Implementation of Load Balancing Per Connection Classifier on Mikrotik for Internet Services at Private Vocational Schools

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Abstract. The Internet network is important because now it has entered the 4.0 era, where all community activities are primarily carried out with the help of the Internet. Therefore, the internet network can also connect. One example of using the Internet is currently needed in the school environment. Teachers and students must carry out learning transformations that are usually paper-based and are presently changing through the Internet. As is the case with all teachers and students in private vocational schools. From the results of observations that have been made, not all teachers and students get good internet service. Then, when checking on the server side, it turned out that the internet network management was not following the standards in the field, so the three ISPs (internet service providers) were not being utilized optimally. One solution emerges from presenting these problems: combining and dividing the burden evenly among the three ISPs. The process of distributing the ISP load evenly is called load balancing. In this study, the load balancing method used is the Per Connection Classifier (PCC) method, which can work optimally. This study's findings indicate that the inefficiencies in internet service provision within private vocational schools are due to suboptimal internet network management practices, leading to the need for more utilization of the available internet service providers (ISPs), and proposes the implementation of load balancing as a solution.

Keywords: Internet, Internet Service Provider, Load Balance, Per Connection Classifier

1 Introduction

The Internet network is important because now we are entering the era of the industrial revolution 4.0, where all community activities are mostly carried out with the help of the Internet [1], [2]. Therefore, the internet network can connect [3], [4]. One example of using the Internet is currently needed in the school environment. The existence of the Internet today has a positive impact on the education sector. The Internet has become necessary for schools, teachers and students [5], [6]. Teachers and students are required to carry out learning transformations which are usually paper-based and are currently changing through the use of the internet network, which can be accessed anytime and anywhere with various devices, computers [7], [8], gadgets, laptops, tablets, and smartphones [9], [10]. As is the case with all teachers and students in private vocational schools.

Private Vocational Schools are one of the vocational high schools that have used the Internet as a media aid in learning, one of which is when carrying out school exams where the answer sheets are no longer paper-based. So, students must carry out the exam process using the Internet. During the exam, the school facilitated the internet network through Wi-Fi, providing internet services through three Internet Service Providers (ISPs). When viewed from the perspective of Internet service providers, it should cover all teachers and students. However, from the results of observations that have been made, not all teachers and students get good internet

service. Then, when checking on the server side, it turned out that the internet network management was not following the field standards, so the three ISPs were not being utilized optimally. From the explanation of the problems above, one solution emerges: combining and dividing the burden evenly among the three ISPs. The process of distributing the ISP load evenly is called load balancing.

Load balancing is dividing an application's or server's traffic load [11], [12]. Generally, load balancing can be done using several methods, namely: ECMP (Equal-Cost Multi-Path), NTH method, and PCC [13], [14], [15]. In previous studies, the load balancing method with the PCC method can work optimally [16], [17]. Then, in other studies, the PCC method also has advantages over other load-balancing methods [18], [19], [20]. This study will carry out load-balancing using the PCC method.

The load balancing process only distributes the traffic load evenly to all ISPs connected to the server and cannot perform ISP backups if one of the connections has problems. So, in this study, the load-balancing process will be combined with the application of failover through a recursive gateway. It is hoped that this research can overcome the problems previously described.

2 Methods

The data collection method used in this study uses three stages: library research, experimental, and analysis. In addition, researchers also note what needs will be used in the research process. The following is a detailed explanation of the three stages of data collection.

2.1. Literature Review

Internet networks are not designed to allow different processes for different types of traffic. This is a problem when having different types of traffic with different terms of service. Applications on the network sending traffic and consuming resources, then the resource-intensive traffic is hurting traffic. In addition to Quality of Service (QoS), a traffic engineering mechanism is also needed to overcome problems that arise when traffic jams occur. One of the protocols that can provide flexible traffic engineering services is load balancing.

