

## ANALYSIS AND IMPLEMENTATION OF SIMPLE QUEUE AND QUEUE TREE METHODS FOR OPTIMIZING BANDWIDTH MANAGEMENT

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### ABSTRACT

This study analyzes the Simple Queue method with Queue tree using a Microtic Router to perform Bandwidth management. Both of these methods will be tested using the parameters of Quality of Services (QOS), namely throughput, delay, jitter and packet loss. The results of the analysis of the Quality of Services will be compared with weighting based on the TIPHON standard, then the results of the analysis will be tested using the Wireshark application. The results of the analysis of these two methods, the Simple Queue method is more suitable because it gets a higher value based on the TIPHON standard. Therefore it is recommended to use Bandwidth management using the Simple Queue method.

**Keywords:** Simple Queue, Queue tree, Microtic, Bandwidth management, QOS

### 1. Introduction

The internet can be interpreted as a wide and large worldwide computer network (Strinati & Barbarossa, 2021). The need for internet access today is very high. Good for the workplace or educational space. The use of the Internet in today's society has very high mobility, whether used for browsing information, downloading data, articles, looking for the latest knowledge or even just for chatting (Hamzah et al., 2021; Yang et al., 2021).

Some of the process of using the internet there are those who download using the Download Manager and some others do browsing such as using the Facebook, Twitter, Yahoo, Youtube, and so on applications (Perifanou et al., 2021; Naeem & Ozuem, 2021). The activities described are active Internet activities which can result in an uneven Bandwidth distribution system. Based on a journal written by Gunawan (2014) with the title Implementation of Queue tree for Optimizing Bandwidth management on Seven Net Semarang, where he examines a problem, namely the Utilization of Microtic Router OS™ for Bandwidth management on Seven Net Semarang, the result is a process of distributing and dividing Bandwidth evenly to all network users, so that the available connections are more stable. From the explanation of the journal, this is because they have not used Bandwidth management such as the Simple Queue or Queue tree method in the internet network used (Ilham, 2018; Prayoga, 2021). Thus if there is only one user who downloads, the other users will experience a slow Internet network.

Microtic is an operating system and software that can be used as a reliable router network, including various features (Susanto & Mulyanto, 2022; Misbahuddin, 2022). One of them is the Microtic Router OS, this is an operating system specifically used to create a router by installing it on a computer. The facilities or tools provided in Microtic Router Os are very complete to build a reliable and stable router. One of the services available on Microtic is Bandwidth limiter, Microtic provides two methods for dividing this Bandwidth, namely the Simple Queue and Queue tree methods (Sadino et al., 2021).

The Simple Queue method is a limiting method using simple limits based on the data rate (Ramadhan et al, 2016). The Simple Queue method is one of the queuing techniques in the Bandwidth management system on the Microtic Router. This queuing technique has convenience in configuration and has a Static Distribution of Bandwidth so that regardless of the number of Users online, the Bandwidth received is also the same. The Queue tree method is a queuing technique in the Bandwidth management system on Microtic Router which has several stages.

The first is Mark Packet, the second is Firewall, the third is Mangle. The *Queue tree* method is also used to limit one-way connections, both Download and Upload

*Bandwidth* is one of the most important parts of a network, therefore the amount of *Bandwidth* or *Bandwidth management* is taken into account in order to create internet access that is evenly distributed to every user/client. By using the *Bandwidth* limiter provided by *Microtic* Os, internet service providers, in this case each user/client will get *Bandwidth* of the same size without disturbing the *Bandwidth* of other users/clients (Siahaan et al., 2016).

With these two *Bandwidth* sharing methods, an analysis and implementation of the *Simple Queue* method and the *Queue tree* method will be carried out for Optimizing *Bandwidth management* when accessing the internet. To get the appropriate method, so that each user/client can use the internet smoothly.

## 2. Literature Review

### 2.1 Computer Networks

A computer network is a group of computers connected to each other using a communication protocol through communication media so that they can use shared resources such as hard disks, printers and other sources of information. The purpose of building a computer network is to carry information accurately and without errors from the sending side to the receiving side through communication media (Geraci et al., 2021).

With a variety of applications that can be accessed through computer networks and the large number of network users, the need for *Bandwidth* is important to ensure that all computer network users have a fair share (Jha & Singh, 2022).

A network operating system is an operating system that is used in a computer network and within the operating system there are services that support computer network operations (Neven et al., 2019). In addition to managing the network operating system itself, the network operating system must also manage other computers that are connected to it on a network.

