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Quality Of Service (QoS) Analysis on The Internet Network (Case Study: Purwodadi Botanical Garden – BRIN)

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Abstract*—A good network service must pay attention to the services provided to its users. When building a network, the main factor is Quality of Service (QoS). QoS is a method for measuring how good the quality of a network service is. The QoS parameters are throughput, packet loss, delay, and jitter according to the Telecommunications and Internet Protocol Harmonization Over Network (TIPHON) standard. Purwodadi Botanical Gardens uses an Internet Service Provider (ISP) from PT Indonesia Comnets Plus (Icon +), and the leased bandwidth is 20 MBps. The Purwodadi Botanical Gardens provides many hotspot networks to make it easier for employees to do their jobs. Therefore, measurements are needed to find out how good the quality of the network services provided is. The measurement results from QoS at several hotspots in Purwodadi Botanical Gardens get results with a throughput value of "127,146 bps", packet loss of "0.0865%", delay of "0.0125 ms", and jitter of "0.0075 ms". It can conclude that the network service quality at the Purwodadi Botanical Gardens, according to the TIPHON standard, is in the "Excellent" category.

***Index Terms*—Quality of Service, bandwidth, throughput, packet loss, delay, jitter.**

I. INTRODUCTION

Purwodadi Botanical Gardens, also known as the Purwodadi Dry Climate Hortus, was founded on January 30, 1941, by Dr L.G.M. Bas Becking. This garden is one of the three branches of the Indonesian Botanical Gardens (Bogor Botanical Gardens), which collects plants that live in dry lowlands [1].

Network analysis using Quality of Service (QoS) is the latency and throughput capable of providing a good network analysis, where this aspect uses in the network analysis. QoSis a mechanism or method that allows services to operate according to their characteristics in an IP (Internet Protocol) network [2]. QoS is a method for measuring how good a network service is; the Quality of Service (QoS) parameters, namely throughput, delay, jitter, and package loss, according to the Telecommunications and Internet Protocol Harmonization Over Network (TIPHON) standard. In the workplace, Purwodadi Botanical Gardens provides internet network services to facilitate the employees. The Internet service rent from an Internet Service Provider (ISP) in Indonesia. Purwodadi Botanical Gardens has provided several connections such as cables and access points in every room to measure the internet can be accessed by employees in the workplace.

However, network service quality has no tests to measure the service quality that can accommodate the needs. For this reason, this study aims to examine the quality of network services in the Purwodadi Botanical Garden area.

II. RESEARCH METHODS

A. *Quality Of Service Analysis*

QoS is a method to measure the quality of a network and define the characteristics and properties of a service. QoS is also used to measure a set of performance attributes specified and associated with a service [3]. Furthermore, QoS is an end-to-end architecture and is not a feature of the network. A network's QoS refers to the speed and reliability of the delivery of various types of data in communication. Through QoS, a network administrator can give priority to specific traffic. QoS offers the ability to define the services' attributes, both qualitatively and quantitatively. The purpose of QoS is to provide different quality of service based on service needs in the network [4]. QoS standards, one of them is TIPHON TR.101329.V2.1.1.1999-06 issues by ETSI (European Telecommunications Standards Institute). It can be seen in table 1 [5].

Table 1. Category of Standard value of Quality of Services *Parameter of Quality of Service (QoS)*

Index Value	*Percentage (%)*	*Category*
3,8 – 4	*95% - 100%*	*Excellent*
3 - 3,79	*75% - 94,75%*	*Good*
2 - 2,99	*50% - 74,5%*	*Fair*
1-1,99	*25% - 49,75%*	*Poor*

B. *Parameter Quality Of Service (QoS)*

Below are some parameters to show the quality of service (QoS) of an internet network, including:

1. Throughput

Throughput is the actual bandwidth that measures at a particular time in transmitting files [6]. Throughput is the amount of data that manages to enter the network at a specific time interval [5]. TIPHON categorizes Throughput as described in table 2 :

Table 2. Standard of Throughput Speed (bps)

Throughput categories	*Throughput (bps)*	*Index*
Excellent	*100 bps*	*4*
Good	*75 bps*	*3*
Fair	*50 bps*	*2*
Poor	*25 bps*	*1*

2. Packet Loss

Packet Loss is the percentage of packets lost during data transmission. It causes by many factors, such as decreased signal in the network, network hardware errors, or radiation from the surrounding environment [6]. What is meant by packet loss is the number of packets that failed to reach the destination sent [5]. TIPHON categorizes packet loss as described in table 3:

Table 3. Standard of Packet Loss (%).

