Journal of Engineering Research and Reports

Volume 26, Issue 5, Page 237-246, 2024; Article no.JERR.115883
ISSN: 2582-2926

Evaluating Internet Network Quality: A Comprehensive Analysis by the Pnup Directorate of Building

Ibrahim Abduh [a*], Husain Syam [b] and Abdul Muis M [c]

[a] *Department of Vocational and Engineering, Universitas Negeri Makassar, Indonesia.*
[b] *Department of Engineering, Universitas Negeri Makassar, Indonesia.*
[c] *Engineering Vocational Education, Universitas Negeri Makassar, Indonesia.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JERR/2024/v26i51150

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/115883

Original Research Article

Received: 12/02/2024
Accepted: 16/04/2024
Published: 22/04/2024

ABSTRACT

This study raises the problem of the condition of the building network of the Directorate of PNUP which has an irregular cabling structure so that if a network installation is carried out by connecting to the nearest switch without regard to cable paths, the cables are not on the path according to the irregular distribution of IP networks and bandwidth. The purpose of this study is to enhance the quality of the internet network in the PNUP Directorate building, compare the network performance before and after revitalizing fiber optic cables, and determine the internet bandwidth requirements in the PNUP Directorate building. The method employed is assessing internet network performance using Quality of Service parameter, by evaluating when the implementation that has been carried out is deemed sufficient, the evaluation is carried out based on the test results of the Quality of Service parameter. The user speed test is performed on public IP, followed by data recording and capture using tilnet tools. The values for delay, throughput, packet loss, and jitter are then processed and calculated. The outcome of this research demonstrates that network revitalization

---

**Corresponding author: Email: jpublicationn@gmail.com;*

has successfully increased bandwidth usage, particularly in data transmission (Tx). Additional capacity and increased network performance after the revitalization allow for greater and more efficient use of bandwidth in transmitting data.

Keywords: Quality of service (QoS); revitalization, bandwidth; wireless LAN; action research.

1. INTRODUCTION

The advancement of telecommunications technology is currently progressing at a rapid pace, therefore, telecommunications technology must offer optimal quality and ease of access to users, for example internet technology, every service user must wish to have good network quality when used in communication. This makes network managers in an agency strive to provide optimal service to internet service users, the quality of the internet network can be said to be poor if the parameter value does not meet the provider's standards and can be said to be good if the internet network parameter value meets the provider's standards [1,2].

Each provider must have a network eligibility standard to determine the good and bad signal quality that will be provided to service users. Network maintenance is very important in maintaining the reliability of network quality in an agency, therefore it is necessary to revitalize the network in stages, to support the stability of internet services provided [3-5]. Internet network revitalization is an activity to expand the fiber optic network from the server to the task implementing unit and unreached centers. With network revitalization, agencies can monitor the quality of the network infrastructure used, whether it is still feasible to operate or not, and repair or upgrade network infrastructure.

Higher education has very different characteristics from basic education. In general, higher education requires more complex resources for the delivery of education. To facilitate such extensive education delivery, the IT infrastructure and assets on campus are crucial for the Information Technology system to provide services for staff and students. Moreover, due to technological advancements that necessitate internet assistance for operations, secure and fast transmission is vital for operational efficiency in modern institutions, including higher education institutions. Thus, the campus network infrastructure must ensure its resilience, availability, and quality [6-9].

The current network condition in the PNUP Directorate building presents several complex issues. For instance, an irregular wiring structure may lead to issues when a technician directly connects to the nearest switch without considering the cable path, resulting in the cable not being on the correct path for irregular network IP and bandwidth division. In addition, the fiber optic cable connected to the PNUP Directorate building has one cable with a total of 6 cores, in the network installation the number of cores used is only 2 cores [10-12].

After studying and observing the existing problems, the authors took the initiative to conduct a research by raising several issues including how to analyze the quality of the internet network in the PNUP Directorate building, how the results of measuring internet quality before and after revitalization in the PNUP Directorate building, and how the network bandwidth requirements in the PNUP Directorate building. So that the results of this research are knowing the quality of the internet network in the PNUP Directorate building, knowing the quality of the internet network before and after revitalizing the fiber optic cable in the PNUP Directorate building, and knowing the internet bandwidth requirements in the PNUP Directorate building.

