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Analysis of the Use of Provider and Mi-Fi Devices on Game Performance in Mobile Legends: Bang Bang Ranked Mode

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Abstract: Online games are a worldwide achievement supported by technological advances that want the best for smartphone users. A weakness or failure in wireless communication is the propagation of the path used. Service providers or provaider have advantages and disadvantages. One of the things that makes it different is the weather conditions, normal weather conditions and rain. Special measurements in Ranked mode, which are carried out in the championship as a single target in order to be the winner, the stability of the connection is crucial to ensure that players can play without any network connection interruptions. This paper contributes to revealing the online game process by analyzing the performance performance of three internet providers (Telkomsel, XL, and Tri) in playing Mobile Legends: Bang Bang, especially in Ranked mode. Measurement using Mi-Fi with postpaid access (no quota restrictions) as an assumption of the same conditions for each provaider. Measurements are carried out using key parameters such as throughput, packet loss, and delay so that the results of the analysis are obtained using statistical methods to search for averages and variances. The results of the analysis from the calculation were obtained that Telkomsel outperformed XL and Tri.

Keywords: Game performance; Mi-Fi; Mobile Legends: Bang Bang; Provider; Ranked mode

Introduction

The internet connection is directly linked to the Internet Service Provider (ISP), which does not implement any policies or filtering on network traffic, with all connections relying on the basic services provided by the ISP (Azamuddin et al., 2020). Network congestion issues have occurred repeatedly, and the Information Technology (IT) department frequently receives complaints regarding poor and intermittent connection quality (Varyani et al., 2020). As networks continue to expand in size and experience increasing traffic loads, along with a growing variety of Quality of Service (QoS) demands, managing such complex infrastructures has become an increasingly difficult task (Gómez et al., 2023).

The expansion of 4G LTE (Long Term Evolution) telecommunications technology in Indonesia has progressed rapidly in recent years. Cellular service providers have continued to extend 4G LTE coverage nationwide by actively developing and enhancing their network infrastructure to support widespread accessibility (Pramono et al., 2020). LTE technology enables seamless access to various multimedia services—such as streaming music, browsing the internet, watching videos, and playing games—on a single connected device. To accurately assess signal performance, it is necessary to employ a real-time method for collecting radio frequency (RF) field data (Harahap et al., 2021). The implementation of 4G LTE in Indonesia aims to enhance internet speed, provide information on local signal quality, and offer greater

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bandwidth to support simultaneous user connections (Akram et al., 2023).

The 4G wireless network connection with 2100 MHz transmission in the city of Mataram is very volatile and unstable in the changing weather conditions. This weather influence causes a change in the propagation of the trajectory to reach the user. To get the best quality from each service provider or provider, the researcher tried three service providers to be used in playing online games. Some of the studies that have been conducted by other researchers as citations are presented as considerations in compiling this research.

Online games have become widespread and can be enjoyed by people of all ages who are capable of playing them. To play these games, a smartphone with specific specifications and a good, stable internet connection are required so that the game can run smoothly, allowing players to enjoy the experience (Yadnya et al., 2020).

One rapidly growing trend is the increasing popularity of mobile games, with Mobile Legends: Bang Bang (MLBB) being one of the dominant games in the market (Ramadianty et al., 2018). This game, which carries the Multiplayer Online Battle Arena (MOBA) genre, features competitive game modes such as Ranked, which require a stable and responsive internet connection to support the player's performance (Pangestu & Wijaya, 2020). The game has been downloaded more than 100,000,000 times on the Play Store. In Indonesia, it has become one of the most popular online games, evidenced by the large number of players and tournaments held in various regions (Wahyudi et al., 2020).

The need for information and communication among individuals will continue to grow rapidly over time. This has driven cellular telecommunications service providers to evolve in order to meet the diverse needs of their consumers (Karo et al., 2021). The assessment of network speed quality and bandwidth requirements is conducted using several devices, including routers, smartphones, and laptops (J et al., 2024). Various tools are employed in the measurement process, such as Wireshark, online games, traffic monitoring applications, and Quality of Service (QoS) parameters to evaluate network performance (Igirisa et al., 2022). The quality of the internet connection is a crucial element in supporting the online gaming experience (Sadzali et al., 2022). High latency, inadequate download and upload speeds, and fluctuations in connection quality can significantly affect player performance (Putra & Rahayu, 2019).

Mi-Fi devices operate on a similar principle to the hotspot or tethering features found on smartphones. However, they are specifically designed to share internet connections more efficiently and reliably. Their main function is to serve as dedicated wireless tethering devices (Endri et al., 2019).

In this context, the role of internet service providers becomes crucial. Service providers often claim to offer fast and stable connections, but the question arises: Does the quality of service provided truly meet the standards necessary to support the online gaming experience, especially in competitive modes like Ranked in MLBB (Rofiq & Yusro, 2020). Along with the development of technology, Mi-Fi devices have become a popular solution to provide more flexible and portable internet connections. Mi-Fi, as a portable Wi-Fi device, allows users to access the internet through cellular networks in various locations (Wibowo & Nugroho, 2020).

