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QUALITY ANALYSIS OF SERVICE LOAD BALANCING USING PCC, ECMP AND NTH METHODS

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Abstract

One of the solutions to get a better quality of internet service is to utilize load balancing technology. We can use more than one different ISP (Internet Service Provider) which is then balanced with load balancing technology, where this technique is used to distribute the traffic load on two or more connection lines in a balanced way so that traffic can run optimally, maximizing throughput, minimizing response time. and avoid overload on any of the connection lines. This study aims to determine the comparison of Quality of Service load balancing with the PCC, ECMP and NTH methods on Mikrotik. The test method uses the web application www.speedtest.cbn.id, www.fast.com (1 connection), the results will show ping, download speed, upload speed, and monitoring from the Mikrotik router side. The research stages used the Network Development Life Cycle method, namely analysis, design, prototype simulation, implementation, monitoring and management. The results of the research are in the form of a performance comparison between load balancing on 2 internet lines using the PCC, ECMP and NTH methods on the proxy router. Based on the tests carried out as a whole the load balance using the ECMP method is superior and more reliable in terms of failover effects.

Keywords : Load Balancing, Quality of Service, PCC, ECMP, NTH

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INTRODUCTION

Advances in communication technology are currently growing very rapidly. Judging from the everyday life of humans who really need access to the internet world to communicate through chat applications, e-mail, social media is a necessity for humans in the millennial era. According to the Association of Indonesian Internet Service Providers, in 2022 internet users in Indonesia will reach 204.7 million or 73.7% of Indonesia's total population [1]. The data shows that more than half of the population are internet users and of course this data shows an increase in internet users in Indonesia.

The increase in internet users in Indonesia continues to arise, including wanting fast and stable internet access so that it has good and optimal performance. The ability to communicate on the internet that knows no distance and time is the main requirement for improving work on the internet. To improve the performance of access to the internet, a solution is needed to guarantee a reliable internet network, therefore companies/agencies use more than one ISP (Internet Service Provider) to maintain the quality of internet access with the aim of avoiding interruption of internet access and having backup access to the internet network if it goes down which results in disrupting the company's performance in carrying out its duties. One of the contributions of information technology science in overcoming the problem of merging two or more internet lines is the load balancing technique.

Research conducted by Zawiyah Saharuna, Rini Nur and Ahmad Sandi (2020) by title "Analisis *Quality Of Service* Jaringan *Load Balancing* Menggunakan Metode PCC dan NTH". In his research, he explained that the application of load balancing can balance throughput values and minimize packet loss values. The throughput value on NTH is more stable for each client than PCC. However, the value of packet loss on PCC is smaller than Nth. The delay and jitter values have no effect on the application of load balancing, but PCC has a smaller delay and jitter value than Nth. The failover mechanism works well on both load balancing methods, but the failover mechanism on Nth is faster than PCC with a downtime value of 3 seconds [2]. Research conducted by Ibnu Asyhar Pratama (2021) by title "Analisa Perbandingan Kinerja *Load Balance* Pfsense Dengan *Load Balance Per Connection*

Classifier Pada Mikrotik Router". In his research, he explained that based on the tests carried out, overall the load balance on Pfsense has superior results than the load balance on Mikrotik [3].

Research conducted by Umar Ali Ahmad, Aliwarman Tarihoran, Yuliantho Mardiansyah (2021) by title "Analis Perbandingan Kinerja *Load Balancing* Dengan Metode Pcc Dan Metode Epmc Pada Mikrotik Routers". In his research, he explained that the use of the ECMP and PCC methods had different characteristics. But for their use, the PCC method was very good to use because the resulting packet loss value was less than ECMP [4]. Research conducted by Ahmad Tantoni, Lalu Mutawalli, Mohammad Taufan Asri Zaen by title "Komparasi *QoS Load Balancing* Pada 4 *Line* Internet dengan Metode PCC, ECMP Dan NTH". In his research, he explained that the QoS load balance comparison using 4 internet lines resulted in the NTH method being the best method for merging many internet lines in terms of ping and throughput testing (download/upload), the results of the merger were very optimal. The ECMP method is a method that produces good throughput which also ranks second. In this study found the PCC method only. can 1 of my internet lines be active, if 1 line is down (disturbances) then the other lines back up the path to the internet without merging the lines that are still active and smooth [5].

