IJSR International Journal of Scientific Research

e-ISSN: 3063-9697

Received date 9 May 2025; Revised 15 June 2025; Published 30 July 2025

DOI: 10.25299/ijsr.2025.29940

Analysis of Wireless LAN Internet Network Performance at SMA 1 Ampek Angkek Using Quality of Service Parameters

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Abstract: School at Public Senior High School (SMAN) 1 Ampek Angkek utilizes internet network services to support teaching and learning activities, administrative operations, and communication among teachers, students, and administrative staff. As internet connectivity has become an essential component of educational activities, evaluating the quality of the network is necessary to ensure that the available bandwidth provides satisfactory performance for all users. This study aims to analyze the Quality of Service (QoS) of the school's internet network by evaluating teacher/staff accounts with a bandwidth allocation of 1 Mbps and student accounts with 512 kbps. The QoS assessment was conducted using four performance parameters: throughput, packet loss, delay, and jitter. Network traffic was captured and analyzed using Wireshark software during two observation periods, namely 10:00–13:00 and 16:00–19:00. The measurement results for teacher/staff accounts showed an average throughput of 916 kbps, packet loss of 0%, delay of 6.812 ms, and jitter of 6.804 ms during the first observation period, while the second period recorded an average throughput of 878 kbps, packet loss of 0%, delay of 7.152 ms, and jitter of 7.145 ms. For student accounts, the average throughput reached 550 kbps and 544 kbps during the respective observation periods, with packet loss remaining at 0%, while average delay and jitter ranged from 10.064 ms to 10.223 ms. Based on these findings, the internet network at SMAN 1 Ampek Angkek demonstrates stable performance and meets QoS standards, indicating that it can support educational and administrative activities effectively.

Keywords: Wireless LAN, Wireshark, QoS Parameters

1. INTRODUCTION

With the rapid development of information and communication technology in the world in the current era of globalization, especially with the internet network that can help communicate with other parties both in a field of work and administration. The use of internet networks in educational institutions has a very important role in improving the quality of education. With the use of the internet network in the school environment, it can help teachers and students to access the learning references needed and expand the scope of knowledge. This causes the need for an internet service provider that is good, stable and can provide convenient services for users. Wireless local area network is one of the wireless networks. Usually, a wireless network connects one computer system with another system using several kinds of wireless transmission media, such as radio waves, microwaves, or infrared light [1]. QoS is an end-to-end architecture and not a feature of a network. QoS of a network refers to the level of speed and reliability of delivery of various types of data in a communication. QoS offers the ability to define the attributes of the service provided, both qualitatively and quantitatively and the purpose of QoS is to provide different quality of service based on the service requirements in the network [2].

The source of the school internet network SMAN 1 Ampek Angkek uses Internet Service Provider from Golden Net with 40 Mbps bandwidth which is managed by the Puskom SMAN 1 Ampek Angkek. School Computer Centre *(Puskom)* grouped for teacher or staff user ID with 1 Mbps bandwidth and student user ID with 512 kbps bandwidth that can be used to access school Wi-Fi internet network services. However, more and more internet network users cause unstable internet network connections that can interfere with the teaching and learning process and administration in the school environment. The internet network at SMAN 1 Ampek Angkek school needs to be analyzed for QoS to find out whether the internet network service is good with the facilities provided by the school and can be a reference for schools to improve the quality of a better internet network for teachers, students and administrative staff.

2. LITERATURE REVIEW

2.1 Wireless LAN

Wireless Local Area Network (WLAN) is a local computer network that uses radio waves (Wireless) as its transmission medium. So, to connect between computers or computers to the internet using wireless signals. The components in WLAN are WLAN interface, access point, antenna. The WLAN interface is in the form of an access device for users who use laptops and is usually already installed on the PCMCIA port, but for desktop computers a device such as a wireless adapter must be added. Access points are the most important device for WLAN networks because they are central devices for connecting between devices and can connect to ISPs [3].

2.2 QoS

QoS is a method for measuring how good a network is and attempts to define the characteristics and properties of a service. QoS is defined and used to measure a set of performance attributes associated with a service. QoS refers to a set of technologies that work throughout the network to ensure the ability to reliably run high-priority applications and traffic within limited network capacity [4].

Performance is a collection of several technical parameters, namely:

- Throughput

Throughput is the effective data transfer rate, measured in bits per second (bps). Throughput is the total number of packet arrivals successfully observed in each time interval divided by that time interval.

