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Comparison Analysis of Load Balance Performance Per Connection Classifier (Pcc) And Equal Cost Multi-Path (Ecmp) Networks for Multiple Path Networks

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Article Info	ABSTRACT
	One technique to improve connection stability in a network is to use more than one Internet Service Provider (ISP). To make this possible, a load balancer is needed. Examples of load balancers are Per Connection Classifier (PCC) and Equal Cost Multi-Path (ECMP). However, both load balancers have drawbacks, where if there is an overload in one ISP line resulting in an imbalance in bandwidth usage, the two load balancers divert all traffic to another ISP. This study analyzes the performance of several load balancing techniques when applied to Mikrotik to maximize traffic flow with dual lanes. The experiment was carried out by applying the PCC, ECMP load balancer on the internet network. The independent parameters observed were throughput, jitter, and delay. The Fuzzy method will choose the ISP that will forward the data with the optimum bandwidth, because this method takes into account the amount of data that will be sent to the gateway through the ISP. The results of the measurement of Quality Of Service (QoS) network performance parameters such as throughput, jitter and delay with PCC and ECMP methods between ISP1 and ISP2 are throughput 22113.58 Kbps, Jitter 63.79 ms, delay 0.000578 ms. While in Utami's research (2017) with the PCC method, measuring Throughput is 2.9 Kbps, Delay is 135.25 ms and Jitter is 65.25 ms.

1. INTRODUCTION

The use of the internet in today's business world has become a very vital main infrastructure as the main gateway to the outside world with extensive knowledge. Internet connections often experience problems, namely the slow internet connection (low speed) when there is a lot of internet access usage at the same time which often results in disconnection from the internet service provider (ISP) because it only uses one ISP and requires recovery. time that interrupts the connection service [1]. Another thing is the disruption of data transmission to the destination (receiver) because it is caused by the unbalanced internet bandwidth usage between each user. Seeing the above, it is necessary to do a study so that the connection constraints and low speed can be resolved. With the development of internet use, it will

greatly affect the amount of bandwidth needed, so that the use of internet connections can run smoothly, for that optimal bandwidth is needed. Internet service performance will be slow and stop if its use exceeds the available bandwidth. Thus, we need a way to anticipate over capacity in bandwidth usage [2].

A redundancy scenario is needed in optimizing internet network traffic so that the system continues to run even if there are components that cannot be used, such as overload in bandwidth availability. In implementing the load balancing function, it is necessary to optimize bandwidth capacity by adding bandwidth sources, if one ISP experiences interference or internet connection traffic density, there will be automatic backups that can anticipate problems [3] [4]. In overcoming these problems, load balancing needs to be implemented by increasing the bandwidth capacity of different Internet Service Providers (ISPs) where Ahmad Dahlan University (UAD) on campus 3 Yogyakarta has not utilized load balancing as a means of anticipating the need for bandwidth usage[5].

By looking at the research above, in this study the author conducts an analysis entitled "Comparative Analysis of Performance Load Balancing Methods Per Connection Classifier (Pcc) and Equal Cost Multi-Path (Ecmp) for Networks with Dual Paths".

2. METHODS

Internet users often experience problems with slow internet connections at peak usage of internet access, which often experience slowness and result in connection loss. To improve the performance of computer networks in Utami's research

(2017), this research proposes the use of two different Internet Service Providers (ISP) or internet connection links. Furthermore, the use of the internet network as usual will result in an additional bandwidth load on one of the ISP so that the network becomes slow and unstable. To improve the connection, a failover process is needed which is the ability of a system to switch gateways automatically (load balancing) which aims to reduce the workload on the ISP so that the connection becomes stable again [6] [7].

