LOAD BALANCE (PCC) WITH RECURSIVE GATEWAY METHOD

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Article Information	Abstract
	The continuous flow of information has become a necessity for organizations. The internet moves information quickly to support the activities of its users, PT. Graha Cipta Bangko Jaya. These organizations must keep running their business even when internet service is unavailable. There are several ways to overcome this problem, one of which is to use at least two different internet sources, which will be combined with failover techniques on the internet connection so that if one internet source is disconnected, it will be automatically transferred to another internet source. The failover technique is usually combined with the load balance technique, and there are several methods for the load balance, one of which is PCC (Per Connection Classifier). The PCC load balance and failover method are commonly used in the gateway check feature on the ip route menu. However, when implementing the gateway check feature, it can only check on the gateway device so that if there is a problem at the provider, it will not be able to be monitored by the router side. So that the router can check directly with the provider, it can add a recursive gateway technique to failover. A device that can support the above method is the Mikrotik Router. A Mikrotik router is a device or operating system specifically designed for routing in computer networks. Later the results of this research can ensure the availability of the internet within the organization and increase the operational productivity of the organization.

1. Introduction

Business and industry development tends to be more complex from year to year. Many business and industrial organizations have developed because they have adopted and integrated the internet network into their business processes. Two internet sources are available to Indonesian users: wired and wireless. PT. Graha Cipta Bangko Jaya is one organization with the leading internet source from cable-based ISPs.

PT. Graha Cipta Bangko Jaya is a Palm Oil Mill (PKS) that utilizes the internet network in daily activities, such as sending reports, zoom meetings and most importantly, weighing palm fruit directly connected to the head office in Jakarta. When there is a very down network problem, it affects the company's performance in carrying out its functions. As a result, queues of cars carrying palm oil can be created because the delivery of the weighing results to the head office is hampered. This happens because only one ISP (Internet Service Provider) is used, and if the ISP line fails or there is a problem with

the local network connecting to the internet, no action is taken to restore the network.Therefore, to get maximum network stability when the ISP used is experiencing problems, it is necessary to add a new internet source that allows transferring internet access sources from the primary ISP to a new ISP or vice versa so that the internet can still be available and its availability guaranteed. Several methods can overcome this problem, namely the Load Balance and Failover methods.

Load balance distributes traffic loads on two or more lines to achieve a balanced connection, more optimal traffic, maximum data throughput, minimal delay, and no overload. Load balance can be applied in companies with at least two Internet connections [1]. In load balance, there are several methods, one of which is PCC (Per Connection Classifier), where PCC can be used to classify connection traffic going through or out of the router into several groups and divide the load into both internet connection lines to avoid overload [2]. At the same time, failover is a technique that applies multiple paths to reach the destination network. However, under normal circumstances, only one ISP is used. Other ISPs serve as backups and will only be used when the primary ISP dies [3]. The failover method usually carried out by PCC load balance is the gateway check feature on the ip route menu. However, when implementing the gateway check feature, it can only check on the gateway device so that if there is a problem at the provider, it will not be able to be monitored by the router side. So that the router can check directly with the provider, it can add even a recursive gateway technique.

2. Method

To complete this report, the research methods used are:
  a. Observation (Observation)
     The author makes field observations by looking directly at and studying the problems in computer networks at PT. Graha Cipta Bangko Jaya.
  b. Interview (Interview)
     In this case, the author asks questions directly to one of the staff who knows about computer networks at PT. Graha Cipta Bangko Jaya.
  c. Library Research (Library Research)
     The research was conducted to study and collect information related to this research. These various sources are

obtained from scientific journals, theses, research reports, books, the internet, and other literature so that the data obtained can be used as a basis for the following research stage.
  d. Laboratory Research
     This research was conducted by the direct practice of the analysis results aimed at testing the correctness of the designed system.
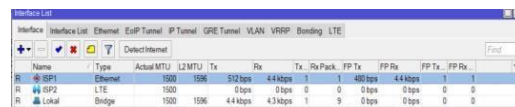
3. Results and Discussion

In this section, we will discuss the stages of implementing PCC load balance and failover with the recursive gateway method in the form of a configuration in the form of screenshots of the router configuration and the results of system testing.