Quality of Service (QoS) is a method used to measure network status and attempt to define the characteristics and quality of a service (Krasniqi et al., 2018). QoS is designed to help users improve their experience by ensuring that users get tested performance from network-based applications (Gao et al., 2017). QoS provides better and planned network service with controlled throughput, jitter, and latency, improving loss characteristics. QoS has the ability to ensure the delivery of crucial data streams or, in other words, a collection of performance criteria that determine user satisfaction with a service (Mazhar et al., 2023).

Quality of Service (QoS) parameters, such as reputation, throughput, delay, and packet loss, may vary among users. In dynamic network environments, evaluating service quality from the user's perspective is essential (Syahputra, 2021). However, relying on service providers to obtain QoS values is often unrealistic due to variations in network conditions, user locations, and access times (Zhu et al., 2019). Meanwhile, user-based evaluations also face several limitations, including high time and cost requirements, limited resources, and inconsistent QoS values resulting from fluctuating network conditions (Khababa, 2025).

This paper contributes to providing a deeper understanding of the impact of internet service quality on player performance, especially in the context of Mobile Legends: Bang Bang in Ranked mode. Through the analysis conducted, this research provides empirical data that can be used as a reference in determining the best internet provider and connection device to support an optimal gaming experience. Furthermore, the findings of this paper also serve as an evaluation tool for internet service providers, particularly those based on Mi-Fi devices, to improve their service quality to meet the specific needs of online gamers. A new contribution from this paper is the influence of raindrops that hit the wireless line of the 4G network due to the changing

weather conditions rain condition (Yadnya & Sudiarta, 2016, 2018).

This paper aims to analyze how the service quality of various internet providers affects player performance in Ranked mode in MLBB. The paper will also explore the use of Mi-Fi devices as an alternative internet connection provider. Using Wireshark software, this research will measure QoS parameters to obtain accurate and detailed data on network performance in normal versus rain condition.

Method

For the completion of data processing from measurement results, the QoS parameters of the Wireshark software application rocks. The QoS parameters used are throughput, packet loss, and delay by using the Mi-Fi Tenda 4G03 N300 device in Ranked mode in the online game Mobile Legends Bang Bang comparing three providers (Telkomsel, XL, and Tri). Data retrieval according to the weather conditions collected during the game takes place. The results of measurement data are analyzed using existing statistical methods by looking for mean and variance.

Mi-Fi Tenda 4G03 N300

The Tenda 4G03 N300 Mi-Fi supports the Wi-Fi 802.11 b/g/n standard, allowing devices to connect through a Wi-Fi network. This Mi-Fi can support multiple devices simultaneously, making it a flexible solution for internet access on various devices (Tenda, 2021).

Figure 1. Mi-Fi Tenda 4G03

The specifications of the Tenda 4G03 N300 Mi-Fi are as follows:

The Mi-Fi device used in this study supports multiple network types, including 4G LTE, 3G UMTS, and 2G GSM. It offers a maximum download speed of up to 150 Mbps and an upload speed of up to 50 Mbps. The device utilizes the 802.11 b/g/n Wi-Fi standard and operates on a 2.4 GHz frequency band. It is capable of supporting up to 32 devices simultaneously. Additionally, it includes USB and external antenna ports, along with a SIM card slot that supports various network operators (Technobezz, 2022).

In this paper, three providers—Telkomsel, XL, and Tri—are used with this Mi-Fi device, and their performance in playing the MLBB game will be measured.

Wireshark

Wireshark is an application used as a network packet analyzer, allowing users to examine in detail the data packets transmitted over a network (Saputra, 2020). It also enables the analysis of a network's Quality of Service (QoS). QoS refers to a network mechanism designed to provide optimal service by ensuring sufficient bandwidth and minimizing delay (Mahendra et al., 2024).

Wireshark is a software tool designed to analyze network traffic by capturing data packets as they traverse the network and presenting them in a format that is easily understood by users (Syahab et al., 2023). Wireshark is a tool capable of capturing data packets transmitted over a network. It also provides analysis features for monitoring and evaluating traffic within wireless local area networks (WLANs) (Susianto & Rachmawati, 2018). Wireshark is a software tool designed for analyzing data traffic within a network. It functions by capturing each data packet transmitted across the network and providing detailed information about the contents of those packets for monitoring and analysis purposes (Hasbi & Saputra, 2021).

QOS

Quality of Service is a measurement method that assesses how well a network performs and is an effort to define the characteristics and properties of a service (Tatama, 2022). Various Quality-of-Service (QoS) techniques are widely used to differentiate service classes and prioritize service requirements in mobile networks. Mobile Network Operators (MNOs) apply these techniques to design strategies that align with the existing network infrastructure (Zeydan et al., 2020).