Categories of Packet Loss	**Packet Loss (%)**	**Index**
Excellent	0%	4
Good	3%	3
Fair	15%	2
Poor	25%	1

3. Delay

Delay or latency or round-trip time delay is the time that is needed to send a packet from a computer to the destination computer [6]. The delay means the length of time it takes for data to travel the distance from origin to destination. Delays can be affected by physical media distance, congestion, or long processing times [5]. TIPHON categorizes delay as follows in table 4:

Table 4. Standard of Delay (ms).

Categories of Latency	**Delay (ms)**	**Index**
Excellent	<150 ms	4
Good	150 ms – 300 ms	3
Fair	300 ms – 450 ms	2
Poor	>450 ms	1

4. Jitter

Jitter can interpret delay variations, which causes by variations in queue length in processing data. Queuing delays on routers and switches can cause jitter [5]. TIPHON categorizes jitter as shown in table 5 below:

Table 5. Standard of Jitter (ms).

Categories of Latency	**Delay (ms)**	**Index**
Excellent	<150 ms	4
Good	150 ms – 300 ms	3
Fair	300 ms – 450 ms	2
Poor	>450 ms	1

C. *Data Collection Method*

Two types of data are collected in this method, namely primary and secondary data.

a. Primary data

Primary data is the data that is obtained by taking the data without intermediaries [7]. In this study, researchers directly checked the Access Point that was determined in the Purwodadi Botanical Gardens environment.

b. Secondary data

Secondary data is data that other people have previously collected. So, the researchers just need to ask for existing data of the agency or organization that has been collected previously [7].

D. *Data Analysis Method*

The data analysis method used is quantitative data analysis. *Quantitative data analysis* is an analytical technique used on quantitative data. Quantitative data is data that can form with numeric symbols or numbers. This method is an approach to data processing through statistical or mathematical methods collected from secondary data. The advantage of this method is a more measurable and comprehensive conclusion than other methods. The results of quantitative analysis are usually in the form of numbers which will then be interpreted in sentence descriptions that the user can understand. Data analysis in this study usually uses two kinds of statistical analysis techniques: descriptive statistics and inferential statistics [8]. Sample data in this research is taken directly from the object of research located at the Purwodadi Botanical Gardens.

E. Research Flow

The flow of research carried out is as follows:

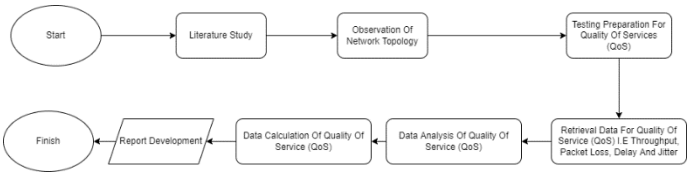

Fig 1. Research Flow

The flow of this research describes in Fig1. Start with a literature study on the theme to be carried out. Then the researchers conduct a direct study on the object of research about the current network topology condition. Furthermore, the researchers prepare for testing QoS. After that, QoS data collect on objects in the form of throughput, packet loss, delay, and jitter. After collecting data, analysis carries out, and the last step is the preparation of reports.

F. Network Topology

The network topology that is currently being applied and still running in this research is as follows:

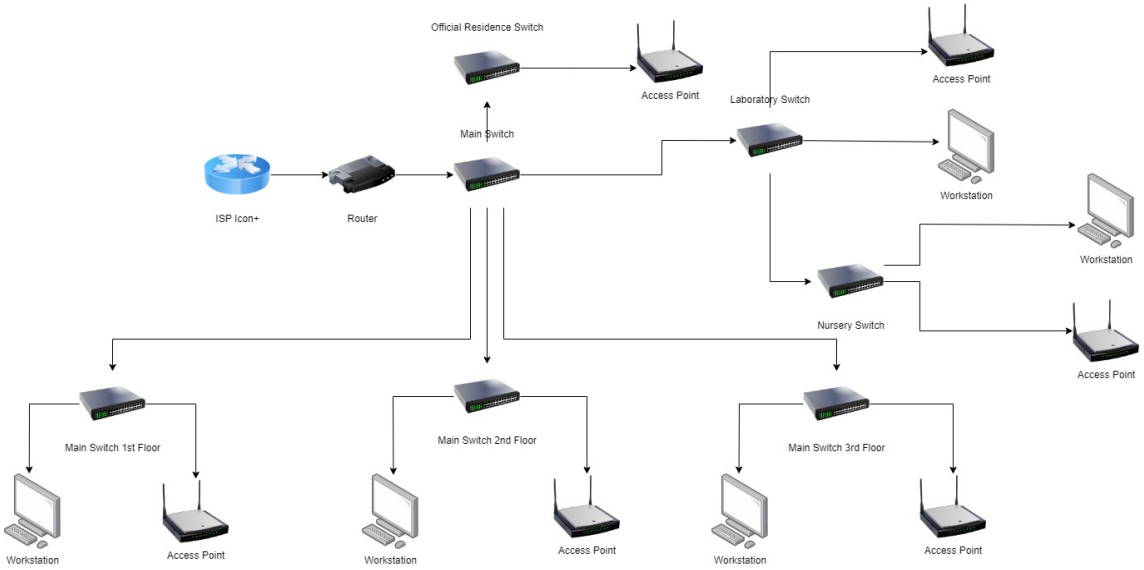

Fig 2. Purwodadi Botanical Garden Network Topology.

Purwodadi Botanical Gardens uses an ISP from *an Icon+* company. The network topology in the Purwodadi Botanical Gardens area describes in Fig 2. The rented bandwidth is 20Mbps. The main switch uses to connect to the main router. Once connected, the switch distributes bandwidth to each floor, such as the main switch on the 1st floor, 2nd floor, and 3rd floor. The main switch on the 1st floor redistributes to several Access Points and workstations. A similar scheme is implemented on the 2nd floor. The main switch on the 2nd floor redistributes to Access Points and workstations. On the 3rd floor, there is a primary division switch, which distributes access points and workstations.

III. RESULT AND DISCUSSION

A. *Data Analysis*

In this study, several data retrieval scenarios carry out. In each network topology segment, two times data retrieval carry out. The data compares with the TIPHON network standard. The data take the form of specific samples carried out randomly. The data taken are throughput, packet loss, delay, and jitter. The test captures the package two times during 09.00 - 11.00 WIB.

Moreover, the second data take at 13.00 - 15.00 WIB. The software that uses for sampling is Wireshark. The data was taken directly from the research location, namely the Purwodadi Botanical Gardens. *Wireshark* is an open-source application used by network admins to analyse network protocols. Admins use this tool frequently is that the tool can view detailed data and is free to use for anyone [9].

B. *Data Measurement Results*

Based on the results of the Quality of Service (QoS) data collection, the following measurement results are obtained:

1. Throughput

The results of throughput measurements during working hours are shown in table 6 and table 7. and the throughput value is by the TIPHON version as standard. Data was taken between the morning hours at 08.00 WIB - 10.00 WIB and the afternoon at 13.00 - 15.00 WIB.

Table 6. Throughput Measurement at 08.00 – 10.00 WIB.

No	Segments	Throughput (bps)	Description	
			Index	Category
1	Floor 1	169.884 bps	4	Excellent
2	Floor 2	130.343 bps	4	Excellent
3	Floor 3	80.55 bps	3	Good
4	Laboratory	115.581 bps	4	Excellent
5	Nursery	239.616 bps	4	Excellent
6	Official residence	81.679 bps	3	Good
	The average of Throughput	136.275 bps	4	Excellent

Table 7. Throughput Measurement at 13.00 – 15.00 WIB.

No	Segments	Throughput (bps)	Description	
			Index	Category
1	Floor 1	83.5985 bps	3	Good
2	Floor 2	120.6686 bps	4	Excellent
3	Floor 3	92.609 bps	3	Good
4	Laboratory	133.391 bps	4	Excellent
5	Nursery	151.419 bps	4	Excellent
6	Official residence	126.419 bps	4	Excellent
	The average of Throughput	118.017 bps	4	Excellent

2. Packet Loss

The results of packet loss measurements during working hours are shown in table 8. and table 9. and the Packet Loss value is by the TIPHON version as standard. Data was taken between morning working hours at 08.00 WIB - 10.00 WIB and afternoon working hours at 13.00 - 15.00 WIB.

Table 8. Packet Loss Measurement at 08.00 – 10.00 WIB.

No	Segments	Packet Loss (%)	Description	
			Index	Category
1	Floor 1	0 %	4	Excellent
2	Floor 2	0.53 %	4	Excellent
3	Floor 3	0 %	3	Excellent
4	Laboratory	0 %	4	Excellent
5	Nursery	0 %	4	Excellent
6	Official residence	0 %	4	Excellent
	The average of packet loss	0 .088 %	4	Excellent

Table 9. Packet Loss Measurement at 13.00 – 15.00 WIB.