1. MikroTik Interface Initialization

   Interface initialization helps facilitate the MikroTik configuration by giving a name to each interface according to the function and desire. The commands performed are as follows:

   The following is an overview of the results of the initialization of the interface on the proxy:

Figure 1. Interface Initialization on Mikrotik

2. DHCP Client Configuration

   A DHCP Client is a network device or computer that requests an IP address request from a DHCP server with the aim of being able to connect to the internet with the IP assigned by the DHCP Server. At this stage, the aim is to obtain an IP address from the ISP. The Mikrotik Router will act as a DHCP client. For DHCP-client configuration, you can use the following command:

   / ip dhcp-client
   add interface=ISP1 disabled=no add-default-route=no

   The following is an overview of the results of the DHCP Client configuration on Mikrotik:

Figure 2. Configure DHCP Client on Mikrotik

3. Giving IP Address

At this stage, an IP address will be assigned to each interface used for the implementation of load balancing and failover. Since in my research I used a DHCP client on ISP1 and ISP2, the IP addresses on the ISP1 and ISP2 interfaces were automatically filled in by themselves. To assign an IP address to MikroTik, you can use the following command:

/ ip address
add   address=192.168.157.1/24
network=192.168.157.0   interface=Lokal
broadcast=192.168.157.255

The following is an overview of the results of the IP addressing:
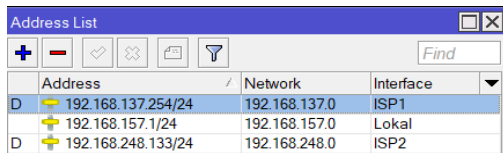

Figure 3. Giving IP Address

4. Konfigurasi IP DNS Server

DNS, or Domain Name System, is a technology for translating domain IP addresses, because actual addressing on the network uses IP addresses. A DNS server is useful for mapping a computer's host name to an IP address. At this stage, the DNS address used is the IP address of each ISP. The configuration is as follows:

/ ip dns
set servers=8.8.8.8,1.1.1.1 allow-remote-requests=yes

The following is an overview of the results of the DNS Server IP configuration:

Figure 4. Configure DNS Server IP

5. NAT Configuration

After configuring IP and DNS, you must add NAT (Network Address Translation) configuration. NAT is useful for clients connected to the internet. NAT will change the packet's source address, specifically the client address with a private IP address, so that the internet can recognize it by translating it into a public IP address. This NAT setting uses the Masquerading NAT method. Since the provider used only provides one public IP address, all client IP addresses will be mapped to one public IP address. For NAT configuration, because this research uses two ISPs, then add two src-nat rules pointing to their respective ISPs with the command:

/ ip firewall nat
add   action=masquerade   out-interface=ISP1 chain=srcnat
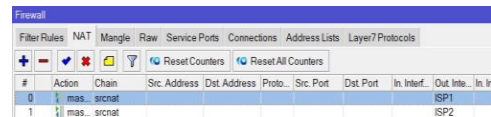*add   action=masquerade   out-interface=ISP2 chain=srcnat*

Figure 5. NAT configuration

6. Mangle Configuration

Mangle helps mark a package, where the marking is done with the desired terms and conditions. The report results will then be used for specific purposes depending on the selected action. In the PCC method, packet marking is based on checking all packets, especially on src-IP, DST-IP, src-port and DST-port. From these parameters, connection marks and routing marks can be performed, which are then used to process specific packets.

The first step in managing an externally initiated connection is to ensure that when a connection request arrives, the connection response goes through the same interface (from the same public IP). Mark all incoming connections to remember the interface used with the command:

/ ip firewall mangle
add in-interface=ether2 action=accept
DST-address=192.168.137.0/24
chain=prerouting

add   in-interface=ether2   action=accept
DST-address=192.168.244.0/24
chain=prerouting
add   new-connection-mark=ISP1
action=mark-connection   connection-
mark=no-mark   in-interface=ISP1
chain=prerouting
add   new-connection-mark=ISP2
action=mark-connection   connection-
mark=no-mark   in-interface=ISP2
chain=prerouting

Use of Action mark-routing can only be used to mangle chain output and prerouting, while mangle chain prerouting captures all traffic destined for routers. To avoid this, DST-address-type= !Local. Then add a PCC rule to split traffic into groups based on source and destination addresses (both addresses). Since the two ISPs have different speeds (4Mbps and 2Mbps), the traffic load is divided into three. The first two sections go through the ISP1 gateway, and the last one goes through the ISP2 gateway.