Research conducted by Reza Pakiding, Catur Iswahyudi and Renna Yanwastika Ariyana (2021) by title "Simulasi Perbandingan *Load Balancing* Dengan Metode Pcc, Ecmp, Dan Nth Menggunakan Gns3". In his research, he explained that based on the results of the Quality of Service test results, the delay, jitter, packet loss and throughput parameters of the PCC method got better scores among other methods. ECMP 34% and PCC method 61%. In the traffic distribution test, the PCC and Nth methods can distribute traffic evenly through both internet sources, while the ECMP method only uses one path when carrying out activities [6]. Research conducted by Ahmad Fauzi and Dwi Yuni Utami (2022) by title "Implementasi *Load Balancing Per address connection* ECMP Algoritma Round Roubin Mikrotik Router". In his research, he explained that Load Balancing Per address pair connection Using the ECMP (Equal Cost Multi Path) Feature Based on the Round Roubin Algorithm From the Combination of SRC or DST Address Mikrotik Router is a method used to combine two or more internet access originating from an ISP (Internet Service Provider), so that in the need for internet access there are two or more lines and can overcome the problem of going down a certain ISP which results in no internet access at a company and is considered very efficient in keeping the internet network rather stable at a company or agency, both private and country [7].

Research conducted by Ahmad Tantoni, Sofiansyah Fadli and Arifin Hargianto (2021) by title "Implementasi *Load Balancing* dengan Metode NTH Menggunakan Mikrotik di SMKN 2 Kuripan". In his research, he explained that the test results obtained the results of improving bandwidth quality after implementation. In the Quality Of Service (QoS) test before and after the implementation of the Nth load balancing with the proxy, the index values for the QoS Modem-1, Modem-2 and Router Nth were obtained with the same result, which was 3.75 in the "Satisfactory" category [8].

Quoted from mikrotik.co.id, load balancing is widely used to distribute connection traffic loads on two or more connection lines in a balanced way with the hope that traffic will run optimally, so as to maximize the bandwidth throughput obtained from the ISP. In addition, load balance can be used to minimize delay and avoid overload on one of the connection lines [1]. There are three load balancing methods provided by MikroTik RouterBoard devices including PCC (Peer Connection Classifier), ECMP (Equal Cost Multi Path) and NTH with each method having advantages and disadvantages.

The purpose of this study was to determine the comparison of QoS load balancing with the PCC, ECMP and NTH methods on the MikroTik RouterBoard. The test method uses speedtest.cbn.id, fast.com, the results will show ping, download speed, upload speed, and monitoring from the MikroTik router side.

This study will discuss a comparative analysis of QoS load balancing with the PCC, ECMP and NTH methods with the implementation on the MikroTik RouterBoard to compare the QoS of the three load balancing methods.

METHOD

In the load balancing network design using the NDLC (Network Development Life Cycle) method which has stages of implementation so that the risk of failure is at a later stage and can be minimized as illustrated in Figure 1 below.

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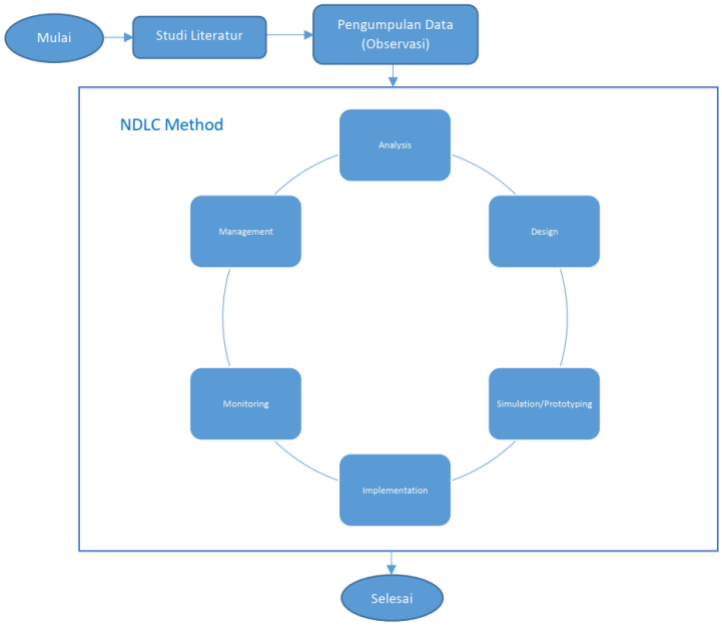