The QoS parameters used in this paper include:

Throughput

Throughput is the total number of successfully received packets at the destination during a specific time interval, divided by the duration of that time interval

(Fauzi et al., 2019). Throughput is the effective data transfer speed expressed in bps (bits per second). Throughput refers to the total number of packets successfully received at the destination within a specific time period, then divided by the duration of that time period. The throughput value can be calculated using the following formula (Yadnya et al., 2020):

$$\text{Throughput} = \frac{\text{Packet Received}}{\text{Time Span}} \quad (1)$$

Table 1. The standardization of throughput according to TIPHON

Index	Throughput	Throughput Categories
4	> 2.1 Mbps	Very Good
3	1.2 – 2.1 Mbps	Good
2	700 – 1200 kbps	Fair
1	338 – 700 kbps	Poor
0	0 – 338 kbps	Bad

Packet Loss

Packet loss is a parameter that describes the condition where total packets are lost, typically occurring due to collisions and congestion in the network. This, in turn, affects all applications, as retransmission inevitably reduces the overall efficiency of the network. The packet loss value can be calculated using the following equation (Yadnya et al., 2020):

$$\text{Packet Loss} = \frac{\text{Packet Sent} - \text{Packet Received}}{\text{Paket Received}} \quad (2)$$

Table 2. The standardization of packet loss according to TIPHON

Index	Packet Loss (%)	Packet Loss Categories
4	0 – 2	Very Good
3	3 – 14	Good
2	15 – 24	Fair
1	25	Poor

Delay

Delay is a QoS parameter that indicates the total time required for a packet to travel from the source to the destination. Factors that can affect delay include hardware, distance, and congestion. The delay value can be calculated using the following equation (Yadnya et al., 2020):

$$\text{Delay} = \frac{\text{Time Span}}{\text{Total Packet}} \quad (3)$$

Table 3. The standardization of delay according to TIPHON

Index	Delay (ms)	Delay Categories
4	< 150	Very Good
3	150 – 300	Good
2	300 – 450	Fair
1	> 450	Poor

Jitter

Jitter is the variation in packet delay during transmission over the network. In the context of networks, especially for real-time applications such as voice calls (VoIP) or online gaming, jitter can significantly affect the quality of service (QoS). Jitter occurs because data packets sent over the network do not always arrive at the destination at the same time. The jitter value can be calculated using the following equation: (Yadnya et al., 2020):

$$\text{Jitter} = \frac{\text{Total Delay Variation}}{\text{Total Packet Received}} \quad (4)$$

Table 4. The standardization of jitter according to TIPHON

Index	Delay (ms)	Jitter Categories
4	0	Very Good
3	1 – 75	Good
2	76 – 125	Fair
1	> 225	Poor

Structure of Measurement

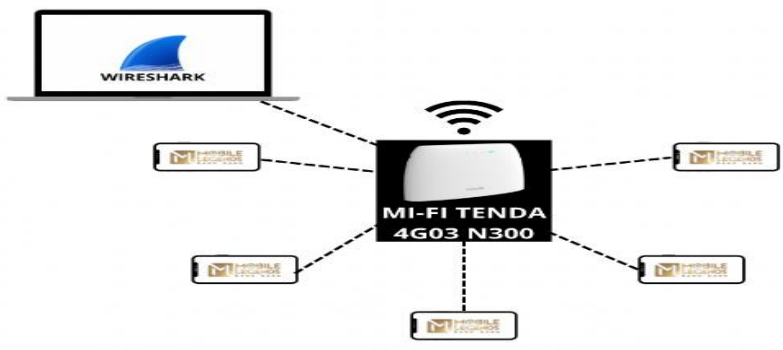

Figure 2. Research framework

The Tenda 4G03 N300 Mi-Fi will be set up and configured to ensure an optimal connection. Five smartphone devices will be connected to this Mi-Fi as test devices for playing the game simultaneously. Each smartphone will be ensured to be in optimal condition, using default settings with no additional background applications running.

One laptop will be connected to the Mi-Fi, and this device will be used as the data collector for QoS using Wireshark software. The laptop settings and the Wireshark software will be adjusted to record all the necessary QoS parameters during the test. Direct measurements on MLBB games are carried out in Line of Side (clear ky) or Non-Line of Side (rain conditions) conditions.

The selection of measurement locations uses a shared tower between Telkom, XL and Indosat providers, so that the measurements are fair and just (apple to apple).

Result and Discussion

The results of this paper show the quality of each provider on the Tenda 4G03 N300 Mi-Fi device as it relates to performance in playing Mobile Legends: Bang Bang in Ranked mode. The measurement was conducted in Base Ground Pra PON NTB 2024 the Gunung Sari area, West Lombok.

Figure 3. Measurement location

Figure 3 shows the data collection location at Homebase 2 of the Esport Team (in the Gunung Sari area), with the measured distance to the Telkomsel BTS approximately 410 meters. The distance to the XL and Tri BTS is around 414 meters.

The measurements were taken from 16:00 to 22:00, following the schedule of the Mobile Legends Professional League Indonesia (MPL ID) competition, under both normal and rainy conditions.

