

Analysis of Internet Connection Bandwidth QOS (Quality of Service) in Supporting the Digitalization of Services at the Surabaya Maritime Polytechnic

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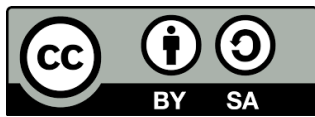
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Jaringan Komputer; Internet;
LAN; WLAN; QoS.

ABSTRACT

To support administrative activities, lectures, teaching and learning processes, and other institutional services, information technology has been utilized as a backbone infrastructure and communication medium. In the current digital era, many devices are designed to be mobile and flexible, creating an increasing demand for flexible and reliable network infrastructure. Internet networks provide solutions to address these requirements. This study focused on analyzing the topology and performance based on Quality of Service (QoS) parameters of the internet network at Surabaya Maritime Polytechnic. From the topology perspective, this study examined the network topology implemented at Surabaya Maritime Polytechnic, while the performance analysis evaluated network quality based on several QoS parameters, including throughput, packet loss, delay, and jitter. The study utilized Wireshark as a network analysis tool. Wireshark is widely used for network performance analysis in both wired and wireless networks because it provides comprehensive packet capture and traffic analysis capabilities to evaluate QoS parameters. In addition, Wireshark is freely available and widely adopted in the field of computer networking. However, one limitation of this application is the lack of automated network performance analysis features, requiring captured data to be further processed and calculated before being converted into measurable QoS parameters for network evaluation.



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INTRODUCTION

Poltekpel Surabaya is an official higher education institution under the auspices of the Human Resources Development Agency (Badan Pengembangan Sumber Daya Manusia [BPSDM]) of the Ministry of Transportation (Rumani et al., 2024). The institution is responsible for educating maritime human resources by producing professional seafarers who are prepared to work and possess competencies aligned with international standards established by the International Maritime Organization (IMO) (Ashari, 2025; Asrifan & Ingilan, 2027; Chibana, 2024; Fadliana et al., 2027; Rumani et al., 2024; Siahaan et al., 2026; Wahid et al., 2026; Widiarti & Widyaningrum, 2026). Surabaya Maritime Polytechnic offers seven study programs, including the Diploma IV Ship Operation Engineering Technology, Diploma IV Ship Machinery Engineering, Diploma IV Ship Electrical Technology, Diploma IV Marine Transportation, Diploma III Nautical Studies, Diploma III Engineering, and Diploma III Shipping Electro-Technology.

To support administrative activities, lectures, teaching and learning processes, and other institutional services, information technology has been utilized as a backbone infrastructure

and communication medium (Alenezi, 2023; Dobrica et al., 2023; Dzemydienė et al., 2023; Gupta & Hayath, 2022; OGUNMAKIN, 2024; Shisakha et al., 2024). Poltekpel Surabaya has implemented various applications for administrative and academic processes, including the SIAKAD (Sistem Informasi Akademik) application (Academic Information System), SiPopeye Online Registration application, P3M application, and other digital platforms. These applications require stable and reliable network infrastructure because the systems are web-based and highly dependent on network connectivity (Eusufzai et al., 2024; Nasim et al., 2025; Sulianta et al., 2024).

With the advancement of computer and communication technologies, the traditional model of a single computer serving all organizational computing tasks has been replaced by interconnected computer systems that perform distributed tasks. Such interconnected systems are referred to as computer networks.

The widespread use of computer networks and the internet has also introduced social, ethical, and political considerations (Battista, 2024; Houssein et al., 2024; Hua et al., 2024). The internet has become integrated into various aspects of society, allowing users from different backgrounds to access information and services regardless of social status, age, or gender (Grošelj et al., 2022; Onunka et al., 2023; Umebali & Ogbuagu, 2025). While internet use for technical, educational, and recreational purposes generally occurs within accepted social norms, challenges may arise when online content involves sensitive topics such as politics, religion, or sexuality. Furthermore, internet communication is no longer limited to text-based information, as high-resolution images and video content can be widely distributed through computer networks. Therefore, responsible internet usage and appropriate information management remain important considerations in digital environments (Dennehy et al., 2023; Franks, 2025; Gursoy et al., 2025; Mihale-Wilson et al., 2022; Trier et al., 2023).

Based on this background, the research questions were formulated as follows: (1) How is the internet connection network topology implemented at Surabaya Maritime Polytechnic? (2) How are the Quality of Service (QoS) characteristics and performance of the internet connection at Surabaya Maritime Polytechnic evaluated based on network performance parameters?

The objectives of this study were to identify the internet network topology implemented at Surabaya Maritime Polytechnic and analyze internet network performance based on QoS parameters. The findings of this research were expected to provide theoretical and practical contributions. Theoretically, this study contributes to the literature on network performance analysis in educational institutions, particularly within the context of maritime education. Practically, the findings provide input for Surabaya Maritime Polytechnic in implementing and developing information technology infrastructure, especially computer network technology, and may serve as a reference for other educational institutions facing similar network performance challenges.

METHOD

Types of Research

This study employed a systematic and comprehensive approach to observe and monitor data traffic on the WLAN network. The researcher analyzed internet network traffic to identify

and measure the parameters required for evaluating the performance of the Surabaya Maritime Polytechnic internet network.