Figure 1. Research methods

1. QoS (*Quality of Service*)
   QoS is a method of measuring how well the network is and an attempt to define the characteristics and nature of a service (service). QoS is used to measure the specified network performance attributes.
   a. *Latency/Delay*
      Delay is the time required for a packet to be sent from one computer to another. Delay in a packet transmission process in a computer network is caused by a long queue, or taking another route to avoid congestion in routing [9]. TIPHON's version of the delay category [10], is grouped into four categories according to table 1 below.

Table 1. Latency/Delay category

Category	Delay
Very Good	< 150 ms
Good	150 s/d 300 ms
Currently	300 s/d 450 ms
Bad	> 450 ms

   b. *Throughput*
   c. *Throughput is the actual bandwidth that is measured in a certain unit of time in transmitting data. In contrast to bandwidth, although the units are the same bits per second (bps), throughput better describes the actual bandwidth at a time and under certain network conditions used to download a file of a certain size.* [9].

2. *Load Balance*
   Load balancing is widely used to distribute connection traffic loads on two or more connection lines in a balanced way with the hope that the traffic will run optimally, so as to maximize the bandwidth throughput obtained from the ISP. In addition, load balance can be used to minimize delay and avoid overload on one of the connection lines. There are several load balancing methods commonly used, as follows [11]:
   a. PCC Method (*Peer Connection Classifier*)
      PCC is a method used in load balancing, with PCC can be used to group connection traffic through the router into several groups, so that you know the gateway path that was passed at the beginning of the connection traffic and on subsequent packets that are still related to the initial connection will be passed on the gateway path the same one [12].
      In particular, PCC will take certain fields from the IP header and the hashing algorithm will change the retrieved fields to be of 32-bit value. This value will then be divided by a denominator that has a specific value and the result will be compared with a remainder value, if it matches then the packet will be forwarded. The fields used in this method include src-address, dst-address, src-port, dstport where these fields can be combined or used singly like, bothaddresses\bothports\dst-address-

and-port\src-address\src-port\both-address-and-ports\dstaddress\dst-port\src-address-and-port [13].

b. ECMP Method (*Equal-Cost Multiple Path*)
Load balance with the ECMP method, which is an improvisation of the round robin load balance method. Load balancing itself is a technique for combining more than one internet connection [14], An example of a topology is shown in Figure 2 below:

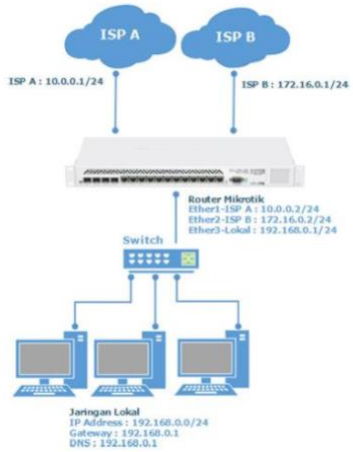

Figure 2. ECMP Method

ECMP stands for "persistent per-connection load balancing" or "per-src-dst-address combination load balancing". As soon as one of the gateways is unreachable or disconnected, check gateway will deactivate the gateway and use the gateway that is still active, so we can get a failover effect. [14].

