International Journal Of Health, Engineering And Technology (IJHET) *E-ISSN 2829 - 8683*
Volume 1, Number 2, July 2022, *Page. 23 - 33*
Email : editorijhess@gmail.com

Bandwidth Management and Web Filtering with Per Connection Queue (PCQ) Method Using Microtik

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Abstract

Communication is a very important activity. Communication is carried out with the aim of exchanging information between several individuals. Communication can be done in various ways. Those who wish to communicate with each other can meet in person or through intermediaries. There are several types of media that function as intermediaries of information. You can use several media such as print media, electronic media, and online media to get various information. Digital communication in the modern era is not far from the Internet because almost all digital communication tools use the Internet. Internet needs vary greatly from old to young, because Internet needs are different, connection management is needed (Management Bandwidth) so that client requests with high connections do not interfere with clients with relatively low connection requests. One of the tools commonly used for connection management is MikroTik with the Peer Connection Queue (PCQ) feature. The reason for choosing Mikrotik is because Mikrotik has complete features at an affordable price. The importance of connection management is to maximize the connection provided by the ISP so that clients can use the Internet without buffering.

Keywords: MikroTik, Bandwidth Management, Per Connection Queue, Web Filtering

INTRODUCTION

At this time the internet is something that can not be separated from everyday life. All the necessary information can be obtained via the internet. There are many places that can be visited to simply access the internet, for example schools, cafes, campuses, malls and other public places. Internet access is needed for various activities, for example to communicate, search data (browsing), download and upload data. Currently the internet is not a new thing, almost every educational institution has an internet network, one of which is in the Airlangga Private Vocational School.

Airlangga Private Vocational School is an educational institution that was established in 2017 located at Jalan Batu Menjah No. 3D Namu Ukur Utara, Sei Bingai District, Langkat Regency, Airlangga Private Vocational School has two majors, namely Computer and Network Engineering (TKJ) as well as Motorcycle Engineering and Business (TBSM). Airlanggga Private Vocational School has 30 units of computers in the computer lab that are connected to the internet using cables and 30 staff and teachers who are connected to the internet using Access Point or wireless. To support teaching and learning activities, Airlangga Private Vocational School provides internet access with a speed of 50 MBps.

The use of the internet at Airlangga Private Vocational Schools has very high mobility which results in the need for resources to support internet needs, for that there is a need for network optimization, one of which is by doing bandwidth management which aims to manage resources so that they can be used as much as possible, so as not to there is a struggle for bandwidth between users, which makes the connection of some devices or users slow, so that it can affect teaching and learning activities.

In addition, the use of the internet in Airlangga Private Vocational Schools has no limitations in the use of applications so that several problems arise when the learning and teaching process takes place, students and teachers use Android and their computers to open applications that have nothing

to do with learning activities such as social media. This problem is not allowed to continue but is sought where the source of the problem is and a solution is sought. The solution to this problem is to do web filtering.

RESEARCH METHODS

The problem solving method used in this study is the Per Connection Queue method. PCQ (Per Connection Queue) on queue type is one of MikroTik's features to help manage traffic rate and packet traffic. In the Mikrotik Operating System, PCQ (Per Connection Queue) is a program for managing network Traffic Quality of Service (QoS). The main purpose of this method is to do bandwidth sharing automatically and evenly to multi clients. The PCQ (Per Connection Queue) principle works by implementing a simple queue or queue trees where there is only one active client using bandwidth, while other clients are in an idle position, the active client can use the maximum available bandwidth, but if other clients are active, then maximum bandwidth that can be used by both clients (bandwidth or number of active clients) so that bandwidth can be distributed fairly to all clients. (Situmorang and Chandra., 2019).

The way web filtering works is to block web access that is considered to contain inappropriate content. MikroTik provides these features in several ways/techniques (Takeuchi, 2017). Features or policies to block the web that can be applied to MikroTik include static DNS, web proxies, route policies, content filters, layer 7 firewalls and destination IP address/port blocks (Takeuchi, 2017). The technique that will be implemented in this research is using a content filter and a layer 7 firewall.