The Internet is a world computer network that functions as a means of communication and information retrieval using existing telecommunication infrastructure (telephone lines, satellites, fiber optics, etc.). Internet connecting many computers into one network that allows data communication between computers.

### 2.2 Bandwidths

*Bandwidth* is the width or width of the frequency range used by signals in the transmission medium. *Bandwidth* can be interpreted as the difference between high frequency signal components and low frequency signal components measured in units of Hertz. (Nabil and Muslihudin, 2013). *Bandwidth* is the width of the frequency coverage that is given to transmit information in units of time per second.

*Bandwidth management* is a way of setting *Bandwidth* so that there is equal distribution of *Bandwidth* usage (Sohal et al., 2022). *Bandwidth management* is used for Management and optimizing various types of networks by implementing *Quality of Services (QOS)* services to determine the types of network traffic. *Bandwidth* distribution that is not divided evenly will cause internet access for users/clients to be slow. In order for the use to be balanced, *Bandwidth management* is needed on *Microtic*. There are two methods commonly used, namely *Simple Queue* and *Queue tree*.

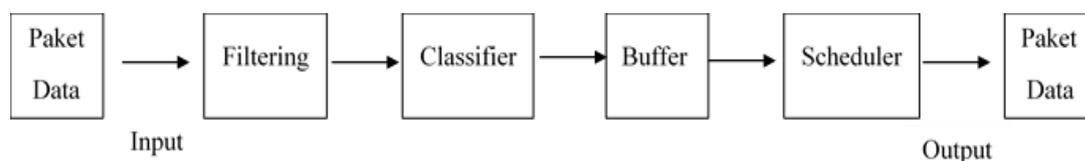


Fig. 1. Process Flow Management System Block Diagram *Bandwidth*

The function of each block diagram is as follows:

a) Filtering functions to filter data packets based on IP addresses and direct data packets to the correct destination. b) The classifier is in charge of directing incoming packets to the appropriate classes to make it easier to handle data packets to queues or buffers. c) Buffer is a place to temporarily store data packets. Buffer adjusts time by applying queuing technique. d) The scheduler is responsible for determining the scheduling of data packets to be sent to destinations from queues or buffers.

### 2.3 *Microtic*

*Microtic* is a network operating system that is widely used by Internet Service Providers (ISPs) for firewall purposes. For *Microtic* administration settings can be done using the Windows Application (WinBox). *Microtic* is currently widely used by ISPs, Hotspot Providers and internet cafe owners. There are many features on *Microtic* for both wired and wireless networks.

### 2.4 *Simple Queue*

The *Simple Queue* method is the easiest way to make *Bandwidth* settings, applied to small to medium scale networks to manage Upload and Download *Bandwidth* usage for each user. *Simple Queue* are a way of limiting by using simple limits based on the data rate. *Simple Queue* is a queuing technique in the *Bandwidth management* system on the *Microtic* Router. *Simple Queue* is a queuing technique with the FIFO (First Input First Output) method. The FIFO queuing technique is that data packets that arrive first will be processed first and put in a queue, then issued in the order they arrived. *Simple Queue*, used to implement simple *Bandwidth management*, such as limiting Uploads and Downloads from clients or limiting traffic from Peer to Peer (P2P) applications.

### 2.5 *Queue tree*

*Queue tree* is a tricky limitation because based on protocols, ports, IP addresses, we even have to activate the Mangle feature on the Firewall if we want to use the *Queue tree*. *Queue tree* functions to limit *Bandwidth* on *Microtic* which has 2 internet connections. If the *Queue tree* configuration is intended to Queue Download *Bandwidth*, then this configuration will not Queue Upload *Bandwidth*. So to Queue Upload and Download traffic from a client computer, you must create two Queue configurations. The image is a *Queue tree* queuing technique algorithm. (Yoga, 2013).



Fig. 2. *Queue tree* Algorithm Queue technique

*Queue tree* queuing technique algorithm process is as follows:

a) Mark Packet is responsible for marking data packets to be processed into the queue. b) The firewall is tasked with selecting packets according to their class classification. c) Mangle is in charge of *Bandwidth* limitation.

### 2.6 *Quality of Services*

*QOS (Quality of Services)* is the ability of a network to provide good service by providing *Bandwidth*, overcoming Jitter and Delay. *QOS* parameters are latency, Jitter, Packet loss and Throughput. *QOS* refers to the ability to provide different services to network traffic with different classes.