In this study, Mikrotik is used which functions to optimize the distribution of bandwidth for each client that will access the internet connection with the Fuzzy Logic algorithm. The concept is that Mikrotik will recognize the packet that will access the internet, then balance the load from the two ISP, then the ISP will choose which path to pass. In this research, the performance quality of the internet connection will be tested using a website, namely www.speedtest.net which can be accessed online. In this trial, the bandwidth grade will be obtained and the throughput, delay and jitter will be obtained. The author also compares the speed of the bandwidth between the Pgncom ISP service providers and the local network before using load balancing and then compares the two ISP that already use load balancing [7][8][9][10].

In the protocol test, how to use the activity of a request made from the client to the server via the TCP or UDP protocol by utilizing a predetermined application program, namely a network analyser. In this test, the test will be carried out five times on the same server, then the data obtained will be made into the form of a comparison table. Where the research chart can be seen as shown in Figure 1.
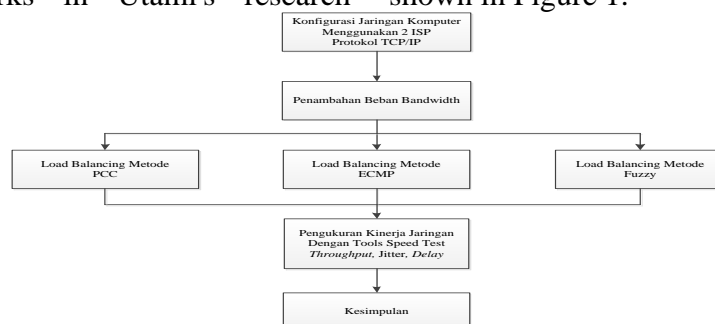

Figure 1. Cognitive process dimension

2.1. Proposed Computer Network Topology
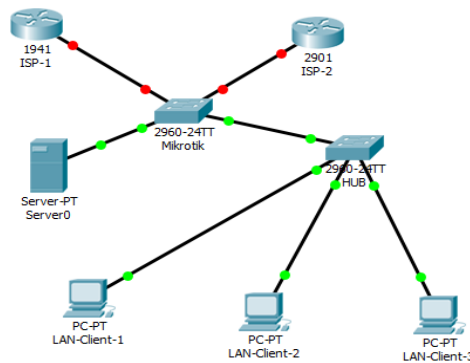In this study the proposed computer network topology is as shown in Figure 2.

Figure 2. Computer Network Topology

In Figure 2 above, you can see two ISP units used by ISP modems and access points that are connected to a local computer network (LAN 24 client PC) via a Mikrotik RB 750 unit. The computer configuration to be tested is with a Star topology LAN network with a switch (HUB) which is connected to the ISP via mikrotik RB 750. In the test, load balancing will be carried out using the PCC and ECMP methods, where the computer configuration is in the PCC and ECMP load balancing tests.

2.2. Load Balancing Method
The load balancing method in this study is carried out by distributing the traffic load in a balanced way through 2 ISP units to optimize bandwidth usage so that more optimal performance is obtained. This method is a technique in distributing data traffic loads on two or more connection lines in a balanced way where the goal is so that traffic can run optimally and maximize throughput, then it will minimize response time and anticipate an overload on one of the existing internet connection rules. on mikrotik. The load sharing process in a load balancing system has a special way and algorithm in its application. The devices used in the implementation of load balancing generally provide several types of algorithms in dividing the traffic load

which aims to match the equalization of traffic loads based on the characteristics of the servers they have. In the load balancing contained in the proxy, there are several things that are important to note for setting load balancing, namely static routes, police routes, firewall mangle and firewall src-nat. Where the firewall mangle is a marker for a router before the packet enters routing where the static route and policy route function to manage uplink flow which is the policy of the routing path that the marked data packets want to pass.