According to Septiawan (2013) in (Sukri and Jumiati., 2017), Quality of Service is a method of measuring how good the network is and is an attempt to define the characteristics and nature of a service. Quality of Service is used to measure a set of performance attributes that have been specified and are usually associated with a service. Quality of Service is designed to help end users (clients) become more practical by ensuring that users get reliable performance from network-based applications.

According to Helmy (2014) in (Sukri and Jumiati., 2017), there are several parameters that must be considered to determine the Quality of Service including Throughput, Delay, Jitter and Packet Loss.

Throughput is the effective data transfer rate, which is measured in bps. 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. To measure the throughput value, you can use the following equation formula:

Throughput = Amount of data received / Length of observation

Table.1 Throughput Category

Latency Category	Throughput (%)	Index
Very Good	100%	4
Good	75%	3
Medium	50%	2
Ugly	> 25%	1

Delay is the time it takes to travel the distance from origin to destination. Delay can be affected by distance, physical media, congestion or also long processing times. To measure the delay value can use the following equation formula:

Average delay = Total Delay / Total packets received

Table.2 Category of Delay

Latency Category	Large Delay	Index
Very Good	< 150 ms	4
Good	150 to 300 ms	3
Medium	300 to 450 ms	2
Ugly	>450 ms	1

This is due to variations in queue length, in data processing time, and also in packet reassembly time at the end of the jitter journey. Jitter is usually called delay variation, closely related to latency, which shows the amount of delay variation in data transmission on the network. Queuing delays on routers and switches can cause jitter. To measure the jitter value, you can use the following equation formula:

Jitter = Total Variation Delay / Total packets received – 1

Table.3 Jitter Categories

Relegation Category	Jitter	Index
Very Good	0 ms	4
Good	0 to 75 ms	3
Medium	75 to 125 ms	2
Ugly	125 to 225 ms	1

Packet Loss is a parameter that describes a condition that shows the total lost packets, which can occur due to collision and congestion on the network and this affects all applications because retransmission will reduce overall network efficiency even though sufficient bandwidth is available for these applications. If the congestion is long enough, the buffer will be full, and no new data will be accepted. To measure the value of packet loss can use the following equation formula:

Packet loss = Data sent – Data received / Data sent X 100

Table.4 Categories of Packet Loss

Relegation Category	*Packet Loss*	Index
Very Good	0%	4
Good	3%	3
Medium	15%	2
Ugly	25%	1

RESULTS AND DISCUSSION

A. Analysis And Design

This research methodology is carried out to find something systematically using scientific methods and applicable sources. With this process, it can provide good and precise research results.

There are several stages of research methodology carried out in solving problems. These stages are as follows:

1. Research Preparation
   This stage is the initial stage in research, namely by doing background problems then identifying problems and then making problem boundaries that will help writers at the next stage.
2. Formulate Problems and Goals
   At this stage the author will formulate the problem and what goals are in accordance with the background so that the results can produce benefits for users.
3. Data Collection

The collection of data related to this research, was collected in 4 ways, namely direct observation, questionnaires (Questionnaire), namely collecting data by asking questions related to research to be given to respondents, literature study, namely studying manual data and references. related to the main problem and the system that will be made as well as interview techniques conducted with principals, teachers, and students in obtaining information about internet speed and effective internet use in the school environment.

4. Making Bandwidth Management and Web Filtering
   This stage is the system design stage for the problem being researched, is the stage for designing the workflow of the system and also designing the application of the method of the system to be made.
5. Testing and Analysis of Bandwidth Management and Web Filtering
   Test and analyze the methods that have been tested previously with the system design that has been made and configure using the Mikrotik RouterBoard. Tests are carried out in order to find errors in the system and make improvements.
6. Conclusion
   In the final stage, conclusions will be obtained which are statements containing the results of this research.