/ ip firewall mangle
add   DST-address-type=!Local
connection-mark=no-mark   in-
interface=ether2 chain=prerouting
* new-connection-mark=ISP1*
action=mark-connection   per-
connection-classifier=both-
addresses:3/0
add   DST-address-type=!Local
connection-mark=no-mark   in-
interface=ether2 chain=prerouting
* new-connection-mark=ISP1*
action=mark-connection   per-
connection-classifier=both-
addresses:3/1
add   DST-address-type=!Local
connection-mark=no-mark   in-
interface=ether2 chain=prerouting
* new-connection-mark=ISP2*
action=mark-connection   per-
connection-classifier=both-
addresses:3/2

After creating the PCC rule, add a mark-routing action based on the connection marker created. Remember to specify the parameters in the interface because policy routing is only needed for traffic destined for the internet.

/ ip firewall mangle

add   action=mark-routing   in-
interface=ether2   connection-
mark=ISP1 chain=prerouting
* new-routing-mark= to_ISP1*
add   action=mark-routing   in-
interface=ether2   connection-
mark=ISP2 chain=prerouting
* new-routing-mark= to_ISP2*
add   new-routing-mark=to_ISP1
action=mark-routing   connection-
mark=ISP1 chain=output
add   new-routing-mark=to_ISP2
action=mark-routing   connection-
mark=ISP2 chain=output

The following is the result of setting the PCC load balance on the firewall mangle:

Figure 6. Results of PCC Marking Load Balance on Firewall Mangle

7.   Making Failover with Recursive Gateway method

Failover with a Recursive Gateway is one way to check the gateway outside the modem network or the ISP gateway (NAP), an easy example is when we have more than one ISP, and one ISP is having problems, Mikrotik will still respond that the status of that ISP no problem or refined, this happens if you only use the failover method, because Mikrotik only pings the nearest gateway, namely the modem, when in fact the ISP is down / to. Therefore, adding a recursive gateway method is necessary to check the gateway outside the modem network or the ISP gateway.

The first step is to create a static route that will be used as a trigger for the recursive gateway. This rule is used as the recursive gateway default route.

In this design, the author uses IP on the internet, namely IP = 8.8.8.8 for ISP1 and IP = 1.1.1.1 for ISP2.
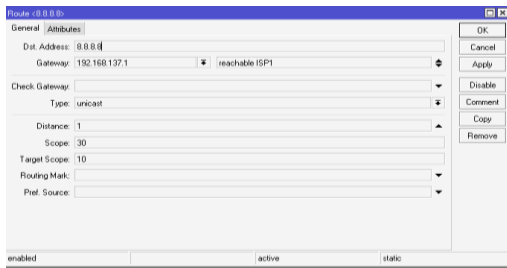
Figure 7. Configuring Recursive Gateway Default
Route on ISP1

Figure 8. Configuring the Recursive Gateway Default
Route on ISP2

Next, to distinguish between ISP1 and
ISP2 triggers, change the Scope parameter
in the rule. In this study, the scope of ISP1
is 30, and the scope of ISP2 is 31.
Furthermore, the Distance for
manipulating the main gateway still uses
the value one because its function is not as
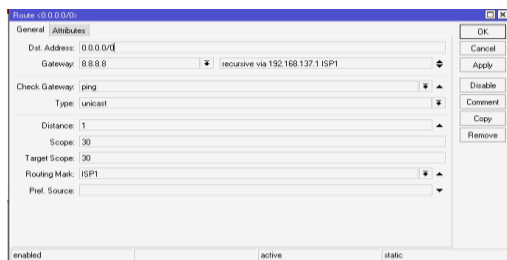a failover but as a check-gateway.
Moreover, do not forget to enable ping on
the check-gateway feature.