c. NTH Method
NTH is not an acronym. But an integer number (number to n). NTH is a round-robin algorithm that determines which division of connections to mangle the routes created for load balancing. NTH load balancing is a load balancing technique that forms a certain series (NTH), which will later be used as a queuing system in the mangle rule that is formed. NTH is implemented in a series consisting of every and packets which will be realized in an integer series. In this load balancing method, incoming data packets will be marked as a variable n with an integer data type [15].
NTH itself is a feature in a firewall that is used as a counter for data packets or connections (packet new). There are two main parameters of this NTH, namely "Every" and "Packet". "Every" is a counter parameter while "Packet" is a packet pointer for how many rules from NTH this will be executed. Thus the use of NTH is done by activating the counter on the mangle, then marked with a 'Route-Mark'. So the route mark is used as the basis for creating a policy route [16].

3. NDLC (*Network Development Life Cycle*)
NDLC (Network Development Life Cycle) is a research method used in the development of network technology, as follows :

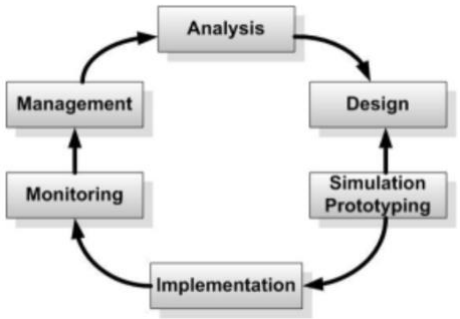

Figure 3. NDLC

The NDLC method in Figure 3 above has 6 stages in its completion [17], among others:

a. Analysis Stage
In this stage, functional requirements analysis, non-functional requirements analysis and existing network topology analysis are carried out. Where the network topology here uses 2 different ISPs, namely ISP iconnet and ISP TBN. Iconnet ISP with bandwidth speed of 45Mbps and ISP TBN with 50Mbps. The proxy used to share the 2 ISPs is the CCR1072-1G-8S+ router.

b. Design Stage
This stage makes a network topology design that will be built in the hope that it will provide a complete picture. The design phase can be in the form of topology design, data access design and cabling layout design which will provide an overview of the network project.

c. Prorotyping Simulation Stage
At this stage there are several network technicians making system simulations that will be worked on such as GNS3, Packet Tracer. Intended to see the performance of the network that was built and also as presentation material and sharing with the work team. In this study the simulation used is using GNS3 because the network device used is a proxy router, so it will be easier to use simulations with GNS3.

d. Implementation Stage
This stage takes longer than the previous stage. In this stage the researcher will carry

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out what has been planned in the previous design.

e. Monitoring Stage
This stage is an important stage so that the computer network runs as expected, therefore monitoring is necessary. At this stage the network that has been set is monitored so that it can see changes from the results of the research conducted.

f. Management Stage
This stage is one of particular concern in matters of rules, policies so that the system that has been built runs well and lasts a long time.

RESULTS AND DISCUSSION

From the results of the research that has been carried out, the results of an analysis regarding the performance comparison between load balance on 2 internet lines using the PCC, ECMP and NTH methods on the proxy router are obtained. Based on QoS parameters such as throughput, packet loss, delay/latency, and jitter.

1. Measurement of Throughput Value
The following is the result of testing the throughput value for each load balancing technique. Where testing is carried out using a web application, namely www.speedtest.cbn.id and www.fast.com (1 connection) with 10 (ten) trials.

