Bandwith Optimization on Hotspot using PCQ Method and L2TP VPN Routing for Online Game Latency

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Abstract— **VPN L2TP (Layer 2 Tunneling Protocol) is available on one of the services at Mikrotik. L2TP is a development of PPTP and a combination of L2F. The network security protocol and encryption used for authentication is the same as PPTP. However, to communicate, L2TP requires UDP port 1701 so that the security is better, L2TP is connected to IPSec to L2TP/IPSec. An example of its use is for the Windows operating system, which by default the Windows OS uses L2TP/IPSec. However, the consequences in terms of configuration are not as simple as PPTP. The client side must also support IPSec when implementing L2TP/IPSec. In terms of encryption, of course, encryption on L2TP/IPSec has a higher level of security than PPTP which uses MPPE. Traffic passing through the L2TP tunnel will experience overhead. The L2TP protocol is more firewall friendly than other types of VPNs such as PPTP. This is a big advantage if using this protocol, because most firewalls do not support GRE. However, L2TP does not have encryption, so it requires additional services to support higher security. So the author concludes that it will be easier to configure with online games. Online game is a type of computer game that is currently growing and requires a computer network . The networks that are usually used are internet networks or internet wifi and the like and always use current technology, such as modems and cable connections. Therefore, internet service providers (ISPs) must provide stable and fast internet quality. Bandwidth Needs Online games must be supported by an internet network that supports the speed and stability of the internet connection, especially the stability of the latency of the online game itself..**

Keywords : L2TP, Online game, Bandwith Optimization,VPN Routing**.**

I. INTRODUCTION

Authors In the current era of computers, laptops and gadgets is a technology that is always carried by someone, it is impossible if there are people who do not understand online games. Since it was first introduced to the world of computer networks in the early 50's, online games have now increasingly developed into a work of art as well as a business opportunity, this is proven by the number of people playing online games either on computers or via smartphones coupled with internet connectivity. which has been advanced so that players can play between countries or with people in other parts of the world. With so many people playing online games either using computers or with cellphones who just fill their spare time and also compete with other players, there are Proplayer (Pro Game) players who spend their time only focusing on playing online games professionally. Of course, with the athlete's title in the name of the game player, what they do is included in a sport or more commonly called eSports. Even though online game players only spend time and energy without any results, gamer players prove that this statement is wrong. A Proplayer can earn $100,000 by participating in a game tournament and supported by their sponsor only. If they win of course they will get more profits. In this case, the profession as a game proplayer is very promising in terms of finance. In Indonesia, e-sports continues to grow with the existence of several national and international scale tournaments held in various places and the recognition of the Indonesia eSport Association (IeSPA) as an Indonesian eSport organization by the Ministry of Youth and Sports in 2014 which also became a bright spot for the development of this sport in the country. Until now, online game users continue to grow rapidly from year to year, therefore internet service providers (ISPs) must provide smooth and stable internet quality. Bandwidth Needs Online games must be supported by speed and stability in terms of internet connection. When using online games, the connection is bad or usually called lag. So that makes the avatar of the online game not move or the traffic falters, this makes the online game player will lose against the enemy because when the avatar of the online game does not move it will be easy to be shot dead.

Bandwidth management is a network management technique in an effort to provide uniform and satisfactory network performance. Bandwidth management is also used to ensure that the available bandwidth meets the needs of data and information traffic and prevents seizure of bandwidth resources. So to overcome the problem of bandwidth dominance between clients with one another, it is necessary to distribute bandwidth evenly. One of the queuing methods used for bandwidth sharing is using the Per Connection Queue (PCQ) queuing method, both by using the Simple Queue feature and also the Queue Tree on the Mikrotik router. This method can be

used to manage multiple clients in very inconvenient conditions if they have to create rules, so that Per Connection Queue bandwidth management will be well controlled to the clint that is connected to the network.

VPN (Virtual Private Network) technology allows everyone to be able to access the local network from outside by using the internet. With VPN technology, client users can access resources from outside networks and get access to the same settings as physically where the network is. So that in a VPN there are always main features in network security, namely encryption and tunneling. The VPN itself has several protocols including SSTP (Secure Soket Tunneling Protocol), PPTP (Point to Point Tunneling Protocol), and the IPSec (Internet Protocol Security) protocol, L2TP (Layer 2 Tunneling Protocol).

