

# Load Balancing and Fail Over MikroTik Implementation Using Per Connection Classifier (PCC) on Two Internet Providers Interconnection

Wiwik Wiharti <sup>a,1,\*</sup>, Ihsan Lumasa Rimra <sup>b</sup>, Silfia Rifka <sup>b</sup>, Ikhrum Hidayatullah <sup>b</sup>, Andre Febrian Kasmar <sup>c</sup>

<sup>a</sup> Department of Electrical Engineering, Politeknik Negeri Padang, West Sumatera, Indonesia

<sup>b</sup> Department of Telecommunication Engineering, Politeknik Negeri Padang, West Sumatera, Indonesia

<sup>c</sup> Department of Information Technology, Politeknik Negeri Padang, West Sumatera, Indonesia

<sup>1</sup> [wiwikwiharti@pnp.ac.id](mailto:wiwikwiharti@pnp.ac.id)

\* corresponding author

## ARTICLE INFO

### Article history

Received April 30, 2023

Revised July 10, 2023

Accepted July 20, 2023

### Keywords

Fail Over

ISP

Load balancing

MikroTik

## ABSTRACT

Load balancing is tasked with dividing and balancing the traffic load on two or more ISPs in a balanced way so that the output obtained when using this technique is to maximize throughput, minimize response time and avoid overload on one ISP line when one of the ISPs experiences a disconnection. This can be seen from the automatic connection switching to an active ISP gateway, so that network performance continues to run normally. Throughput testing in the morning, afternoon, and evening showed very good value changes after load balancing was applied. Delay and Packet Loss tests also show a change in value from bad to very good after the implementation of the Load balancing system. The results of this study indicate that in measuring network performance for conditions of delay, packet loss, jitter and throughput before and after system implementation using load balancing and failover with the Per Connection Classifier (PCC) method, different results were found

This is an open access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



## 1. Introduction

The need for the internet is currently very high and has become a mandatory thing for humans with various varied uses such as searching for information or the latest knowledge articles or playing online games. This causes an increase in connection traffic on the internet and workloads on the servers of internet service providers. Especially on a network that has a small bandwidth, it will greatly disrupt network connection traffic and can cause the internet connection to be cut off. With the high need for internet use among the community, it is hoped that there will be solutions or various alternatives for internet users to be able to access the internet easily and without interruption of internet connection.

With a very large need for the internet, sometimes administrators use more than one ISP (Internet Service Provider) so that the internet needs of their users can be met and the results are satisfactory. Administrators sometimes provide an alternative by separating internet lines based on departments if in a company. This method is considered less effective because one day there will be inequality in

the condition of internet users. If department A has a small bandwidth but is used by many users and department B with a bandwidth that is widely used for only a few users, then internet access in department A will be slower than department B [1].

The use of the Load balancing technique is a very effective technology solution option by utilizing Mikrotik to optimize the distribution of bandwidth and connection paths for each client who wants to access the internet without any inequality. Load balancing process on MikroTik RB941 Router using Static Route with Address List, EqualCost Multi-Path (ECMP), Per Connection Classifier (PCC) and Nth methods can solve this problem. If the main connection is lost, the internet connection will automatically switch to an active connection line. So that it does not interfere with internet users in learning and working in an organization [2].

Per Connection Classifier is a mangle option that sorts data into streams that can be tagged for later identification. PCC divides incoming data into streams and then uses routing rules to sort traffic evenly (or not) across multiple WAN connections. The PCC function contained in the "Mangle Facility" is to sort traffic into streams [3].

Load balancing is tasked with dividing and balancing the traffic load on two or more ISPs in a balanced way so that the output obtained when using this technique is to maximize throughput, minimize response time and avoid overload on one ISP line [9] when one of the ISPs experiences a disconnection. This can be seen from the automatic connection switching to an active ISP gateway, so that network performance continues to run normally. Throughput testing in the morning, afternoon, and evening showed very good value changes after load balancing was applied. Delay and Packet Loss testing also shows a change in value from bad to very good after the implementation of the Load balancing system [4].