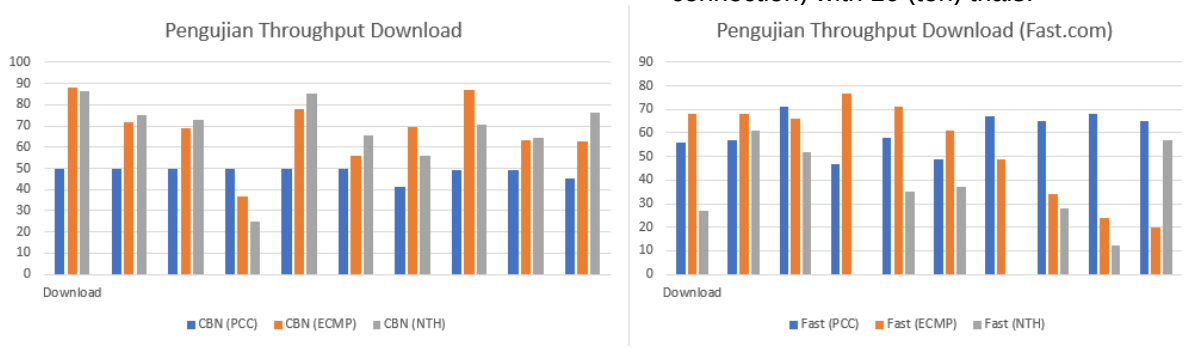

Figure 4. Download Throughput Testing

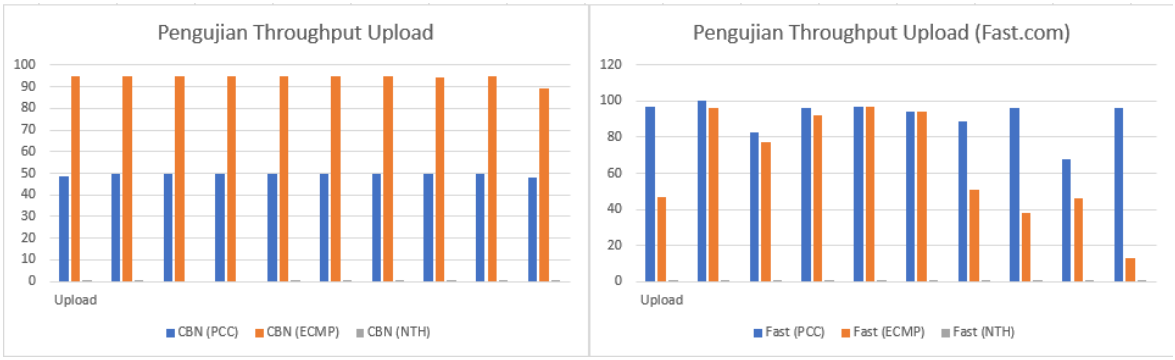

Figure 5. Upload Throughput Testing

Based on Figures 4 and 5, it can be seen that the throughput values produced between the three load balance methods look very significant. Where in Figure 4 the average download obtained uses the www.speedtest.cbn.id web application, namely PCC (48.23Mbps), ECMP (68.15Mbps) and NTH (67.67Mbps) while using www.fast.com, namely PCC (60.3Mbps), ECMP (53.8Mbps) and NTH (38.62Mbps). Whereas in Figure 4.2 the average upload obtained uses the www.speedtest.cbn.id web application, namely PCC (49.4Mbps), ECMP (94.21Mbps) and NTH (0.17Mbps) while using www.fast.com, namely PCC (91.6Mbps), ECMP (65.1Mbps) and NTH (0.24Mbps). The ECMP method is superior in download speed with a bandwidth speed of 68.15Mbps and upload speed with a bandwidth of 94.21Mbps using www.speedtest.cbn.id, while on www.fast.com (1 connection) the PCC method is superior with download bandwidth speed 60.3Mbps and 91.6Mbps uploads.

2. Measurement of Packet Loss Value
The test was carried out 10 (ten) times for each load balancing technique using a web-based application, namely https://devicetests.com/packet-loss-test with the size of packets sent 2800 packets within 10 seconds.

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Table 2. Comparison of packet loss values

Test	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
PCC	0,00	0,25	0,00	0,00	0,00	0,00	33,75	0,00	50,57	0,04
ECMP	0,00	52,04	0,21	48,39	50,04	0,00	57,71	53,04	0,21	0,00
NTH	99,25	63,64	99,11	86,32	99,61	99,39	99,21	99,29	99,21	89,68

Judging from the comparison of the packet loss values for the three load balances provided in table 2, the load balancing technique for the PCC method ranges from 0 ms to 50.57 ms with an average value of 8.46 ms, the ECMP method ranges from 0 ms to with 57.71 ms with an average value of 28.16. Whereas the load balancing on the NTH method is very clear with the values obtained ranging from 63.64 ms to 99.61 ms with an average value of 93.47 ms. The smaller the average packet loss value obtained, the better the method used.