Wireshark was used as a network analysis tool to capture and analyze performance parameters, including throughput, packet loss, delay, and jitter. This study aimed to (1) test the proposed hypotheses and (2) evaluate the actual performance conditions of the Surabaya Maritime Polytechnic internet network.

Research Data

Data in the form of data taken from traffic or network traffic in the form of digital data which is electronic transaction data between servers and clients. Data in the form of network protocols which is a method of exchanging communication between server to server, server to client or client to client, in this study the focus of data is TCP (Transmission Control Protocol) protocol data. Why use data from the TCP protocol, TCP/IP protocol is a protocol that is used in almost all networks both LAN, MAN, WAN and the Internet.

Data Collection Methods

The implementation of this research collects data through several steps:

1. The first step is to observe the topology of the Surabaya Shipping Polytechnic Internet Network
2. The second step is to map Internet Network data traffic using the Wireshark application.

Data Analysis Techniques

The data analysis used was to calculate the data captured from the monitoring of the Wireshark application, by capturing the traffic of the Surabaya Shipping Polytechnic Internet network data. The data is then filtered by capturing the protocols needed in the analysis, in this case the protocol to be used is the TCP protocol. In the QoS analysis of the WLAN Network of the Surabaya Shipping Polytechnic, the focus is on the calculation of Throughput, Packet Loss, Delay and Jitter.

RESULTS AND DISCUSSION

Overview.

The Surabaya Shipping Polytechnic Computer Network is a combination of wire networks or using UTP (Unshield Twisted Pair) and Fiber Optic (FO) cable connections and also Wireless LAN networks using Wi-Fi (Wireless Fidelity) technology.

Wi-Fi Technology (Wireless Fidelity)

Wi-Fi technology is a wireless network technology that uses radio frequencies to exchange information in two directions. This Wi-Fi standard has several variations, such as 802.11a, 802.11b, 802.11g, 802.11n, 802.11ac, and

802.11ax (Wi-Fi 6). Each variation has a different speed and range. The implementation of Wi-Fi at the Surabaya Shipping Polytechnic uses Wi-Fi 4, Wi-Fi 5 and Wi-Fi 6. And most of the devices at the Surabaya Shipping Polytechnic are connected to Wi-Fi, both laptops, PCs, smart phones, tablets, projectors and printers.

WLAN Topology of Surabaya Shipping Polytechnic

In the implementation of WLAN, the Surabaya Shipping Polytechnic applies a star topology where Ap is the center of the topology. An illustration of the Star topology can be seen in the image below.