There are several studies that have investigated Load Balancing and Failover Using Mikrotik with the Per Connection Classifier (PCC) Method on the Interconnection of Two Internet Service Providers (ISP), such as the research conducted by Nanang Sadikin and Faprianda Rossy Ramadhan which showed that the load balancing system 2 ISP and fail over can be applied directly as a solution in overcoming problems that arise on the internet network, so that it can be maximized in helping PT. Visionet Data International Service Point Setiabudi.

This study aims to implement load balancing on two ISP connection lines using the Per Connection Classifier (PCC) method on the Mikrotik router and n failover techniques if one of the ISP lines has a problem or one of the ISP connections is down or disconnected.

## 2. Literature Review

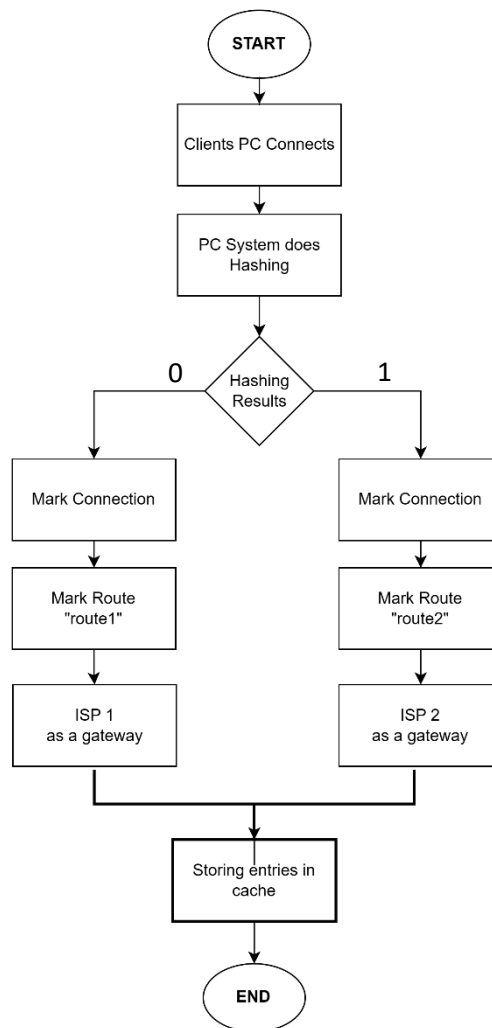
PCC works by taking some fields from the IP header and TCP or UDP header, then with the help of a hashing algorithm will produce an output. The output is obtained by summing several IP header fields, then dividing by a predetermined denominator, and the remainder when compared with a certain remainder, if they are the same, the packet will be captured. We can select source-address, destination-address, src-port, etc.-port in this operation.

The source-address and destination-address can be retrieved from the IP packet header and the src-port and dst-port are retrieved from the TCP or UDP packet header. One hash method that can be used is Modulo. modulo is a number operation that returns the remainder of the division of one number by another. Suppose two numbers a and b, a modulo b (abbreviated a mod b) is the integer remainder of the division of a by b. For example, "1 mod 3", "4 mod 3", and "7 mod 3" have a result of 1, because all three numbers have a remainder of 1 when divided by 3, while "9 mod 3" is 0.

Applying the modulus operation in Number theory belongs to modulo arithmetic. The hashing function is used because it has one of the deterministic properties. The point is that if we enter an input that says "hello" and produce an output of "1", and the statement is absolute, so if we input "hello" a second time it will produce an output of "1". Figure 1 below shows a block diagram of the PCC method.

The system built is the implementation of load balancing using the PCC method using 2 internet connections from two different provider connections on Mikrotik. The two internet connections come from the Axis provider and the Telkomsel provider.

This load balancing system will be combined with a failover system to handle if there is a downtime in one of the internet connection lines that can occur at any time.