3. Measurement of Delay/Latency Values
In measuring the delay/latency value, 10 (ten) trials were carried out using web applications, namely www.speedtest.cbn.id and www.fast.com with 1 connection by looking at the resulting ping value.

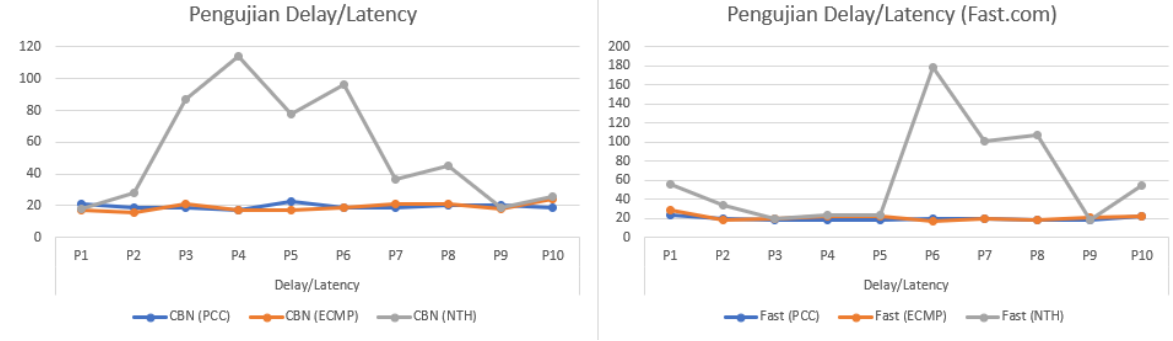

Figure 6. Delay/Latency Testing

Based on the results of the graph in Figure 6 above, it can be seen that the differences between the three load balancing techniques are very significant. In Figure 6 it is shown that it has an average PCC (19.6 ms), ECMP (19.1 ms) and NTH (54.8 ms) using the web application www.speedtest.cbn.id while the average PCC is (19, 5 ms), ECMP (21 ms) and NTH (61.8 ms) using the www.fast.com web application. This underlies when the failover process occurs, the NTH method takes longer than the PCC and ECMP methods.

4. Measurement of Jitter Value
Measurements were carried out 10 (ten) times using web-based applications www.speedtest.cbn.id and www.fast.com (1 connection) by looking at the resulting jitter value.

