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Computer network design and implementation using load balancing technique with per connection classifier (PCC) method based on MikroTik router

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Abstract

A computer network system in a company or agency generally uses more than one Internet Service Provider (ISP) to maintain the quality of its internet services. When one of the ISP's services that are used is interrupted and the internet connection is lost, then the techniques that can be used are load balancing and failover. This study aims to establish a network of two ISPs using load balancing methods and failover techniques with MikroTik. Load balancing to equalize traffic loads and stabilize internet connections for each client and apply failover techniques with 2 ISPs. The method used is the Network Development Life Cycle which redesignates the new network topology by analyzing Quality of Service (QoS) based on the THIPON standard. Based on the test results, the QoS value obtained is 3.75 during busy internet usage hours and the QoS value is 4 at normal hours. Overall, the implementation of computer networks using load balancing techniques with the PCC method showed good changes, this was concluded based on the results of distributing questionnaires before and after implementation from the previous score of 0.4 rising to 0.89.

Keywords: Computer Network, Load Balancing, MikroTik, Network Development Life Cycle, Per Connection Classifier.

1. Introduction

Indonesia currently has many internet users with an increase from year to year. World Bank data in 2020 shows that as many as 53.7% of the total population of Indonesia are recorded as active internet users, which is equivalent to 127.5 million people[1]. The rapid development of this can affect the traffic load because the server is used with excessive amounts (overload). In the meantime, companies, educational institutions, and cafes sometimes use more than one network to meet their needs[2]. The goal is that internet connection disconnection can be avoided when one

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of the ISP services used is experiencing problems. To overcome this, the load balancing technique is deemed appropriate to be applied. The load balancing technique can work well when requests coming from clients have managed to balance the balance evenly, so that traffic can run optimally, maximize output, and minimize response time to avoid overloading one of the connection lines[3].

One of the companies is experiencing network instability problems and the network's inability to support its daily operational performance. By using two types of ISP and making MikroTik as a load balancer using failover technique, it is hoped that it will be able to overcome these obstacles. Technically, load balance is not doubling the connection, but dividing the workload or connection load. MikroTik is also expected to be able to optimize bandwidth for each client who wants to access the internet. The mechanism is that MikroTik will mark packets that want to access the internet, then choose which ISP path to go through and equalize the load on the two ISPs. Meanwhile, if one gateway connection is being disconnected, the failover technique will make the other gateway automatically support all network traffic. This is supported by the results of previous studies using two types of ISPs that successfully spread the number of connection loads on all ISP gateways used in a balanced manner[4].

The grouping of connection traffic that comes in and out of the router into several groups is done by using the Per Connection Classifier (PCC) method. This grouping can be distinguished by scr-address, scr-port, and dst-port. MikroTik will mark the gateway path that has been passed at the beginning of the previous connection traffic. So that the next data packets that are still related will be passed on the same gateway path as the previous data packets that have been sent called PCC Matcher[5]. The PCC method is also superior to the ECMP and NTH methods[6].

2. Literature Review

The failover system configuration went well when one of the internet connection lines was disconnected, which the system would automatically switch to an active ISP. This also applies when one line of internet connection is lost, the active ISP will automatically back up the internet connection of the entire network. This study combines the two internet lines into the MikroTik RouterBoard with the Peer Connection Classifier load balancing and failover method. The result is that the number of connection loads on all ISP gateways used is successfully distributed in a balanced way. However, the size of the packets that are passed to each ISP is not balanced, because the PCC method only divides based on the connection, not the size of the packets that pass through the ISP[4].

Analyzed the performance of several load balancing techniques when applied to MikroTik to maximize traffic flow with dual lanes. Experiments were carried out by applying PCC, ECMP, and Fuzzy load balancers to the internet network. The independent parameters observed were throughput, jitter, and delay. By using the fuzzy logic method, the throughput, jitter, and delay values between ISP1 and ISP2 are more balanced in terms of bandwidth usage than the PCC and ECMP methods[7]. Utilizes the connection distribution method using the PCC method which can classify connection traffic coming in and out of the router. This is to avoid overloading bandwidth usage capacity, so that internet network traffic continues to run. This research results in a client server relationship that is intact because it is always on the same path. This is because the PCC rule will always remember the destination source IP address[2].