2. LITERATURE REVIEW

2.1 Network

A network is an operating system consisting of a number of computers and other network devices that work together to achieve a goal. A network is also defined as a work network consisting of interconnected nodes, with or without cables, where each node functions as a workstation. One of the nodes is a media service or server, which is a node that manages certain functions of other nodes. Computer network technology is essentially a fusion of computer technology and communication technology. The concept of computer networks was initiated in the United States in the 1940s by a Harvard University research group led by professor H. Aiken. Initially this project only wanted to utilize a computer device that could be used together and to work on several processes without wasting much time. Therefore, Batch Processing was created so that several programs could be run on a computer with queuing rules [13].

2.2 Fiber Optic

Fiber optic is a waveguide used for light transmission. It consists of a dielectric fiber core, usually derived from glass, surrounded by a layer of plastic sheath glass characterized by a refractive index lower than the core. The light transmitted through the optical fiber is trapped inside the core due to the total intenal reflection phenomenon [14]. Fiber optics serve as a transmission medium, utilizing light as a conduit for information (data) [15]. The advantages of fiber optic cable include:

1. Has a wide frequency bandwidth (wide bandwidth). The optical carrier frequency works in the high frequency area, which is around 1013 Hz to 1016 Hz, so that the information carried will be a lot.
2. Very low attenuation compared to cables made of copper, especially at frequencies that have wavelengths around 1300 nm, which is 0.2 dB/km.
3. Immune to electromagnetic wave interference. Fiber optic is made of glass or plastic which is an insulator, meaning it is free of magnetic field interference, radio frequency and electrical interference.
4. Can transmit digital information at high speed. The ability of fiber optics to transmit high frequency signals is very suitable for sending digital signals in digital multiplex systems at speeds of several Mbit/s to Gbit/s.
5. The size and weight of fiber optic is small and light, so the use of space is more economical.
6. Does not conduct electricity because it is made of glass or plastic so that it cannot be irrigated with electric current (avoid short circuit).
7. The system is reliable (20-30 years) and easy to maintain.
8. Low Cast and flexible.

2.3 Quality of Service (QoS)

Quality of Service is a technique for managing bandwidth, delay, and packet loss for flows in a network. The goal of a QoS mechanism is to affect at least one of the four basic QoS parameters specified. QoS is designed to help end users (clients) be more productive by ensuring that users get reliable performance from network-based applications. QoS refers to the ability of a network to provide good service to specific network traffic through different technologies. QoS is a major challenge in IP-based networks and the internet as a whole [16]. In terms of networking, QoS refers to the ability to provide different services to network traffic of different classes. The ultimate goal of QoS is to provide a better and planned network service with dedicated bandwidth, controlled jitter and latency and improved loss characteristics. Or QoS is the ability to guarantee the delivery of important data flows or in other words, a collection of various performance criteria that determine the level of satisfaction of using a service [17].

2.4 QoS Parameters

Throughput: Throughput is the total number of successful packet arrivals observed at the destination during a given time interval divided by the duration of that time interval. Throughput is the actual ability of a network to transmit data. Usually, throughput is always associated with bandwidth because throughput can indeed be called bandwidth in actual conditions.

Delay: Delay is the time delay of a packet caused by the transmission process from one point to another point that is the destination. Delay in the network can be classified as follows:

a. **Package Delay:** Delay caused by the time required for the formation of IP packets from user information. This delay only occurs once, at the source of the information.
b. **Queuing Delay:** This delay is caused by the processing time required by the router in handling packet transmissions on the network; generally this delay is very small, approximately around 100 microseconds.
c. **Propagation delay:** The process of traveling information while in the transmission medium, such as SDH, coaxial or copper cables, causes a delay called propagation.

Delay calculation equation:

$$\textit{Average delay} = \frac{delay\ total}{package\ accept\ total}$$

Table 1. Delay Category

Latency Category	Delay	Index
Very good	< 150 m/s	4
Good	150 to 300 m/s	3
Medium	300 to 450 m/s	2
Bad	>450 m/s	1

(Source: ETSI 1999-2006)

Table 2. Packet Loss Category

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

(Source: ETSI 1999-2006)

Table 3. Jitter Category

Degradation Category	Peak Loss	Index
Very good	0%	4
Good	1 to 75 m/s	3
Medium	76 to 125 m/s	2
Bad	>225%	1

(Source: ETSI 1999-2006)