Throughput value can be calculated using Equation (1).

$$Throughput = \frac{jnumber\ of\ received\ data}{time\ sending\ data} \quad (1)$$

Table 1. TIPHON Throughput Categories

Degradation category	Throughput	Index
Very good	>2.1 Mbps	4
Good	1200 kbps - 2.1 Mbps	3
Medium	700 - 1200 kbps	2
Not so good	338 - 700 kbps	1
Bad	0 - 338 kbps	0

- Packet loss

Packet loss is a parameter that describes a condition that shows the total number of lost packets that can occur due to collision and congestion in a network service.

Packet Loss value can be calculated using Equation (2).

$$Packet\ loss = \frac{(sending\ packet - received\ packet)}{sending\ packet} x100\% \quad (2)$$

Table 2. TIPHON Packet Loss Categories

Degradation category	Packet loss (%)	Index
Very good	0 - 2	4
Good	3 - 14	3
Medium	15 - 24	2
Bad	>25	1

Meanwhile, based on ITU-T there are three categories of packet loss standardization as follows [6].

Table 3. ITU-T G.114 Packet Loss Categories

Packet loss (%)	Category
0 - 1	Good
1 - 5	Simply
>10	Bad

- Delay

Delay is the time it takes for data to travel from origin to destination. Delay is affected by distance, physical media, congestion and long processing time.

Delay value can be calculated using Equation (3).

$$Delay = \frac{total\ delay}{total\ paket\ yang\ diterima} \quad (3)$$

Table 4. TIPHON Delay Categories

Degradation category	Delay (ms)	Index
Very good	<150	4
Good	150 - 300	3
Medium	300 - 450	2
Bad	>450	1

Meanwhile, based on ITU-T there are three categories of delay standardization as follows [6].

Table 5. ITU-T G.114 Delay Categories

Delay (ms)	Category
0 - 150	Good
150 - 400	Simply
>400	Bad

- Jitter

Jitter is the variation in delay caused by variations in queue length during data processing and reassembly of packets at the end of the jitter journey.

The jitter value can be calculated using Equation (4).

$$Jitter = \frac{total\ variation\ delay}{total\ receved\ packet} \quad (4)$$

Table 6. TIPHON Jitter Categories

Degradation category	Jitter (ms)	Index
Very good	0	4
Good	1 - 75	3
Medium	76 - 125	2
Bad	125 - 225	1

Meanwhile, based on ITU-T there are three categories of jitter standardization as follows [6].

Table 7. ITU-T G.114 Jitter Categories

Jitter (ms)	Category
0 - 20	Good
20 - 50	Simply
>50	Bad

2.3 Quality of Service (QoS) Model

There are three Quality of Service (QoS) service models, namely as follows [5-6]:

a. Best-effort service.
Best-effort service is used to make all efforts to send packets to a destination. The use of best-effort service will not guarantee that the packet can reach the desired destination. Some applications can use best-effort service, for example FTP and HTTP which can support best-effort service without experiencing problems.

b. Integrated service.
Integrated services provide applications with a guaranteed level of service through end-to-end negotiation of network parameters. Applications will request the level of service required to operate and depend on the QoS mechanism to provide network resources starting from the beginning of the transmission of the application.

c. Differentiated service.
Differentiated service provides a set of classification tools and queuing mechanisms for protocols or applications with certain priorities over different networks. Differentiated service relies on the ability of the edge router to provide classification of packets of different types that pass through the network.

2.4 Wireshark

Wireshark is one of the free and open-source packet analyzers. This tool is used for network troubleshooting, analysis, software and as well as developing communication protocols, as well as education, of the many network administrator applications to analyze the performance of their network and control data traffic on the network managed by Wireshark [7-8].

3. METHODOLOGY

3.1 Research Methods

This stage of the research, researchers used the action research method. The action research methods in the research include:

a. Diagnose.
At this stage of the research, problem identification is carried out to find the main problem with the aim of obtaining a clear picture of the problem that will be the basis of research at SMAN 1 Ampek Angkek.

b. Conduct Action Plan.
After understanding the subject matter and then proceed to develop an action plan to solve the existing problems. In this action plan stage, analyze the software, hardware, and Wireless LAN network scheme at SMAN 1 Ampek Angkek which will be applied to the measurement of QoS parameters.

c. Acting.
At the stage of acting, researchers implement the action plan that has been prepared. Researchers conducted network measurements with the QoS monitoring system model on the LAN wireless network at SMAN 1 Ampek Angkek, namely throughput, packet loss, delay and jitter using Wireshark software.

d. Conduct Evaluation.
After the QoS parameter measurement is complete. Then the researchers conducted an analysis, and the results obtained from the research will be compared with the assessment of the TIPHON and ITU-T standardization versions. Then it can be categorized that the QoS value of internet network services at SMAN 1 Ampek Angkek according to the TIPHON standardization is in the very good, good, medium, and bad categories and according to the ITU-T standardization in the good, sufficient, and bad categories.