B. Bandwidth Implementation and Management Flowchart with Method Per Connection Queue (PCQ)

The following is a flowchart of implementation and bandwidth management with the method per connection queue (PCQ):

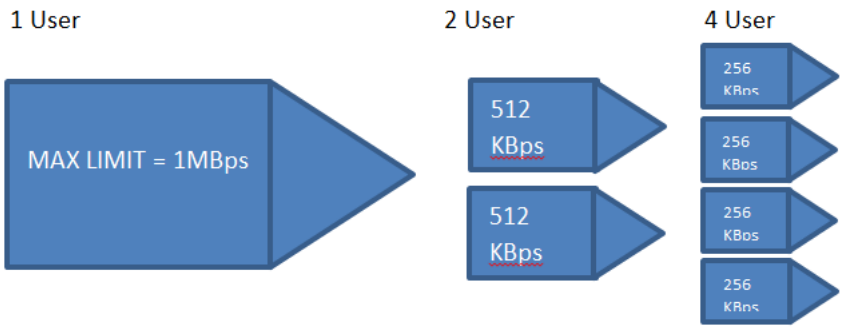

Figure.1 Bandwidth Management Flowchart with Per Connection Queue (PCQ) Method

C. Network Topology Design

Network topology design using Cisco Packet Tracer application.

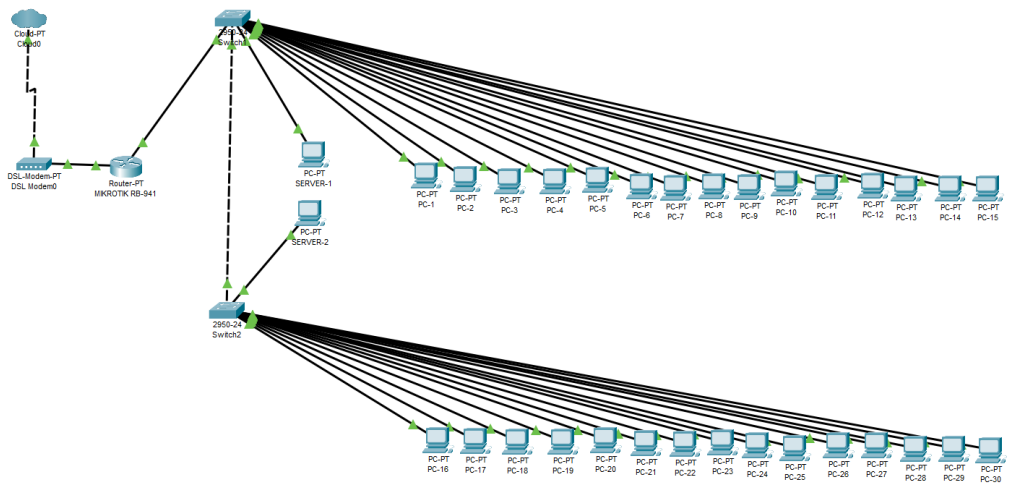

Figure.2 Network Topology at Airlangga Private Vocational School

D. IP Address Design

The source of internet access at the Airlangga Private Vocational School comes from the IndiHome Modem which has a network ID of 192.168.1.0/24 with an IP Address of 192.168.1.1. The Mikrotik router located in the TKJ (Computer and Network Engineering) Lab room receives internet access from the IndiHome Modem via the ETH 1 INTERNET port which has a network ID of 192.168.1.0/24 with an IP Address of 192.168.1.2. The ETH 2 LOCAL port is connected to a 48 port D – Link switch and a 24 port TP – Link switch located in the TKJ (Computer and Network Engineering) LAB room with network ID 192.150.3.0/24 with IP Address 192.150.3.1.