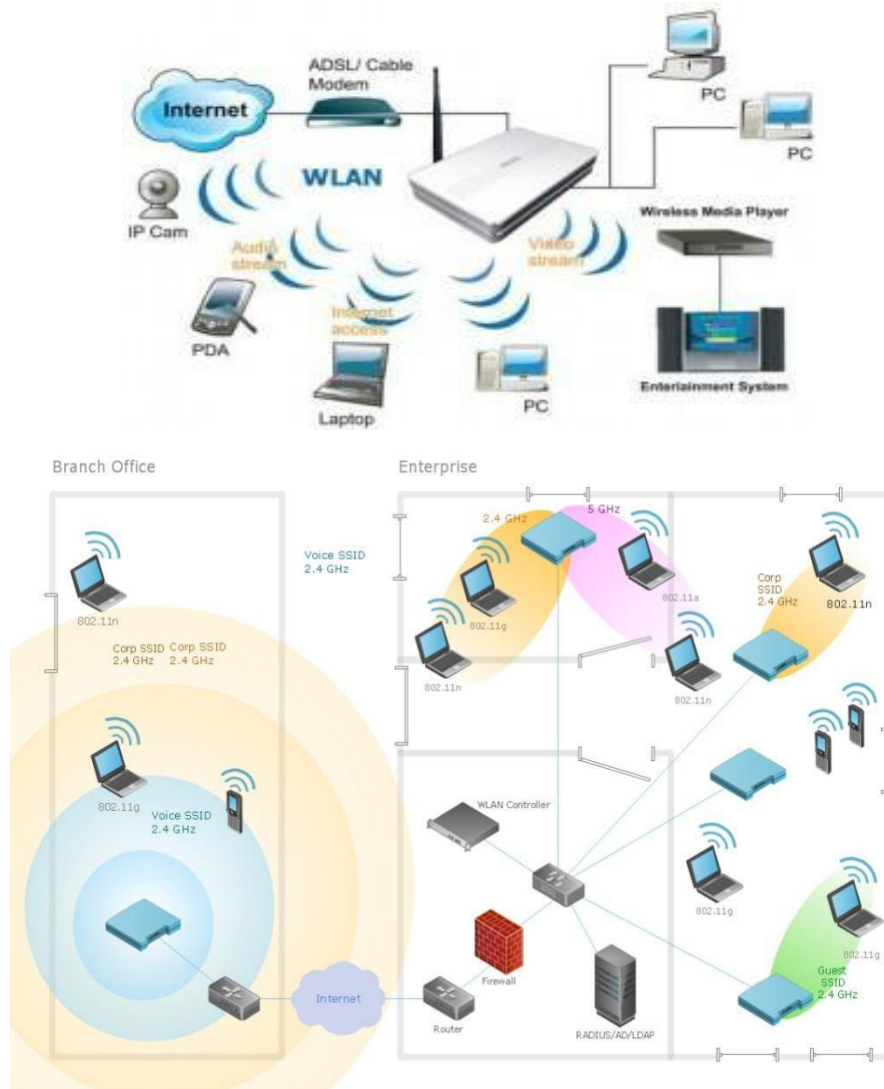


Figure 1. Star WLAN Topology

Wireshark App

Wireshark is a network analysis software that allows users to record and analyze network traffic in real-time. Wireshark can be used to troubleshoot network issues, identify outages, optimize network performance, and even troubleshoot security issues. The use of the wireshark application is widely used by network administrators or network admins in monitoring the network so that they can monitor the real condition of the existing network. Wireshark can be downloaded for free at the <https://www.wireshark.org/> link

1. How Wireshark works

- Wireshark starts by recording data sent over a network, whether it's in the form of a network packet or an Ethernet frame.
- Wireshark then analyzes the data that has been recorded and displays information about each packet sent over the network, including the protocols used, the source and destination addresses, the contents of the packets, and more.
- After that, users can take appropriate actions based on the information displayed by Wireshark, such as troubleshooting network issues, optimizing network performance, or identifying security issues.

2. Benefits of wireshark app in analyzing networks

- Troubleshoot network issues: Wireshark can help network administrators to troubleshoot network issues by looking at network traffic and determining if there are any issues with the network, such as missing packets or slow traffic.
- Analyze security: Wireshark can be used to capture and analyze network traffic to find out if any malicious attacks or activities are happening on the network.
- Monitor network performance: Wireshark can help network administrators to monitor network performance and identify points that are causing slow performance or other issues.

Data Capture

Internet network traffic data can be monitored and captured using the Wireshark application. This data is retrieved by recording / recording Internet network traffic with WLAN. For data recording, you can see the image below as follows

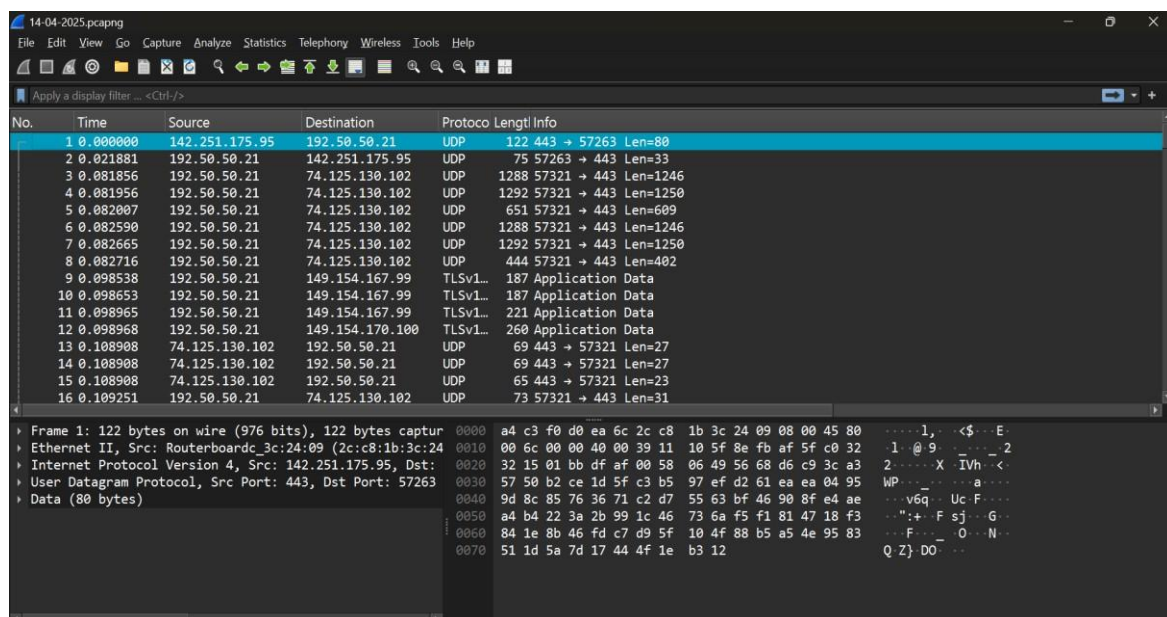


Figure 2. Wireshark application data recording—

The wireshark data above is data on all protocols on the WLAN (Wi-fi) network of the Surabaya Shipping Polytechnic. To facilitate analysis, the data is filtered with a TCP protocol filter. This TCP Protocol data will be analyzed starting from throughput, packet loss, delay and jitter. The data of the wireshark application with the TCP protocol filter can be seen from the image below:

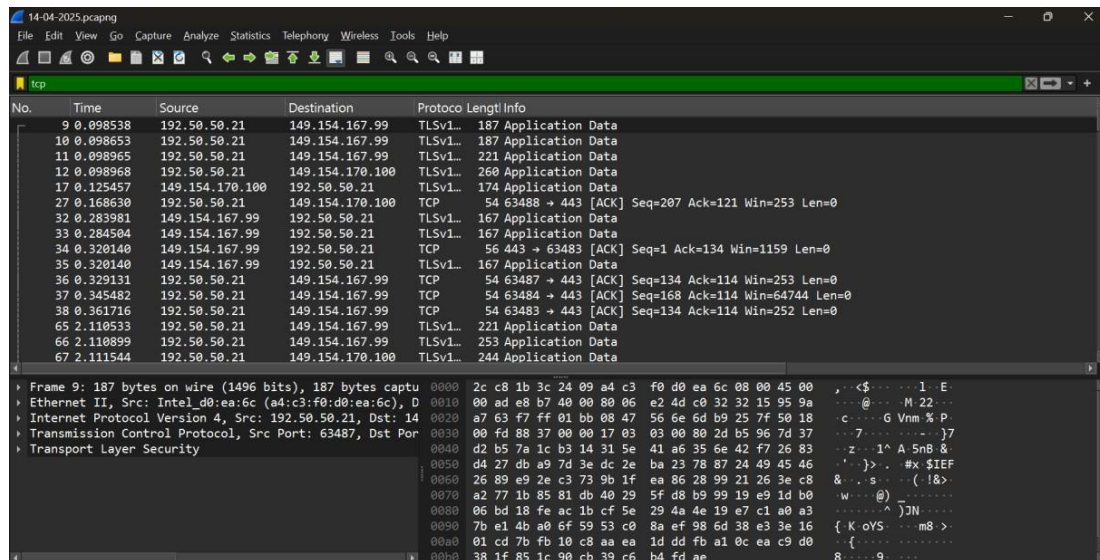


Figure 3. Wi-Fi app Wi-Fi traffic data with TCP protocol filter

Data with the TCP protocol filter is then downloaded / downloaded by converting data from the wireshark application data to the spreadsheet application or Ms Excel application so that the delay and jitter can be calculated, for throughput analysis it can be seen by displaying the statistics from the TCP protocol filter through the Statistic menu and then selecting the Capture File Properties menu. Data from the TCP protocol statistic filter can be seen from the image below

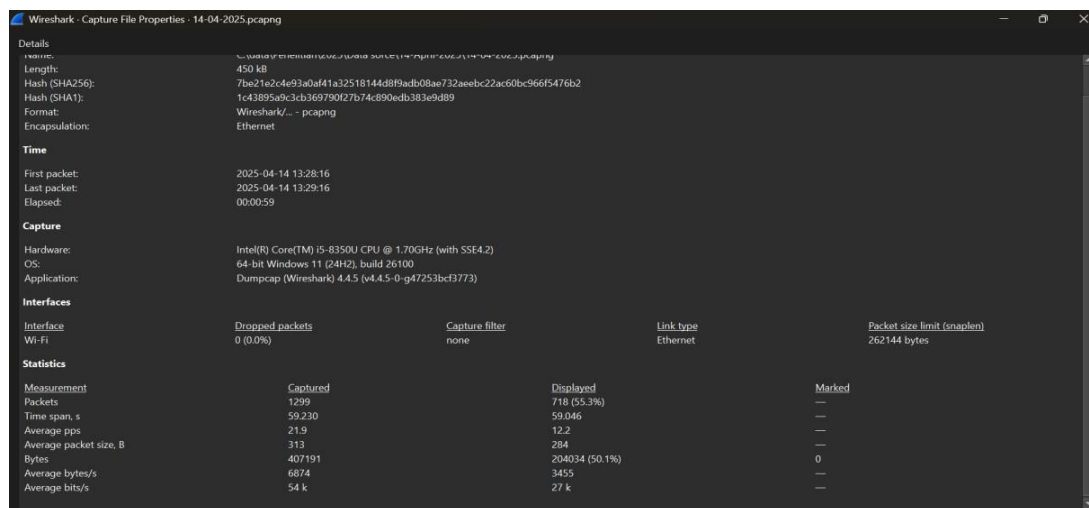


Figure 4. TCP protocol filter statistics

For the analysis of the throughput of the above statistic data, data from the number of bytes and the time span of the data are entered into the throughput calculation with the formula: $\text{Throughput} = (\text{Number of Bytes}) / (\text{Time Span})$

In addition to throughput, delay and jitter, there is one more aspect in QoS analysis, namely the packet lost aspect where packet lost data can be seen in the wirehark application with a special filter, namely with a `tcp.analysis.ack_lost_segment` filter. Packet lost data can be seen from the filter as shown below