3.2 Data Collection Methods

In order to get the correct data results about the research at SMAN 1 Ampek Angkek conducted, a data collection method is needed to achieve the research objectives. Data collection methods carried out include:

a. Observation.
Directly observing the internet network at SMAN 1 Ampek Angkek in order to know the condition of the network that will be carried out research. Research is conducted by measuring data using Wireshark software to determine the value of QoS, namely Throughput, packet loss, delay and jitter.

b. Interview.
Conduct interviews to obtain information about the internet network and how to process the internet network at the research location.

c. Literature study.
Studying literature references from previous studies related to research as a guide for writers to conduct better research.

3.3 Research Scenario

Network measurements were carried out on teacher/staff accounts with 1 Mbps bandwidth and student accounts with 512 kbps bandwidth in the area of office buildings, teachers' rooms, laboratories and classroom buildings in heavy user conditions starting from 10.00-13.00 WIB and low user conditions at 16.00-19.00 WIB in the SMAN 1 Ampek Angkek school environment. QoS measurement is done by accessing website services, namely Youtube and Kemendikbud (www.kemendikbud.go.id) using Wireshark software [9-10]. The following can be seen in the flow chart of QoS analysis testing in figure 1.

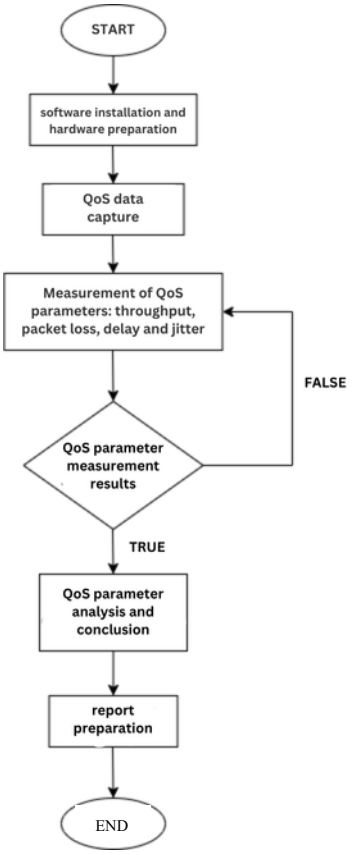
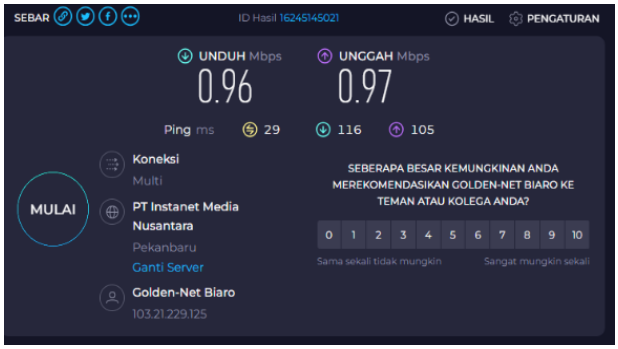


Figure 1. Flowchart of QoS Analysis

4. RESULTS AND DISCUSSION

4.1 Bandwidth Testing Analysis

Testing the speed of the internet network connection at SMAN 1 Ampek Angkek using the Speed test by Okla tool. Researchers conducted bandwidth testing on teacher/staff accounts of 1 Mbps and student accounts of 512 kbps, the results of the test provide information about the speed of network connections at school. The results of bandwidth testing are as follows [11].



(a)

(b)

Figure 2. Bandwidth Testing (a) Teacher/Staff Account Mbps and (b) Student Account 512 kbps.