2.3. PCC Configuration
In the configuration on PCC using a device, namely RB433UAH the following conditions will be applied:
1. Ether1 and Ether2 are connected to different ISP providers and the amount of bandwidth used is not the same where ISP-1 is 512 kbps then ISP-2 is 256 kbps.
2. In this case openDNS and internal web-proxy will be used in this configuration.
The Mikrotik RouterOS used is version 4.5 the reason is because in the PCC configuration used is starting from version 3.24. The network topology and IP address used can be seen as the following command and figure 3:

```
/ip address
add address = 192.168.101.2/30 interface = ether1
add address = 192.168.102.2/30 interface = ether2
add address = 10.10.10.1/24 interface = wlan2
/ip dns
set allow-remote-requests = yes
primary-dns = 208.67.222.222
secondary-dns = 208.67.220.220
```

Figure 3. PCC Configuration Using RB433UAH

In connecting to the client, the connection to wireless is used on wlan2 where the client IP range is 10.10.10.2 - 10.10.10.254 with the netmask being 255.255.255.0 and the IP address used on wlan2 is 10. 10. 10.1 which is used on wlan2 . There is an additional mangle that is made in bold if an ISP uses DNS. After the IP and DNS configuration is in the right condition, a default route must be installed into the IP gateway of each ISP so that it can continue all traffic that is not related to the gateway. We use a check-gateway that works if there is a disconnected gateway then another gateway will take over.

Figure 4. Example of Internet Connection Topology More than one ISP

Load balancing on 2 internet connection lines, then the initial settings are the same as the routing settings so that routers and clients under the router can connect via the internet. Because it has two sources of internet connection, there will be 2 paths of NAT masquerade.

Figure 5. NAT settings on 2 ISP

After completing the standard configuration of the connection to the internet, the next step is that we can start setting up ECMP load balancing. In a fairly easy way where we just add the default gateway path with dst-address = 0.0.0.0 and gateway path = ISP-A, ISPB.
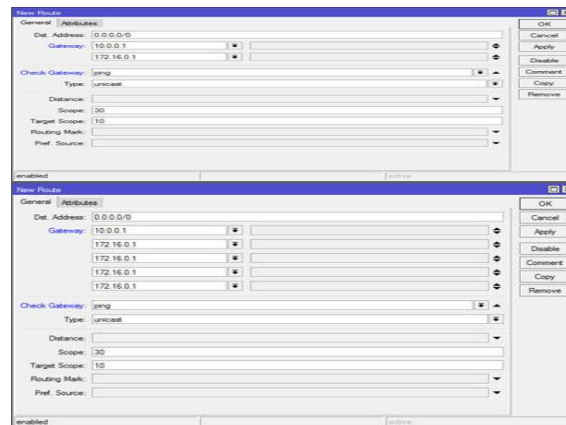

Figure 6. ECMP Load Balance Settings

3. RESULTS AND DISCUSSION

Monitored traffic are processes running on both ISPs where incoming and outgoing data traffic is carried out through a gateway with a certain bandwidth as shown in Figure 7.

It can be seen that both ISP 1 and ISP2 gateways have been active to transmit incoming and outgoing data as well as local computers connected through routers. The following Table 4.1 is a comparison of speed equalization data after and before using load
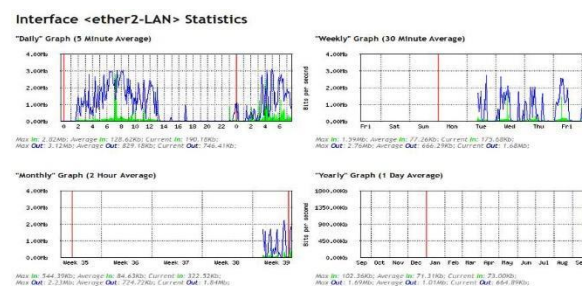
Figure 7. Traffic Monitoring Results

Table 1. Monitoring Results After Using Load Balancing

	1	2 Mbps	64,6	1027,7	29,1
	2	2 Mbps	170,6	1018,2	30,2
	3	2 Mbps	149,2	1034,4	28,6
	4	2 Mbps	45 kbps	1027,7	29,2
77.920 MB	5	2 Mbps	46 kbps	1064,2	30,7
	6	2 Mbps	88 kbps	1057,8	27,6
	7	2 Mbps	60,9	1051 kbps	26,6
	8	2 Mbps	60,4	685,1	16,8
	9	2 Mbps	74,9	1010,7	37,2