## 3. Research Methodology

### 3.1 Research Framework

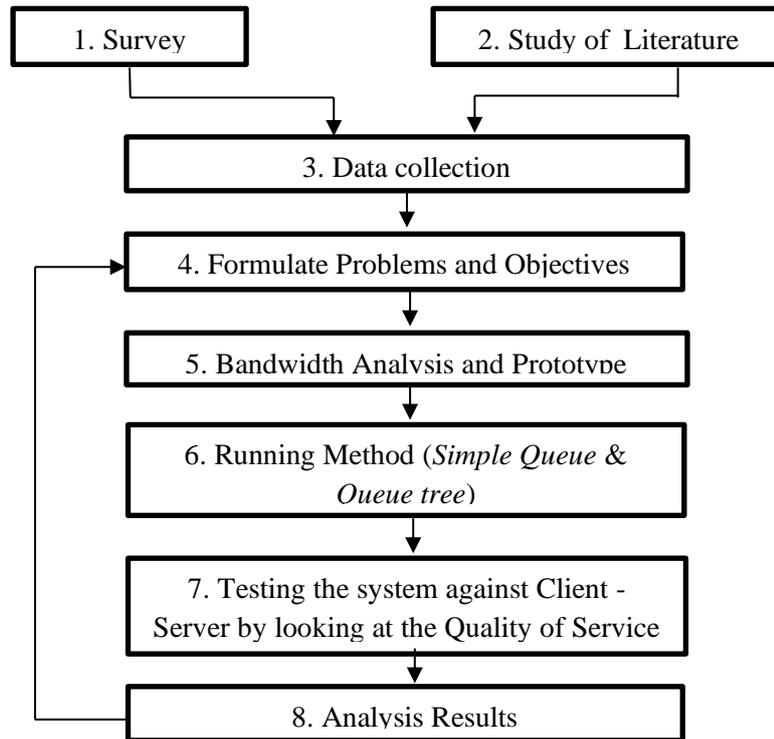


Fig. 3. Research Framework

The first step is to observe the problems that occur in the place of research that aims to find out the problems that occur and find solutions. The data collection stage is carried out by direct observation, the data collected is the result when downloading or uploading. After the data is collected and studied. The next step is to observe the obstacles encountered when downloading or uploading.

The formulation of the problem and objectives is a combination of field surveys and literature studies. After several problems were identified in the field survey, several literature studies related to problem solving were searched. After obtaining these problems, the objectives of this study were formulated.

*Bandwidth* Analysis and Prototype Proposals section aims to analyze and understand the techniques to be used in analyzing *Bandwidth* and prototyping proposals which will later be tested at the research site. From several literature studies, several recommendations for suitable methods have been obtained in this case *Bandwidth management*. Therefore the *Simple Queue* method is used, the most suitable method is used. *Simple Queue* are also the easiest way to perform *Bandwidth management* which is applied to small to medium scale networks to manage *Bandwidth* usage Upload and Download for each User.

The *Queue tree* method is relatively more complicated, but can limit *Bandwidth* based on groups and even hierarchically, to configure it, you have to set the Mangle feature on the firewall first.

The test to be carried out is to measure several *QOS* parameters (Throughput, Packet loss, Delay and Jitter). Throughput is used to determine the number of packets received in good condition against the total transmission time required from the Server to the User. Packet loss is used to determine the number of packets that are lost or do not reach the destination when sending data from source to destination. Delay is the time required for data to cover the distance from origin to destination while Jitter is a variation of Delay. There are many variations of delay in data transmission on the network, queue delays on routers and switches can cause jitter.

The results of the analysis aim to analyze whether the system that has been designed is as expected. Analyzing is done to compare the results obtained at the system testing stage.

#### 4. Results and Discussion

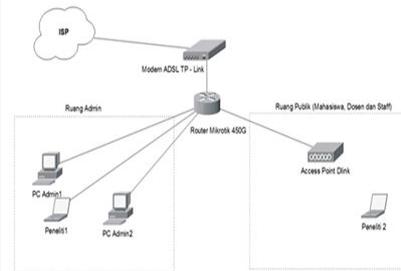


Fig. 4. Network Topology Design

This topology is designed for all clients to get the same *Bandwidth* allotment . The difference with the previous topology has not been done properly *Bandwidth management*, to connect to the Access point The client will be notified of the password from Wifi, in the current design besides the client being notified of the password *Bandwidth management* is also carried out so that each client will get the same *Bandwidth* allotment

##### 4.1 Design Test Scenario

Testing was carried out in two stages, the first stage was testing the *Simple Queue* method and then calculating the *Quality of Services* . Before testing the router , it must first be configured on ether 1 to connect to the ISP, on Ether 2 the *Simple Queue* method will be configured and on Ether 3 the *Queue tree* method will be configured .