4.2 Quality of Service (QoS) Analysis Results

After measuring wireless LAN networks on teacher/staff accounts with 1 Mbps bandwidth and student accounts with 512 kbps bandwidth in office buildings, teachers' rooms, laboratories and classroom buildings in heavy user conditions at 10.00-13.00 and low user conditions at 16.00-19.00, then analyze the internet network that has been measured to determine the performance of internet network services based on TIPHON and ITU-T standards.

a. Analysis of QoS Results on Teacher/Staff Accounts

- Throughput

Throughput of teacher/staff accounts with 1 Mbps bandwidth in office buildings, teachers' rooms, laboratories and classroom buildings by accessing Youtube and Kemendikbud website services.

Table 8. Teacher/Staff Account Throughput

Building	Website	Throughput (kbps)	
		10.00-13.00	16.00-19.00
Office Building	Youtube	921	939
	Ministry of Education	938	830
Teacher's Room	Youtube	1006	935
	Ministry of Education	1046	773
Laboratory	Youtube	927	956
	Ministry of Education	792	923

Classroom building	Youtube	1019	851
	Ministry of Education	686	819
Average Throughput		916	878

Refer to the table above, the average throughput of teacher/staff accounts in office buildings, teachers' rooms, laboratories and classroom buildings in heavy user conditions at 10.00-13.00 is 916 kbps in the "medium" category, and in low user conditions at 16.00-19.00 is 878 kbps in the "medium" category based on TIPHON.

- Packet loss

Packet loss of teacher/staff accounts with 1 Mbps bandwidth in office buildings, teachers' rooms, laboratories and classroom buildings by accessing YouTube and Kemendikbud website services.

Table 9. Packet Loss of Teacher/Staff Account

Building	Website	Packet loss (%)	
		10.00-13.00	16.00-19.00
Office Building	Youtube	0	0
	Ministry of Education	0	0
Teacher's Room	Youtube	0	0
	Ministry of Education	0	0
Laboratory	Youtube	0	0
	Ministry of Education	0	0
Classroom building	Youtube	0	0
	Ministry of Education	0	0
Average Packet Loss		0	0

Refer to the table above, the average packet loss for teacher/staff accounts in heavy user conditions at 10.00-13.00 has an average of 0% (TIPHON: "very good", ITU-T: "good") and low user conditions at 16.00-19.00 has an average of 0% (TIPHON: "very good", ITU-T: "good").

- Delay

Delay for teacher/staff accounts with 1 Mbps bandwidth in office buildings, teachers' rooms, laboratories and classroom buildings by accessing YouTube and Kemendikbud web services.

Table 10. Teacher/Staff Account Delay

Building	Website	Delay (ms)	
		10.00-13.00	16.00-19.00
Office Building	Youtube	6,344	6,147
	Ministry of Education	7,243	7,982
Teacher's Room	Youtube	5,076	6,215
	Ministry of Education	6,557	8,775
Laboratory	Youtube	6,334	6,062
	Ministry of Education	8,132	7,507
Classroom building	Youtube	5,683	6,216
	Ministry of Education	9,141	8,319
Average Delay		6,812	7,152

Refer to the table above, the average delay for teacher/staff accounts in heavy user conditions at 10.00-13.00 has an average of 6.812 ms (TIPHON: "very good", ITU-T: "good") and low user conditions at 16.00-19.00 has an average of 7.152 ms (TIPHON: "very good", ITU-T: "good").

- Jitter

Teacher/staff account jitter with 1 Mbps bandwidth in office buildings, teachers' rooms, laboratories and classroom buildings by accessing YouTube and Kemendikbud website services.

Table 11. Teacher/Staff Account Jitter

Building	Website	Jitter (ms)	
		10.00-13.00	16.00-19.00
Office Building	Youtube	6,334	6,147
	Ministry of Education	7,123	7,926
Teacher's Room	Youtube	5,076	6,217
	Ministry of Education	6,557	8,775
Laboratory	Youtube	6,333	6,062
	Ministry of Education	8,126	7,505
Classroom building	Youtube	5,691	6,216
	Ministry of Education	9,198	8,319
Average Jitter		6,804	7,145

Refer to the table above, the average jitter for teacher/staff accounts in heavy user conditions at 10.00-13.00 has an average of 6.804 ms (TIPHON: "good", ITU-T: "good") and low user conditions at 16.00-19.00 has an average of 7.145 ms (TIPHON: "good", ITU-T: "good").

b. Analysis of Student Account QoS Results

1. Throughput

Throughput of student accounts with 512 kbps bandwidth in office buildings, teachers' rooms, laboratories and classroom buildings by accessing YouTube and Kemendikbud website services.