VPN L2TP (Layer 2 Tunneling Protocol) is available on one of the services at Mikrotik. L2TP is a development of PPTP and a combination of L2F. The network security protocol and encryption used for authentication is the same as PPTP. However, to communicate, L2TP requires UDP port 1701 so that the security is better, L2TP is connected to IPSec to become L2TP/IPSec. An example of its use is for the Windows operating system, which by default the Windows OS uses L2TP/IPSec. However, the consequences in terms of configuration are not as simple as PPTP. The client side must also support IPSec when implementing L2TP/IPSec. In terms of encryption, of course, encryption on L2TP/IPSec has a higher level of security than PPTP which uses MPPE. Traffic passing through the L2TP tunnel will experience overhead.

In this day and age, there are many business opportunities that are fairly easy to obtain, such as making Hotspots, Warnets or RT RW Net businesses. The same thing happened to the Crown Hotspot network entrepreneur in Bendega Village, Tanjung Karang, which provides hotspot services for browsing, streaming, downloading, online games and also as an online game tournament organizer. As an internet access provider, of course you want to provide the best service to hotspot clients. The number of clients on Hotspot Mahkota is very large so that it affects the speed of internet access, the use of uneven bandwidth makes the internet slow and has an impact on the Fair Usage Policy (FUP) so that when hotspot users access online games, clients don't feel comfortable while playing. online games or when procuring online game tournaments, so Hotspot Mahkota hopes for a system that is able to manage bandwidth and stabilize latency when playing online games, The difference from Abdul Aziz's research with the title Analysis of bandwidth requirements in the distribution of online game traffic for PUBG cod and browsing data using Mikrotik at Warnet Atk Wanasaba only discusses the distribution of bandwidth for each traffic for browsing data and online games. The difference with my research is online game latency. using L2TP VPN all online Game applications

II. MATERIALS AND METHODS

The research methodology used in this study is a prototype. There are five of the seven stages used, namely the requirements gathering stage (identification stage), building prototyping (design stage), prototype evaluation (evaluation stage), coding the system (configuration stage), testing the system (trial stage). Needs Collection. At the requirement gathering stage, it is the stage of collecting data and analyzing the data that has been collected through several methods including: observation, interviews, and references in the form of articles obtained from the internet, especially those that discuss bandwidth and l2tp vpn.

A. Data collection

At this stage, data collection was carried out to identify the problems that occurred in the HOTSPOT MAHKOTA in the village of Bendega Tanjung Karang. There were 3 methods of data collection used, namely observation, interviews and documentation. The explanation of each data collection method used is as follows:

1. Observation

The observation method is used to collect data by observing or monitoring directly on the Mahkota Hotspot Server so that information related to systems that are already running can be obtained such as network devices, network infrastructure and systems used. From the results of observations that have been made on the Mahkota Hotspot Server, the following information is obtained:

HOTSPOT CROWN in the village of Bendega Tanjung Karang has a server room in which there are network infrastructure devices, servers and clients.

Table 1. Interview Results

No	Question	Answer
1	What games are often used in the crown hotspot?	Mobile Legend and Firefire
2	What are the complaints when the client is playing online games?	Games become leggy when a lot of people use the internet
3	Are there any problems regarding the right	Yes, there are still problems with the right system to

	system for optimizing online games?	implement.
4	What solutions have been implemented to overcome these problems?	Not yet, only limiting bandwidth for all hotspot users.
5	What are your hopes for the future regarding this issue?	It is hoped that it will provide the right solution so that all traffic can run smoothly and there will be no lag when playing online games.

Network devices used include Mikrotik RB750Gr3, Access Points, Switch Hubs and PC Servers. There are 5 Access Points client connected to the server via the Hub switch.

