

# OPTIMIZATION OF LOAD BALANCING FOR MULTI ISP BANDWIDTH MANAGEMENT MICROTIC WITH ANDROID BASED CONFIGURATION AND NOTIFICATION SYSTEMS IN 27 SENIOR HIGH SCHOOL

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## ABSTRACT

Load Balancing is a technique for separating between two or more network links, by distributing traffic loads on two or more balanced connection lines so that internet traffic can be balanced. SMA Negeri 27 Bandung is one of the high schools located in Bandung city. But now there is a problem in the use of multi ISP at 27 Senior High Schools in Bandung, namely not optimal use of ISP in these schools because there are currently three ISP where one ISP is only being made a backup. So that the use of three ISP can run optimally and avoid overloading, we need a technique that can divide the traffic load on three ISP to be balanced, also not to mention the problem of bandwidth because bandwidth management has not been implemented, nor is there network monitoring. The system development method used in this study is to use the PPDIOO method. Based on the problems that occur, it is made by applying load balancing technology using the PCC method so that traffic loading for three ISP can be balanced and evenly distributed. Also bandwidth management using simple queue for simple bandwidth settings for clients. And monitor the network with the help of third-party applications from Mikrotik. The results of the study show that the implementation of internet load balancing in 27 Senior High Schools in Bandung can be used simultaneously and in balance. Then the bandwidth distribution is evenly distributed using the simple queue method. Then to configure the notification can be used anywhere because it can be used with the MikoTik application via Android mobile.

**keywords :** Load Balancing, PCC, Bandwidth, Network Monitoring, ISP

## 1. INTRODUCTION

SMA Negeri 27 Bandung is one of the high schools located in Bandung city. SMA Negeri 27 Bandung that uses services with Multi ISP aims to further improve the quality of internet services in supporting daily activities at the school. The current condition of the internet in SMA 27 Bandung currently has different bandwidth, namely ISP 1 of 50MB / s, ISP 2 of 20MB / s, and ISP 3 of 40MB / s. Based on the results of

interviews with one of the IT staff at 27 Bandung Senior High School, there were several problems that occurred in Bandung 27 High School, namely not optimal computer networks in schools because at this time the school used three ISPs where one ISP was used to actively provide services internet to many rooms in the school then there are two ISPs that are only given specifically to one room in the school. Also the problem of costs is one of the concerns for the three ISPs in SMA 27 Bandung because of the current situation. Then continued Pa Okta as an IT staff at 27 Bandung High School, but still had not made bandwidth settings so that there was a connection struggle. Then after further pa Okta claimed to want a system for monitoring real-time networks to regulate the control of the existing network in 27 Public High School Bandung.

Based on these problems, this research intends to optimize the use of three ISPs so that they can be used optimally and together to balance traffic load and network monitoring and notifications using android in Bandung 27 SMA, namely "Load balancing optimization for MultiISP Bandwidth Management with Android Based Configuration and Notification System "

Therefore based on the intended purpose, the author also aims to conduct research as follows:

1. Optimizing the three ISPs to be used simultaneously in Public High School 27 Bandung.
2. Facilitate the distribution of bandwidth so that the internet connection is divided equally.
3. Facilitate configuration and network monitoring so that you can configure anywhere with Android based.

## 2. RESEARCH CONTENT

### 2.1 Theoretical Basis

The following are some of the theoretical foundations used by the authors as supporting the basic theory of "Optimizing Load Balancing for Multi-ISP Mikrotic Bandwidth Management with Android-Based Configuration and Notification Systems at SMAN 27 Bandung".