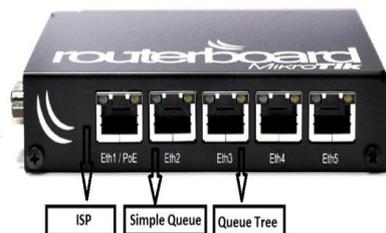


Fig. 5. Router Configuration Design

The second test is configuring the router using the *Queue tree* method , the next step is the same process as testing the *Simple Queue* method , namely browsing various different websites , then calculating *QOS* on the client using the Wireshark application.

Table 1 - Percentage and Value of *Quality of Services*

No	Score	Percentage (%)	Index
1	3.8 – 4	95 – 100	Very satisfy
2	3 – 3.79	75 – 94.75	Satisfying
3	2 – 2.99	50 – 74.75	Less satisfactory

##### 4.2 Throughput Design Using the *Simple Queue* Method

$$\% \text{ Throughput} = \frac{\text{Packages Received}}{\text{User Bandwidth Allocation}} \times 100\%$$

$$= \frac{\text{Packages Received}}{\text{Observation Period}}$$

Throughput category according to the Tiphon standard is divided into four categories, namely Very good, Good, moderate and bad, while the Throughput category standard according to Tiphon is as shown in table 2.

Table 2 - Throughput Categories

No	Throughput category	Throughput	Index
1	Very good	100	4
2	Good	75	3
3	Currently	50	2
4	Bad	<25	1

( Source: TIPHON)

### 4.3 Packet loss design with the *Simple Queue* method

$$\text{Packet Loss} = \frac{\text{Data Package Sent} - \text{Data Package Received}}{\text{Sent Data Packages}} \times 100\%$$

The Packet loss category according to the Tiphon standard is divided into four categories, namely Very good, Good, moderate and bad, while the standard Packet loss category according to Tiphon is as shown in table 3.

Table 4. 3 Packet loss categories

No	Degradation Category	Packet loss (%)	Index
1	Very good	0	4
2	Good	3	3
3	Currently	15	2
4	Bad	25	1

(Source : TIPHON )

### 4.4 Delay Design with the *Simple Queue* Method

$$\text{Delay (Average)} = \frac{\text{Total of Delay}}{\text{Total Packages Received}}$$

Delay category according to the Tiphon standard is divided into four categories, namely Very good, Good, moderate and bad, while the Delay standard according to Tiphon is as shown in table 4.

Table 4 - Delay Categories

No	Latency Category	Large Delay (ms)	Index
1	Very good	< 150 ms	4
2	Good	150ms to 300ms	3
3	Currently	300ms to 450ms	2
4	Bad	> 450ms	1

( Source: TIPHON)

### 4.5 Jitter Design with the *Simple Queue* Method

$$= \frac{(\text{Total of Delay} - (\text{Delay Average}))}{\text{Total Packages Received}}$$

Jitter category according to the Tiphon standard is divided into four categories, namely Very good, Good, moderate and bad, while the Jitter category standard according to Tiphon is as shown in table 5.

Table 5 - Jitter Categories

No	Jitter category	Jitters (ms)	Index
1	Very good	0 ms	4
2	Good	0ms to 75ms	3
3	Currently	75 ms to 125 ms	2
4	Bad	125 ms to 225 ms	1

( Source: TIPHON)

#### 4.6 Analysis of Throughput Using the *Simple Queue* Method

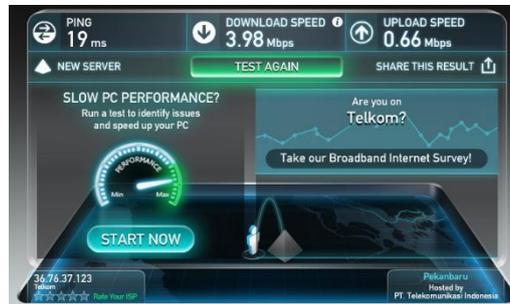


Fig. 6. Speedtest results of the *Simple Queue* method

In Figure 6 testing internet traffic using the *Simple Queue* method shows that the download speed is 3.98 Mbps and the upload speed is 0.66 Mbps.