Figure 4. Measurement data collection

The data from this paper are visualized through graphs that compare QoS values such as throughput, packet loss, and delay, which were collected using Wireshark software during the gameplay.

Throughput

Figure 5 shows a graph comparing the throughput values under normal conditions for the three different providers. The highest throughput value is found on the Telkomsel provider with a value of 11.61 kbps, while the lowest value is on the Tri provider with a value of 1.94 kbps.

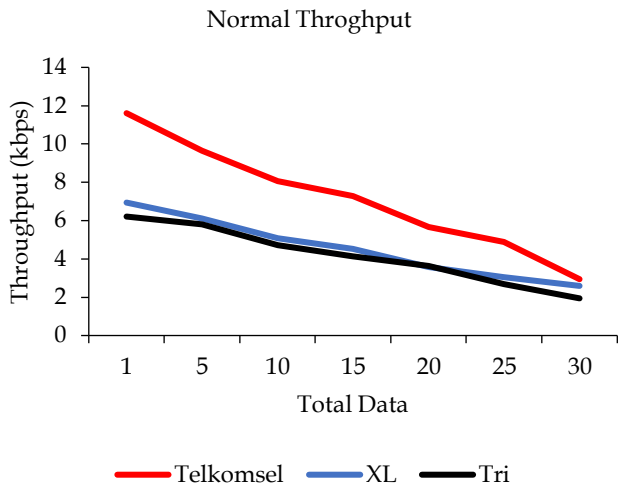

Figure 5. Comparison of throughput under normal conditions

Below is an example of the throughput value calculation measured under normal conditions:

$$\text{Throughput} = \frac{\text{Packet Received}}{\text{Time Span}}$$

$$= \frac{1066497}{734.677}$$

$$= 1451.654 \text{ x } 8$$

= 11613.23 bits/s
= 11.61 kbps

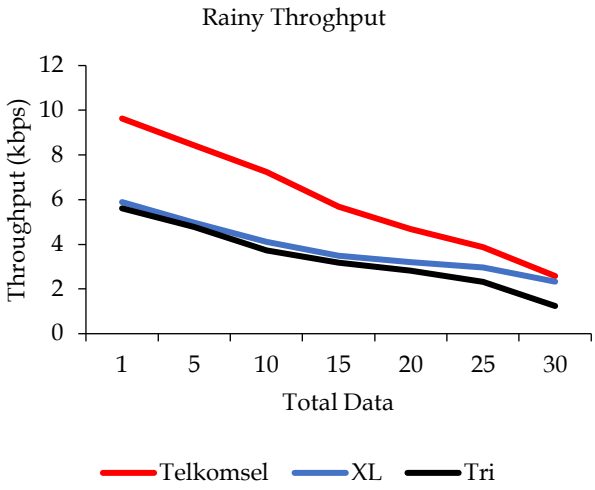

Figure 6. Comparison of Throughput under Rainy Conditions

Figure 6 shows a graph comparing the throughput values under rainy conditions for the three different providers. The highest throughput value is observed with the Telkomsel provider, having a value of 9.63 kbps, while the lowest value is found with the Tri provider, which has a value of 1.24 kbps.

Below is an example of the throughput value calculation measured under rainy conditions:

$$\text{Throughput} = \frac{\text{Packet Received}}{\text{Time Span}}$$
$$= \frac{265130}{682.596}$$
$$= 388.414 \text{ x } 8$$
$$= 3107 \text{ bits/s}$$
$$= 3.10 \text{ kbps}$$

Packet Loss

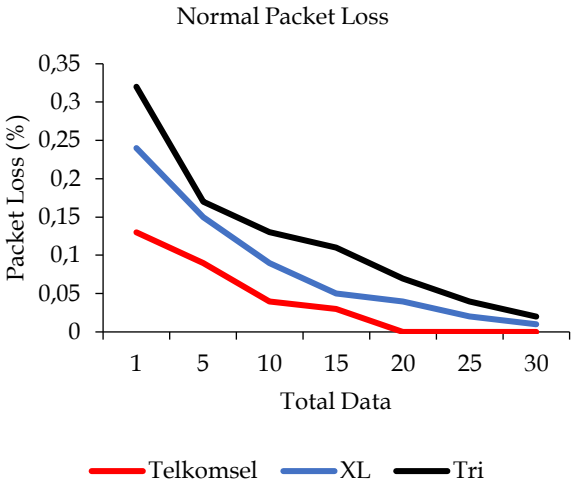

Figure 7. Comparison of packet loss under normal conditions

Figure 7 shows a graph comparing the packet loss values under normal conditions for the three different providers. The highest packet loss value is observed with the Tri provider, at 0.32%, while the lowest value is found with the Telkomsel provider, at 0%.