### 2.1.1 Computer Network

Computer networks can be said as a system consisting of various computers and their resources that are designed to be able to use existing resources, so they can access the information needed. The purpose of building a computer network is to send data or information from the sender to the recipient quickly and accurately. Computer networks based on their scale and network coverage can be classified into Local Area Networks (LAN), Metropolitan Area Networks (MAN), Wide Area Networks (WANs). Basically every computer network that functions as a client and also a server. There are also computer networks that have dedicated computers to be servers while others are clients. So based on its function, computer networks can be divided into two types, namely Client Server and Peer to Peer. [1]

### 2.1.2 Load Balancing

Load balancing in computer networks is a technique for dividing loads into several paths or links. This is done if to go to a network there are several lines (links). The purpose of load balancing is so that no link gets a load greater than the other links. It is expected that by dividing the load into several links, the balance of use of these links will be achieved. [1]

### 2.1.3 Metode PCC (Per Connection Classifier)

Load balancing techniques on microtics have several methods used including the PCC Method as follows:

Per Connection Classifier is a method that specifies a packet to the gateway of a particular connection. PCC groups connection traffic that goes in and out of routers into several groups. This grouping can be distinguished by src-address, dst-address, src-port and so on-port. Mikrotik will record the gateway path that has been skipped at the beginning of the connection traffic. So that the next data packages that are still related will be passed to the same gateway path as the previous data packet that has been sent. [2]

### 2.1.4 Mikrotik

Mikrotik is an operating system and software that can be used to make computers become reliable router networks, including various features made for IP networks and wireless networks.

Mikrotik is designed to be easy to use and very well used for computer network administration purposes such as designing and building a small to complex computer network system. [3]

### 2.1.4 Bandwidth

Bandwidth is the maximum speed that can be used to transmit data between computers on a TCP / IP-based computer network. Definition of Bandwidth is the number of sizes of a data or information that can flow from one place to another in a network at a certain time. Bandwidth can be used to measure both analog

data flow and digital data. Now it has become common if the word bandwidth is more used to measure the flow of digital data. [4]

### 2.1.5 ISP (Internet Service Provider)

An ISP is a company or entity that provides Internet connection services and other related services. Most telephone companies are Internet service providers. They provide services such as relationships to the Internet, domain name registration, and hosting.

This ISP has a network both domestically and internationally so that customers or users of connections provided by ISPs can connect to global Internet networks. The network here is in the form of transmission media that can stream data that can be in the form of cable (modem, cable rental, and broadband), radio, or VSAT. The development of ISP technology is developing not only by using telephone networks but also using technologies such as fiber optic and wireless. [5]

## 2.2 Research methods

The research method that is currently used by researchers is qualitative research methods, where the function is to find out the problem in the research whether it is still temporary so that it will develop or not change at all after conducting field research. Broadly speaking the research method will be carried out as follows:

### 2.2.1 Data Collection method

The stages in data collection, including:

#### 1. Literature Study

Collect all information about load balancing using the PCC method on computer networks, learn the PCC method to limit and separate traffic, study all related material from various sources which will be examined in this study.

#### 2. Observation

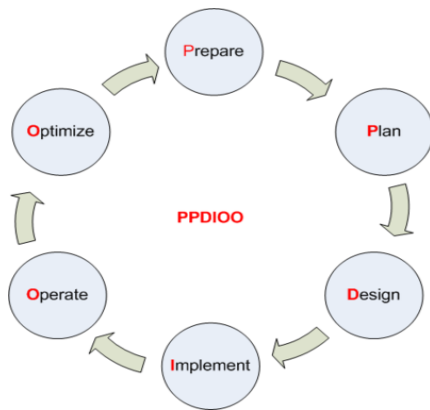
Collect data and conduct a direct review of the problems taken.

#### 3. Interview

Direct interview with Mr. Okta, as IT Staff at SMA Negeri 27 Bandung regarding problems regarding networking at the school.tersebut.

### 2.2.2 System Development method

This study uses the PPDIOO model (Prepare, Plan, Design, Implement, Oprate, and Optimizer) PPDIOO is a methodology originating from Cisco that is popularly used in the development of network technology. The PPDIOO cycle image can be seen in Figure 1



**Figure 1.** PPDIIO System Development Method

The following steps are carried out in this study:

**1. Prepare**

At this stage make a plan for the software and hardware specifications needed with the needs and network capabilities of the proposed architectural design.

