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Internet Network Analysis on Local Provider X Using QoS Method

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Abstract

Local Provider X is an internet service provider at the village level with a focus on supporting household internet needs with 2-5 device connections per home. There are At Least 55 home connections in this provider. With the increasing number of users, the service quality of the Local Provider X internet network needs to be tested to maintain service quality. The testing was carried out using the the Quality of Service (QoS) method with the Action Research approach. Four main parameters were tested, namely throughput, packet loss, delay, and jitter. The assessment used was the TIPHON standardization developed by the European Telecommunications Standards Institute (ETSI). The test results revealed that the throughput value was in the range of 395.60 - 755.42, which had an average index of 2 with the "Average" category. The packet loss value was in the range of 0.01 - 1.89 with an index of 4 and the "Very good" category. The delay value was in the range of 9.64 - 20.70, which had an index of 4 and the "Very Good" category. The jitter value is in the range of 12.04 - 21.94, which has an index of 3 and the category "Good.". Based on the evaluation of all parameters, the overall QoS Index for Local Provider X’s internet network was calculated at 81.25%.

1. INTRODUCTION

The use of the internet has expanded significantly, with devices such as smartphones, tablets, laptops, and computers driving the rapid development of internet infrastructure [1]. To access the internet, individuals must subscribe to an internet service provider (ISP) [2]. As the number of internet users continues to grow, the number of ISPs has also increased, leading to intense competition among providers. These providers compete on various factors, including pricing, product offerings, bandwidth, and service quality.

Indonesia, in particular, presents immense potential for internet service providers. With an internet user penetration rate of 73% of its population, and more than 54% of its population consisting of Gen Z and millennials—who lead highly digital lifestyles—the country offers both opportunities and challenges for ISPs [3]. However, the increasing number of users sharing the same network can negatively impact network quality [4].

Poor network quality often results in a subpar user experience, characterized by low throughput, high packet loss, delay, and jitter, which can frustrate users when accessing online services [5]. Common causes of poor internet quality include inadequate network management, uneven bandwidth distribution, and poorly placed access points.

To address these issues, Quality of Service (QoS) analysis can be employed to identify network weaknesses and provide a foundation for designing effective traffic optimization strategies [6]. QoS is a method used to evaluate network performance based on four key parameters: throughput, jitter, delay, and packet loss [7]. Tools like Wireshark, a network packet analyzer, can capture and display detailed information about packets traversing the network, aiding in the analysis process [8].

Previous studies have utilized the QoS method to analyze network performance, focusing on the four parameters mentioned above [6] [8], [9]. A commonly used standard for categorizing these parameters is TIPHON,

developed by the European Telecommunications Standards Institute (ETSI) [7],[10]. By leveraging QoS metrics and techniques, ISPs can gain valuable insights into network performance, optimize bandwidth management, and improve the overall quality of their services.

Research using the QoS method has been conducted in various settings, including schools [11], [12], [13], business premises [14], [15], campuses [16], and government institutions [17]. However, there is limited research examining QoS on local internet provider networks. This study aims to fill this gap by analyzing the quality of service provided by Local Provider X and offering recommendations for network improvements. Enhancing service quality is critical, as it ensures customer satisfaction and encourages users to continue subscribing to the provider's services.

2. RELATED WORK

2.1. Quality of Service (QoS)

Quality of Service (QoS) refers to the ability of a network to manage bandwidth effectively and address issues such as jitter and delay [9]. It can also be used to define the characteristics and properties of a service [11]. According to the TIPHON standard, QoS is measured using four key parameters: throughput, jitter, packet loss, and delay (latency) [17]. Below are the definitions and formulas for each parameter:

2.1.1. Throughput

Throughput refers to the network's ability to transmit packets in real-time. It is calculated by dividing the total number of successfully transmitted packets by the duration of the time interval [11].

$$Troughput = \frac{Packet\ Sent}{Time} \quad (1)$$

The TIPHON standard categorizes throughput as shown in Table 1 below.

Table 1: Throughput Category Index

Throughput (Kbps)	Index	Category
>2100	4	Very good
1200-2100	3	Good
338-1200	2	Average
0-388	1	Bad

2.1.2. Packet loss

Packet loss refers to the number of packets lost during transmission. This typically occurs due to network collisions or congestion [8]. Other studies describe packet loss as the portion of packets lost during data transmission, which can be caused by factors such as weak signals, improper network hardware selection, or environmental interference [18].

$$PL = \frac{(Packet\ Sent - Packet\ Received)}{Packet\ Sent} x100\% \quad (2)$$

The TIPHON standard categorizes packet loss as shown in Table 2 below.