Configured each method and then tested each on QoS in their research with the parameters of delay, jitter, packet loss, and throughput, distribution of traffic paths, and CPU Load load on the router side. As a result, the PCC method scored better than the other methods. In CPU Load testing, the Nth method is better than other methods with the CPU Load value reaching 32%, the ECMP method 34%, and the PCC method 61%. In testing the distribution of traffic, 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]. The application of the load balance technique on the MikroTik x router with the PCC method can separate the internet connection through the two available ISP lines. This can overcome the problem of traffic accumulation on one of the ISP links so that it can reduce latency and improve the performance of the existing network. The research was conducted by implementing load balancing and failover mechanisms on the network using a MikroTik Router device, while the PCC method was used to overcome traffic density problems on the network. However, the implementation of bandwidth management using Per Connection Queue (PCQ) has succeeded in overcoming the problem of bandwidth monopoly by certain users. PCQ also allows routers to share bandwidth dynamically and evenly[8].

The implementation of load balancing using the PCC (Per Connection Classifier) method at Krisnadwipayana University on an internet connection with 2 ISP services needs to be considered for the possibility of interference with

the internet connection. PCC (Per Connection Classifier) is a load balancing method in merging 2 ISP services. So we need an internet network that is always on standby when an internet connection fails. The test is carried out in two stages, the first is carried out with 1 ISP service. Second, by using PCC during normal conditions and when there is a lost connection on one of the links. By using 2 ISP services, local and international bandwidth can be separated which was carried out in the second test. Merging 2 ISPs with the PCC load balancing method makes it possible to separate traffic, so the router will set based on the src-address and dst-address of a connection. The second test can be proven using 2 ISP services with PCC load balancing and is much better for internet network connection services, because there is a system that is always on standby when a lost connection occurs on one link. Mikrotik server security by blocking local IP when accessing Mikrotik IP, the Mikrotik server is safe from attacks [9].

Load Balancing And Failover On Two ISP Connection Lines Using Bandwidth Based Load Balancing Method The addition of ISPs uses the method by dividing users into two subnets, subnet-A using ISP-A connection and subnet-B using ISP-B connection with respective management management. Bandwidth based method is used in conditions when the two ISPs for load balancing have different throughput bandwidth quality. works by monitoring traffic conditions on the ISP-A and ISP-B interfaces, if one of them is already overloaded which has been determined (threshold), it will automatically create a main internet connection path to the other without breaking the client connection that is connected to the main internet. The system that was built was able to solve the problem when one of the ISP's connection lines was lost (failover technique), this can be seen from the automatic transfer of connection lines to the gateway from an active ISP, so that the system continues to run normally. In selecting Wireless devices for Stations and Access Points, it is recommended to choose devices that have good download throughput quality. There will be an imbalance in bandwidth usage, if ISP-A has a small bandwidth but is used by many users and ISP-B has a large bandwidth but is used by fewer users, so internet access at ISP-A will be slower than ISP-B. There are differences in the results of network performance measurements for delay, packetloss, jitter, & throughput conditions due to the influence of network overhead, network configuration, firewall process, chipset, hardware, RouterOS, firmware, drivers, distance, physical media, congestion. Load balancing and failover with this bandwidth based load balancing method is suitable for use on two ISP connection lines that have different bandwidth sizes and can be expanded to use more than two ISP connection lines. [10].

The difference between this research and previous studies lies in the research method used. After the data is collected, the Network Development Life Cycles network development method will be applied [11]. Then the evaluation is carried out after the network topology is updated according to the development plan and before development by conducting a QoS analysis based on the THIPON standard issued by the European Telecommunications Standards Institute (ETSI) standard body[12]. Calculations obtained are based on measurement data obtained from the Wireshark application [13].