**2. Plan**

At this stage it covers the characteristics of the area and assesses the existing network, to determine whether the existing system infrastructure, area, and operational environment can support the proposed system

**3. Design**

In this meeting, we discussed the logical details of the design of infrastructure in accordance with the mechanism of the system, designing the mechanism of the system that will run according to the needs and results of the analysis.

**4. Implement**

At this stage is the phase to implement everything that has been planned according to the design and analysis that has been done before.

**5. Operate**

At this stage is the phase of testing the system that is run in realtime.

**6. Optimize**

At this stage involves the role of the network administrator by seeing and resolving problems, before problems that affect the network appear.

**2.3 Result and Discussion**

The following is an explanation of the results and discussions that have been carried out by the researcher

**2.3.1 System Analysis**

Analysis is an action taken to find out more details about the object to be studied.

**2.3.1.1 Problem Analysis**

In its development at this time, the internet has become a necessity in getting information and delivering information. The higher demand for

information contained on the internet is directly proportional to the high delivery of existing data packages that will affect the level of data access via the internet.

At this time in SMA Negeri 27 Bandung used several ISPs to fulfill the internet connection needs at the school. The current condition of the internet at 27 Bandung High School has different bandwidth, namely ISP 1 at 50MB / s, ISP 2 at 20MB / s, and ISP 3 at 40MB / s. The problem that occurs in 27 Public High School Bandung at this time is that there is one of the three ISPs used there to be distributed to many rooms in 27 Bandung Senior High School which causes an internet connection to be less than optimal. Also other causes because in SMA 27 Bandung at this time in terms of costs that have been spent to pay three ISPs but which are often used by one ISP and two other ISPs are rarely used. Besides that, also in 27 Public High Schools in Bandung have not implemented bandwidth settings to limit the use of internet networks.

**2.3.3 Stage Plan**

At this stage there are a number of things that are done, namely making a plot that explains the configuration stages and the testing steps taken. Configurations are performed on the Router Routerboard. The parameters that will be configured on the Mikrotik routerboard are as follows:

- a. IP Address configuration phase
- b. Load Balancing configuration stage
- c. Bandwidth configuration stage
- d, Network monitoring configuration stage

The above stages of configuration are carried out in stages so that if something goes wrong it can be easy to fix it. For more

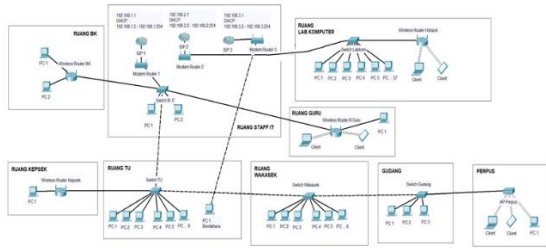
clarify, the following is a description of the configuration flow mentioned above.

**2.3.4 Step Design**

At this stage, discussing the logical details of the design of infrastructure in accordance with the mechanism of the system, designing the mechanism of the system that will run according to the needs and results of the analysis. At this stage, it will also be discussed about system design for optimizing load balancing and managing bandwidth using proxy, which includes network architecture..

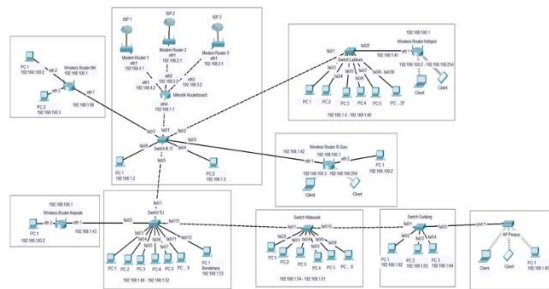
**2.3.4.1 Network Architecture**

Optimization of Load Balancing will be implemented in SMAN 27 Bandung. The following is a picture of the current network topology design.



Picture 2. Current Network Topology Design

Then this is the proposed network topology design where all three ISPs are already incorporated using mikrotik.