Table 2: Packet Loss Category Index

Packet Loss (%)	Index	Category
<3	4	Very Good
>3 - 15	3	Good
>15 - 25	2	Average
>25	1	Bad

2.1.3. Jitter

Jitter refers to fluctuations in packet delay caused by variations in queue lengths during data processing [9]. It often occurs due to queue delays in routers or switches [13].

$$Jitter = \frac{\sum \Delta t}{N} \quad (3)$$

The TIPHON standard categorizes jitter as shown in Table 3 below.

Table 3: Jitter Category Index

Jitter (ms)	Index	Category
0	4	Very Good
1 - 75	3	Good
75 -125	2	Average
125 -225	1	Bad

2.1.4. Delay

Delay refers to the time required for a packet to be transmitted, often due to queuing or rerouting to avoid congestion [11]. Delay can be calculated using the following formula:

$$Av.Delay = \frac{Total\ Delay}{Total\ Packet\ Sent} \quad (4)$$

The TIPHON standard categorizes delay as shown in Table 4 below.

Table 4: Delay Category Index

Delay Value (ms)	Index	Category
<150	4	Very Good
>150 – 300	3	Good
>300 – 400	2	Average
>450	1	Bad

2.1.5. QoS

The overall QoS index is calculated by dividing the sum of the index values for all parameters by the maximum possible index value, then multiplying by 100%.

$$QoS = \frac{index\ value\ obtained}{Maximum\ index\ value} x100\% \quad (5)$$

The TIPHON standard categorizes the QoS index as shown in Table 5 below.

Table 5: QoS Category Index

QoS	Index	Category
3.8 - 4	4	Very Good
3 – 3.79	3	Good
2 – 1.99	2	Average
1 – 1.99	1	Bad

2.1.6. Wireshark

Wireshark is a free, open-source network packet analyzer available at www.wireshark.org [11]. It is widely used for network troubleshooting and software testing due to its reliability in capturing and analyzing data packet traffic [8]. Wireshark offers various features, including filters, search tools, and detailed network data analysis capabilities [19].

2.1.7. Local Internet Provider X

Local Internet Provider X was established in 2021 and primarily serves village households with 2–4 users per home. The provider currently has 55 customers, as indicated by its WhatsApp group. The network topology used by Local Provider X is as follows:

1. The internet is connected to the server.
2. The server is connected to a router.
3. The router distributes the internet to customers' homes via fiber optic cables.
4. At the customer's home, the connection is captured and distributed using a wireless LAN.

Local provider X offers two payment schemes:

- **Monthly Scheme**: Customers pay IDR 150,000 for unlimited usage over 30 days
- **Voucher Scheme**: Customers can choose from three packages:
  - 4 hours for IDR 1,500
  - 10 hours for IDR 2,500
  - 24 hours for IDR 5,000

Most villagers are workers with schedules from 07:00 to 14:00, so network traffic is low during these hours. However, traffic begins to increase after 14:00, peaking after the Maghrib prayer at 18:00.

3. RESEARCH METHODOLOGY

This study employs a quantitative method combined with an action research approach. Quantitative research involves collecting numerical data and analyzing it statistically, while the action research approach is used to develop effective strategies and solutions [14]. Action research typically consists of several stages, including diagnosis, action planning, implementation, and evaluation. Some studies also include a learning phase [5]. In this study, the action research framework proposed by [19] will be adopted, which includes four key stages: planning, action, observation, and reflection.

3.1. Action

The first step in the action phase is to install Wireshark on the device that will be used to capture and analyze internet network data packets. The second step involves collecting data by capturing packets that traverse the network using Wireshark at specific times. This step aims to provide an overview of the internet network's performance. The final step is to analyze the collected data based on the predefined Quality of Service (QoS) parameters, including throughput, packet loss, delay, and jitter.

3.2. Observation

The observation phase consists of two main steps. First, the data analysis results obtained from Wireshark are evaluated to identify which QoS parameters require improvement. Second, a detailed investigation is conducted to determine the root causes of the issues affecting the problematic parameters. This step is crucial for understanding the underlying factors contributing to the network's performance challenges.

3.3. Reflection

The findings from the data analysis are used as a basis for reflection and further planning. The researcher will discuss the results with Local Provider X to reflect on the findings and collaboratively identify potential solutions. Once the root causes of the network issues are understood, the next step is to formulate actionable recommendations for improvements that Local Provider X can implement to enhance its service quality.

4. RESULTS AND DISCUSSIONS

4.1. Experiment Condition

The experiment was conducted five times at different times and durations to evaluate the quality of the internet network under varying conditions. The variations in timing and duration were designed to capture network performance during different usage periods. Details of the experiment variations are presented in Table 6.