Below is an example of the packet loss value calculation measured under normal conditions:

$$\text{Packet Loss} = \frac{\text{Packet Sent} - \text{Packet Received}}{\text{Packet Received}}$$
$$= \frac{1011 - 995}{1011}$$
$$= 0.0158 \text{ x } 100\%$$
$$= 0.0158\%$$
$$= 0.01\%$$

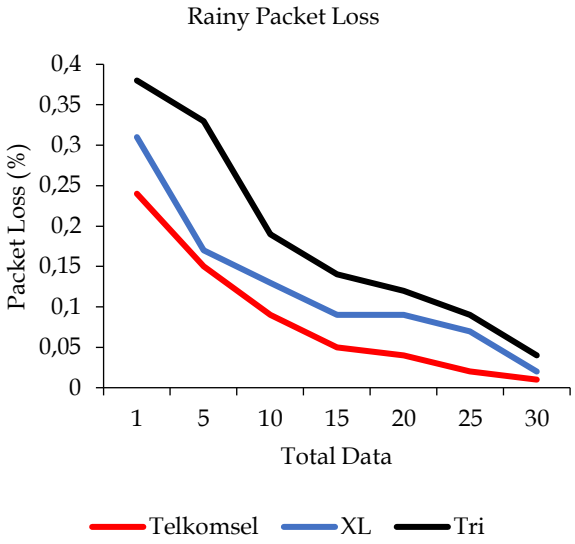

Figure 8. Comparison of packet loss under rainy conditions

Figure 8 shows a graph comparing the packet loss values under rainy conditions for the three different providers. The highest packet loss value is observed with the Tri provider, at 0.38%, while the lowest value is found with the Telkomsel provider, at 0%.

Below is an example of the packet loss value calculation measured under rainy conditions:

$$\text{Packet Loss} = \frac{\text{Packet Sent} - \text{Packet Received}}{\text{Packet Received}}$$
$$= \frac{2035 - 1979}{2035}$$
$$= 0.0275 \text{ x } 100\%$$
$$= 0.0275\%$$
$$= 0.02\%$$

Delay

Figure 9 shows a graph comparing the delay values under normal conditions for the three different providers. The highest delay value is observed with the Tri provider, at 128.84 ms, while the lowest value is found with the Telkomsel provider, at 26.13 ms.

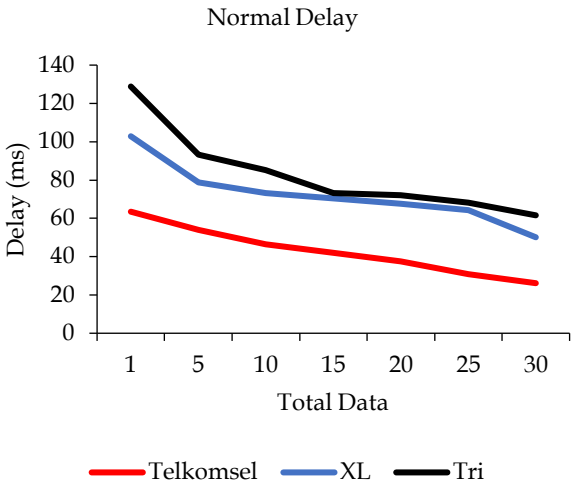

Figure 9. Comparison of delay under normal conditions

Below is an example of the delay value calculation measured under normal conditions:

$$\text{Delay} = \frac{\text{Time Span}}{\text{Total Packet}}$$
$$= \frac{796.832}{2432}$$
$$= 0.327 \times 100$$
$$= 32.7 \text{ ms}$$

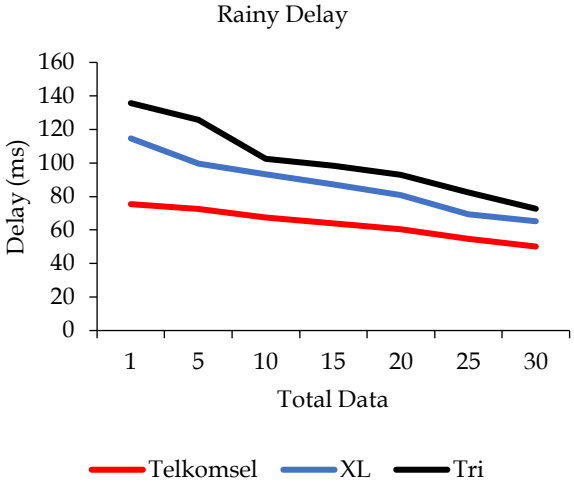

Figure 10. Comparison of delay under rainy conditions

Figure 10 shows a graph comparing the delay values under rainy conditions for the three different providers. The highest delay value is observed with the Tri provider, at 135.72 ms, while the lowest value is found with the Telkomsel provider, at 50.14 ms.

Below is an example of the delay value calculation measured under rainy conditions:

$$\text{Delay} = \frac{\text{Time Span}}{\text{Total Packet}}$$
$$= \frac{682.596}{1011}$$
$$= 0.675 \times 100$$
$$= 67.5 \text{ ms}$$

The measurement results show that the internet service quality based on QoS measurements using the TIPHON standard results in differences in the average values for each provider.