Packet loss: Packet loss is defined as the failure of an IP transmission to reach its destination. The failure of the packet to reach its destination can be caused by several possibilities, including:

a) Traffic overload in the network.
b) Congestion in the network.
c) Errors that occur on the receiving side can be caused by *overflow* in the *buffer.*

Packet loss calculation equation:

$$Packet\ loss = \frac{(\text{data packets sent} - \text{data packets received})}{\text{total packets sent}} \times 100\%$$

Jitter: Jitter is the variation of delay between packets that occurs on an IP network. The magnitude of the jitter value will be greatly influenced by variations in traffic load and the amount of collisions between packets (congestion) in the IP network. The greater the traffic load in the network will cause a greater chance of congestion, thus the value of jitter will be greater. The greater the jitter value, the lower the QoS value. To get a good network QoS value, the jitter value must be kept to a minimum.

Jitter calculation equation:

$$Jitter = \frac{\text{total delay variation}}{\text{packets received} - 1}$$

The total delay variation is obtained from:

(*Delay* 2 - *delay* 1) + (*delay 3-delay* 2) + . . . + (*delay* n - *delay (*n-1))

3. METHODS

At this stage the researcher will carry out the Action Research research method, namely by diagnosing to identify the main problems that exist so that they can be used as a basis for change, making an action plan by compiling an appropriate action plan for network quality testing, then by taking action by implementing the action plan in order to solve the problem by testing the quality of the internet network based on QoS parameters, and the last is by evaluating when the implementation that has been carried out is considered sufficient, the evaluation is carried out based on the test results of the QoS parameters.

Researchers collect data by observing traffic from the internet network in the PNUP Directorate building. Internet network analysis with stages of the Analysis process that refers to Quality of Service (QoS) to speedtest testing on the cloud flare server to ensure that the device used is connected to the network connection. The user performs a speed test on the cloud flare, then proceeds with data recording and capture, the data obtained is then processed and calculated the value of delay, throughput, packet loss, and jitter.

4. RESULTS AND DISCUSSION

4.1 Results

Sampling was conducted for 10 days continuously at three different times of the day, with the aim of observing and evaluating relevant network performance metrics, with respect to throughput, latency, packet loss, and jitter parameters.

Throughput: Throughput refers to the amount of data that can be sent or received by the network in a given time. In this measurement, throughput will be measured at the PNUP Directorate Building at three different times in one day. Throughput measurement is done by calculating the amount of data successfully transferred within a certain period of time. Throughput data collected for 10 days will be analyzed to determine the average daily throughput, throughput comparison between different times, and to identify factors that can affect throughput performance.

Latency: Latency refers to the time taken by data packets to travel from source to destination in the network. In this measurement, latency was measured at the PNUP Directorate Building at three different times in one day. Latency measurement is done by recording the time taken by data packets to travel. Latency data collected for 10 days will be analyzed to determine the average daily latency, latency differences between different times, and to identify factors that can affect latency performance.

Packet Loss: Packet loss refers to the loss of data packets during the transmission process over the network. In this measurement, packet loss was measured at the PNUP Directorate Building at three different times in one day. Packet loss measurement is done by recording the number of packets lost during a certain period of time. Packet loss data collected for 10 days will be analyzed to determine the daily packet loss rate, the difference in packet loss between different times, and to identify factors that can cause packet loss.

Jitter: Jitter refers to the variation of delay time in the transmission of data packets over the network. In this measurement, jitter was measured at the PNUP Directorate Building at three different times of the day. Jitter measurement is done by recording the time difference between the expected packet arrival time and its actual arrival time. The jitter data collected for 10 days will be analyzed to determine the level of daily jitter variation, the difference in jitter between different times, and to identify factors that can affect the level of jitter.

By combining these measurement data over 10 days at three different times of the day at the PNUP Directorate Building, we can analyze the network quality, identify performance patterns and trends, and take appropriate corrective measures to improve the network quality at that location.