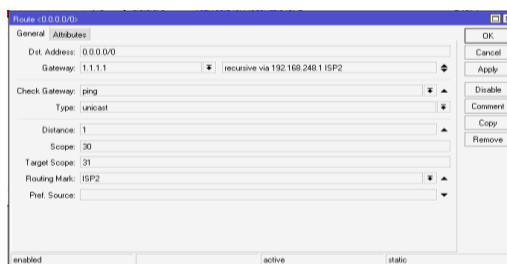Figure 9. Configuring Check Gateway and Routing
Mark on ISP1

Figure 10. Configuring Check Gateway and Routing
Mark on ISP2

Then add a default route based on the
previously created PCC mark-routing. The
gateway can use a predetermined IP,
8.8.8.8 for ISP1 and 1.1.1.1 for ISP2.

For failover to work, as usual, we still
specify the order of the Distance gateway
main (primary) or a backup gateway
(backup). Distance with a smaller value
will take precedence, and a more
considerable Distance will work as a
backup.

After that, so that the recursive can run
normally, point to the Target-Scope based
on the trigger rule created earlier.

> *ISP's default route 1 uses target
> scope=30*
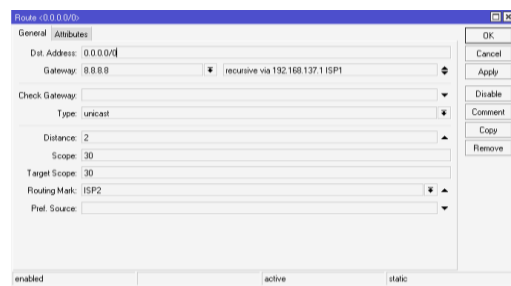> *ISP 2 default route using target
> scope=31*

Figure 11. Configuring Routing Mark as Backup
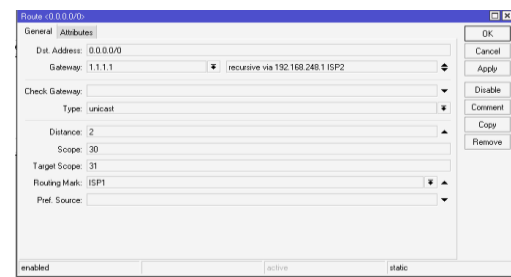Gateway from ISP1

Figure 12. Configuring Routing Mark as Backup
Gateway from ISP2

After all the steps are done, the complete
routing rule can be seen in the image
below:

Figure 13. Results of Making Routing Rules

8. Test

The test is run to analyze the PCC Load
Balance method by watching videos from
two different sources, namely through the
website www.youtube.com and another

through www.drive.google.com, and to prove whether the PCC method can mark which gateway or path can be used. Testing the PCC method can be carried out in the hope of being efficient and approaching the break-even point. If there is a use of the number of connections, the amount of traffic passing through ISP1 and ISP2 can be monitored by the Winbox application itself as follows:
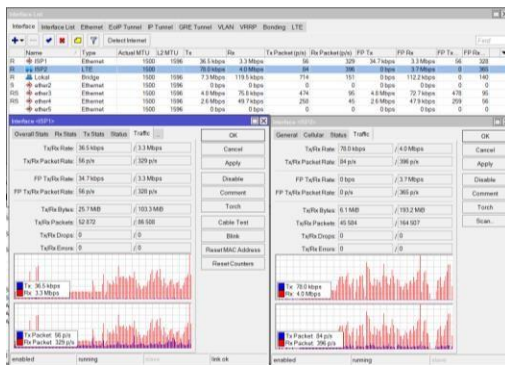