3. Research Methodology

3.1. Research Stages

This study uses qualitative and quantitative methods. The data collection stages itself includes questionnaires which are distributed to the several respondents before and after the research, combined with the application of the Network Development Life Cycle systematically as shown in Figure 1.

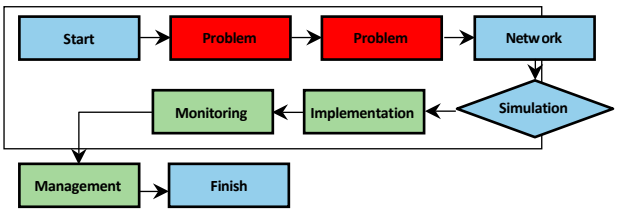


Fig. 1. Flowchart of Thinking Diagram

Meanwhile, the network topology design used is the current topology. The design topology shown in Figure 2.

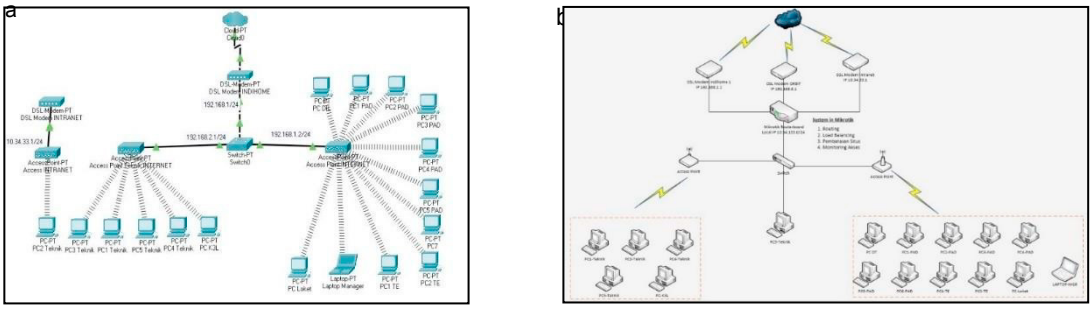


Fig. 2. (a) Ongoing Topology; (b) Network Topology Design.

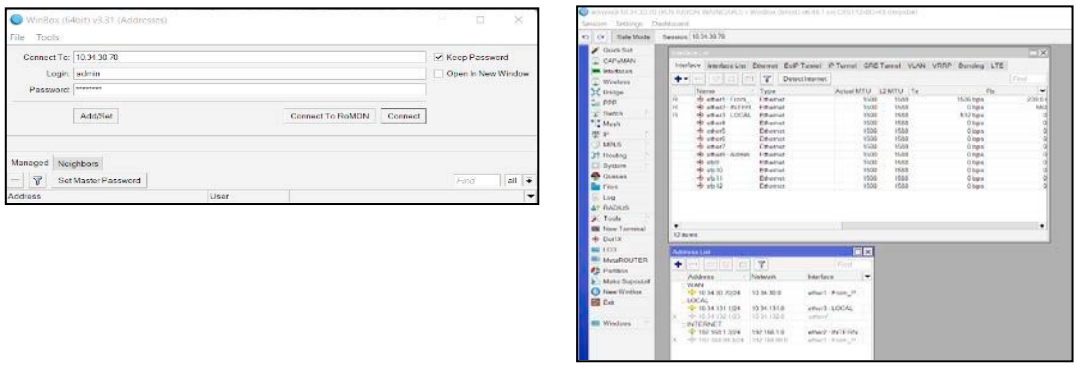
To solve the problems, it proposed to install a MikroTik Routerboard which acts as a router. The features in MikroTik can be accessed using Winbox. Winbox can be configured with the Command-line Interface (CLI) or with the menus found in the User Interface (UI). The application of load balance is used to distribute the connection traffic load on two or more connection lines in a balanced way so that traffic runs optimally, to maximize the throughput bandwidth obtained from the provider[9]. The method used in load balance with MikroTik is the PCC method which specifies a packet to a certain connection gateway. PCC groups the connection traffic that will go through or out of the router into several groups. MikroTik will mark the gateway that has been passed at the beginning of the connection traffic, so that subsequent data packets that are still related to the previous data packet will be passed on the same gateway path.