There are many methods for load balancing, but one of the methods used in this research is the Per Connection Classifier (PCC) method. This method determines the best load-balancing method for your data transfer application. Tests in this study use Quality of Service (QoS) parameters such as throughput, packet loss, and fairness index [21]. Throughput is the total number of packets that arrive at the destination in the specified 30-time interval divided by the period of the time interval. Packet loss is data packets lost during transmission. And the final fairness index to determine whether users or applications receive adequate resources [22], [23].

2.2. Experimental

The experimental procedure is the procedure for testing the system: configure the router, send data between the client and server using the The Internet Control Message Protocol (ICMP), and check whether the client and server are connected. Then configure and test load balancing on the network to see if the router load balancer is ready [24].

2.3. Analysis

Analytical steps are carried out to find out the causes and consequences of the problems found. In this analysis, the client sends data to the server to determine the throughput value. After sending, the packets are captured by Router A and Router B. This differs from calculating packet loss values because Router S catches packets when lost. The fairness index is determined from the throughput value collected and calculated using the fairness index formula.

3 Results and Discussions
3.1 Nth Collection of Data and Parameters

Before carrying out load balancing testing, researchers prepare data and determine what parameters are needed. Hardware and software requirements have been described in the previous chapter. Then, researchers make the necessary parameters in implementing load balancing with the PCC method, including grouping IP addresses. The IP address used by research is class B for medium to large-scale networks. The following is a grouping of IP addresses according to the points where there are access points.
  a. Kurikulum   : 172.16.10.1/16

b. LAN-Client   : 172.17.10.1/16
c. LAB :   172.18.10.1/16
d. Surveillance   : 172.19.10.1/16
e. Dapodik   : 172.20.10.1/16
f. Wifi :   172.21.10.1/16 – 172.33.10.1/16

3.2 Topology Design and Manufacturing

In implementing a wide area network, a clear design and topology are needed so that you don't get confused and know the paths and cable lines connected from the access point to the central server. The following is a picture of the implemented network design and topology.
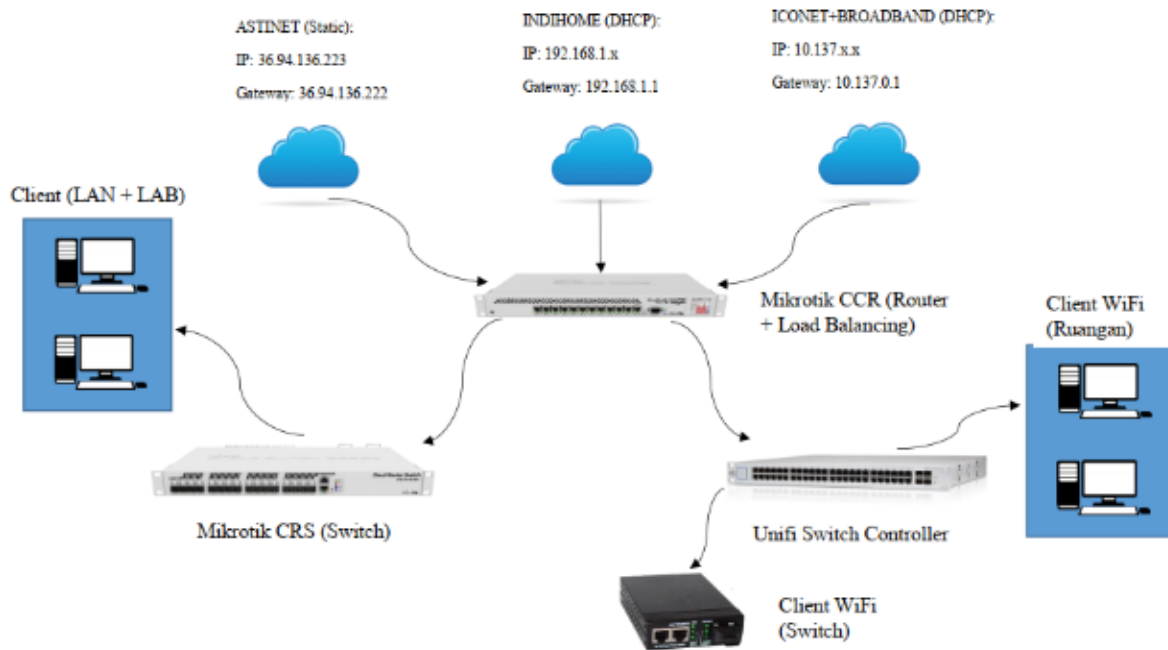