**Figure 1.** Block diagram of PCC Method

### 3. Method

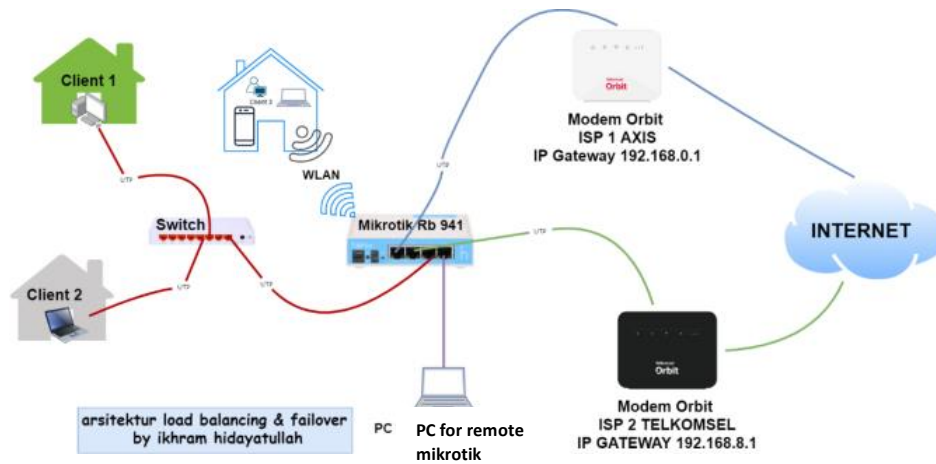
#### 3.1. System Implementation

After the design scenario is created, then proceed to the implementation stage. At this implementation stage consists of 2 parts, namely:

1. Physical development of the system

## 2. System installation and configuration

### 3.2. System Design



**Figure 2.** Fail over and load balancing architecture

The architecture of the system to be built is shown in Figure 2. The hardware and software required for this implementation are software and hardware.

The next step is to configure Load Balance and Failover with Mangel application for PCC method. In its function, the mangle is used to mark every connection that enters the router through the interface. The process of this mangle is based on srcaddress, dst-address, src-port, and dst-port, from that connection-mark and routing-mark can be done to process specific packets, the marking can be done more specifically by using a working chain in the stages of the data management process. By using this mangle later the PCC method will be applied.

Mangle works by marking the connections entered from the input as connection-mark=ISP1, and connection-mark=ISP2 through the output, thus dividing the connections that are issued from the router through each interface with a mark-routing action. Mangle with the Per Connection Classifier (PCC) method is a feature on the Mikrotik Router that works by tracking incoming or outgoing connections through the router based on certain groupings.

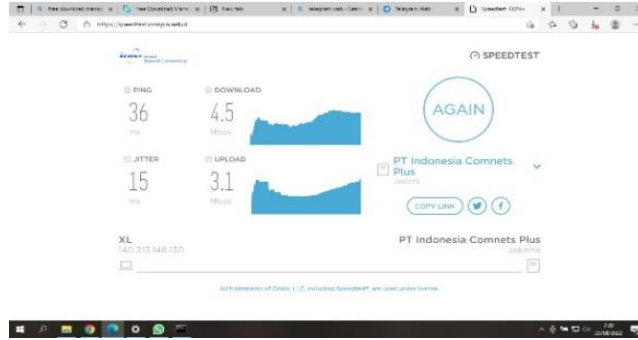
### 3.3. Testing and Measurement

At the stage of test system design, a design is made in testing the performance of the Load balancing system using the PCC method and testing the QOS (Quality of Service) parameters of the internet network before and after Load balancing is carried out.

To do a test using Speed Test to see the upload and download speed values before and after load balancing, Command Prompt to see the gateway path that is passed and see the path shift during a failover. And in the Wireshark application only to see the parameters of delay, packet loss, jitter and throughput because the quality of internet service is not only measured by how much bandwidth speed is given. And in Wireshark it only measures QoS parameters.

## 4. Results

In the initial network test stage, using available web-based applications, in this network test it will be known the value of the download speed and upload speed as well as the ping value of the ISP used.



**Figure 3.** Initial Network Testing ISP 1



**Figure 4.** ISP Initial Network Testing 2

**Table 1.** Network Table Before Load Balancing

	ISP 1 (AXIS)		ISP 2 (TELKOMSEL)		
ping (ms)	download	upload	ping (ms)	download	upload
36	4,5 mbps	3,1 Mbps	203	5,1 Mbps	5,4 Mbps
50	0,9 Mbps	2,8 Mbps	196	7,0 Mbos	6,5 Mbps
39	1,3 Mbps	4,8 Mbps	41	9,3 Mbps	11,1 Mbps
35	0,4 Mbps	1,1 Mbps	41	4,1 Mbps	9,2 Mbps
4,1	5,2 Mbps	3,1 Mbps	38	9,7 Mbos	11,9 Mbps

It can be seen from table 1 that the value of download and upload speeds for each ISP is relatively low, some of which are only 0.4 Mbps for download speed and 1.1 Mbps for upload speed. And also that can happen because of the weather that sometimes rains or even with the condition of the place that has access to a provider that is not good.