Table 1. IP Address Management Design.

Interface	ISP	Interface Name	IP address	Network ID
ether1	TELKOM	INTRANET	10.34.33.1	10.34.33.0
ether2	TELKOM	ISP1_INDIHOME	192.168.1.1	192.168.1.0
ether4	TELKOMSEL	ISP2_ORBIT	192.168.8.1	192.168.8.0
ether3	-	LOCAL	10.34.133.1	10.34.133.0
Wlan1	-	Wireless	10.34.134.1	10.34.134.0

3.2. User Interface Design

The following is the user interface design for login display on Winbox and display the menu on Winbox:



(a) (b)

Fig. 3. (a) Login Display on Winbox; (b) Display Menu on Winbox.

3.3. Evaluation Design

The evaluation design refers to internet QoS or the ability of a network to provide better services for certain data traffic on various types of technology platforms. QoS is not obtained directly from the existing infrastructure, but is obtained by implementing it on the network in question[9]. The parameters that will be tested are throughput, packet loss, delay, and jitter. The Wireshark application to view and analyze the QoS of the internet network in commercial rooms, engineering, and counters with the following scenario: 1)The capacity of each bandwidth to be tested is up to 50 Mbps for ISP 1 and 20 Mbps for ISP 2; 2) Data retrieval was carried out for five days during peak hours (08.00 to 13.00) and normal hours (14.00 to 15.00) before the implementation of load balancing; 3)Meanwhile after the implementation of load balancing, data retrieval is carried out for five days during peak hours and normal hours. After the QoS parameter data is obtained, a QoS analysis will be carried out and compare the results between before and after the implementation of load balancing using a MikroTik router.

4. Implementation Results

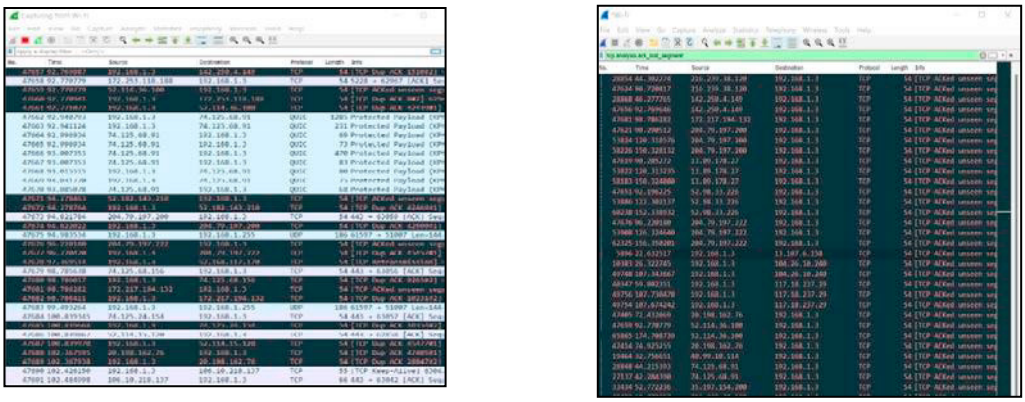
This test and analysis aim to determine the QoS (Quality of Service) of internet network. The capacity of each bandwidth to be tested is up to 50 Mbps for ISP 1 and 20 Mbps for ISP 2. The steps of the research carried out are as follows.

4.1. Determine Location

The research location survey aims to determine the location that will be used as a place to collect research data. In this study, the location used as a place of measurement is the office building which includes the engineering section, the counter, and the commercial section.