Table 5. Average QoS measurement data under normal conditions

Provider	Throughput (kbps)	Packet Loss (%)	Delay (ms)
Telkomsel	6.98	0.035	42.27
XL	4.44	0.078	70.52
Tri	4.08	0.111	78.91

Table 5 shows the average values of the three providers under normal conditions, where the throughput values indicate that Telkomsel has the highest performance at 6.98 kbps, followed by XL at 4.44 kbps, and Tri at 4.08 kbps. For the average packet loss, Telkomsel has 0.035%, XL has 0.078%, and Tri has 0.111%, indicating that Telkomsel has the lowest data packet loss rate. Meanwhile, the average delay for Telkomsel is 42.27 ms, which is lower compared to XL (70.52 ms) and Tri (78.91 ms), thus demonstrating better quality.

Table 6. Average QoS measurement data under rainy conditions

Provider	Throughput (kbps)	Packet Loss (%)	Delay (ms)
Telkomsel	5.86	0.058	62.99
XL	3.78	0.118	85.94
Tri	3.29	0.172	99.23

Table 6 shows the average values for the three providers under rainy conditions, where the throughput values indicate that Telkomsel has the highest performance at 5.86 kbps, followed by XL at 3.78 kbps, and Tri at 3.29 kbps. For the average packet loss, Telkomsel has 0.058%, XL has 0.118%, and Tri has 0.172%, indicating that Telkomsel has the lowest data packet loss rate. Meanwhile, the average delay for Telkomsel is 62.99 ms, which is lower compared to XL (85.94 ms) and Tri (99.23 ms), thus demonstrating better quality.

Table 7. Average data of QoS value changes from normal to rainy conditions

Provider	Throughput (kbps)	Packet Loss (%)	Delay (ms)
Telkomsel	1.12	0.023	20.72
XL	0.66	0.040	15.42
Tri	0.79	0.061	20.32

Based on these results, Telkomsel shows superior service quality compared to XL and Tri in supporting Mobile Legends: Bang Bang gaming activities, both under normal conditions and rainy conditions.

Conclusion

Based on the analysis of the average measurement results for throughput output, in normal conditions (Telkomsel 6.98 kbps; XL 4.44 kbps; Tri 4.08 kbps) and in rainy conditions (Telkomsel 5.86 kbps; XL 3.78 kbps; Tri 3.29 kbps), for the average packet loss in normal conditions (Telkomsel 0.03%; XL 0.06%; Tri 0.11%) and in rainy conditions (Telkomsel 0.05%; XL 0.11%; Tri 0.17%), and for the average delay in normal conditions (Telkomsel 42.27 ms; XL 70.52 ms; Tri 78.91 ms) and in rainy conditions (Telkomsel 62.99 ms; XL 85.94 ms; Tri 99.23 ms). Based on the analysis results, the best provider for playing Mobile Legends: Bang Bang is Telkomsel. In normal conditions, Telkomsel has the highest average throughput at 6.98 kbps, the lowest packet loss at 0.03%, and the fastest delay at 42.27 ms, compared to XL and Tri. Even in rainy conditions, Telkomsel remains superior with a throughput of 5.86 kbps, packet loss of 0.05%, and delay of 62.99 ms, which are still better than XL and Tri. With stable throughput performance, low packet loss, and minimal delay, Telkomsel provides a more optimal gaming experience compared to the other providers.

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Author Contributions
Conceptualization, methodology, formal analysis, data acquisition, writing—original draft preparation, writing—review and editing, M.R.A., M.S.Y., and A.Z.; All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
No conflict of interest.

References

Akram, A., Melvandino, F. H., Bragaswara, W. Y., & Ramza, H. (2023). *Analisis Kinerja Jaringan 4G LTE Menggunakan Metode Drive Test di Kelurahan Kampung Rambutan, Jakarta Timur* (Thesis). Fakultas Teknologi Industri & Informatika, Teknik Elektro, Universitas Muhammadiyah Prof. Dr. HAMKA.

Azamuddin, W. M. H., Hassan, R., Aman, A. H. M., Hasan, M. K., & Al-Khaleefa, A. S. (2020). Quality of Service (QoS) Management for Local Area Network (LAN) Using Traffic Policy Technique to Secure Congestion. *Computers*, *9*(2), 39. https://doi.org/10.3390/computers9020039

Endri, J., Handayani, A. S., Jannah, R., & Al-Kausar, J. (2019). Wajanbolic Reflection Antenna for 4G Service in Urban and Sub Urban Areas. *Journal of Physics: Conference Series*, *1167*, 012020. https://doi.org/10.1088/1742-6596/1167/1/012020

Fauzi, A. A., Dasril, D., & Imansyah, F. (2019). Analisis Quality of Service dengan Metode Walk Test Terhadap Pengaruh Posisi Pengambilan Data User pada Event Mobile Legend Telkomsel. *Jurnal Teknik Elektro Universitas Tanjungpura*, *7*(1). https://doi.org/10.26418/j3eit.v7i1.32495