Average Measurement Results of PNUP Directorate Building

a. Before Revitalization

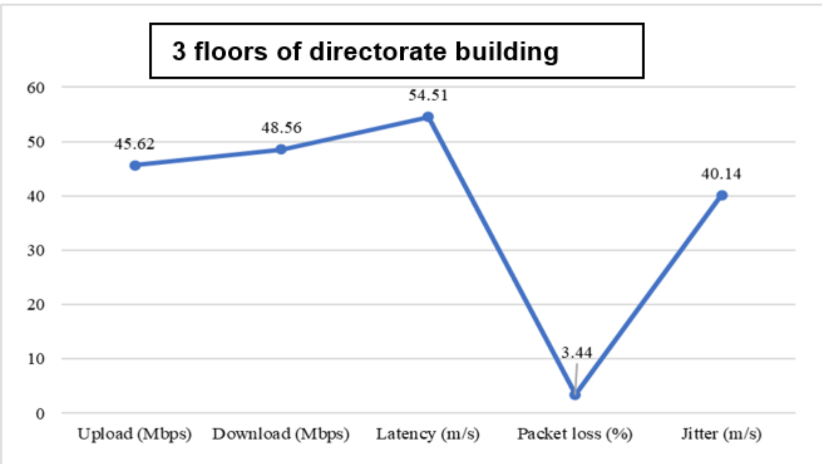

Fig. 1. Measurement chart before revitalization

Table 4. Average measurement results on floors 1, 2 and 3

Peng Location	Upload (Mbps)	Dowld (Mbps)	Latency (m/s)	Packet loss (%)	Jitter (m/s)
3 Directorate Building measurement floor	45.62	48.56	54.51	3.44	40.14

b. After Revitalization

Table 5. Average results of measurements on floors 1, 2 and 3

Measurement Location	Upload (Mbps)	Download (Mbps)	Latency (m/s)	Packet loss (%)	Jitter (m/s)
3 Directorate Building measurement floor	41.75	133.8	33.8	0.35	5.89

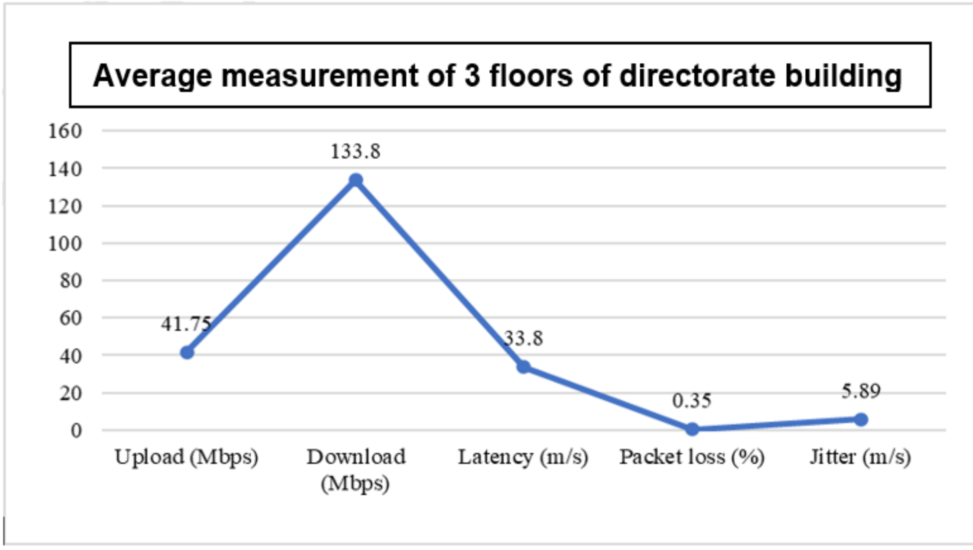

Fig. 2 Measurement chart before revitalization

c. Bandwidth Usage

Before Revitalization

Fig. 3. Traffic bandwidth usage before revitalization

d. Total bandwidth usage (transmission and reception): Tx (transmit) was 343.9 GB, and Rx (receive) was 236.8 GB.

After Revitalization

Fig. 4. Traffic bandwidth usage after revitalization

Total bandwidth usage (transmission and reception): Tx (transmit) was 1253.8 GB, and Rx (receive) was 109.2 GB.

Based on this comparison, there is a significant increase in bandwidth usage after network revitalization. Thus, network revitalization has successfully increased bandwidth usage significantly, especially in data transmission (Tx). The additional capacity and improved network performance after revitalization allows for greater and more efficient bandwidth usage in transmitting data.