2. Interview

The method of data collection using interviews was carried out to obtain more detailed information related to the system that has been running, the obstacles faced, the expectations of the Mahkota Hotspot in the village of Bendega Tanjung Karang so that the solution can be determined. Interviews were conducted with the owner of the Mahkota Hotspot, namely with Mr. Misbah. List of questions and answers from interviews, as shown in table 1.
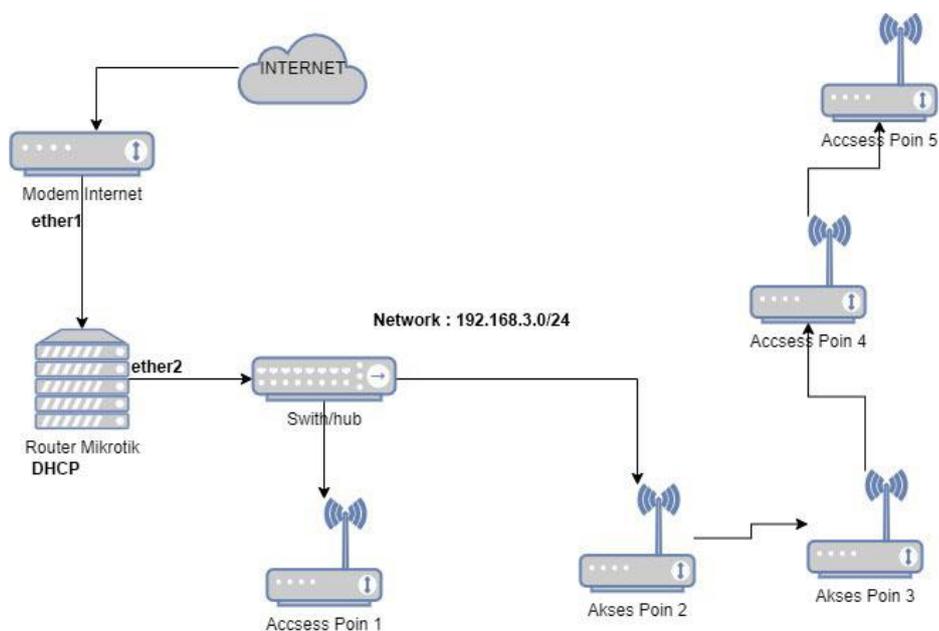
Figure 1The existing network topology

The collection method through documentation is carried out to obtain documents related to the network topology design that has been used. The network topology used by the Mahkota Hotspot Server is currently, as shown in the following figure 1. On the Mahkota Hotspot Server, there is 1 (one) hotspot server that is directly connected to the internet modem, and consists of 5 access points that are connected to switches/hubs.

3. Building Prototype

This stage contains a trial design for internet connection stability analysis, IP addressing design, as well as hardware and software requirements based on the results of data analysis in the previous stage.

Old Network Design

The old network design contains the network topology currently used at Mahkota Hotspot, before the implementation of the latency optimization system using L2TP VPN. The following is an old network design that is used.
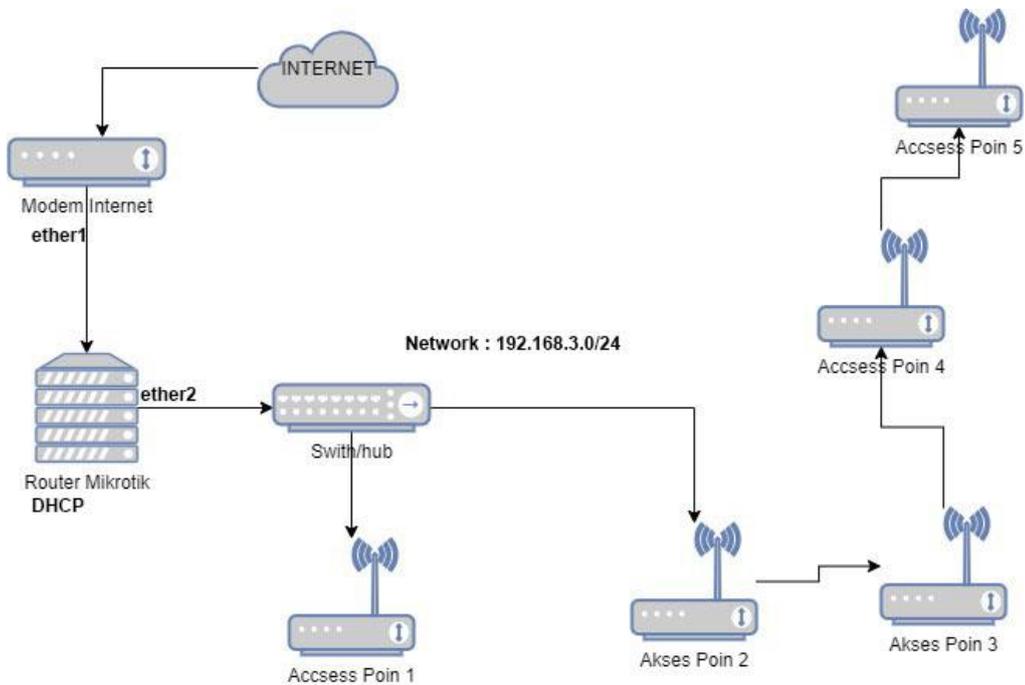
Figure. 2Network topology before l2tp game vpn is applied