Table 6: Experiment variations

Experiment	Time	Duration
1	19:33-20:04	31 minutes 20 seconds
2	13:00-13.22	22 minutes 01 seconds
3	17:14-17:24	09 minutes 08 seconds
4	09:43-10:06	23 minutes
5	15:26-15:51	25 minutes

4.2. Throughput

The throughput test results indicate that the highest throughput values were observed in experiments 5 and 4, while the lowest throughput was recorded in experiment 2. Despite the variations in throughput values across experiments, all results fell within the "Average" category, with an index of 2. The detailed findings are presented in Table 7.

Table 7: Throughput Analysis Results

Experiment	Throughput (Kbps)	Index	Category
1	501.15	2	Average
2	395.60	2	Average
3	640.85	2	Average
4	726.42	2	Average
5	755.42	2	Average

4.3. Packet Loss

The packet loss test results show that the highest packet loss value occurred in experiment 1, while the lowest value was observed in experiment 5. Despite these differences, all packet loss values were within the "Very Good" category, with an index of 4. This indicates minimal packet loss across all experiments, as shown in Table 8.

Table 8: Packet Loss Analysis Results

Experiment	Packet Loss (%)	Index	Category
1	1.89	4	Very Good
2	0.06	4	Very Good
3	0.05	4	Very Good
4	0.26	4	Very Good
5	0.01	4	Very Good

4.4. Delay

The delay parameter test results reveal that the lowest delay value (9.64 ms) occurred in experiment 4, while the highest delay value (20.70 ms) was recorded in experiment 2. Despite these variations, all delay values fell within the "Very Good" category, with an index of 4. The detailed results are presented in Table 9.

Table 9: Delay Test Results

Experiment	Delay (ms)	Index	Category
1	9.76	4	Very Good
2	20.70	4	Very Good
3	12.97	4	Very Good
4	9.64	4	Very Good
5	11.79	4	Very Good

4.5. Jitter

The jitter test results show that the highest jitter value (21.94 ms) occurred in experiment 2, while the lowest value (12.04 ms) was observed in experiment 5. All jitter values fell within the "Good" category, with an index of 3. The detailed results are presented in Table 10.

Table 10: Jitter Test Results

Experiment	Jitter (ms)	Index	Category
1	17.24	3	Good
2	21.94	3	Good
3	13.95	3	Good
4	12.09	3	Good
5	12.04	3	Good

4.6. Average Value of QoS Parameters

After testing the four QoS parameters across five experiments, the average index values were calculated as follows:

- **Throughput**: Average index of 2, categorized as "Average."
- **Packet Loss**: Average index of 4, categorized as "Very Good."
- **Delay**: Average index of 4, categorized as "Very Good."
- **Jitter**: Average index of 3, categorized as "Good."

The overall QoS index value was calculated using the formula:

$$QoS = \frac{Index\ Value\ Obtained}{Maximum\ Index\ Value} * 100\% \quad (6)$$

The calculation yielded a QoS value of 81.25%, which falls within the "Good" category. The detailed results are presented in Table 11.

Table 11: QoS Index Value

Parameter	Total Index Value	Average
Throughput	10	2
Packet Loss	20	4
Delay	20	4
Jitter	15	3
Total	=(65/80)*100% =81.25%	3.25

4.7. Reflection

Based on the findings, the researcher formulated recommendations for Local Provider X. Although the throughput values were categorized as "Average," the other parameters (packet loss, delay, and jitter) performed well, falling into the "Good" and "Very Good" categories. To improve network performance, Local Provider X should consider increasing its bandwidth to enhance throughput values, potentially elevating them to the "Good" or "Very Good" categories.

Improving throughput is expected to increase the overall QoS value, leading to enhanced user satisfaction and network performance. A better quality of service can create a perception of comfort and reliability among users, encouraging them to continue using Local Provider X's services [20].

5. CONCLUSION

Based on the analysis of the internet network performance of Local Provider X using the Quality of Service (QoS) method, the results indicate that two parameters—packet loss and delay—achieved an average index of 4, categorized as "Very Good." The jitter parameter achieved an average index of 3, falling into the "Good" category. However, the throughput parameter scored an average index of 2, categorized as "Average." Overall, the QoS assessment yielded a score of 81.25%, which is classified as "Good."

The throughput parameter is a critical area for improvement, as its "Average" score could negatively impact customer comfort and satisfaction when using the internet. Given that the other parameters (packet loss, delay, and jitter) performed well, it can be concluded that the low throughput is likely due to insufficient bandwidth. Therefore, the author recommends that Local Provider X increase its bandwidth to enhance throughput performance. This improvement is expected to elevate the overall QoS score, ensuring a better user experience and maintaining customer loyalty.

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