Table.5 IP Address Design in the TKJ (Computer and Network Engineering) Lab Room Airlangga Private Vocational School

Nama Perangkat	***Interfaces***	***IP Address***	***Subnetmask***	***Gateway***
Modem	*Port* 1	192.168.1.1	255.255.255.0	-
Router Mirkrotik RB941	*Port* ETH 1 INTERNET	192.168.1.2	255.255.255.0	192.168.1.1
	Port ETH 2 LOCAL	192.150.3.1	255.255.255.0	-
Personal Computer connected to the TP Switch – Link 24 Port	Local Area Connection / Ethernet	192.150.3.101-192.150.3.116	255.255.255.0	192.150.3.1
Personal Computer connected to Switch D – Link 48 Port	Local Area Connection / Ethernet	192.150.3.117-192.150.3.132	255.255.255.0	192.150.3.1

E. Physical Network Device

In the design of the topology, the network devices needed are:

Table.6 Physical Network Device Needs

No	Device Name	Specification
1	*Modem*	4 Port
2	*Switch*	TP - Link 24 Port dan D – Link 48 Port
3	*Router*	Mikrotik RB - 941
4	*Personal Computer*	Intel Core i3, RAM 4 GB, *Harddisk Internal* 500 GB dan Intel Core i5, RAM 8 GB, *Harddisk Internal* 500 GB
5	*Cable* UTP (*Unshielded Twisted Pair*) dan Connector RJ 45	Belden Cat 5

F. Bandwidth Management Display Using SpeedTest

The test process is carried out using the Speedtest.net website in order to get the Download and Upload values according to the configuration that has been done previously.