Gao, Y., Cheng, W., Zhang, H., & Li, Z. (2017). Heterogeneous Statistical QoS Provisioning Over Wireless Powered Sensor Networks. *IEEE Access*, *5*, 7910–7921. https://doi.org/10.1109/ACCESS.2017.2694046

Gómez, J., Riaño, V. H., & Ramirez-Gonzalez, G. (2023). Traffic Classification in IP Networks Through Machine Learning Techniques in Final Systems. *IEEE Access*, *11*, 44932–44940. https://doi.org/10.1109/ACCESS.2023.3272894

Harahap, P., Pasaribu, F. I., & Siregar, C. A. (2021). Network Quality Comparison 4G LTE X and Y in Campus UMSU. *Journal of Physics: Conference Series*, *1858*, 012010. https://doi.org/10.1088/1742-6596/1858/1/012010

Hasbi, M., & Saputra, N. R. (2021). Analisis Quality of Service (QoS) Jaringan Internet Kantor Pusat King Bukopin dengan Menggunakan Wireshark. *JUST IT: Jurnal Sistem Informasi, Teknologi Informasi dan Komputer*, *12*(1), 17-23. https://doi.org/10.24853/justit.12.1.%25p

Igirisa, R., Taliki, S., & Alhamad, A. (2022). Analisis Kebutuhan Bandwidth dan Kualitas Kecepatan Jaringan Wifi UNISAN pada Game Online. *BALOK*, *1*(1). https://doi.org/10.37195/balok.v1i1.87

J, S., Jumnal, A., P K, U., C, R., Askar, S. S., & Abouhawwash, M. (2024). Bio-Inspired ACO-Based Traffic Aware QoS Routing in Software Defined Internet of Things. *Applied Artificial Intelligence*, *38*(1). https://doi.org/10.1080/08839514.2024.2371739

Karo, F. K., Nugraha, E. S., & Gustiyana, F. N. (2021). Analisis Hasil Pengukuran Performansi Jaringan 4G LTE 1800 MHz di Area Sokaraja Tengah Kota Purwokerto Menggunakan Genex Assistant Versi

3.18. *Jurnal Teknik Telekomunikasi*, *10*(2), 45-54. https://doi.org/10.24246/aiti.v16i2.115-124

Khababa, G. (2025). Collaborative Filtering Techniques for Predicting Web Service QoS Values in Static and Dynamic Environments: A Systematic and Thorough Analysis. *IEEE Access*, *13*, 45350–45376. https://doi.org/10.1109/ACCESS.2025.3550284

Krasniqi, F., Maraj, A., & Blaka, E. (2018). Performance Analysis of Mobile 4G/LTE Networks. *2018 South-Eastern European Design Automation, Computer Engineering, Computer Networks and Society Media Conference (SEEDA_CECNSM)*, Kastoria, Greece, 2018, pp. 1-5. https://doi.org/10.23919/SEEDA-CECNSM.2018.8544937

Mahendra, Y., Sasongko, S. M. A., & Yadnya, M. S. (2024). Analisis Hasil Pengukuran Quality of Service (QoS) dan Kuat Sinyal 4G LTE pada Kondisi Line of Sight (LoS) dan Kondisi Non Line of Sight (NLoS) di Daerah Urban Studi Kasus (Lingkungan Universitas Mataram). *Jurnal Media Informatika*, *6*(1), 688-695. Retrieved from https://ejournal.sisfokomtek.org/index.php/jumin/article/view/4800

Mazhar, T., Malik, M. A., Mohsan, S. A. H., Li, Y., Haq, I., Ghorashi, S., Karim, F. K., & Mostafa, S. M. (2023). Quality of Service (QoS) Performance Analysis in a Traffic Engineering Model for Next-Generation Wireless Sensor Networks. *Symmetry*, *15*(2), 513. https://doi.org/10.3390/sym15020513

Pangestu, A. W., & Wijaya, A. F. (2020). Analisis Pengaruh Provider Internet Terhadap Kualitas Bermain Mobile Legends di Kota Bandung. *Jurnal Informatika*, *9*(3), 87-95.

Pramono, S., Alvionita, L., Ariyanto, M. D., & Sulistyo, M. E. (2020). Optimization of 4G LTE (Long Term Evolution) Network Coverage Area in Sub Urban. *AIP Conference Proceedings*, *2217*, 030193. https://doi.org/10.1063/5.0000732

Putra, A. P., & Rahayu, S. (2019). Kualitas Layanan Internet pada Game Online: Studi Kasus Mobile Legends di Indonesia. *Jurnal Komunikasi*, *11*(1), 50-63.

Ramadianty, V. D., Dasril, D., & Imansyah, F. (2018). *Analisis Pengukuran Performansi Jaringan 4G LTE Telkomsel dalam Event Game Mobile Legends: Bang-Bang di Pontianak* (Thesis). Jurusan Teknik Elektro, Fakultas Teknik, Universitas Tanjungpura, Pontianak.