Figure 2. The old network design contains the network used today where the hotspot server is connected directly to the internet, and there are 5 access points that are connected via a switch.

B. Alternative Network Design

In the alternative network design, which contains the network design when VPN L2TP is applied, the following is an alternative network design that is used. The alternative network design can be seen in Figure 3.
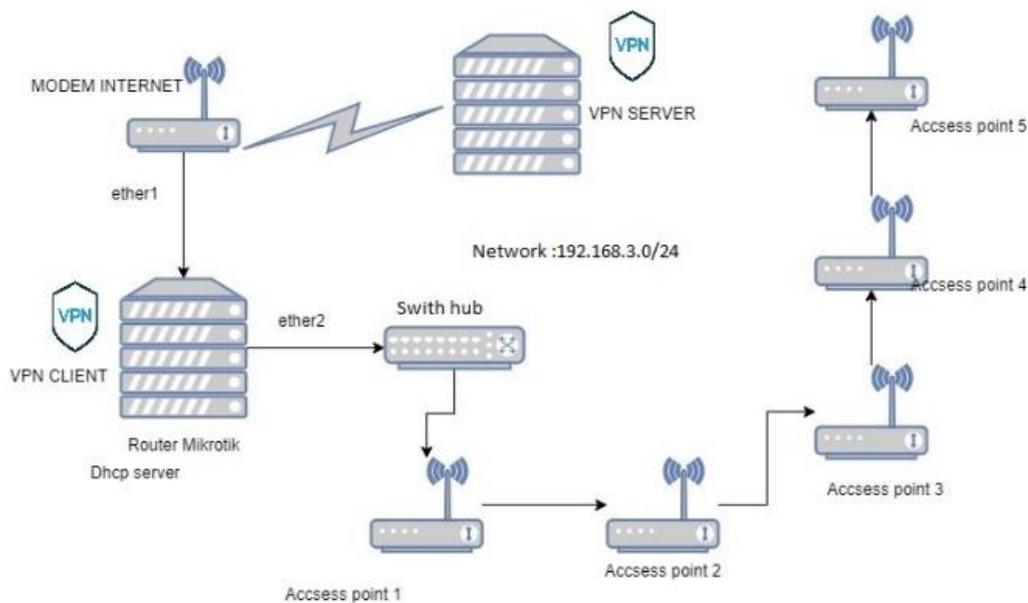
Figure 3. alternative network design of hotspot crown

On the alternative network, there is a hotspot server that has been integrated with VPN L2TP configured on the Mikrotik Router server and there are 5 access points that are connected via a switch using a straight lan cable.

C. IP Addressing Network Design

The design for addressing the IP address that is connected between the L2TP VPN and the Mikrotik router is as shown in the table 2.

Table 2. Design of TCP/IP Addressing

No	device name	Interface	IP address	Subnetmask	Gatwey
1	Server Hotspot	Ether 1	192.168.3.1	255.255.255.0	
			DHCP Server		
2	User 1	Ether 2	192.168.3.2	255.255.255.255.0	192.168.3.1
3	User 2	Ether 2	192.168.3.3	255.255.255.0	192.168.3.1