Picture 3. Network Topology Design To Be Built

### 2.3.5 Implementation of Network Topology That Will Be Made

After the system setup is made, the next step is to implement. In this case the stage refers to the system design that has been made. After the system design is made, the next step is to implement. In this case the stages refer to the system design that has been made.

### 2.3.6 Implementation of Load Balancing Configuration

Based on the results of the analysis of internet problems and conditions that have been described from the network topology, this is an implementation for load balancing configurations. Before entering into the load balancing configuration we will configure the IP Address first. Figure 5 is the display of the IP Address configuration in Winbox.

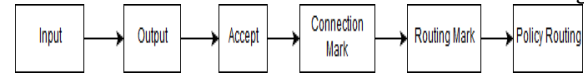
Address	Network	Interface
192.168.1.1/24	192.168.1.0	ether4_Local
192.168.2.2/24	192.168.2.0	ether2_ISP-2
192.168.3.2/24	192.168.3.0	ether3_ISP-3
192.168.4.2/24	192.168.4.0	ether1_ISP-1

Picture 4. IP Address configuration

### 2.3.7 Load Balancing Configuration

After configuring the IP Address, the next step is configuring the PCC load balancing method. This configuration consists of starting a firewall

firewall and routing. The mangle firewall configuration consists of input, output, accept, connection mark, and routing mark. Figure 6 is the flow of a load balancing configuration consisting of a firewall and routing.



Picture 5. Load Balancing Configuration Flow

The workflow at the input stage in load balancing configuration is to mark the input of each ISP in accordance with each Ethernet. At the output stage, this rule is used to mark output and also add three routing marks because it will use three ISPs. Furthermore, in the accept rule stage, it is used to enter each destination address from the ISP to the local ethernet. Furthermore, at the connection mark Rule stage, it is used to configure three ISP load balancing using the PCC method. Finally, do the routing mark by using the connection mark that was created previously and the intended interface is Ethernet4 (Local) / interface that will receive the result of load balance. Here are some images that contain scripts from each load balancing configuration path.

```

/ip firewall mangle
add action=mark-connection chain=input in-interface=ether1_ISP-1 \
new-connection-mark=conn-1 passthrough=yes
add action=mark-connection chain=input in-interface=ether2_ISP-2 \
new-connection-mark=conn-2 passthrough=yes
add action=mark-connection chain=input in-interface=ether3_ISP-3 \
new-connection-mark=conn-3 passthrough=yes

```

Picture 6. Script in Input Phase

```

add action=mark-routing chain=output connection-mark=conn-1 new-routing-mark=\
ke-1 passthrough=no
add action=mark-routing chain=output connection-mark=conn-2 new-routing-mark=\
ke-2 passthrough=no
add action=mark-routing chain=output connection-mark=conn-3 new-routing-mark=\
ke-3 passthrough=no

```

Picture 7. Script in Output Phase

```

add action=accept chain=prerouting dst-address=192.168.1.0/24 in-interface=\
ether4_Local
add action=accept chain=prerouting dst-address=192.168.2.0/24 in-interface=\
ether4_Local
add action=accept chain=prerouting dst-address=192.168.3.0/24 in-interface=\
ether4_Local

```

Picture 8. Script in Accept Phase

```

add action=mark-connection chain=prerouting dst-
address-type=!local \
  in-interface=ether4_Local new-connection-
mark=conn-1 passthrough=yes \
  per-connection-classifier=both-addresses-and-
ports:3/0
add action=mark-connection chain=prerouting dst-
address-type=!local \
  in-interface=ether4_Local new-connection-
mark=conn-2 passthrough=yes \
  per-connection-classifier=both-addresses-and-
ports:3/1
add action=mark-connection chain=prerouting dst-
address-type=!local \
  in-interface=ether4_Local new-connection-
mark=conn-3 passthrough=yes \
  per-connection-classifier=both-addresses-and-
ports:3/2

