the absence of packet loss and relatively consistent delay and jitter values.

Measurement at Padat Karya Street, Prabumulih

1. IM3:
    - Distance to BTS: approximately 4.8 km
    - Throughput: 85 kbps (Poor)
    - Packet Loss: 1.0% (Good)Delay: 59.947 ms (Very Good)
    - Jitter: 59.908 ms (Good)
2. Telkomsel:
    - Distance to BTS: approximately 950 m
    - Throughput: 220 kbps (Poor)
    - Packet Loss: 0% (Very Good)Delay: 28.270 ms (Very Good)
    - Jitter: 28.113 ms (Good)
3. 3 (Three):
    - Distance to BTS: approximately 1.0 km
    - Throughput: 138 kbps (Moderate)
    - Packet Loss: 0% (Very Good)
    - Delay: 58.681 ms (Very Good)
    - Jitter: 57.145 ms (Good)

At this site, Telkomsel demonstrated the most consistent performance based on the combination of zero packet loss and relatively stable delay and jitter values.

Discussion

The analysis of Quality of Service (QoS) parameters across three measurement locations in Prabumulih City confirms that 4G LTE network performance varies significantly among providers and geographical areas. This variation indicates that network quality is not solely determined by the technology used, but is also strongly influenced by environmental and infrastructural factors. The observed differences among Telkomsel, IM3, and Three (3) demonstrate that each operator exhibits distinct performance characteristics depending on location and network load conditions.

Signal attenuation was identified as one of the main factors affecting network performance. This phenomenon was primarily caused by variations in the distance between users and Base Transceiver Station (BTS) towers. The increasing distance led to weakened signal strength and reduced throughput, particularly evident for the IM3 provider at City Mall and along Padat Karya Street. This finding is consistent with wireless communication theory, which establishes that signal power decreases as transmission distance increases, directly impacting data transfer capacity.

Signal distortion due to network congestion also significantly influenced QoS performance. High user density resulted in bandwidth competition among subscribers, which caused fluctuating throughput values, increased latency, and elevated jitter. This condition was

especially noticeable during peak usage hours when many users accessed the network simultaneously. As a result, even in areas with strong signal reception, service quality could deteriorate due to insufficient bandwidth allocation per user.

Noise and electromagnetic interference further contributed to QoS degradation, particularly in densely populated and commercially active areas. Co-channel interference occurred when multiple BTS units operated on overlapping frequencies, leading to packet collisions and retransmissions. Environmental interference from electronic devices and surrounding infrastructure also introduced noise that reduced signal clarity. These conditions collectively caused an increase in packet loss and latency, thereby affecting user experience.

In contrast, locations with higher BTS density, such as the Prabumulih Traditional Market area, consistently exhibited better QoS performance. The presence of multiple BTS installations allowed network traffic to be distributed more evenly, reducing congestion and maintaining stable throughput levels. Users in this area experienced lower delay and jitter, indicating that proper BTS placement plays a crucial role in ensuring optimal LTE service quality.

Overall, the findings of this study demonstrate that 4G LTE network quality in Prabumulih City is highly dependent on a combination of signal attenuation, network congestion, noise, and BTS distribution. Although all three providers operate using the same LTE technology, differences in infrastructure planning and traffic management result in varying service performance. These results provide valuable insights for network operators to optimize BTS placement, improve bandwidth management, and minimize interference in order to enhance user satisfaction and ensure more consistent QoS across different urban areas.

Conclusion and Recommendations

Based on the QoS analysis of the 4G LTE networks of IM3, Telkomsel, and 3 (Three) in Prabumulih City, the following conclusions are drawn:

1. QoS measurements using throughput, packet loss, delay, and jitter parameters were successfully conducted using the Wireshark application at three locations between 13:00 and 16:00 WIB.
2. The Prabumulih Traditional Market area exhibited the best overall network quality due to the high density of BTS installations.
3. At City Mall Prabumulih, 3 (Three) demonstrated the most stable network performance.
4. At Padat Karya Street, Telkomsel provided the most reliable QoS among the three providers.
5. Differences in QoS performance were primarily influenced by signal attenuation, distance from BTS towers, user density, network congestion, and environmental conditions.

Overall, the results confirm that BTS proximity and user density are the dominant determinants of 4G LTE network quality in Prabumulih City.

Disclosure Statement

The authors declare no conflict of interest related to this study.

Acknowledgments

The authors would like to express their sincere gratitude to Universitas Bina Darma, the Faculty of Vocational Studies, and all parties who supported and facilitated this research in Prabumulih City.

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Biographical Notes

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