Figure 14. Testing the Application of the PCC Load Balance Method

The test results show that the two ISP lines are active simultaneously when accessing videos on different websites. It can be seen in the upstream interface (ISP) and Rx traffic. Rates 3.3 Mbps and 4.0 Mbps according to the connection speed at each ISP. Next, we can see which ISP path is used when accessing a website by doing a traceroute. Traceroute can be done by opening a command prompt and typing tracert followed by the website you want to monitor, as shown below:
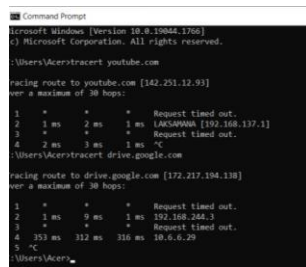

Figure 15. Traceroute Test

From the results of the two traceroute tests above for different IP addresses, it can be seen that they both go through different ISP gateways. The destination of the website www.youtube.com goes through the ISP1 gateway (192.168.137.1) while the destination website www.drive.google.com goes through the ISP2 gateway (192.168.248.3).

After carrying out the above implementation, it was found that the nature of PCC remembers the path traversed by connection traffic, and can then analyze the connections that occur and determine the size of packets that pass through each interface, so that it is known if the PCC method has been successful or not.

The following are the results of monitoring that occurs when the client laptop downloads a file:
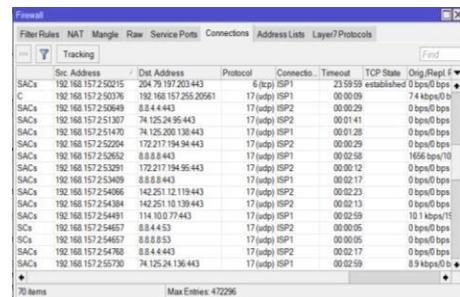

Figure 16. PCC Testing Works in Classifier

From the observations made, the results of ISP1 and ISP2 connections that have been marked are almost balanced, namely 7 and 8 times. That is, the PCC has marked the connection as balanced and sent it to the routing process. Then the connection marked as ISP1 will be traversed to the Routing-mark Line-1, namely the ISP1 gateway, and the connection marked as ISP2 will be passed to the Routing-mark Route-2, namely the ISP2 gateway.

Furthermore, the movement of failover with the recursive gateway method can be seen on the Mikrotik IP-Route menu. After that, for the initial stage of failover testing with this recursive gateway method, ISP1 and ISP2 will be turned on as shown below:
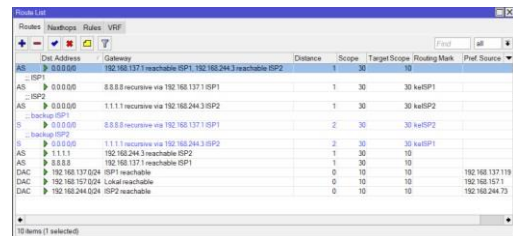

Figure 15. ISP1 And ISP2 Are On

In Figure 13, it can be seen that the ISP1 backup and ISP2 backup are blue, which indicates that the gateway settings are not running because the main gateway settings are still in good condition, so there is no

need to use ISP backups. Furthermore, the test is continued by turning off the internet source on ISP 1, as shown below:
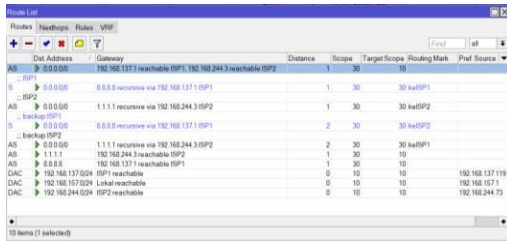

Figure 16. ISP1 Is Off And ISP2 Is On

Figure 14 shows a change where when ISP1 is turned off, the ISP1 gateway settings and ISP1 backups are immediately blue or not running and are transferred to ISP2, and ISP2 backup internet sources are used. Then turn on the ISP1 internet source again, then turn off the ISP2 internet source. It will be like the following picture:
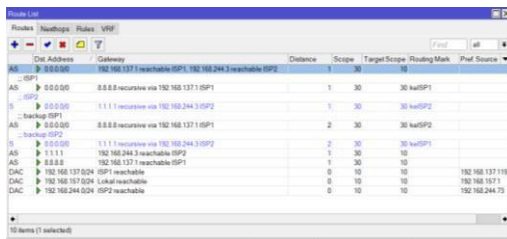

Figure 17. ISP1 is On, and ISP2 is Off

Figure 15 shows a change where when ISP1 is turned on and ISP2 is turned off, the gateway settings for ISP1 and backup ISP1 change to black, while for ISP2 and backup ISP2, it turns blue or does not work.