```

Picture 8. Script in Connection Mark phase

```

add action=mark-routing chain=prerouting
connection-mark=conn-1 in-interface=\
ether4_Local new-routing-mark=ke-1
passthrough=yes
add action=mark-routing chain=prerouting
connection-mark=conn-2 in-interface=\
ether4_Local new-routing-mark=ke-2
passthrough=yes
add action=mark-routing chain=prerouting
connection-mark=conn-3 in-interface=\
ether4_Local new-routing-mark=ke-3
passthrough=yes

```

Picture 9. Script in routing mark Phase

Furthermore, after doing the mangle firewall process, a new rule must be made in the routing table so that it can pass the data packet to the ISP gateway that matches the packet marking that was made in the mangle process. Also the stage of routing policy is to determine the traffic path to each gateway. The following is an image from the script for the routing policy stage.

```

/ip route
add check-gateway=ping distance=1
gateway=192.168.4.1 routing-mark=ke-1
add check-gateway=ping distance=1
gateway=192.168.2.1 routing-mark=ke-2
add check-gateway=ping distance=1
gateway=192.168.3.1 routing-mark=ke-3
add distance=1 gateway=192.168.4.1
add distance=1 gateway=192.168.2.1
add distance=1 gateway=192.168.3.1

```

Picture 10. Skrip Pada Tahapan Policy Routing

Figure 11 will show the results of the load balancing configuration that has been done in the Winbox support software.

Dest. Address	Gateway	Distance	Routing Mark	Pref. Source
AS 0.0.0.0/0	192.168.4.1 reachable ether1_1SP-1	1	ke-1	
AS 0.0.0.0/0	192.168.2.1 reachable ether2_1SP-2	1	ke-2	
AS 0.0.0.0/0	192.168.3.1 reachable ether3_1SP-3	1	ke-3	
AS 0.0.0.0/0	192.168.2.1 reachable ether2_1SP-2	1		
S 0.0.0.0/0	192.168.4.1 reachable ether1_1SP-1	1		
S 0.0.0.0/0	192.168.3.1 reachable ether3_1SP-3	1		
DAC 192.168.1.0/24	ether4_Local reachable	0		192.168.1.1
DAC 192.168.2.0/24	ether2_1SP-2 reachable	0		192.168.2.2
DAC 192.168.3.0/24	ether3_1SP-3 reachable	0		192.168.3.2
DAC 192.168.4.0/24	ether1_1SP-1 reachable	0		192.168.4.2
DC 192.168.27.0/...	wlan1 unreachable	255		192.168.27.1
DAC 192.168.192.0...	ovpn-out1 reachable	0		192.168.192.36

Picture 11. Load Balancing Configuration

Langkah selanjutnya adalah konfigurasi NAT, this configuration is used so that the client computer can connect to the internet, it is necessary to translate the private IP that the client has to the public IP.

The first line in the command above is a command to enter the NAT configuration menu. Then the command instructs the router to replace the source IP address of a package to the public IP address that has the "ISP-1" interface, the "ISP-2" interface, and the "ISP-3" interface with the masquerade method. Figure 7 will show the NAT configuration that has been done in the Winbox support software. .

#	Action	Chain	Sr...	Ds...	P...	S...	D...	Out. Int...	Bytes	Packets
0	masquerade	srcnat						ether1_...	175.1 MB	2 950 125
1	masquerade	srcnat						ether2_...	39.8 MB	546 255
2	masquerade	srcnat						ether3_...	38.9 MB	535 530

Picture 12. NAT Configuration

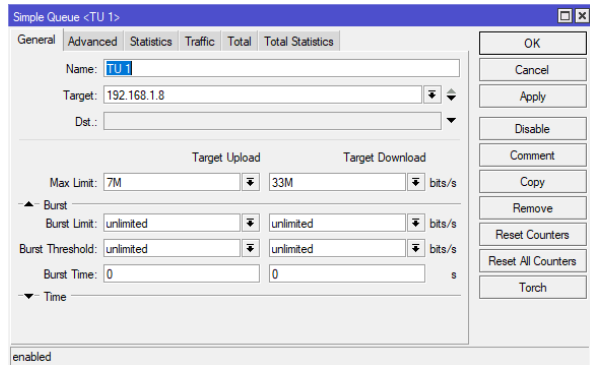
### 2.3.8 Configuration Bandwidth Distribution

On a network that has many clients, a method is used to regulate bandwidth in order to prevent exploitation in bandwidth usage so that the client will get the bandwidth allotment. For this bandwidth sharing configuration the author uses the simple queue method on proxy.