Final Network Testing After load balancing using the saddest web-based application, in the network test it will be known the value of the download speed and upload speed and the magnitude of the ping value of the ISP used.

**Table 2.** Network Table After Load balancing

PING (ms)	DOWNLOAD	UPLOAD
39	15.7 Mbps	14.5 Mbps
63	18.5 Mbps	17.3 Mbps
40	16.7 Mbps	16.6 Mbps
37	17.2 Mbps	14.4 Mbps
41	16.4 Mbos	13.4 Mbps

It can be seen in table 2 that when both ISPs are active and working at the same time, you can immediately see the value of the download speed and upload speed which has increased significantly, even for download speeds of up to 18.5 Mbps. while the upload speed rose with the highest value of 17.3 Mbps. So from the data above, the implementation of load balancing has been successfully

implemented. Speedtest testing with monitoring on winbox is carried out speedtest and then monitoring using applications or tools available on winbox, namely the interface list.

The parameters seen from the two traffics in this interface list are the average size of packet distribution (Tx/Upload) and (Rx/Download) from each ISP gateway. From Figure 20, as shown in the yellow box, it can be seen that the load has been divided between ISP 1 interface and ISP 2 interface, so it can be concluded that load balancing has worked successfully and it can be seen that traffic has been distributed to ISP 1 and ISP 2 interfaces.

To prove that this load balancing system is truly balanced, the author uses the next test method by doing live streaming on the same website, namely [www.detik.com](http://www.detik.com) but on a different PC, after that the author will try to see which gateway route is traversed by each PC with the traceroute command at the command prompt.

From the tests that have been carried out, the results show that when PC Client1 performs a life streaming on the [www.detik.com](http://www.detik.com) site, then the author does a traceroute at the command prompt and it appears that the gateway traversed is 192.168.8.1 indicating that client1 passed the route gateway ISP 2. As for PC client2 when doing life streaming on the [www.detik.com](http://www.detik.com) site then the author does the same thing to see the route traversed by PC client2 by means of a traceroute at the command prompt and get the result that is 192.168.0.1 which indicates that PC client2 is on the ISP1 gateway path. This test proves that load balancing has gone well, because it has equalized the distribution of connection paths from the two ISPs.

## 5. Conclusion

Based on the results of the implementation of load balancing and failover using Mikrotik with the Per Connection Classifier (PCC) method on the interconnection of two different internet service providers (ISPs), stem load balancing that has been built using the Per Connection Classifier (PCC) method can be implemented and used as a way to creating an alternative source of internet connection that is quite reliable because it can increase download and upload speeds and can also divide connection lines in a balanced way based on the size of the request packet, so that the two ISPs can work optimally. The failover system that has been made can be implemented and can overcome problems when one ISP experiences a down or lost connection, by means of all the load being transferred automatically to an active ISP, so that clients can still access the network without being afraid of not being able to internet.

In measuring network performance for conditions of delay, packet loss, jitter and throughput before and after system implementation using load balancing and failover with the Per Connection Classifier (PCC) method, different results were found. Where when the two ISPs are active, the values for throughput are 1180 bps, packet loss is 0%, jitter is 40,564 ms and delay is 40,552 ms. Meanwhile, for conditions when one ISP is down or disconnected, the value for throughput is 1202 bps, packet loss is 0%, jitter is 44,382 ms and delay is 44,466 ms.

## References

- [1] Mishra Assistant Professor, A. (2015). Network Load balancing and Its Performance Measures. *International Journal of Computer Science Trends and Technology*, 3(1), 77–81. Retrieved from [www.ijcstjournal.org](http://www.ijcstjournal.org)
- [2] Christanto, F. W., Susanto, S., & Priyanto, A. (2019). Load balancing-Failover Methods using Static Route with Address List, ECMP, PCC, and Nth for Optimizing LAN Network: A Comparison. *International Journal of Communication Networks and Information Security*, 11(3), 409–416.