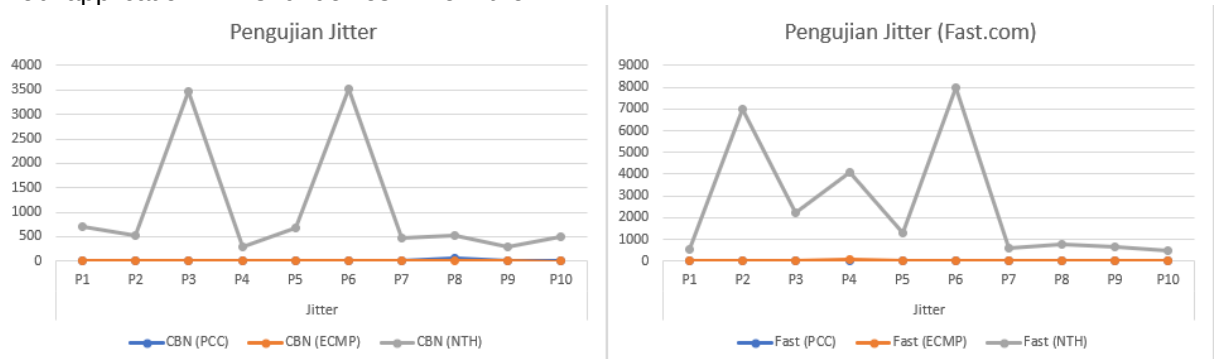

Figure 7. Jitter Testing

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After the experiment is carried out, then look for the average jitter value resulting from the three load balancings. We can see in Figure 7 a very significant difference where the average value of PCC (7.4 ms), ECMP (1.2 ms) and NTH (1,095 ms) using the web application www.speedtest.cbn.id and the average value -average PCC (27.9 ms), ECMP (32.2 ms) and NTH (2566 ms) using the www.fast.com web application. The ECMP load balancing method is superior to the other methods when using the www.speedtest.cbn.id web application, while when using the www.fast.com web application the PCC method is superior to the other two methods. In jitter testing, the smallest average value is better than the larger average value.

5. Failover Testing
   Failover testing is carried out by continuously PINGing with the amount of data sent 100 times and the domain accessed is www.google.com. During the data transmission process, the failover scenario is done by deactivating one of the ISPs. So you can see the change in response time.