To do the queue on Mikrotik the author uses Simple Queue. We will be able to make bandwidth settings simply based on the client's IP Address by determining the maximum upload and download speeds that can be reached by the client. This writer did this simple queue process by using bandwidth burst method.

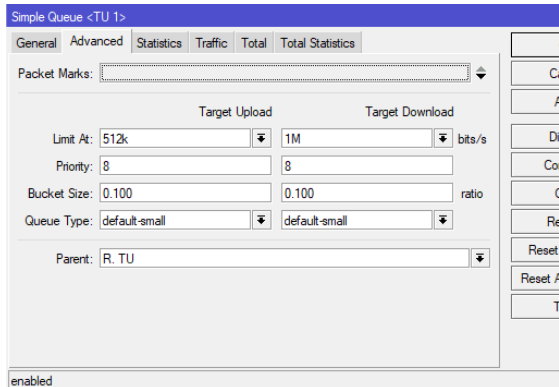
The first stage configuration that will be carried out is for what is currently handled by ISP 1, which consists of the teacher's room, IT staff room, BK room, etc. The maximum download speed to get there is 33MB / s, while the upload speed is 7MB / s. Where each client will get a minimum download speed of 1MB / s and upload of 512Kb / s.

Select the queue Winbox menu → on the simple queue tab click the button “+”, then fill in as shown below.



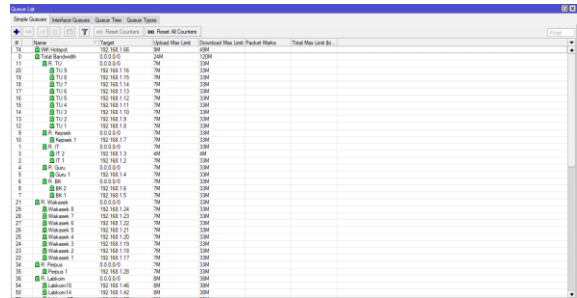
Picture 13. Bandwidth Configuration

1. Click the advanced tab then fill it as shown below

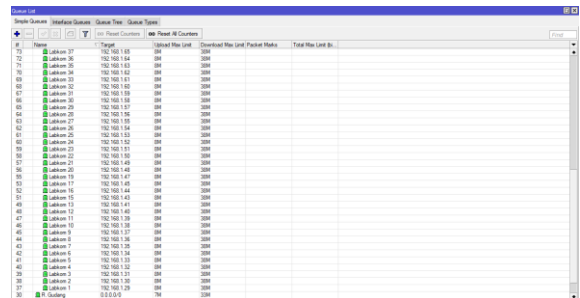


Picture 14. Bandwidth configuration (2)

Then the following results from the bandwidth configuration that will be shown in Figure 15 and Figure 16.



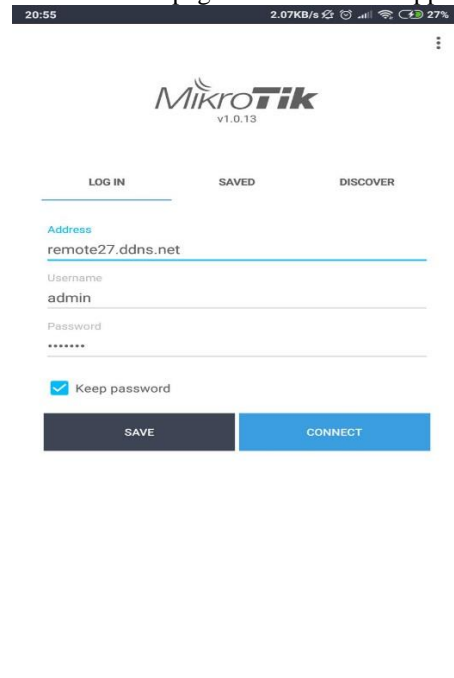
Picture 15. Bandwidth Configuration Results (1)