9. QoS Test

QoS testing should be carried out to measure the quality of Internet services used for load balancing. Because the quality of internet services is not only measured by the amount of bandwidth provided, the quality of good internet services also has other characteristics such as short delay time, reduced packet loss, and others.

a. Throughput Test

Table1. Throughput Testing Before Implementing

Gateway Status	Throughput (kbps)			average	Note:
	PC1	PC2	PC3	(kbps)	
ISP1	415	464	298	392	1
ISP2	434	326	283	348	1

Table 2. Throughput Testing After Implementation

Gateway Status		Throughput (kbps)			average	Note:
ISP1	ISP2	PC1	PC2	PC3	(ms)	
ON	ON	1159	886	780	942	2
OFF	ON	554	383	445	461	1
ON	OFF	473	672	115	420	1

b. Packet Loss Test

Table 3. Packet Loss Testing Before Implementing

Status *Gateway*	Packet Loss (%)			rata-rata	Ket
	PC1	PC2	PC3	(kbps)	
ISP1	3,2	3,5	1,4	2,7	3
ISP2	3,8	4,0	2,8	3,5	3

Table 4. Packet Loss Testing After Implementation

Status *Gateway*		Packet Loss (%)			rata-rata	Ket
ISP1	ISP2	PC1	PC2	PC3	(ms)	
ON	ON	0,2	0	0	0,06	4
OFF	ON	3,6	2,6	0,1	2,1	3
ON	OFF	2,1	2,3	0,4	1,6	3

c. Delay Test

Table 5. Delay Testing Before Implementing

Gateway Status	Delay (ms)			average	Note:
	PC1	PC2	PC3	(kbps)	
ISP1	80,60	73,28	68,13	74	4
ISP2	83,44	67,23	70,63	73,77	4

Table 6. Delay Testing After Implementation

Gateway Status		Delay (ms)			average	Note:
ISP1	ISP2	PC1	PC2	PC3	(ms)	
ON	ON	65,33	54,67	59	59,67	4
OFF	ON	80,33	63,67	69,44	69,44	4
ON	OFF	77,33	56	64,7	64,7	4

d. Jitter Test

Table 7. Jitter Testing Before Implementing

Gateway Status	Jitter (ms)			average	Note:
	PC1	PC2	PC3	(kbps)	
ISP1	15,61	12,42	8,92	12,32	3
ISP2	18,75	16,34	12,14	15,74	3

Table 8. Jitter Testing After Implementation

Gateway Status		Jitter (ms)			average	Note:
ISP1	ISP2	PC1	PC2	PC3	(ms)	
ON	ON	13.92	11.07	8.78	11.26	3
OFF	ON	19.46	16.83	11.99	16,10	3
ON	OFF	14.03	11.22	8.61	11.29	3

4. Conclusion

Based on the results of this study, the following conclusions were obtained:

1 By implementing a load balance using the PCC method, you can distribute the amount of load connected evenly to all the ISP gateways used. However, the size of the packets forwarded to each ISP is unbalanced because the PCC method is broken down only by Connection, not the size of packets passing through the ISP.

2 Per Connection Classifier works by grouping incoming or outgoing connection traffic into groups and then distinguishing based on the source IP address, destination IP address, source port, and destination port.

3 PCC testing is done by dividing the load or traffic volume that passes through ISP1 and ISP2, which is then monitored by the Winbox application.

4 Applying the Failover technique with the Recursive Gateway is already functioning properly. When one of the internet gateway connections is lost, or the Connection is down, all internet connection loads will be transferred automatically to the gateway that is still active.

5 Quality of Service (QoS) testing is carried out using the parameters of packet loss, throughput, delay and jitter on the Wireshark application. It is found that using the PCC load balance of two ISPs, the QoS results are better.

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