4.2. Measurement Results using Wireshark

Measurements were made to measure delay, jitter, packet loss, and throughput using Wireshark as a network analyzer according to the standards used by the IT industry today[2]. When the application is running with user interaction, Wireshark is run to capture the network QoS parameters. The data processing of the QoS parameter measurement results consists of the measurement results during peak hours and normal hours with a load of 7000 packages using two types of data, namely documents (*.doc) and video (YouTube) in three rooms (technical, counter, and commercial) at the office.



(a) (b)

Fig. 4. (a) & (b) QoS Analysis with Wireshark

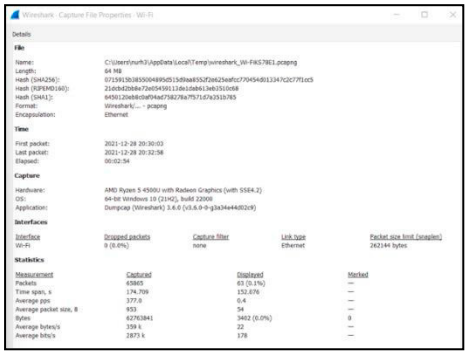


Fig. 5. QoS Analysis with Wireshark.

4.3. Results of Measurement and Calculation of QoS Parameters

The analyzed value is the average value of the measurement results and the calculation of QoS parameters. The analysis was carried out for five working days in the engineering room, counter, and trade during peak hours and normal hours both before and after the results of the research were implemented. This QoS parameter measurement is also carried out with separate ISP connections. In addition, the QoS parameters used in the measurement and calculation are throughput, packet loss, delay, and jitter. The following is a graph of the measurement and test results based on QoS parameters:

- Delay

Fig. 6. (a) QoS Delay Parameters during Rush Hours; (b) QoS Delay Parameters during Normal Hours.

- Jitter

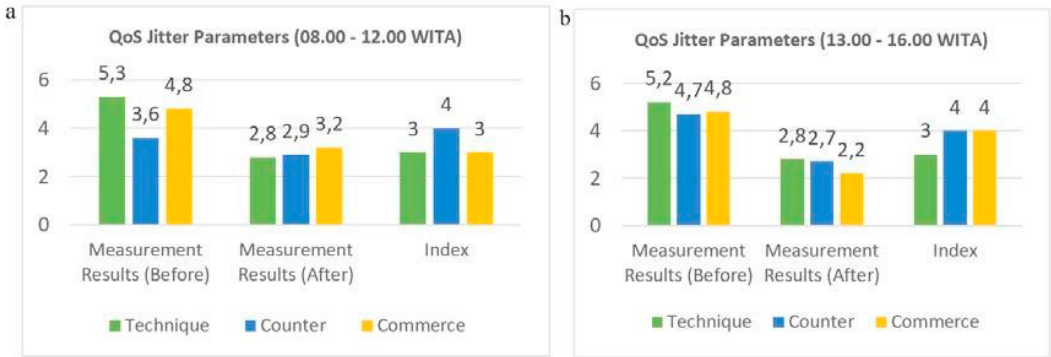


Fig. 7. (a) QoS Jitter Parameters during Rush Hours; (b) QoS Jitter Parameters during Normal Hour

- Packet Loss

Fig. 8. (a) QoS Packet Loss Parameters during Rush Hours; (b) QoS Packet Loss Parameters during Normal Hours.