Picture 16. Bandwidth Configuration Results (2)

### 2.3.9 Installation and Configuration for Network Monitoring

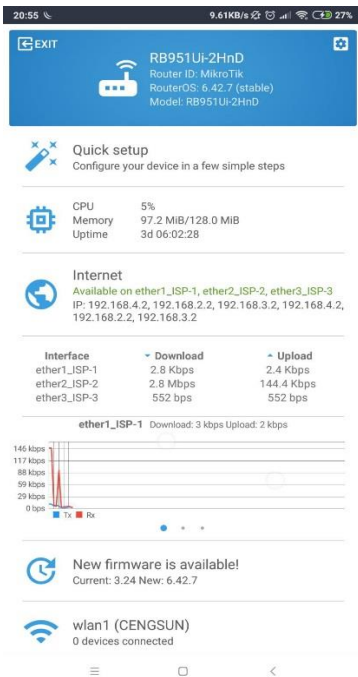
At this stage use third-party applications available on the Google Play Store, namely MikroTik. Figure 17 is the main page of the MikroTik application.



Picture 17 MikroTik Application

Type the address / address, user, and proxy password that will be configured or monitored. Click Connect and wait a while until it is connected to the Router Routerboard. Then the display will appear as below. Type the address / address, user, and proxy password that will be configured or monitored. Click

Connect and wait a while until it is connected to the Router Routerboard. Then the display will appear as shown below.



Picture 18. microtik main page

### 2.3.10 Testing plan

Testing will be carried out for multi ISP load balancing systems and bandwidth management. For load balancing testing will be done in several ways, namely the failover method, balance method, then also with the help of speedtest.net online based application. Assistance from speedtest.net's online application is also done to test bandwidth that has been applied. For testing of bandwidth, it will be used in burst bandwidth mode.

#### 2.3.10.1 Testing and results of Load Balancing

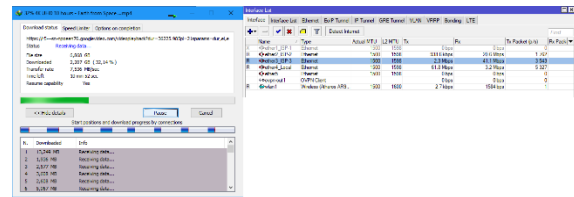
In the testing phase, the authors will measure the extent to which multi ISP load balancing systems that have been built can run optimally. The method of testing is by looking at the work and quality of the load balancing system. The following are the results of testing of system load balancing:

##### 1. Failover testing

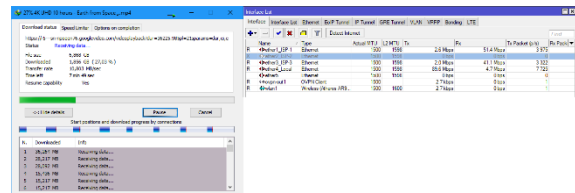
At this stage the author performs a failover test by turning off the internet connection path from one of the ISPs. In this case the authors do the testing with:

- a. Disable the ISP one, and let the ISP ISP and ISP three active.
- b. Disable the ISP two, and let the ISP one and the ISP three be active.
- c. Disable three ISPs, and let one ISP and two ISPs be active.

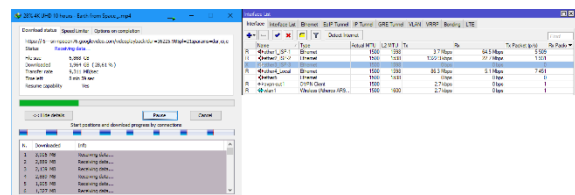
The following are the results of failover tests that will be shown in figure 19, image, 20, figure 21.