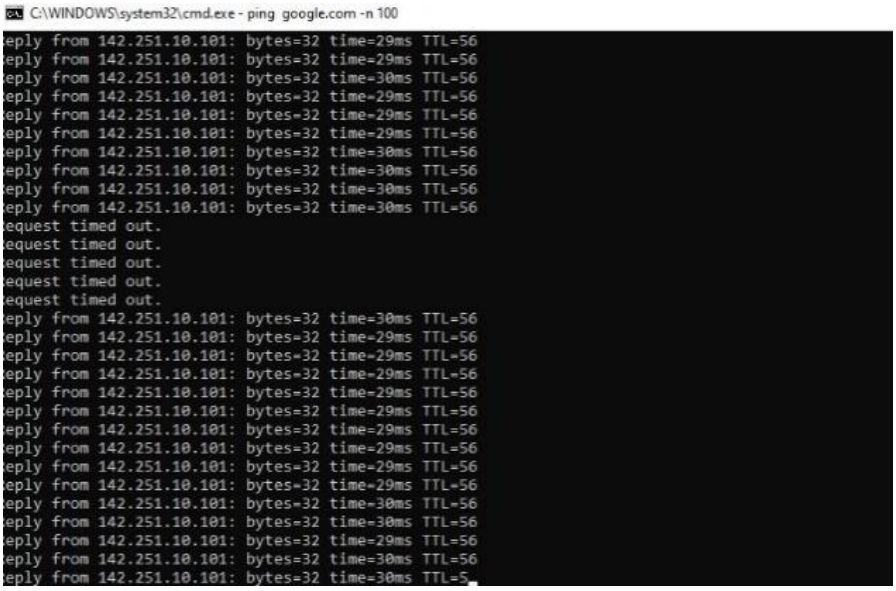

Figure 8. Changes in response time during failover on PCC

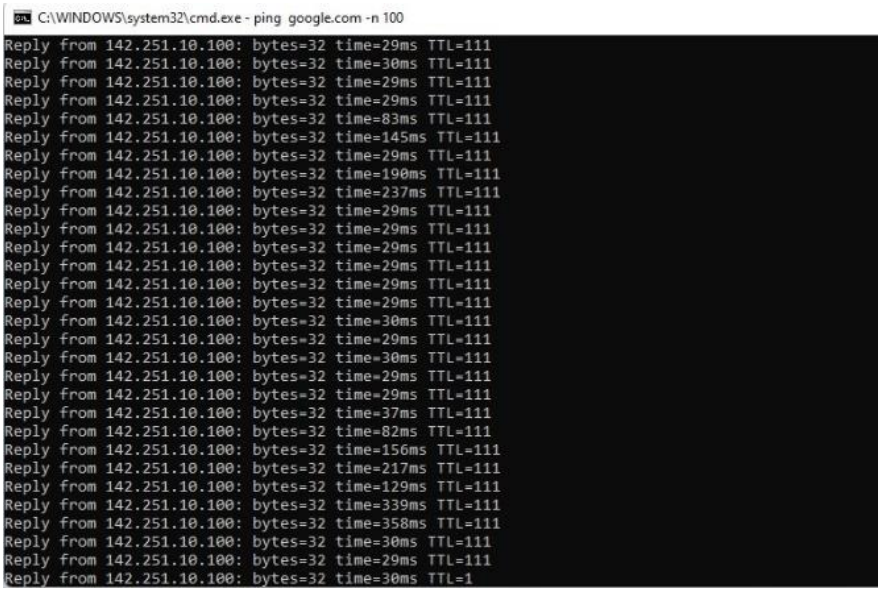

Figure 9. Response time changes during failover on ECMP

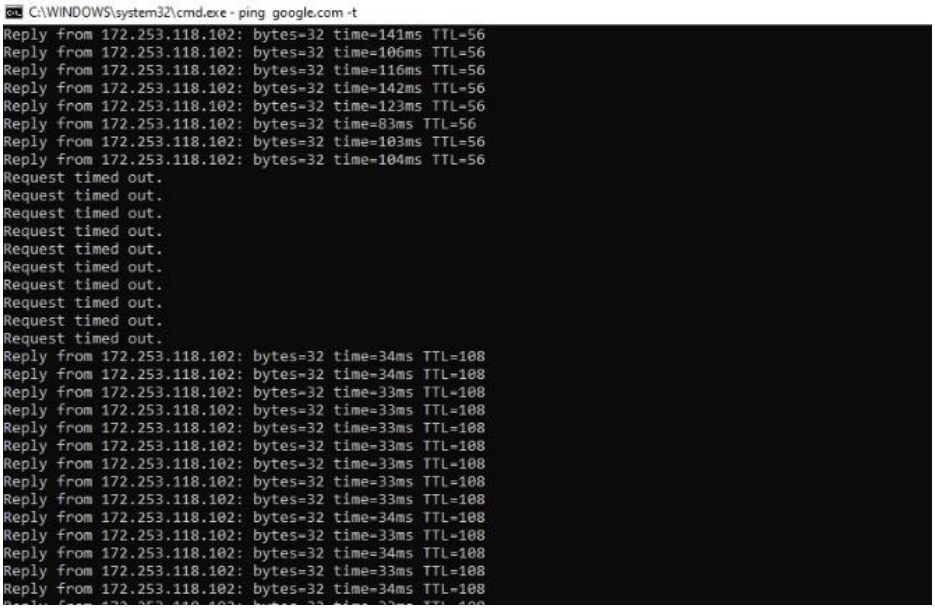

Figure 10. Changes in response time on failover on NTH

Based on Figures 8, 9 and 10 above, it can be seen that when one of the ISPs is turned off, there is a change in the response time and even an RTO (Request Timed Out) occurs. The time needed to perform a backup when one ISP is down depends on the delay/latency. In the ECMP method load balance the resulting time changes are more stable than the time changes generated in the PCC and NTH methods.

CONCLUSION

Based on the results of research that has been carried out on a comparative analysis of load balancing techniques using the PCC, ECMP and NTH methods by conducting 10 (ten) experiments using the web applications www.speedtest.cbn.id and www.fast.com respectively parameters of Quality of Service (QoS) obtained some conclusions as follows :

1. Implementation of load balancing using the ECMP, PCC and NTH methods applied to the Mikrotik RouterBoard goes well and produces a balance of traffic on the two ISP lines based on the bandwidth limit used.
2. Based on the 5 QoS parameters tested, the results are described as follows:
   a. The values of throughput, delay/latency and jitter in the ECMP load balance method are more stable compared to the PCC and NTH load balance methods.
   b. The packet loss value in the PCC load balance method is smaller than the ECMP and NTH load balance methods.
   c. The failover value on the ECMP method gets a faster and more stable response time when one ISP is down compared to the PCC and NTH load balance methods. Changes in response time can be seen from the resulting delay/latency time.

This load balancing system does not add up two or more connection lines, but this load balancing system divides traffic based on the connection paths that are passed so that bandwidth is used in a balanced way and reduces overload when sending data packets [18].

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