Design a simple queue bandwidth system The bandwidth distribution design uses the Per Coinction Queue (pcq) method so that each user gets an equal bandwidth allocation by means of a simple queue as shown in the image 4.
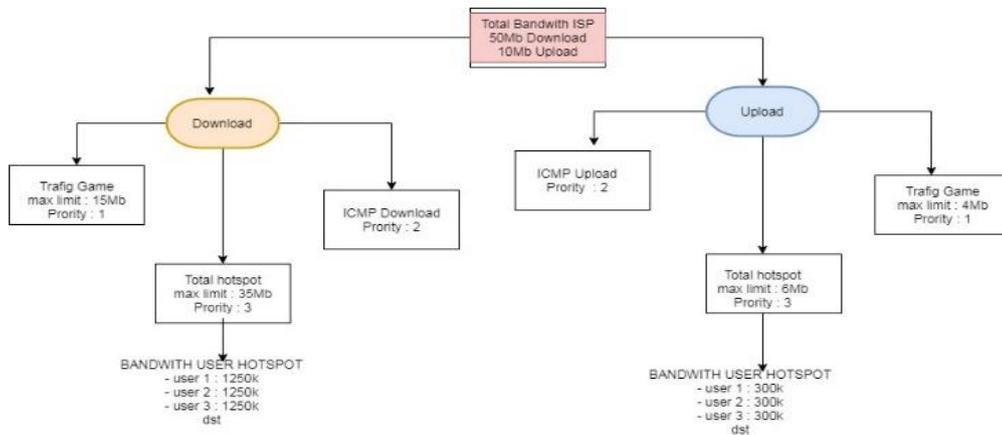
Figure. 3Design a simple queue bandwidth system

Seen in Figure 4. is a simple queue bandwidth system design, where the Total Bandwidth isp download 50Mbps and upload 10Mbps are allocated the max bandwidth limit to the game tarfig of 15Mbps with priority 1, and for uploads, the max bandwidth limit is 4Mbps and all hotspot users who log in to Hotspot will get bandwidth dynamically through Mikrotik for 300k upload and 1250k download.

Design a bandwidth queue tree system

After discussing the simple queue design system, the author will explain the queue tree bandwidth design as shown Figure 5.
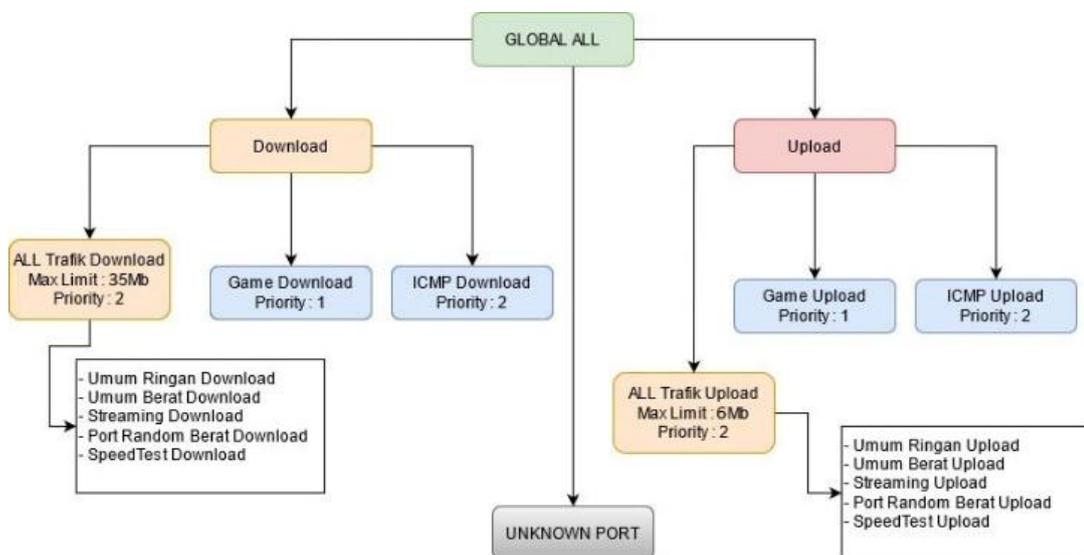
Figure 5. Design a bandwidth queue tree system

Seen in Figure 5 is a queue tree bandwidth system design that will be carried out on the crown hotspot server. Globall All bandwidth will be divided into Download and Upload to determine the max limit and priority bandwidth given to each hotspot user so they don't fight over bandwidth to other traffic. It can be seen that all download traffic is given a max limit of 35Mbps with a priority of 2, and this bandwidth is divided into general light download traffic, heavy general download streaming download, heavy random download port and download speedtest. Then for All Traffic Uploads, the maximum bandwidth limit is 6Mbps with a priority of 2, and this bandwidth is divided into general light upload traffic, heavy upload general, heavy upload and speedest upload random ports, and unregistered ports will enter the UNKNOWN PORT bandwidth.