- Throughput

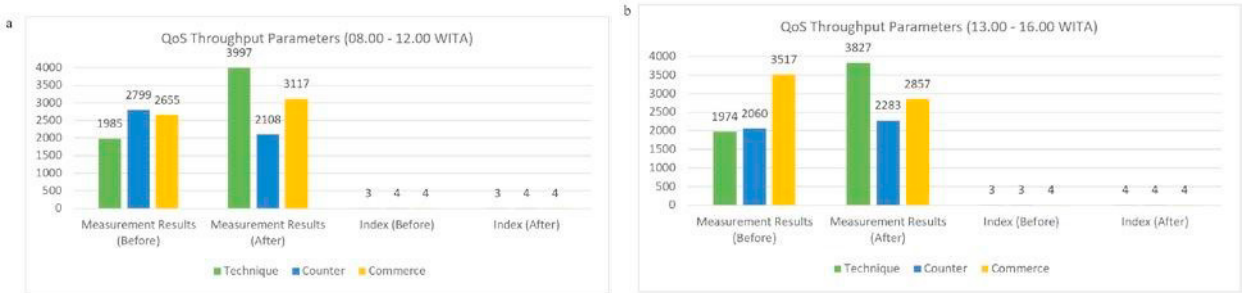


Fig. 9. (a) QoS Throughput Parameters during Rush Hours; (b) QoS Throughput Parameters during Normal Hours.

4.4. Comparative Analysis

Based on the measurement data, the authors conducted observations and interviews again in the field with the results are employees experience difficulties when accessing different networks between internet and intranet networks due to not having a router installed, from the previously designed simulation runs smoothly. All clients get a dynamically distributed IP address. However, when it is implemented, it is found that not all clients get an IP address because the access point conditions are not optimal because they are old, with a load balancing system, traffic does not pile up on one ISP only, so the QoS parameters become better parameter values.

4.5. Evaluation Analysis

User survey analysis was made based on the results of distributing questionnaires conducted before and after the load balancing technique was applied to 31 respondents to obtain data on the quality of internet and intranet services. The questionnaire used a combination of questions with a Likert scale of 1 to 5 consisting of 12 questions related to the quality of internet and intranet services, the questionnaire was made online using Google Forms. There are 4 variables measured based on the Quality of Services (QoS) parameters, namely delay, packet loss, jitter, and throughput.

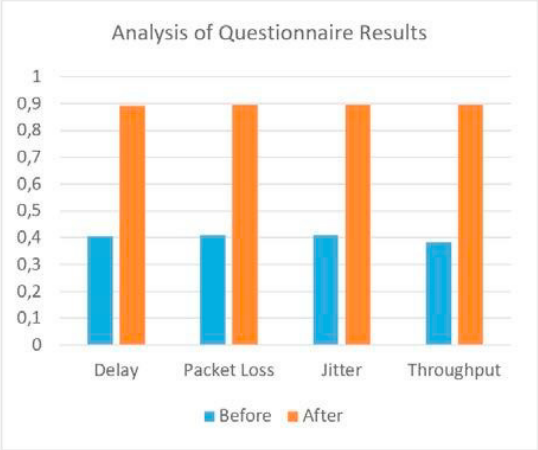


Fig. 10. Questionnaire Analysis Results

5. Conclusions

The design and implementation of a computer network with a load balancing technique using the PCC method based on MikroTik router, which is applied when ISP 1 fails in connection, ISP 2 will immediately take over the existing traffic data so that the internet connection can run well. Meanwhile, the performance of a computer network that uses load balancing techniques with the PCC method that has been applied, through the data from the Quality of Service (QOS) analysis consisting of delay, jitter, packet loss and throughput with a QoS value of 3.75 during busy internet usage hours. (08.00-12.00 WITA) and QoS value 4 at normal hours (13.00-16.00 WITA). The results of research on the implementation of computer networks that use load balancing techniques with the PCC method also show good changes. This is based on the results of distributing questionnaires before and before implementation from the previous one getting a score of 0.4, increased to 0.89.

Further development is recommended to use an ISP with a fixed bandwidth (Dedicated) service and not a shared bandwidth or up to internet service, because when this research was implemented, there was no infrastructure in the Sumba Jaya area, so the author still uses shared bandwidth internet services. Furthermore, the use of installed access points is one of the causes in determining the QOS of an internet network, this is proven when the PT XYZ office is still installed with an outdoor access point that is more than 5 (five) years old, the network becomes unstable.

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