Besides speedtest.net data is also needed using the Wireshark application, namely to see the number of packets sent and received. Throughput testing using the *Simple Queue* method is carried out in 9 sessions, namely:

1. Testing by browsing to the [www.facebook.com](http://www.facebook.com) address, so that the number of packets received is obtained

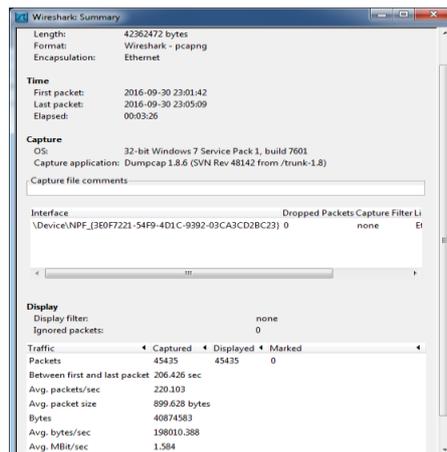


Fig. 7. Screenshot Capture Wireshark [www.Facebook.com](http://www.Facebook.com)

To calculate the length of observation can be calculated using the formula:

$$\text{Observation Time} = \sum \text{Time Delta From Previous Display Frame} = \mathbf{206.426 \text{ s}}$$

Where :

$$\text{Throughput} = \text{Data Packet Received} / \text{Observation Time} = 40874583 \text{ bytes} / 206,426 \text{ s} = 198010.388 \text{ bytes/s} = \mathbf{1.584 \text{ Mbps}}$$

$$\% \text{ Throughput} = ( \text{Throughput} / \text{Bandwidth Width} ) \times 100 = ( 1.584 / 3.98 ) \times 100 = \mathbf{39.80 \%}$$

Throughput parameter for several websites, the data obtained is entered into table 6, so that later the average throughput is obtained.

Table 6 - Throughput Value Data

No	Website Address	Throughput
1	www.youtube.com	54.74 %
2	www.facebook.com	39.80 %
3	www.google.co.id	11.18 %
4	www.mecafe.com	11.81%
5	www.dailymotion.com	24.67 %
6	www.bing.com	12.93 %
7	www.yahoo.com	16.41 %
8	www.kaskus.co.id	59.44 %
9	plus.google.com	19.70 %
Average		27.85 %

**4.7 Analysis of Delay Using the Simple Queue Method**

To calculate the Delay, data is needed using the Wireshark application, namely to see the total packets received. Delay testing using the Simple Queue method is carried out in 9 sessions, namely:

1. Testing by browsing to the www.facebook.com address, so that the number of packets received is obtained, to get the total delay can be calculated using the formula:

$$\text{Total Delay} = \sum \text{Time Delta From Previous Display Frame} = \mathbf{206.426 \text{ s}}$$

Where :

$$\text{Average Delays} = \text{Total Delay} / \text{Total Packages Received} = 206.426 \text{ s} / 45435 = 0.00454 \text{ s}$$

$$= \mathbf{4.54 \text{ ms}}$$

Table 7 - Delay value data

No	Website Address	delays
1	<u>www.youtube.com</u>	4.54 ms
2	www.facebook.com	3.26 ms
3	www.google.co.id	12.57 ms
4	www.mecafe.com	14.70 ms
5	www.dailymotion.com	7.07 ms
6	www.bing.com	10.49ms
7	www.yahoo.com	9.20 ms
8	www.kaskus.co.id	7.16 ms
9	Plus.google.com	8.90 ms
Average		8.65 ms

**4.8 Throughput Analysis Using Queue tree Method**



Fig. 8. Queue tree Method Speedtest Results

Jitter parameter to several websites, the data obtained is entered into table 8, so that later the average Jitter value is obtained .