3.1 Daily Internet Usage

Daily internet usage is the result of monitoring client computers on a Local Area Network (LAN) that downloads and uploads data through routers that are forwarded through ISP1 and ISP2 as shown in Figure 8.
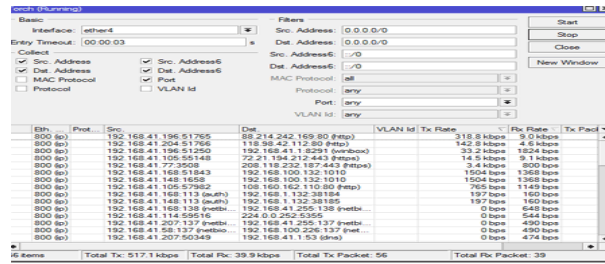
Figure 8. Daily Internet Usage

3.2 Deployment of Tx and Rx Packages to 2 ISP

The spread of Tx and Rx packets are data packets that are transmitted or received to and from the gateway through ISP1 and ISP2 as shown in Figure 9.
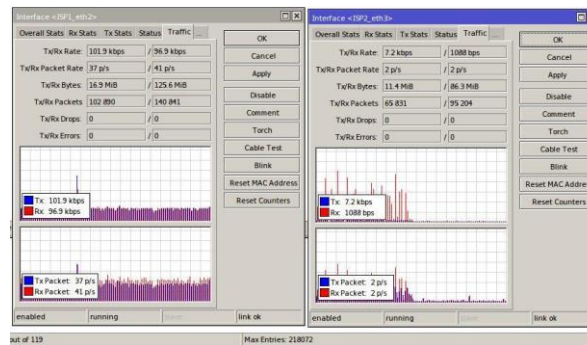

Figure 9. Spread of Tx and Rx Packets

3.3 Load Balancing Performance Test

At this stage, the quality test of the connection that has been built is carried out where the test is carried out five times on the same server using a test application, then the received data will be made into a comparison table.

3.3.1 Load Balancing Testing with Per Connection Classifier (PCC) Method

In this test, it is carried out by measuring the Throughput, Jitter and Delay values using Load Balancing with the Per Connection Classifier method as shown in Table 3.

Table 3. Test Results for PCC Load Balancing Method

Test PCC	ISP-1			ISP-2		
	Throughput (Kbps)	*Jitter (ms)*	*Delay (ms)*	*Throughput (Kbps)*	*Jitter (ms)*	*Delay (ms)*
1	21484,375	67,47	0,00055	23632,813	63,44	0,00041
2	23096,1328	60,21	0,00062	25405,746	62,24	0,00052
3	24438,4766	74,33	0,0006	26882,324	61,54	0,00056
4	22111,7188	68,14	0,0006	24322,891	60,01	0,00046
5	20893,5547	70,14	0,00059	22982,91	63,21	0,00054
Avg	**22404,8516**	**68,058**	**0,00059**	**24645,337**	**62,088**	**0,0005**

From Table 3 above, the results of the Throughput test can be plotted as in Figure 10.
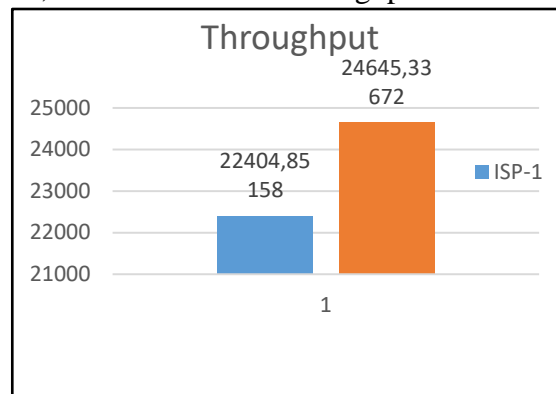