- [3] Discher, S. (2016). Load balancing Using. What Is Load balancing and Why Would I Want It?, 29–33. Retrieved from <https://mum.mikrotik.com/presentations/US12/steve.pdf>
- [4] Safrianti, E. (2021). Peer Connection Classifier Method for Load balancing Technique. *International Journal of Electrical, Energy and Power System Engineering*, 4(1), 127–133. <https://doi.org/10.31258/ijeeipse.4.1.127-133>
- [5] Abbas Karimi, Faraneh Zarafshan, Adznan, Ramli, Iqbal. 2009. A New Fuzzy Approach for Dynamic Load balancing Algorithm. *Faculty of Engineering UPM Malaysia* (Vol. 6, No. 1)
- [6] Sugeng, W. 2010. *Jaringan Komputer dengan TCP/IP*. Bandung: Modula.
- [7] Rido Aldila, Hamid Azwar, Muhammad Diono. 2016. “Analisis Perbandingan Implementasi Load balancing PCC (Per Connection Classifier), NTH Dan ECMP (Equal Eost Multi Path).” *Jurnal Aksara Elementer* 5 (2): 1–8.
- [8] Suryanto, Teguh Prasetyo, Noer Hikmah. 2018. “Implementasi Load Balancing Menggunakan Metode Per Connection Classifier (PCC) Dengan Failover Berbasis Mikrotik Router (Studi Kasus PT. Sumber Rejeki Power).” In *Seminar Nasional Inovasi Dan Tren (SNIT) 2018*, 230–38. Bekasi, Jawa Barat.
- [9] Sopandi, Daniel T. Kustanto. 2008. *Membangun Server Internet dengan Mikrotik*. Yogyakarta: Gava Media
- [10] Nugroho, B. 2005. *Instalasi dan konfigurasi jaringan linux dan windows*. yogyakarta : ANDI
- [11] Setiawan, W. 2014. *Pengertian Dan Penjelasan IPv4 atau Alamat IP (Internet Protocol) Versi 4*. Palcomtech
- [12] Suryanto, Teguh Prasetyo, Noer Hikmah. 2018. “Implementasi Load balancing Menggunakan Metode Per Connection Classifier (PCC) Dengan Failover Berbasis Mikrotik Router (Studi Kasus PT. Sumber Rejeki Power).” In *Seminar Nasional Inovasi Dan Tren (SNIT) 2018*, 230–38. Bekasi, Jawa Barat.
- [13] Pangestu, Y., Setiyadi, D. & Khasanah, F. N. 2018. Metode Per Connection Classifier Untuk Implementasi Load balancing Jaringan Internet. *Jurnal Penelitian Ilmu Komputer, System Embedded & Logic p-ISSN: 2303-3304, eISSN: 2620-3553* 6 (1): 1 - 8 (Maret 2018).
- [14] Rasna & Ashari, A. 2019. Application Load balancing With Nth Method Multiple Gateway Internet Networks. *IJCCS (Indonesian Journal of Computing and Cybernetics Systems)* Vol.13, No.2, April 2019, pp. 159~168 ISSN (print): 1978-1520, ISSN (online): 2460-7258.
- [15] Muhammad, M & Hasan, I. 2016. Analisa Dan Pengembangan Jaringan Wireless Berbasis Mikrotik Router Os V.5.20 Di Sekolah Dasar Negeri 24 Palu. *Jurnal JESIK* (Vol.2 No.1 Januari-Juni 2016 p. ISSN: 2477-5290 e. ISSN: 2502-2148 10 Vol.2 No.1 Januari-Juni 2016.
- [16] Herlambang, M. Linto dan Azis Catur L. 2008. *Panduan Lengkap Menguasai Router Masa Depan Menggunakan Mikrotik RouterOS*. Yogyakarta: ANDI.
- [17] Anwar, M. K & Nurhaida, I. 2019. Implementasi Load balancing Menggunakan Metode Equal Cost Multi Path (ECMP) Pada Interkoneksi Jaringan. *InComTech: Jurnal Telekomunikasi dan Komputer*, Vol.9, No.1, April 2019.
- [18] Saputro, Daniel T. & Kustanto. 2008. *Membangun Server Internet dengan Mikrotik*. Yogyakarta: Gava Media.