Table 12. Student account throughput

Building	Website	Throughput (kbps)	
		10.00-13.00	16.00-19.00
Office Building	Youtube	574	493
	Ministry of Education	558	529
Teacher's Room	Youtube	561	608
	Ministry of Education	535	509
Laboratory	Youtube	583	597
	Ministry of Education	434	516
Classroom building	Youtube	582	593
	Ministry of Education	576	514
Average Throughput		550	544

Refer to the table above, the average throughput of student accounts in office buildings, teachers' rooms, laboratories and classroom buildings in heavy user conditions at 10.00-13.00 is 550 kbps in the "not good" category and in low user conditions at 16.00-19.00 is 544 kbps in the "not good" category based on TIPHON.

2. Packet Loss

Packet Loss student accounts with 512 kbps bandwidth in office buildings, teachers' rooms, laboratories and classroom buildings by accessing YouTube and Kemendikbud website services.

Table 13. Packet Loss Student account

Building	Website	Packet loss (%)	
		10.00-13.00	16.00-19.00
Office Building	Youtube	0	0
	Ministry of Education	0	0
Teacher's Room	Youtube	0	0
	Ministry of Education	0	0
Laboratory	Youtube	0	0
	Ministry of Education	0	0
Classroom building	Youtube	0	0
	Ministry of Education	0	0
Average Packet Loss		0	0

Refer to the packet loss table, the student account of the user-dense conditions at 10.00-13.00 has an average of 0% (TIPHON: "very good", ITU-T: "good") and the user-less conditions at 16.00-19.00 has an average of 0% (TIPHON: "very good", ITU-T: "good").

3. Delay

Delay of student accounts with 512 kbps bandwidth in office buildings, teachers' rooms, laboratories and classroom buildings by accessing YouTube and Kemendikbud web services.

Table 14. Student Account Delay

Building	Website	Delay (ms)	
		10.00-13.00	16.00-19.00
Office Building	Youtube	8,927	10,215
	Ministry of Education	10,956	10,750
Teacher's Room	Youtube	9,021	8,026
	Ministry of Education	10,071	12,372
Laboratory	Youtube	8,738	8,305
	Ministry of Education	14,076	12,087
Classroom building	Youtube	8,412	8,256
	Ministry of Education	10,311	11,778
Average Delay		10,064	10,223

Refer to the table above, the average delay parameter for student accounts in heavy user conditions at 10.00-13.00 has an average of 10.064 ms (TIPHON: "very good", ITU-T: "good") and low user conditions at 16.00-19.00 has an average of 10.223 ms (TIPHON: "very good", ITU-T: "good").

4. Jitter

Jitter on student accounts with 512 kbps bandwidth in office buildings, teachers' rooms, laboratories and classroom buildings by accessing YouTube and Kemendikbud website services.

Table 15. Student Account Jitter

Building	Website	Jitter (ms)	
		10.00-13.00	16.00-19.00
Office Building	Youtube	8,926	10,216
	Ministry of Education	10,953	10,750
Teacher's Room	Youtube	9,020	8,026
	Ministry of Education	10,071	12,370
Laboratory	Youtube	8,738	8,304
	Ministry of Education	14,077	12,059
Classroom building	Youtube	8,412	8,257
	Ministry of Education	10,313	11,779
Average Jitter		10,055	10,220

Refer to the table above, the average jitter parameter for student accounts in heavy user conditions at 10:00-13:00 has an average of 10.055 ms (TIPHON: "good", ITU-T: "good") and low user conditions at 16:00-19:00 has an average of 10.220 ms (TIPHON: "good", ITU-T: "good").

5. CONCLUSION

Based on the results and discussion, analyzing the performance of wireless networks using Quality of Service (QoS) parameters, researchers obtained several conclusions, namely as follows:

- Quality of service analysis measures throughput, packet loss, delay and jitter on teacher/staff accounts and student accounts using Wireshark software.
- The measurement results on the teacher/staff account at 10:00-13:00 have an average throughput of 916 kbps, packet loss of 0%, delay of 6.812 ms, and jitter of 6.804 ms while at 16:00-19:00 has an average throughput of 878 kbps, packet loss of 0%, delay of 7.152 ms, and jitter of 7.145 ms.
- Measurement results on student accounts at 10:00-13:00 have an average throughput of 550 kbps, packet loss of 0%, delay of 10.064 ms, and jitter of 10.055 ms while at 16:00-19:00 has an average throughput of 544 kbps, packet loss of 0%, delay of 10.223 ms, and jitter of 10.220 ms.

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