Figure 1. Private Vocational High School Network Topology

Figure 1, it can be seen that 3 ISPs are connected directly to the Mikrotik router, where load balancing will be applied to the router. Then, Mikrotik, as the main router, also provides facilities such as a DHCP server to speed management for each user. The following are details of the internet network topology:

a. Mikrotik CCR 1016-12G
    1. LAN-Kurikulum   : Ethernet 1
    2. LAN-Client   : Ethernet 2
    3. LAN-LAB   : Ethernet 3
    4. LAN-Surveillance   : Ethernet 4
    5. LAN-Wifi   : Ethernet 5
    6. LAN-Dapodik   : Ethernet 9
    7. ISP-ICON+   : Ethernet 10 (45 Mbps UpTo + Dedicated)
    8. ISP-Indihome   : Ethernet 11 (300 Mbps UpTo)
    9. ISP-Astinet   : Ethernet 12 (10 Mbps Dedicated)
b. Unifi Switch Controller (Switch)
    1. Port PoE   : Access Point Unifi
    2. Port Standar (non PoE) : User Switch (LAN)

After everything is connected, the next step is configuring the system so that load balancing can be applied and users can connect to the Internet.

3.3 System Configuration

Implementation Each router must go through the configuration stage first. In this study, the router configuration was applied to the CCR1016-12G series Mikrotik devices, where the series was chosen because it saw the field conditions of many users using internet access. The router configuration process does not only configure standards (users can connect to the Internet) but up to load balancing configurations. As explained in the previous chapter, the load-balancing method used in this study is the PCC method. The configuration process begins with changing the router's identity to configure load balancing. The following is a detailed process that is done.

A. Identity Configuration

Each router must have a user identity to distinguish one router from another. By "Default", the identity in MikroTik is "MikroTik". Identity can be changed as desired. Log in to the Mikrotik router via Winbox, Figure 2 (a). The next step is to select the "system > identity" tab. In Figure 2 (b), a box will appear to enter the router's identity name. Use the command line, open "New Terminal", and type the command in Figure 3.
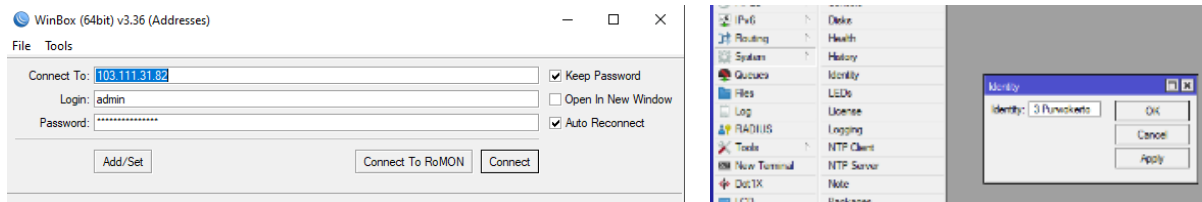
Figure 2. (a) Login Mikrotik   (b) System Identity Router

Figure 3. Command Line New Terminal

B. IP Address Configuration

IP address settings on Mikrotik are needed to access the physical interface via network logic addresses. The IP address used is adjusted to the specifications described in the previous point. Following are the steps of IP address configuration:

1. First, change the interface name that will be given an IP address by clicking "interfaces" and then double-clicking the interface to be replaced, Figure 5. To assign an IP address to the interface via the IP menu -> Addresses -> "+", Figure 4.
2. The IP address is adjusted according to predetermined criteria, and the interface is selected according to the needs. Figure 6 displays the results of the IP address configuration. There is a writing code "D" in the first column, meaning dynamic or dynamically obtained IP address from the ISP (Internet Service Provider).
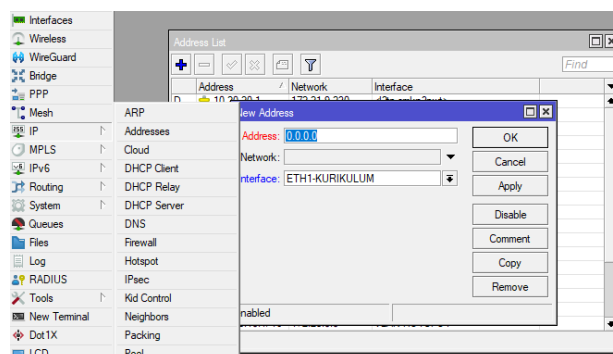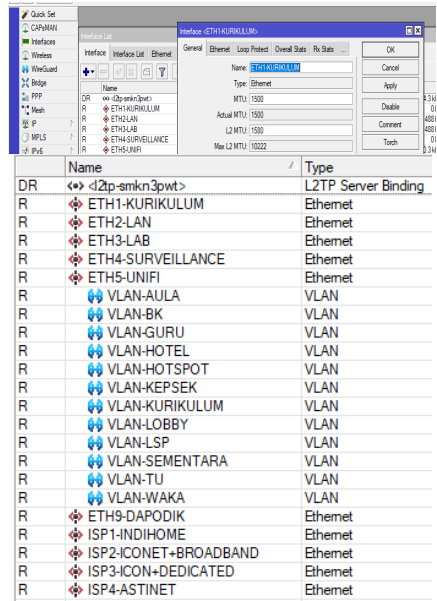

Figure 4. IP Addresses Interfaces
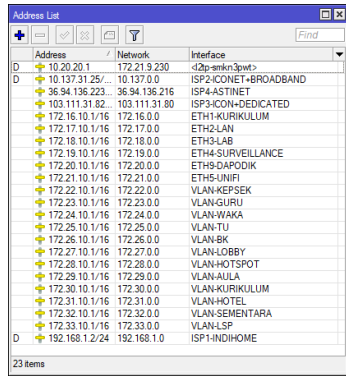
Figure 5. General Interfaces

Figure 6. Configure IP Addresses

C. Configure DNS

If a TCP/IP network has a lot of hosts, it will be difficult for humans to remember the existing IP addresses (perhaps for computers, this is not a problem). These IP addresses need to be covered with names that humans can remember easily using DNS (Domain Name Service). The DNS used in this research is from Cloudflare because it can hide the real IP address of a web hosting. There are 4 DNS used because each ISP will have 1 DNS later. The following DNS Cloudflare provides include 1.1.1.1, 1.0.0.1, 1.1.1.2, and 1.0.0.2. To provide DNS via IP -> DNS -> "+" menu as shown in Figure 7 (a). Suppose you want to use the command line, open "New Terminal", and type the command as shown in Figure 7 (b).
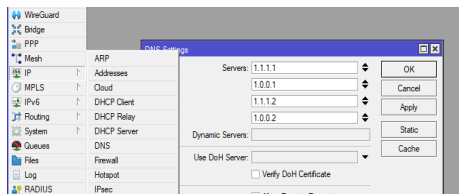
Figure 7. (a) Domain Name Service   (b) Command Line DNS

D. Firewall Configuration

A firewall is a system or device that allows network traffic that is considered safe to pass through and prevents unsafe network traffic. Firewalls are also used to control access to anything that has access to the private network from outsiders. The following is a firewall configuration so that users can connect to outside networks. On the Winbox UI view, navigate to IP -> Firewall. Then the Firewall window will appear, then select NAT and select the + sign, Figure 8.

Figure 8. Firewall Configuration

All ISPs connected to Mikrotik must be configured as above. Figure 9 below is the result of the configuration of the three ISPs.