D. Hardware and Software Requirements

The hardware and software requirements in writing this thesis are as follows:
a. Hardware Requirements (Hardware)
b. PC computer for configuration and monitoring
c. Router Mikrotik Rb750Gr3
d. Switches/hubs.
e. Access points.
f. Software Requirements (Software)
g. Winbox as a tool used to run a proxy router.

E. Evaluation of Prototype

At the evaluation stage, it contains a statement of acceptance and approval of the system that has been submitted to the owner of Hotspot Mahkota, evidenced by the statement letter contained in the attachment.

F. Coding System

installation and configuration

At this stage, it contains the installation and configuration carried out on each device involved based on the trial design.

Table 3. Trial scenario

Number of Trials	Type of manufacture	description
3 times, on Freefire game	Without using vpn l2tp games.	Measure the stability of the internet connection when playing games, and the latency of online games.
3 times, on Freefire game	Using l2tp game vpn	
3 times, on Mobile legend game	Without using vpn l2tp games.	
3 times, on Mobile legend game	Using l2tp game vpn.	

III. RESULTS AND DISCUSSION

This chapter discusses configuration and configuration test results which include configuration on the Mahkota Hotspot Server Router such as Hotspot creation, bandwidth management using pcq, and l2tp vpn routing for online game traffic and the online game trial phase. Here are the steps taken.

A. Installation and Configuration Stage

At the installation and configuration stage there are 2 stages, namely the installation and configuration of the Hotspot server.

Login Winbox

On the Mahkota Hotspot Router, there are five configurations, namely Bdidge-Hotspot creation, IP address, DNS, NAT and hotspot server installation. You can see picture of the Winbox login process using the Mikrotik username and password.
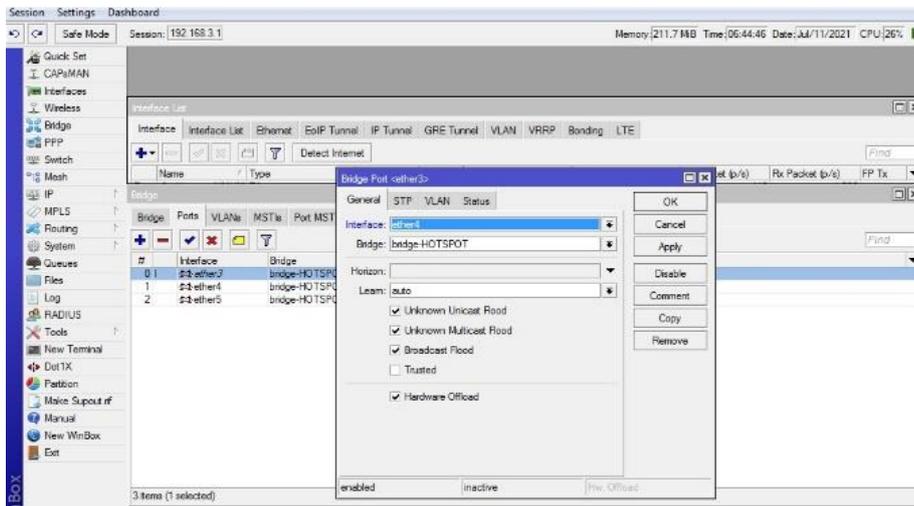
Figure 4. Result of port bridge

Figure 4 shows the results of making port2, port3 and port4 which are entered into one bride-Hotspot interface.

Figure 5. IP address bridge-Hotspot

It can be seen in Figure 5 that the IP address address has been created with the address 192.168.1.1/24 which points to the Internet Router, 192.168.3.1/24 points to the Hotspot, and 10.5.50.174 leads to the L2TP VPN dynamically marked with the letter D = Dynamic.