4.2 Discussion

Network Quality Analysis: In the analysis of the quality of the Directorate Building internet network, a comparison was made between the conditions before revitalization and after revitalization. The following is a description of the internet network quality analysis based on throughput, latency, packet loss, and jitter parameters:

Before Revitalization:

Throughput:

Upload: 45.62 Mbp
Download: 48.56 Mbps
Latency: 54.51 ms (milliseconds)
Latency measures the time it takes for data to travel from the sender to the receiver. A lower latency value indicates a faster network response.
Packet Loss: 3.44%

Packet loss indicates the percentage of data packets that are lost or fail to be delivered during the transmission process. A lower packet loss percentage indicates a better network quality.

Jitter: 40.14 ms

Jitter measures the variation in the arrival time of data packets at the destination. A lower jitter value indicates a more stable and consistent network quality.

After Revitalization:
Throughput:
Upload: 41.75 Mbps
Download: 133.8 Mbps
Latency: 33.8 ms

There is a decrease in latency value after revitalization, indicating a faster network response.

Packet Loss: 0.35%

There is a decrease in packet loss percentage after revitalization, indicating an increase in data transmission reliability.

Jitter: 5.89 ms

There is a decrease in jitter value after revitalization, indicating better stability and consistency in data packet delivery.

Based on this comparison, it can be seen that after revitalization, there was an increase in several internet network quality parameters. Download throughput has increased significantly, while upload throughput has decreased. Latency, packet loss, and jitter also decreased in value after revitalization, indicating an improvement in network response and reliability.

The revitalization of the internet network had a positive impact in improving the quality of the network in the Directorate Building. Although upload throughput has decreased, the increase in download throughput and the decrease in latency, packet loss, and jitter overall provide a better user experience in using the internet network in the Directorate Building after revitalization.

Network Quality Improvement: With the addition of two transmission lines and two MicroTik CCR1036-12G-4S routers, this network revitalization is expected to increase overall throughput. The addition of two transmission lines will enhance data transfer capacity, The two MicroTik CCR1036-12G-4S routers will provide optimal data traffic management. In addition, with a failover or load balancing configuration between the two routers, the network will have a high degree of redundancy. This allows if one of the routers goes down, the network can still operate through the other router, minimizing downtime.

More Flexible and Manageable Network Settings: With the addition of the MicroTik CCR1036-12G-4S router, network settings will become more flexible and better managed. The MicroTik CCR1036-12G-4S router is equipped with an intuitive user interface and advanced network management features. This makes it possible to perform network setup, monitoring, and troubleshooting with ease. MicroTik routers also provide flexibility in setting network policies, optimizing throughput, and enhancing network security with firewalls and other security features.

Network Problem Identification: Based on the comparison of the internet network quality of the Directorate Building before and after revitalization, there are significant improvements in several network quality parameters. However, there are several problems that can be identified as the cause of disruption in the stability of internet access before revitalization. The following is an identification of problems that might disrupt the stability of internet access before revitalization:

a. **High Latency:** Before revitalization, latency had a fairly high value of 54.51 ms. This indicates a significant delay in the data traveling from the sender to the receiver. High latency can be caused by factors such as physical distance between the building and the internet service provider, non-optimal network configuration, or excessive network load.
b. **Significant Packet Loss:** The packet loss rate of 3.44% before revitalization indicates that data packets were lost or failed to be delivered during the transmission process. This can result in poor quality of service, especially in applications that require high speed and reliability such as video streaming or voice calls.
c. **High Jitter:** Jitter that has a high value before revitalization (40.14 ms) indicates the variation in the arrival time of data packets at the destination. High jitter can cause instability in data delivery, especially in applications that require consistent data flow such as video streaming or real-time applications.
d. **Throughput Limitations:** Although the download throughput was 48.56 Mbps before revitalization, this value may still be considered low for user needs. In addition, the upload throughput which only reaches 45.62 Mbps can also be a limitation in sending data from users to the server.

5. CONCLUSION

The conclusions from the research results of the Internet Network Quality Analysis at the Directorate Building are:

- The quality of the Internet Network in the Directorate Building was carried out using Cloud Flare's Speed Test tool by paying attention to parameters such as Throughput, Latency, Packet Loss, and Jitter.
- Based on data on the quality of the PNUP Directorate Building internet network before and after revitalization, the following conclusions can be drawn:

Before Revitalization:

Throughput: Upload of 45.62 Mbps and Download of 48.56 Mbps.
Latency: Average latency of 54.51 ms.
Packet loss: Packet loss rate of 3.44%.
Jitter: Average jitter of 40.14 ms.
After Revitalization:
Throughput: Upload of 41.75 Mbps and Download of 133.8 Mbps.
Latency: Average latency of 33.8 ms.
Packet loss: Packet loss rate of 0.35%.
Jitter: Average jitter of 5.89 ms.