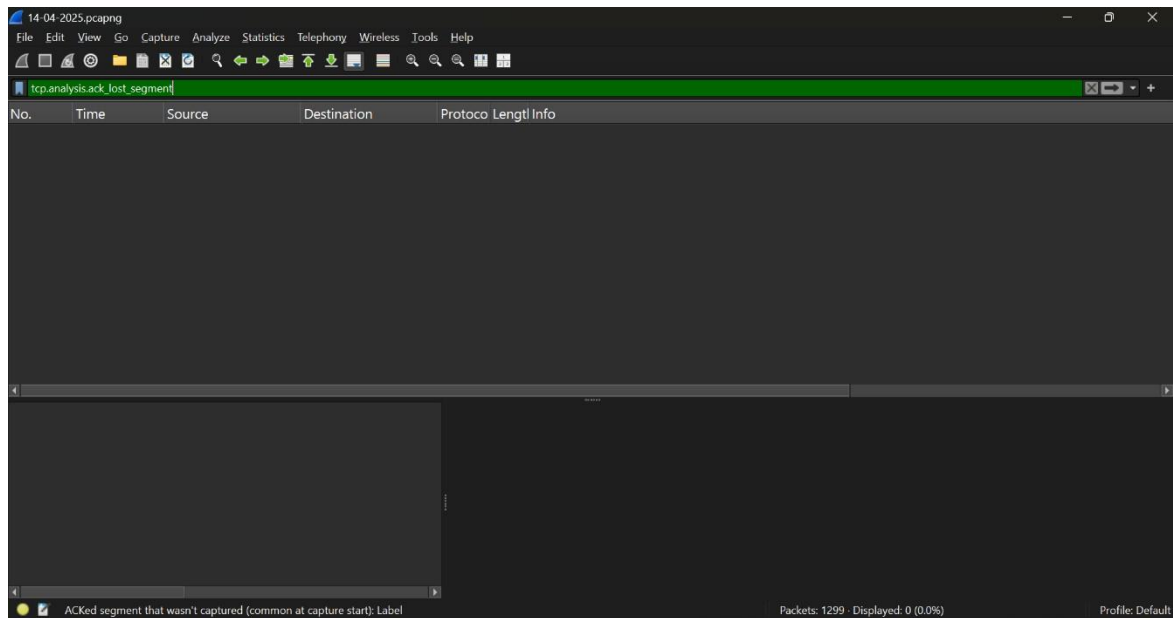


Figure 5. Wireshark filter application data tcp.analysis.ack_lost_segment

The filter will tcp.analysis.ack_lost_segment indicate how many packet losses occurred during data loss or recording, in the image there is no packet loss, it shows that at the time of recording there was no packet loss or no packet data was lost. For comparison, it will be shown how if a packet loss occurs in the wireshark application it will be as shown below:

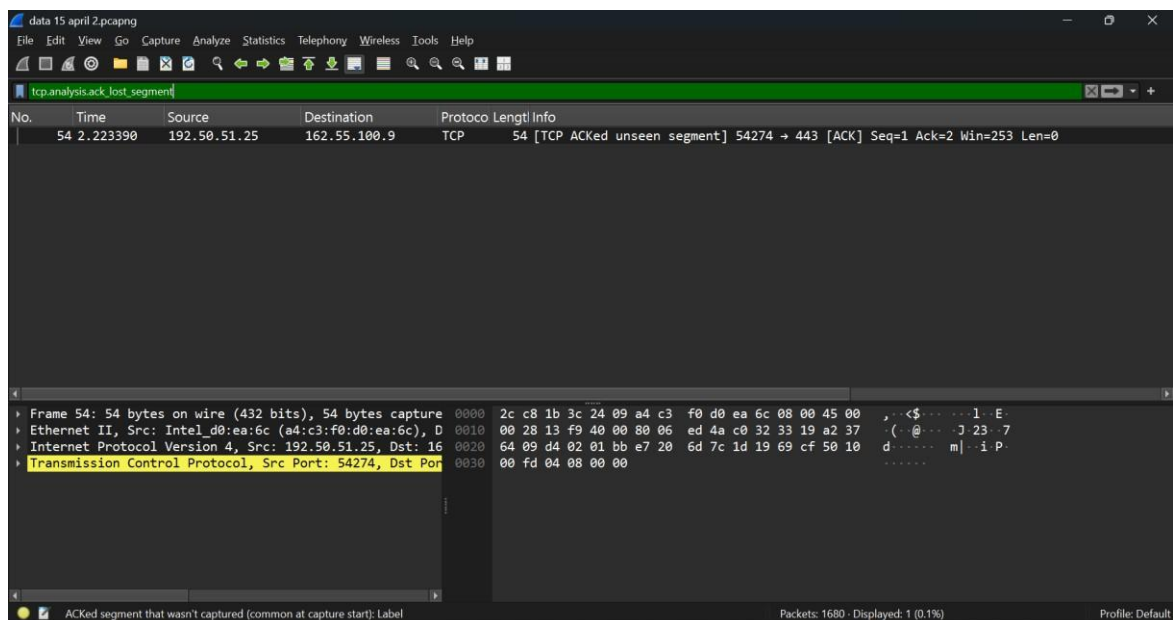


Figure 6. tcp.analysis.ack_lost_segment filter with packet loss

From the image above, it can be seen that there is a packet loss at the time of data recording. For more details, the data can be seen from statistics by opening the statistics menu then selecting the Capture File Properties menu, which can be seen as shown in the image below