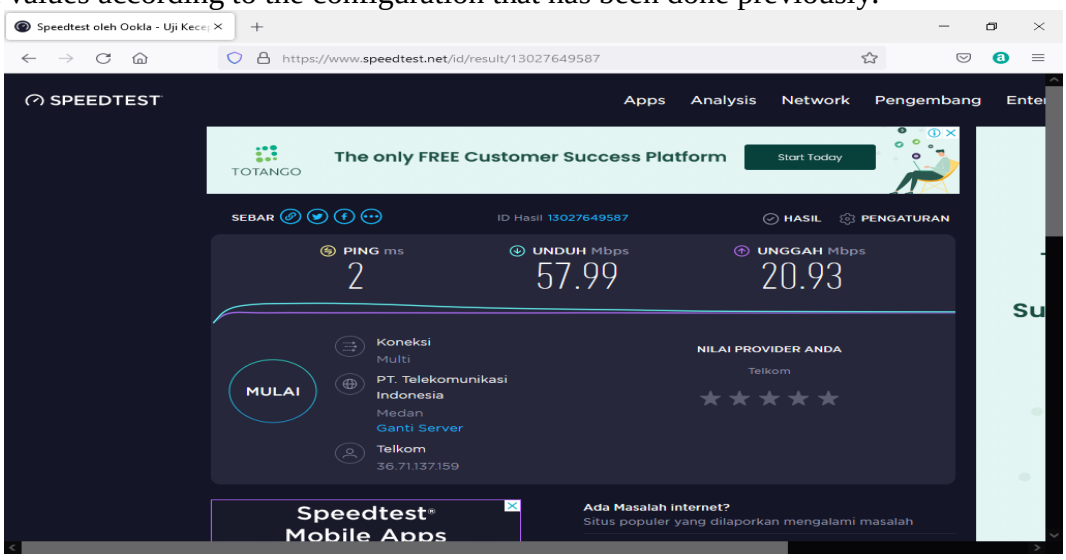

Figure.3 Bandwidth Before Configuration

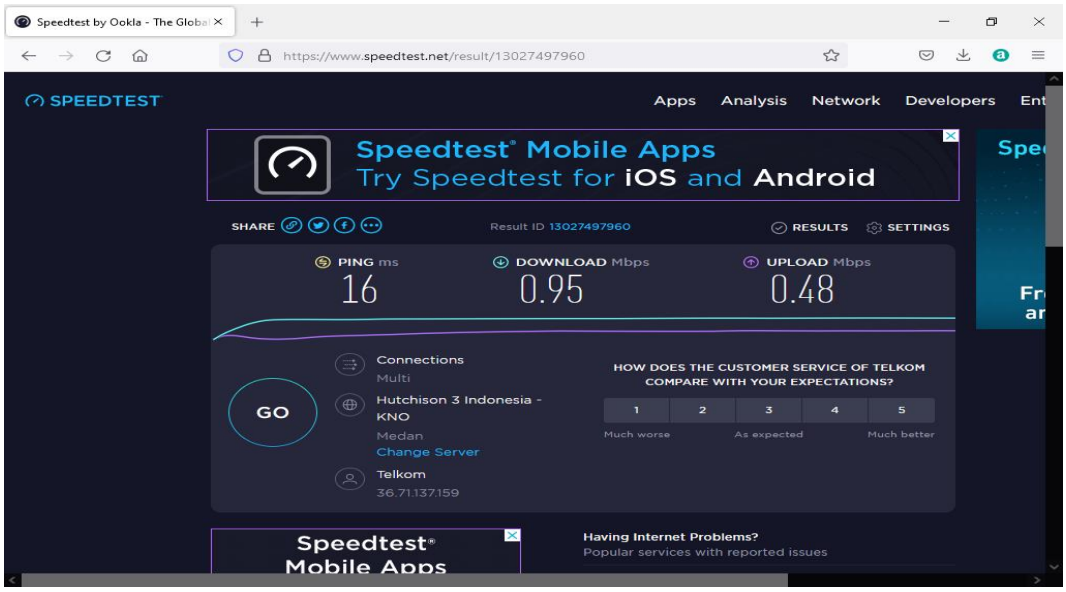

Figure.4 Bandwidth After Configuration

G. Display on Web Filltering

Testing access on the website using Layer7 Protocols Web Filtering.