Figure 9. ISP Configuration

E. Configure DHCP Server

Dynamic Host Configuration Protocol (DHCP) is a service that allows devices to distribute/assign IP addresses automatically to hosts on a network. How it works, the DHCP Server will respond to requests the DHCP Client sends. The following are the steps for configuring the DHCP server.

1. Click the IP menu -> DHCP Server -> Click DHCP Setup. By pressing the DHCP Setup button (Figure 10), the DHCP wizard will direct you to make settings by displaying dialogue boxes at each step. Then it will be asked to determine which interface the DHCP Server will be active on. In this case, the DHCP Server is activated, for example, ETH1-CURRICULUM, then click Next.
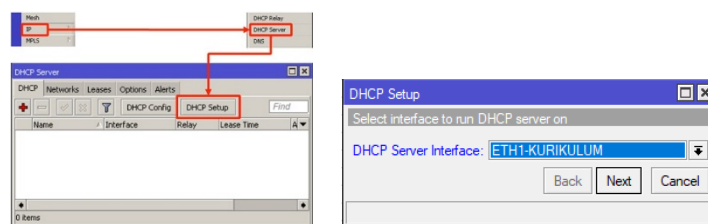

Figure 10. DHCP Setup

2. Previously, the IP address 172.16.10.1/16 was installed on ETH1-CURRICULUM. So in the second step, determining the DHCP Address Space will automatically take the same IP segment. If the previous interface does not have an IP, it can be determined manually at this step. Next, specify the IP Address that the DHCP Client will use as the default gateway later. The wizard will automatically use the IP address installed on the ETH1-CURRICULUM interface. Determine the IP Address distributed to the Client, Figure 11. The wizard will automatically fill in the IP host on the segment that has been used. In this example, IP 192.168.4.1 is not included in Addresses To Give Out because that IP is already used as a gateway and will not be distributed to clients.
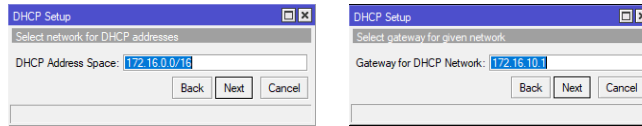
Figure 11. IP Address that will be distributed to the Client

3. Determine which DHCP Client will make DNS requests to which server. The wizard will automatically retrieve the DNS setting information that has been made on the DNS menu or IP. But it is also possible if a DNS Client request is specified to a certain server. The final step determines the Lease-Time, which is how long an IP Address will be loaned to the Client. To avoid being full or running out of IP, don't set the Lease-Time too long, for example, 10 minutes. Figure 12 below is the result of the DHCP server configuration:
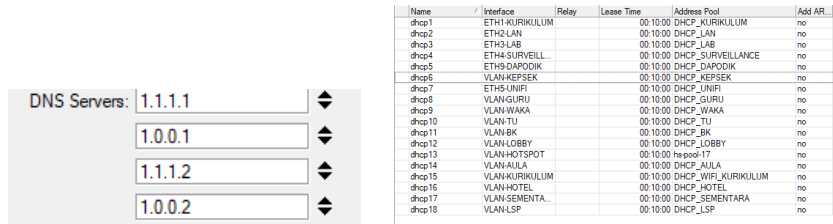
Figure 12. DHCP server configuration

F. Load Balancing Configuration

After all the basic configuration steps have been completed, the final step is configuring load balancing using the PCC method. The following are the configuration steps.