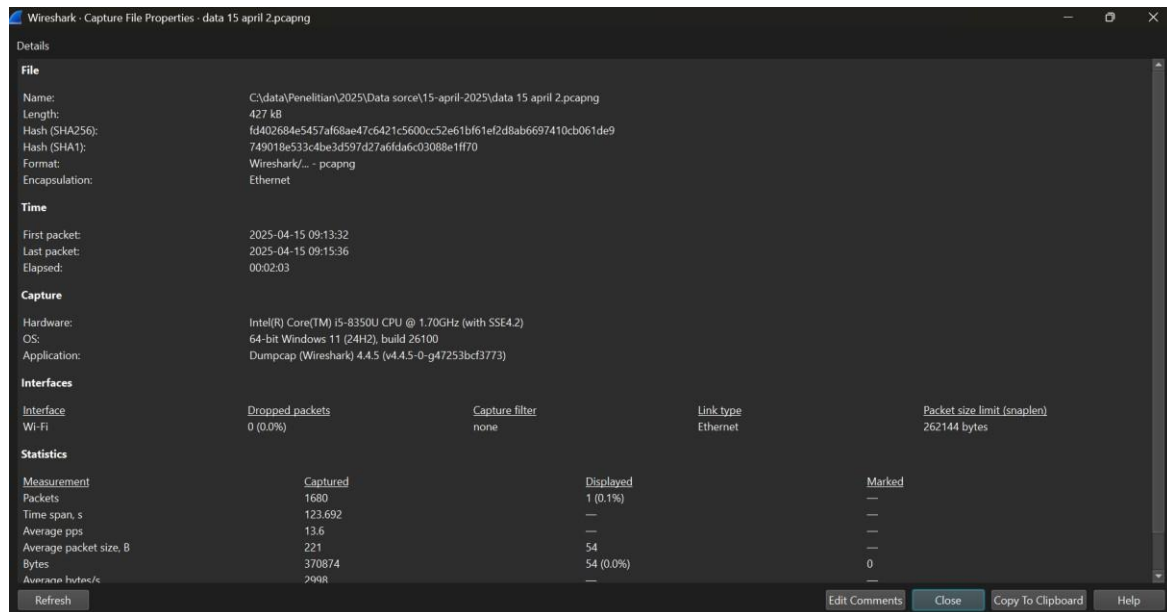


Figure 7. enu statistic Caputure File Properties

From the image above, data can be taken, then to find out how much packet loss can be entered the following formula: $\text{packet loss} = ((\text{package sent})) / (\text{package sent}) \times 100\%$.

In addition to the throughput and packet loss parameters, there are delays and jitters, these two parameters can be calculated by taking TCP protocol filter data then the data is stored or exported in .csv format, from the data that is taken only the time column is then processed and averaged and entered in the average delay formula as follows: $\text{Average delay} = (\text{Total delay}) / (\text{Number of packets received})$ with the same data source to determine the jitter value can be calculated by enter the formula as follows: $\text{jitter} = (\text{Total delay variation}) / (\text{Total packets received})$

Data Analysis

In this study, data collection was carried out for a period of 6 (six) working days, namely April 14, 2025, April 15, 2025, April 16, 2025, April 23, 2025 and 25

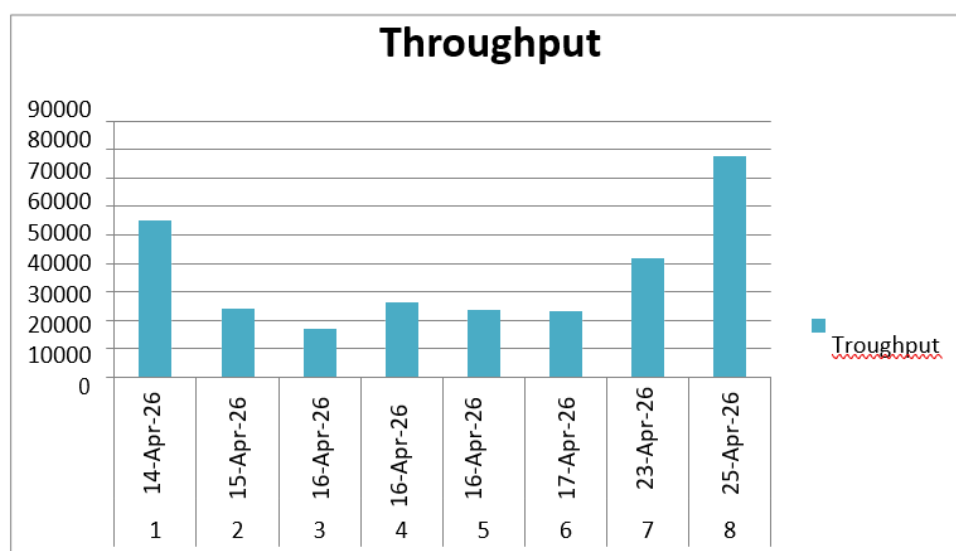
April 2025, there will be a variety of times both in the morning, afternoon and evening. This is intended to find out the real or real characteristics of the network both when the load hours are low and at the hours with high loads, with the retrieval process it is hoped that the data obtained can describe the real conditions of the WLAN network performance of the Surabaya Shipping Polytechnic WLAN

1. Analisa Parameter Throughput

Throughput is the effective data transfer rate, which is measured in bps (bits per second). Throughput is the total number of successful packet arrivals observed at a destination during a given time interval divided by the duration of that time interval. From the data that has been captured or recorded for a period of 6 working days and calculations, the following throughput tables and graphs are obtained:

Table 1. Throughput

No	Date	Sampling	Quantity Byte	Time Span (s)	Throughput (byte)	Throughput (bps)
1	14-Apr-26	1	407191	59.23	6874.742529	54997.94023
2	15-Apr-26	2	370874	123.692	2998.366911	23986.93529
3	16-Apr-26	1	287297	136.66	2102.275721	16818.20577
4	16-Apr-26	2	405672	122.794	3303.679333	26429.43466
5	16-Apr-26	3	364768	123.976	2942.246886	23537.97509
6	17-Apr-26	1	497344	172.896	2876.550065	23012.40052
7	23-Apr-26	1	462593	88.808	5208.911359	41671.29087
8	25-Apr-26	1	844812	87.114	9697.775329	77582.20263

**Graph 1.** Graph Throughput

From the results of the throughput parameter analysis where from all sampling of data capture and recording on the wireshark application, it can be seen that the value of all throughput shows above 100 bps, where the throughput parameter above 100 bps is indexed 4 (very good).

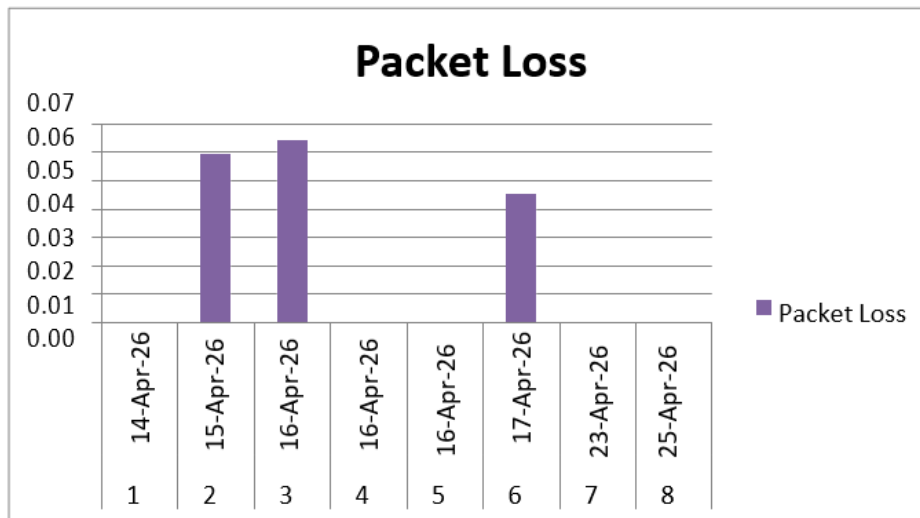
2. Analisa Parameter packet loss

Packet Loss is a parameter that describes a condition that indicates the total number of packets lost due to collision and congestion on the network. From the data that has been captured or recorded for a period of 6 working days and calculations, the packet loss table and graph is obtained as follows:

Table 2. Table packet loss

No	Date	Sample	Package Dikirim	Packages accepted	Packet Loss (%)
1	14-Apr-	1	1299	1299	0.00
2	15-Apr-	2	1680	1679	0.06
3	16-Apr-	1	1560	1559	0.06
4	16-Apr-	2	1842	1842	0.00
5	16-Apr-	3	1987	1987	0.00

No	Date	Sample	Package Dikirim	Packages accepted	Packet Loss (%)
6	17-Apr-	1	2206	2205	0.05
7	23-Apr-	1	2019	2019	0.00
8	25-Apr-	1	2077	2077	0.00



Graph 2. Graph Packet loss

From the packet loss analysis carried out from the wireshark application data in the sampling of data collection for 6 (six) working days, there are 3 conditions where there is a lost package. From the data above, the volume of lost packages is

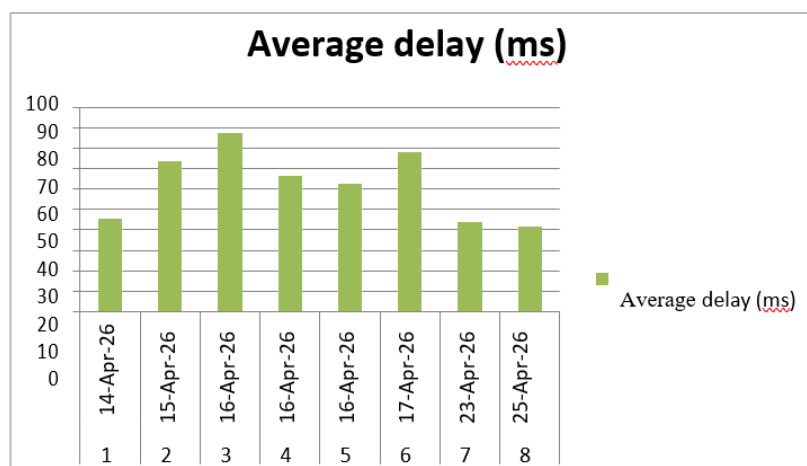
0.05% equals 0.06% and from 8 (eight) times of recording, only 3 (three) packets were missing. If you look at the average volume of packets lost 0.02%, the volume is very small, even close to 0% indexed 4 (very good).