Table 8 - Jitter Value Data

No	Website Address	Jitter
1	<a href="http://www.youtube.com">www.youtube.com</a>	4.40 ms
2	<a href="http://www.facebook.com">www.facebook.com</a>	16.44 ms
3	<a href="http://www.google.co.id">www.google.co.id</a>	12.50 ms
4	<a href="http://www.mecafe.com">www.mecafe.com</a>	15.84ms
5	<a href="http://www.dailymotion.com">www.dailymotion.com</a>	4.49 ms
6	<a href="http://www.bing.com">www.bing.com</a>	10.36 ms
7	<a href="http://www.yahoo.com">www.yahoo.com</a>	11.28 ms
8	<a href="http://www.kaskus.co.id">www.kaskus.co.id</a>	3.00 ms
9	<a href="http://Plus.google.com">Plus.google.com</a>	37.77 ms
Average		12.90 ms

#### 4.9 Packet loss analysis using the *Queue tree* method

Packet loss testing using the *Simple Queue* method is carried out in 9 sessions, namely:

1. Testing by browsing to the [www.facebook.com](http://www.facebook.com) address, so that the number of packets sent and received is obtained. To get packet loss, it can be calculated using the formula:

Packet loss = (Data Package Sent - Data Package Received) x 100%

= (12299 - 12299) x 100%

= **0 %**

#### 4.10 *Quality of Services* value recapitulation

After obtaining the values of the *QOS* parameters, namely Throughput, Delay, Jitter and Packet loss, the data is entered into table 9, then compared with the TIPHON standard, so that the index results are obtained

No	<i>QOS</i> parameters	Obtained value	TIPHON	
			Category	Index
1	Throughput	15.80 %	Bad	1
2	delays	12.898 ms	Very good	4
3	Jitter	12.90 ms	Good	3
4	Packet loss	0 %	Very good	4

In table 9 the results are obtained by using the *Queue tree* method The throughput obtained is 15.80% which means it is bad, the Delay gets a very good index, so does the Jitter, it gets a value of 12.90 ms which gets a good index and Packet loss gets a very good index.

Table 10 - Summary Comparison of the *Simple Queue* and *Queue tree* Methods

No	Website Address	Method		Range
		<i>Simple Queue</i>	<i>Queue tree</i>	
1	Throughput	27,85 %	15,80 %	12,05 %
2	Delay	8,65 ms	12,898 ms	4,248 ms
3	Jitter	8,51 ms	12,90 ms	4,39 ms
4	Packet loss	0 %	0 %	0 %

Table 10 shows a comparison of the ranges between the *Simple Queue* and *Queue tree* methods, the *Simple Queue* method has a higher Throughput value than the *Queue tree* method , Delay *Queue tree* is longer than the *Simple Queue* , the distance is up to 4.28 ms, so is the Jitter method , the *Simple Queue* is faster than the *Queue tree* method , while the Packet loss has the same range between the two methods.

Table 11 - Summary of Values from the *QOS Simple Queue* and *Queue tree* Methods

No	Parameter	Method			
		<i>Simple Queue</i> (TIPHON)		<i>Queue tree</i> (TIPHON)	
		Category	Index	Category	Index
1	Throughput	Currently	2	Bad	2
2	delays	Very good	4	Very good	4
3	Jitter	Good	3	Good	3
4	Packet loss	Very good	4	Very good	4
Average (TIPHON)			3,25		3

Table 11 shows the recapitulation according to the TIPHON standard between the *Simple Queue* and *Queue tree* methods, in the *Simple Queue* method the Throughput parameter gets the Moderate category, Delay in the *Queue tree* gets a very good category with index 4, so does Jitter and Packet loss in the *Simple Queue* method and *Queue tree* have the same index, the average results of the *Simple Queue* and *Queue tree* methods are index different, the *Simple Queue* method gets a higher score of 3.25, while for the two categories the methods are the same, namely getting a satisfactory category.

## 5. Conclusion

From the analysis and design and then implementing it, several conclusions were obtained regarding the analysis of the *Simple Queue* and *Queue tree* methods, namely: It turns out that the two *Simple Queue* and *Queue tree* methods are quite well implemented in *Bandwidth management*, this is because both of them get satisfactory categories according to the TIPHON standard, where the *Simple Queue* method gets an index of 3.25 while the *Queue tree* gets an index of 3.00. The *Simple Queue* produces a Throughput of 27.85%, which is greater than *Management Bandwidth* by using *Queue tree* that is equal to 15.80% with a range of 12.05%. After testing the comparison of the two methods, namely *Simple Queue* and *Queue tree*, the analysis and calculation results obtained are more suitable for using the *Simple Queue* method, this is because the throughput value of the *Simple Queue* method is greater than the *Queue tree*, causing the *Quality of Servicess* using the internet to be better.

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