Figure 10. Throughput Load Balancing Test Results PCC Method

From Table 3 above, the Jitter test results can be plotted as shown in Figure 11.
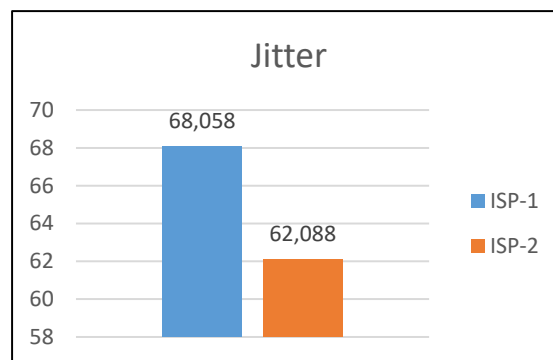

Figure 11. Jitter Load Balancing Test Results PCC Method

From Table 3 above, the results of the delay test can be plotted as shown in Figure 12.
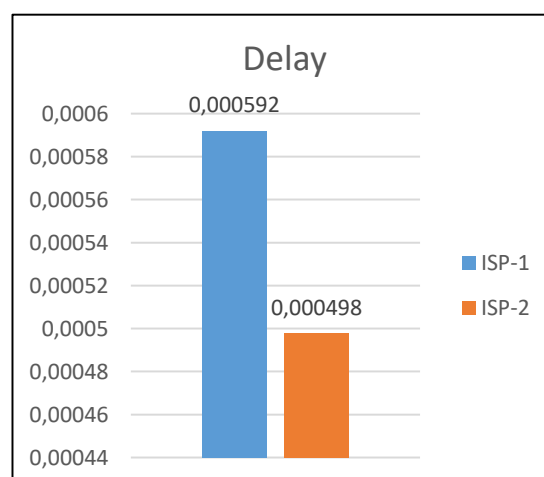

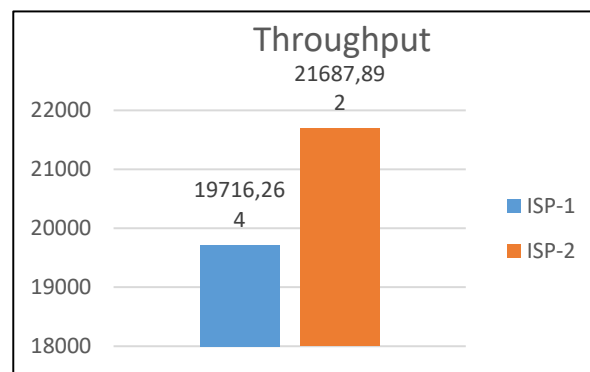**Figure 12.** Delay Load Balancing Test Results PCC Method

3.3.2 Testing With Load Balancing Equal Cost Multi-Path (ECMP) Method

In this test, measuring the Throughput, Jitter and Delay values using the ECMP Load Balancing method can be seen in Table 4.

Table 4. Test Results for ECMP Load Balancing Method

Test ECMP	ISP-1			ISP-2		
	Throughput (Kbps)	*Jitter (ms)*	*Delay (ms)*	*Throughput (Kbps)*	*Jitter (ms)*	*Delay (ms)*
1	18906,25	60,24	0,00061	20796,87	62,14	0,00046
2	20324,59	61,33	0,0007	22357,05	60,74	0,00059
3	21505,85	54,22	0,00067	23656,44	61,24	0,00062
4	19458,31	65,24	0,00067	21404,14	65,24	0,00051
5	18386,32	64,58	0,00066	20224,96	70,21	0,00061
Avg	**19716,264**	**61,122**	**0,00066**	**21687,892**	**63,914**	**0,00056**

From Table 4 above, the results of the Throughput test can be plotted as shown in Figure 13.