Rofiq, M., & Yusro, M. (2020). Studi Eksperimen Pengaruh Latency pada Kinerja Pemain dalam Game Mobile Legends. *Jurnal Teknik Elektro dan Komputer*, *6*(4), 297-305.

Sadzali, M. E., Lufianawati, D. E. T., & Suhendar, S. (2022). *Analisis Perbandingan Quality of Service (QoS) Jaringan 4G LTE Provider Digital Kota Tangerang* (Undergraduate Thesis). Jurusan Teknik Elektro, Fakultas Teknik, Universitas Sultan Ageng Tirtayasa, Cilegon, Banten.

Saputra, H. A. (2020). Analisis QOS Jaringan 4G dengan Menggunkan Aplikasi Wireshark (Studi Kasus: Tepian Samarinda, Taman Samarinda, dan Taman Cerdas). *Prosiding SAKTI (Seminar Ilmu Komputer dan Teknologi Informasi)*.

Susianto, D., & Rachmawati, A. (2018). Implementasi dan Analisis Jaringan Menggunakan Wireshark, Cain and Abels, Network Minner. *Jurnal Cendikia*, *16*(1), 120–125. Retrieved from https://www.neliti.com/publications/277420/implementasi-dan-analisis-jaringan-menggunakan-wireshark-cain-and-abels-network

Syahab, A. S., Ujianto, E. I. H., & Rianto, R. (2023). Penggunaan Wireshark dan Nessus untuk Analisis SSL/TLS pada Keamanan Data Pengguna Website. *JIKA (Jurnal of Informatics)*, *7*(2), 183–192. https://doi.org/10.31000/jika.v7i2.7566

Syahputra, I. (2021). *Analisis Perbandingan W-LAN 802.11 AX pada Aplikasi Live Streaming Tiktok dan Instagram* (Undergraduate Thesis). Universitas Islam Riau. Retrieved from https://repository.uir.ac.id/11029/

Tatama, V. (2022). *Analisis Quality of Service pada Jaringan Telkomsel Orbit pada Jaringan Telkomsel Orbit Menggunakan Aplikasi Wireshark* (Undergraduate Thesis) Universitas Tanjungpura. Retrieved from http://36.95.239.66/1117/

Technobezz, T. (2022). *Tenda 4G03 N300 Review: A Reliable Portable Router for on-the-go Internet Access*. Retrieved from https://www.technobezz.com/

Tenda, T. (2021). *Tenda 4G03 N300 Mobile Router Product Overview*. Retrieved from https://www.tendacn.com

Varyani, N., Zhang, Z.-L., & Dai, D. (2020). QROUTE: An Efficient Quality of Service (QoS) Routing Scheme for Software-Defined Overlay Networks. *IEEE Access*, *8*, 104109–104126. https://doi.org/10.1109/ACCESS.2020.2995558

Wahyudi, L. A., Yadnya, M. S., & Sasongko, S. M. A. (2020). *Analisis Performansi Jaringan 4G XL Axiata pada Daerah Rural dalam Game Mobile Legends: Bang Bang*. Retrieved from https://perpusft.unram.ac.id/index.php?p=fstream-pdf&fid=1779&bid=8484

Wibowo, R. A., & Nugroho, P. S. (2020). *E-Book: Pengantar Game Online dan Kualitas Jaringan di Indonesia*. Penerbit Universitas Terbuka.

Yadnya, M. S., & Sudiarta, I. W. (2016). Measurement of Drop Size Distribution Rain in Mataram Utilize Disdrometer Acoustic for Flood Prediction. *The Proceedings of ISITIA, IEEE Indonesia Section*, 107-110.

Yadnya, M. S., & Sudiarta, I. W. (2018). Synthesis of 4G Outdoor Femtocells Under Rain Conditions in Mataram. *AIP Conference Proceedings*, *2043*, 020017. https://doi.org/10.1063/1.5080036

Yadnya, M. S., Sasongko, S. M., & Wahyudi, L. A. (2020). Pengukuran Performansi Game Online di Daerah Rural dalam Variasi Waktu dan Karakter Hero pada Mobile Legends Bang Bang. *DIELEKTRIKA*, *7*(1), 25-29. Retrieved from https://dielektrika.unram.ac.id/index.php/dielektrika/article/view/235

Zeydan, E., Mangues-Bafalluy, J., Dedeoglu, O., & Turk, Y. (2020). Performance Comparison of QoS Deployment Strategies for Cellular Network Services. *IEEE Access*, *8*, 176073–176088. https://doi.org/10.1109/ACCESS.2020.3027626

Zhu, S., Sun, Z., Lu, Y., Zhang, L., Wei, Y., & Min, G. (2019). Centralized QoS Routing Using Network Calculus for SDN-Based Streaming Media Networks. *IEEE Access*, *7*, 146566–146576. https://doi.org/10.1109/ACCESS.2019.2943518