No	Segments	Packet Loss (%)	Description	
			Index	Category
1	Floor 1	0 %	4	Excellent
2	Floor 2	0.06 %	4	Excellent
3	Floor 3	0.05 %	4	Excellent
4	Laboratory	0 %	4	Excellent
5	Nursery	0.4 %	4	Excellent
6	Official residence	0 %	4	Excellent
	The average of packet loss	0 .085 %	4	Excellent

3. Delay

The results of the Delay measurement during working hours are shown in Table 10. and Table 11. and the Delay value is by the TIPHON version as standard. Data was taken between morning working hours at 08.00 WIB - 10.00 WIB and afternoon working hours at 13.00 - 15.00 WIB.

Table 10. Delay measurement at 08.00 – 10.00 WIB.

No	Segments	Delay (ms)	Description	
			Index	Category
1	Floor 1	0.065 (ms)	4	Excellent
2	Floor 2	0.009 (ms)	4	Excellent
3	Floor 3	0.0135 (ms)	4	Excellent
4	Laboratory	0.009 (ms)	4	Excellent
5	Nursery	0.003 (ms)	4	Excellent
6	Official residence	0.011 (ms)	4	Excellent
	The average of delay	0.018 (ms)	4	Excellent

Table 11. Delay measurement at 13.00 – 15.00 WIB.

No	Segments	Delay (ms)	Description	
			Index	Category
1	Floor 1	0.0115 (ms)	4	Excellent
2	Floor 2	0.0086 (ms)	4	Excellent
3	Floor 3	0.0095 (ms)	4	Excellent
4	Laboratory	0.006 (ms)	4	Excellent
5	Nursery	0.005 (ms)	4	Excellent
6	Official residence	0.007 (ms)	4	Excellent
	The average of delay	0.007 (ms)	4	Excellent

4. Jitter

Jitter measurement results During working hours are shown in Tables 12. and 13. The Jitter value is by the TIPHON version as standard. Data was taken between morning working hours at 08.00 WIB - 10.00 WIB and afternoon working hours at 13.00 - 15.00 WIB.

Table 12. Jitter measurement at 08.00 – 10.00 WIB.

No	Segments	Jitter (ms)	Description	
			Index	Category
1	Floor 1	0.0065 (ms)	4	Excellent
2	Floor 2	0.009 (ms)	4	Excellent
3	Floor 3	0.0135 (ms)	4	Excellent
4	Laboratory	0.009 (ms)	4	Excellent
5	Nursery	0.003 (ms)	4	Excellent
6	Official residence	0.011 (ms)	4	Excellent
	The average of Jitter	0.008 (ms)	4	Excellent

Table 13. Jitter measurement at 13.00 – 15.00 WIB.

No	Segments	Jitter (ms)	Description	
			Index	Category
1	Floor 1	0.0115 (ms)	4	Excellent
2	Floor 2	0.0086 (ms)	4	Excellent
3	Floor 3	0.0095 (ms)	4	Excellent
4	Laboratory	0.006 (ms)	4	Excellent
5	Nursery	0.005 (ms)	4	Excellent
6	Official residence	0.007 (ms)	4	Excellent
	The average of Jitter	0.007 (ms)	4	Excellent

It is concluded from the results of the Quality of Services (QoS) measurement that the average throughput was 122.71725 bps in the "Excellent" category, and the index value was 4. Packet Loss was 0.115% in the "Excellent" category, and the index value was 4. Delay 0.0088 ms with the "Excellent" category and index value 4. Jitter is 0.0088 ms with the "Excellent" category and index value 4, as in table 14.

Table 14. Index Quality of Service (QoS).

No	Quality of Service (QoS)	Description	
		Index	Category
1	Throughput	4	Excellent
2	Packet Loss	4	Excellent
3	Delay	4	Excellent
4	Jitter	4	Excellent
	The average of Index quality	4	Excellent

Based on the TIPHON standard for the category, "Excellent" is when the QoS value is 3.8 - 4, "Good" is when the QoS value is 3 - 3.79, "Fair" is when the QoS value is 2 - 2.99 and "poor" is when the QoS of 1 - 1.99. From Table 14 the Quality-of-Service index according to the TIPHON standard obtained 4 results in the "Excellent" category.

IV. CONCLUSIONS

Based on the results of network Quality of Service (QoS) measurements at the Purwodadi Botanical Gardens, the following conclusions can conclude:

1. QoS measurements at Purwodadi Botanical Gardens carry out using the Wireshark tool, and several QoS parameters used were throughput, packet loss, delay, and jitter.
2. Measurement of Quality of Service (QoS) obtained throughput of 127.7146 bps in the "Excellent" category, packet loss of 0.0865% in the "Excellent" category, delay of 0.0125 ms in the "Excellent" category, and jitter of 0.0075 ms with "Excellent" category.
3. Measurement of Quality of Service (QoS) at Purwodadi Botanical Gardens, according to the TIPHON standard, obtained four results in the "Excellent" category.

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