Figure 13. Throughput Load Balancing Test Results ECMP Method

From Table 4 above, the Jitter test results can be plotted as shown in Figure 14.
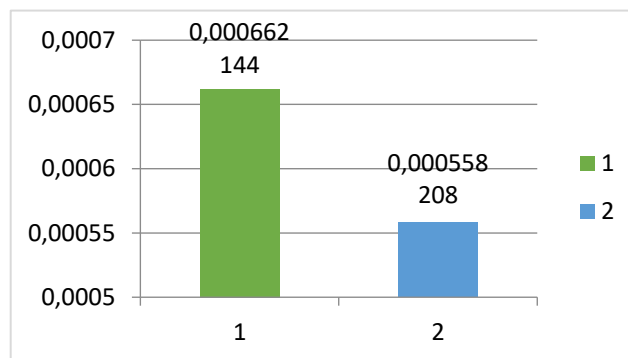
Figure 14. Jitter Load Balancing Test Results ECMP Method

From Table 4 above, the results of the delay test can be plotted as shown in Figure 15.
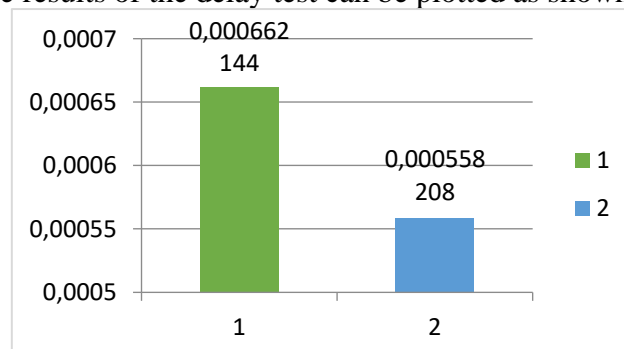
Figure 15. Delay Load Balancing Test Results ECMP Method

From the data in the table above, the average results of each method can be seen as in Table 5.

Table 5. Average Results of Each Method

PCC	Throughput (Kbps)	Jitter (ms)	Delay (ms)
ISP-1	22404,852	68,058	0,000592
ISP-2	24645,337	62,088	0,000498
Average	**23525,0942**	**65,073**	**0,000545**
ECMP	**Throughput (Kbps)**	**Jitter (ms)**	**Delay (ms)**
ISP-1	19716,264	61,122	0,00066
ISP-2	21687,892	63,914	0,00056
Average	**20702,078**	**62,518**	**0,00061**
Enhancement PCC-ECMP	22113,5861	63,7955	0,000578
Enhancement (%)	**12**	**3,92**	**11,92**

3.4 Performance Comparison

This study discusses load balancing using 2 ISP with different capacities using PCC and ECMP methods. In measuring load balancing with PCC and ECMP methods without using a server that will monitor the data transmitted by the client to the gateway and measure the bandwidth capacity of the 2 ISP used. From the data in Table 5, the results of measuring network performance parameters of Quality Of Service (QoS) such as the average value of throughput, jitter and delay using the PCC and ECMP methods between ISP1 and ISP2 are:

Throughput : (23525,0942+20702,078)/2
= 22113,58 Kbps
Jitter : (65,073 + 62,518)/2 = 63,79 ms
Delay : (0,000578 + 0,000610)/2
= 0,000578 ms

Utami Research (2017):
PCC method
Throughput : 2,9 Kbps
Jitter : 65,25 ms
Delay : **135,25 ms**

4. CONCLUSION

After conducting network load balancing experiments with two ISP router units by measuring Throughput, Jitter and Delay parameters using the Equal Cost Multi-Path (ECMP) method and the per connection classifier (PCC) method, it can be concluded that the PCC method produces Throughput, Jitter and The delay between ISP1 and ISP2 is more balanced in terms of bandwidth usage than the ECMP method where the results of measuring Quality Of Service (QoS) network performance parameters such as throughput, jitter and delay with the PCC and ECMP methods between ISP1 and ISP2 is the average throughput value of 22113.58 Kbps, Jitter 63.79 ms, Delay 0.000578 ms. While in Utami's research (2017) with the PCC method of measuring 2.9 Kbps, Jitter is 65.25 ms and Delay is 135.25 ms.

5. ACKNOWLEDGMENT

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