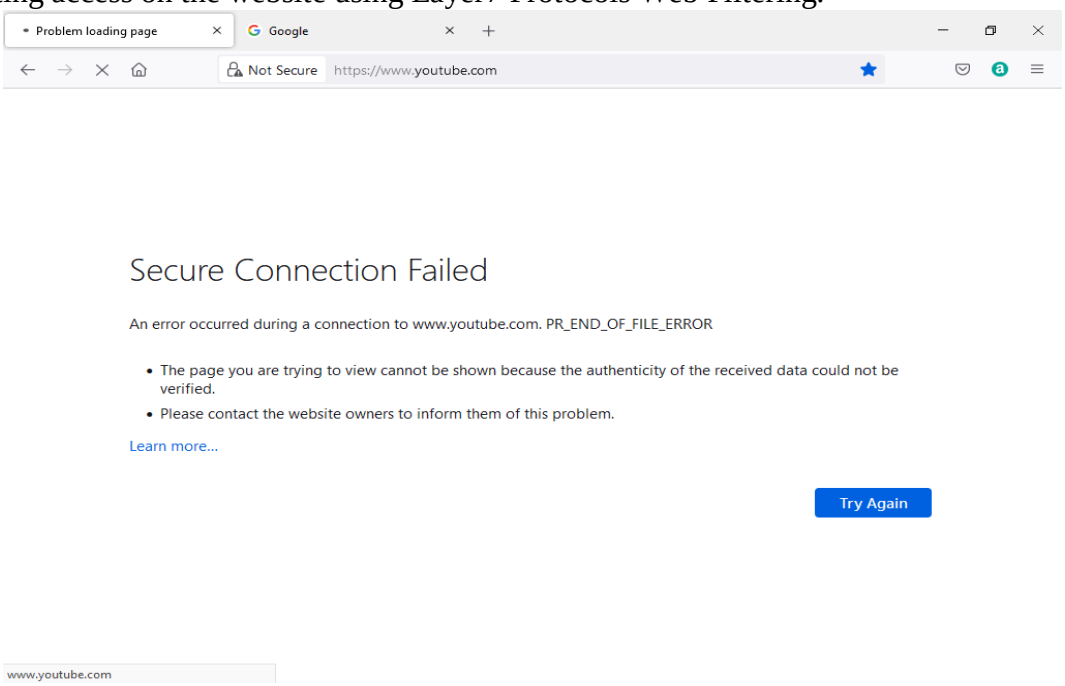

Figure.5 Display when accessing www.youtube.com

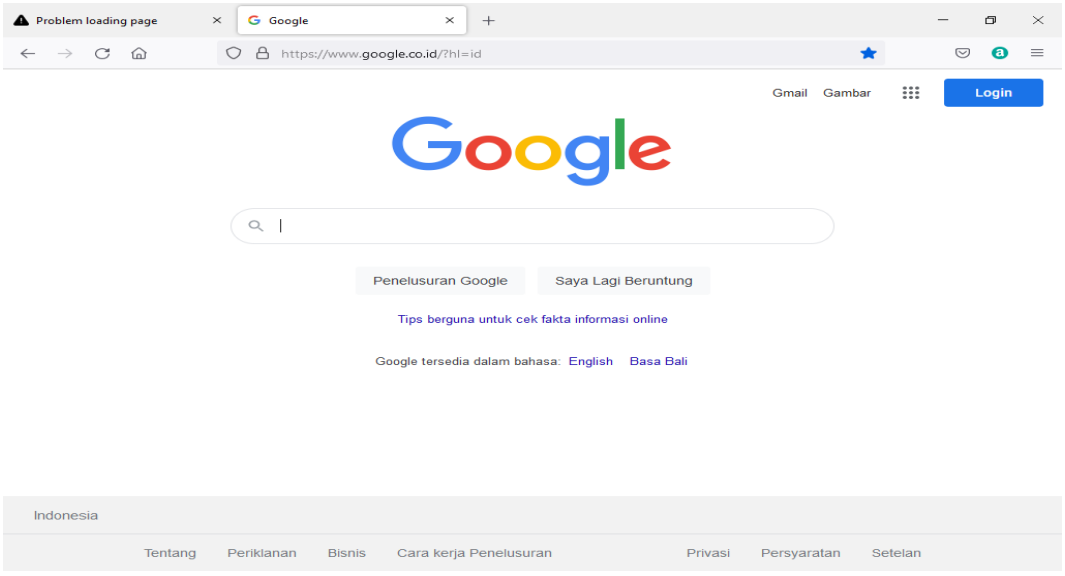

Figure.6 Display when accessing www.google.com

Seen when trying to access the youtube web page, the internet connection will be lost. But when trying to access the google web page, the internet connection seems to be able to access the google web page.

H. Display On WireShark

Here is a view using the Wireshark application:

Figure.7 Appearance Before Application of PCQ Method

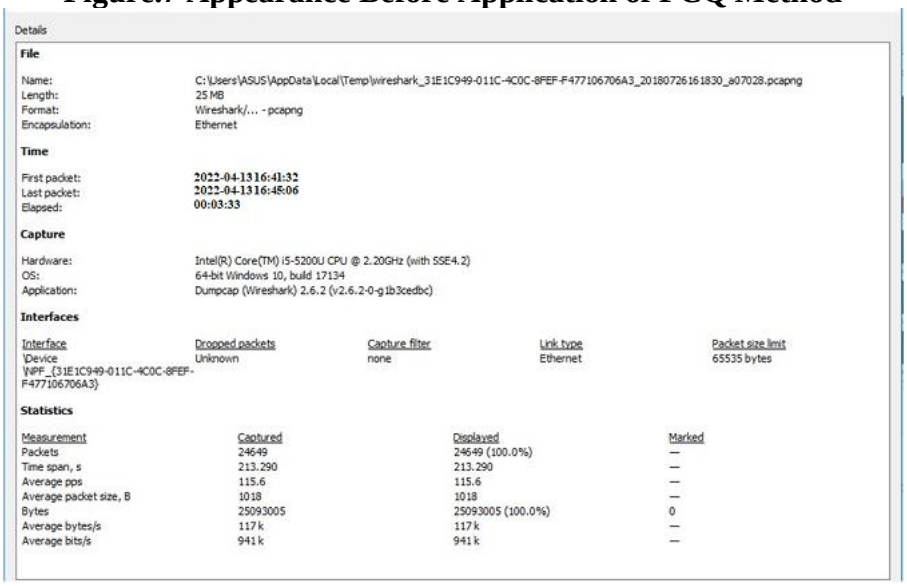

Figure.8 Display After Application of PCQ Method

I. Calculation of QoS (Quality Of Service) Parameters

Data obtained from sending packets from the Wireshark application

Table.7 Packets Delivery from Wireshark app

Package to-	**No Queue Tree and PCQ (in second)**	**With Queue Tree and PCQ (in second)**
1	1.375233	1.178492
2	1.537823	1.419270
3	1.578931	1.436903
4	1.730933	1.570238
5	1.752012	1.592501
Amount	7.974932	7.197404
Total variation	376.779	414,009

- **Delay**

Delay testing without using Queue Tree and PCQ.

Average delay = Total delay / Total packets received
= 7.974932/14451
= 0.00055186 s = 0.55186 ms.

Delay testing using Queue Tree and PCQ.

Average delay = Total delay / Total packets received
= 7.197404/24649
= 0.000292 s = 0.292 ms.

- **Jitter**

Jitter testing without using Queue Tree and PCQ methods.

Jitter = total delay variation / (total packet received – 1)
= 376,779 / (14451 – 1)
= 376,779 / 14450
= 0.026074671 s = 26.074671 ms.

Jitter testing using Queue Tree and PCQ methods.

Jitter = total delay variation / (total packet received – 1)
= 414,009 / (24649 – 1)
= 414,009 / 24648
= 0.01679686 s = 16.79686 ms.

- **Throughput**

Throughput testing without using Queue Tree and PCQ metode methods

Throughput = data packets received / length of observation
= 14451 / 72,688
= 198,809 bytes/s
= 0.19414903 kbps.

Throughput testing using Queue Tree and PCQ . methods

Throughput = data packets received / length of observation
= 24649 / 213,290
= 115,566 bytes/s

- **Packet Loss**

Testing Packet Loss without using Queue Tree and PCQ methods

Packet Loss = Data sent – Data received / Data sent x 100
= 14451 – 14451 / 14451 x 100
= 0%.

Testing Packet Loss using Queue Tree and PCQ metode methods

Packet Loss = Data sent – Data received / Data sent x 100
= 24649 – 24649 / 24649 x 100
= 0%. = 0.112857 kbps.

J. Overview of Method Results Per Connection Queue

Table.8 Testing Results of QoS Parameters Before and After Using the Per Connection Queue Method

QoS Parameter Testing	**Average *Delay* (ms)**	***Jitter* (ms)**	***Through put (kbps)***	***Packet Loss (%)***
Before using the method PCQ	0,55186	26,074671	0.19414903	0
After using the method PCQ	0,292	16,79686	0.112857	0

CONCLUSION

Mikrotik RouterOS is a Linux machine designed specifically for networking purposes. This Mikrotik is so interesting today, because with its complete features and ease of use and also the price is relatively cheaper. If we already understand the concept of networking well, it will be so easy to implement in MikroTik with its GUI tool (Winbox), so we don't need to memorize commands to make settings or settings. For developing countries, MikroTik solutions are very helpful for ISPs or small companies that want to join the internet.

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