3. Analisa Parameter delay

Delay (Latency) is the time it takes for data to travel the distance from origin to destination. Delay can be affected by distance, physical media, congestion or also long process time. From the data that has been captured or recorded for a period of 6 working days and calculations, the table and graph of Delay are obtained as follows:

Table 3. tabel delay

No	Date	Sampling	Average Delay (s)	Rata-rata delay (ms)
1	14-Apr-26	1	0.045525295	45.52529453
2	15-Apr-26	2	0.073626083	73.62608274
3	16-Apr-26	1	0.087552704	87.55270402
4	16-Apr-26	2	0.066663212	66.666321173
5	16-Apr-26	3	0.062439027	62.4390272
6	17-Apr-26	1	0.078375194	78.37519447
7	23-Apr-26	1	0.04391739	43.91739029
8	25-Apr-26	1	0.041859395	41.85939518



Graph 3. Graphics delay

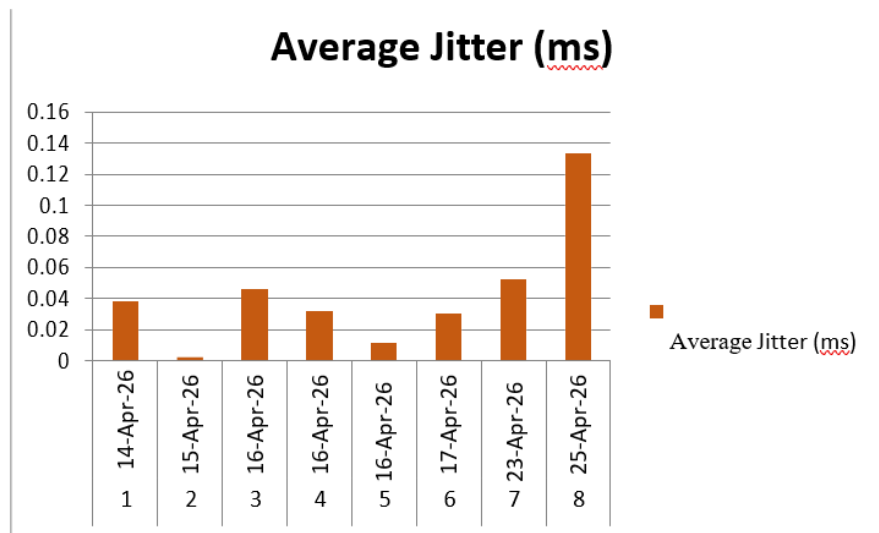
From the delay analysis carried out from the recording data for 6 (six) working days and 8 (eight) times of data recording samples with the wireshark application, the results were obtained as shown in the table and the delay graph above. The value of the average delay of 8 samples indicates a range ranging from 41,859 ms to 87,553 ms. Of these values, the value is still within the range of a value smaller than 150 ms, where if the delay is below 150 ms, it is indexed 4 (very good).

4. Analisa Parameter Jitter

Jitter is caused by variations in queue length, in data processing time, and also in the time of packet recollection at the end of the jitter journey. From the data that has been captured or recorded for a period of 6 working days and calculations, tables and jitter graphs are obtained as follows:

Table 4. Jitter Table

No	Date	Sampling	Overnight wins (s)	Average Jitter (ms)
1	14-Apr-26	1	3.85659E-05	0.038565921
2	15-Apr-26	2	2.09881E-06	0.00209881
3	16-Apr-26	1	4.64424E-05	0.046442358
4	16-Apr-26	2	3.15836E-05	0.031583605
5	16-Apr-26	3	1.17501E-05	0.011750126
6	17-Apr-26	1	3.04655E-05	0.030465549
7	23-Apr-26	1	5.22065E-05	0.052206538
8	25-Apr-26	1	0.000133539	0.133538795



Graph 4. Graphics jitter

From the analysis of jitter parameters, the value was obtained according to the recording data table on the wireshark application for 6 (six) days with 8 (eight) times, the sample was obtained from 0.002 ms to 0.13 ms. The jitter value was in the range of 0 ms to 75 ms with an index of 3 (good).

CONCLUSION

In the digital era, the use of technology has become increasingly widespread, and the need for computer networks is crucial in supporting the learning process, educational administration, office administration, and service activities at the Surabaya Maritime Polytechnic. The networks used include UTP cable networks, fiber optic (FO) networks, and WLAN, with the main topology being Star topology and several sections utilizing Mesh topology. Based on measurements using Wireshark with the parameters of Throughput, Packet Loss, Delay, and Jitter, the WLAN performance of the Surabaya Maritime Polytechnic was generally categorized as very good, with Throughput values above 100 bps, Packet Loss of 0.02%, an average Delay below 150 ms, and Jitter values ranging from 0.02–0.13 ms. However, this study still focused on the internet network and did not include local networks, which occasionally experienced interruptions that affected users' connection quality. In addition, several devices still used Wi-Fi 4 and Wi-Fi 5 technologies and required upgrades to newer technologies. Therefore, further research is recommended to conduct more comprehensive measurements of local networks and cover all areas utilizing Wi-Fi 4 and Wi-Fi 5 technologies to obtain a more complete overview of network performance. These efforts are expected to support optimal improvements in WLAN quality.

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