Picture 19 Failover Testing (a)



Picture 20 Failover Testing (b)

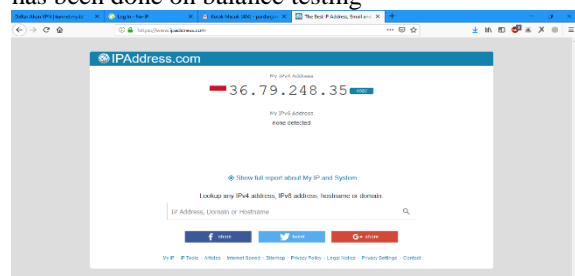


Picture 21 Failover Testing (c)

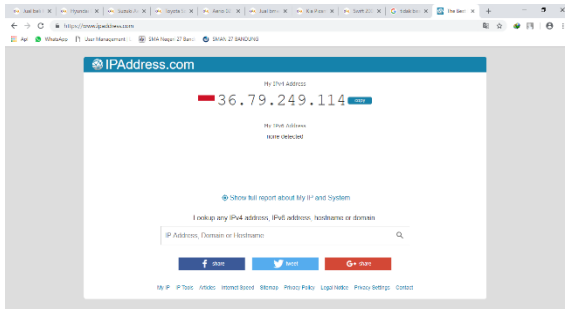
From the test results from Figure 15, Figure 16, and Figure 17, the results obtained are that the download process continues without any connection disruption because automatically from one ISP it will back up network performance.

##### 1. Balance testing

At this stage the author tests, namely by accessing the same site from the same client by using a different browser application to prove that the load balancing system that has been implemented is truly balanced. In this test the author accesses the site ipaddress.com with the browser application used is using Mozilla Firefox and Google Chrome. Figure 22 and figure 23 are the results of testing that has been done on balance testing



Picture 22 balance Testing (a)

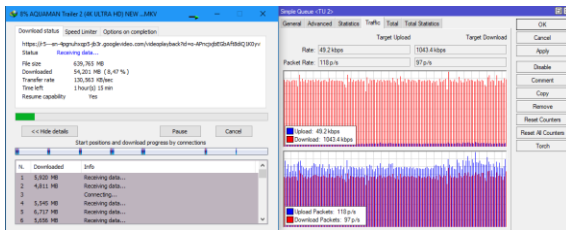


Picture 23 Balance Testing

From the tests that have been done, it was found that when accessing the ipaddress.com site from a different browser application using the Mozilla Firefox and Google Chrome browsers, the router can share the connection path for each application properly.

### 2.3.10.2 Bandwidth Testing

For this bandwidth management test because the authors do bandwidth using the simple queue method, they will experiment with bandwidth burst mode. For the internet connection, it still uses load balancing. What will be an experiment in this test is to use Internet Download Manager (IDM) and an online based application, speedtest.net.



Picture 24. Bandwidth Testing with IDM



Picture 25. Testing with speedtest.net

Can be seen from the test results that have been tried that the client has got the bandwidth limit as configured.

## 3. CLOSING ENTRIES

### 3.1 Conclusion

The conclusions obtained after conducting research are as follows:

1. Load balancing systems that have been built using the PCC method for three ISPs in 27 Bandung Senior High School have been able to solve the problem because it can be used simultaneously and balanced so that it has improved in terms of speed from the internet.

2. The system that has been built for sharing bandwidth using the simple queue method has been able to solve the problem because the internet connection has been divided evenly in Public High School 27 Bandung.

3. For configuration and monitoring can be done anywhere because it can be accessed with the MikroTik application via mobile android.

### 3.2 Advice

The following is a description of the author regarding some suggestions that might be used as development in the research that has been carried out, including:

1. Development of load balancing systems using other methods besides the PCC method for three or more connection lines.

2. In further development it is expected to use the login page so that user monitoring is more optimal.

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