- Based on this comparison, it can be concluded that after network revitalization, there was a significant improvement in several network quality parameters.
- Throughput: There was a decrease in upload throughput after revitalization, but a significant increase in download throughput. This indicates that the download capacity of the network has increased significantly after revitalization.
- Latency: There is a decrease in latency after revitalization, which indicates an

increase in response speed in sending data from the sender to the receiver.

- Packet loss: There was a significant decrease in the packet loss rate after revitalization. This indicates an improvement in data transmission reliability and a reduction in packet loss.
- Jitter: There was a significant decrease in jitter after revitalization. This indicates a consistent improvement in data delivery stability.

Thus, it can be concluded that network revitalization has successfully improved the quality of the PNUP Directorate Building internet network. The decrease in latency, packet loss, and jitter, as well as the increase in download throughput, are indications of an increase in network stability and performance after revitalization.

Network bandwidth usage in the PNUP Directorate building can be summarized as follows:

Tx (transmit) bandwidth usage increased from 343.9 GB to 1253.8 GB after revitalization. This indicates an increase in the volume of data transmitted over the network.

Rx bandwidth usage (reception) decreased from 236.8 GB to 109.2 GB after revitalization. Although the Rx usage figure has decreased, it should be noted that the lower Rx usage could be due to changes in usage patterns or network optimization that reduces the amount of data received.

As such, network revitalization has managed to significantly increase bandwidth usage, especially in data transmission (Tx). The additional capacity and improved network performance after revitalization allows for greater and more efficient bandwidth usage in transmitting data.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Alehandrew Michael HH. Server monitoring system using SNMP. Widyakala Journal. 2019;163.
2. Andi Supriyadi DG. Recognizing Topology and Network. Agricultural Informatics. 2007;16(2):4.
3. ETSI. Telecommunications and Internet protocol harmonization over networks (TIPHON); End to End Quality of Service in TIPHON System; 2006.
4. Fatoni. Intranet network service quality analysis (Bina Darma University Case Study). 2011;3.
5. Gheorghe L. Designing and implementing linux firewalls and QoS using netfilter, iproute2, NAT, and L7-filter. Birmingham Mumbai: Packt Publishing; 2006.
6. Nurlina. Water level monitoring using a singlemode-multimode-singlemode structure glass optical fiber sensor (SMS) Based on OTDR. Makassar: Hasanuddin University; 2021.
7. Praja FG, Aryanta D, Lidyawati L. Analysis of calculation and measurement of fiber optic network transmission Telkomsel Regional Central Java. Journal of Reka Elkomika. 2013; 44.
8. Sujana AP. Supporting devices for network traffic forensics. Junal Teknik Komputer Unikom. 2014;32.
9. Syahril Amin AC. Quality of service (QOS) analysis of the internet network at the rendani airport office. Indonesian Scientific Journal. 2021; 3050.
10. Gunawan AH. Quality of Service in Data Communication; 2008.
11. Hariyadi. Fiber optic communication system and its utilization at PT Semen Padang. Rang Engineering Journal; 2018.
12. Nazi Yaullah RS. Performance analysis of proxy-based internet network. Arsitron. 2012;3(1):6-8.
13. Masse BA. Building A Wireless Network With Bandwidth ManagemenT. Electronic Journal of Information and Computer Systems. 2016;19-24.
14. Fausta DE, Kusuma R. The use of fiber optic as one of modern material in telecommunication (Data Transmission). Indonesian Journal of Applied Physics; 2013.
15. Muharor A, Panjiasmara B, Bonok Z. Analysis of air channel fiber optic transmission at 1310 nm wavelength from optical distribution point (ODP) - Optical

Network Termination (ONT). Jambura Journal of Electrical and Electronics Engineering (JJEEE). 2019; 18.

16. Budiman A, Duskarnaen MF, Ajje H. Quality of service (QOS) analysis on the internet network of smk negeri 7 jakarta. Pinter Journal; 2020.

17. Kamarullah AH. Application of quality of service method on a dense traffic network. Jurnak Computer Network, Sriwijaya University; 2009.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/115883