1. Determine Classifier, Denominator, and Reminder Values. I will choose Both addresses and ports as the classifier because this Internet will be used in several locations with distribution routers. The denominator value is 19, while the remainder starts from 0 to 18.
2. Create a local IP list. This research only applies load balance traffic to and from the Internet that passes through the WAN. Meanwhile, local traffic will be bypassed. To ensure that, you have to make a list of IPs used by the local network. In the firewall window, select Address Lists, and add a local network.
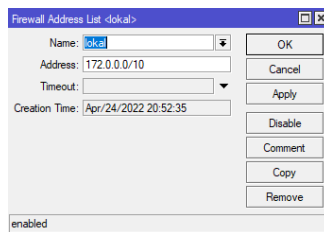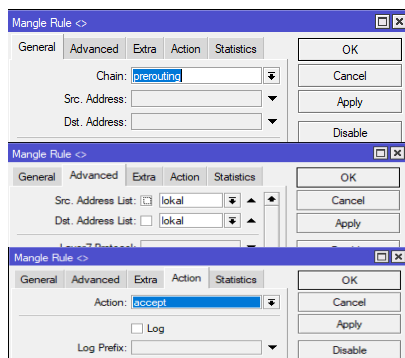

Figure 13. Firewall Address Lists

3. Bypass Local Route. So that traffic to and from the local network that passes through the router is not subject to load balance, then you need to add a mangle like the one below. Select the mangle tab in the firewall window, Figure 14.

Figure 14. Local Route Bypass

4. Mark Connection with PCC. Even without marking connections, mark routing can be done with this PCC method which will later be passed to certain paths. However, it is better to mark the connection first before marking routing for efficient use of resources. Following is the configuration of the connection tagging.
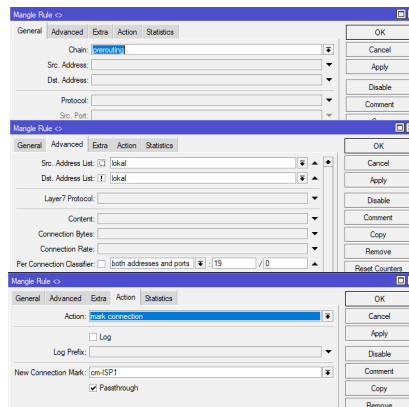

Figure 15. Mark routing with the PCC method

5. Each connection that leads to ISP 1 to ISP 3 will be collected first, along with the results of the mark connection configuration, Figure 16. Next is unification by way of mark routing. The configuration is almost the same as the mark connection. The difference is the action used is mark routing. The following is the result of the configuration.

Figure 16. The result of the mark connection configuration

6. Route the Marked Connection to the Gateway of Each Line. After everything has been set, the next step is to perform routing from the mark routing connection to each ISP network.
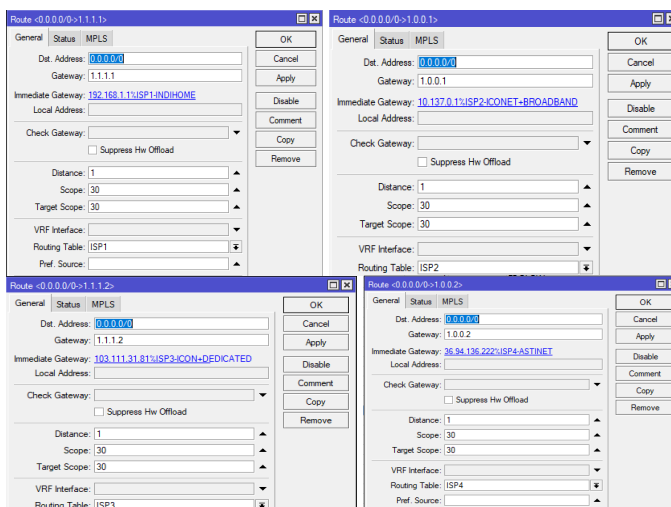
Note:
- DST. Address: 0.0.0.0/0 (routing all IP addresses)
- Gateway: Customize DNS that has been installed
- Distance: Sequence of connection. If the sequence is 1, then all connections will run together
- Routing Table: connecting each routing mark with each ISP.

Figure 17. Marked Connections to Gateway Each Line

4 Conclusion

Based on the results of this application, an experimental process has been carried out to show that the implementation of load balancing is very effective in private vocational schools. The burden given to the three existing ISPs is evenly distributed, and no one is overloaded. In addition, the traffic for each user is also smooth.

5 Acknowledgements

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