Figure 6. Results of Nat

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It can be seen in Figure 6 that the results of the nat have been successfully created with the Out interface on ether1-Internet.
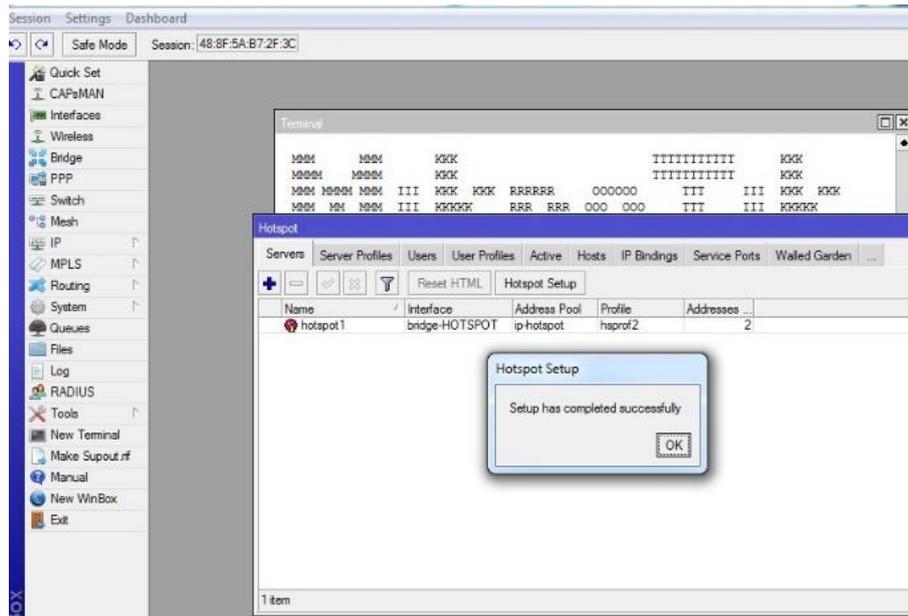
Figure 7. Hotspot server installation

It can be seen in Figure 7 that the installation of the Mahkota Hotspot server has been successfully created, with the description that setup has completed successfully.

Figure 8. Testing hotspot url access

Figure 8 shows the test results to access the hotspot using a browser by typing the url Mahkota.co.id and the hotspot login page will appear.

B. Test Results

The test results are divided into two parts, namely configuration verification and test scenarios.

1. Configuration Verification

The results of this configuration verification are the results of the connection between the ISP modem router and the L2TP VPN. And test game latency using a web browser and also by playing online games mobile legends and freefire.

2. Trial using speedtest and online games

To do a trial test, whether the online game latency is stable or not, you can open the website from a web browser.

First try using speedtest

At this stage, speedtest testing is carried out using a web browser for 3 trials

Do a speed test test using a web browser by typing the url https://speed.cloudflare.com/.
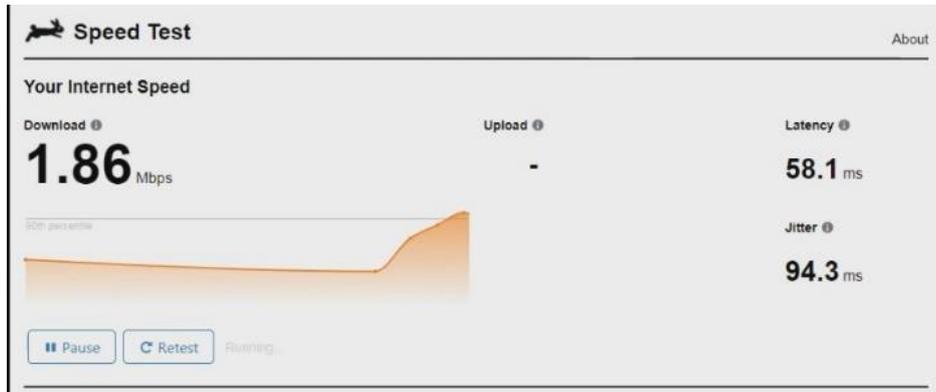
Figure 9. Latency test before vpn l2tp

In Figure the online game latency test was performed 3 times and the results of the speedtest latency test after the L2TP GAME VPN was activated, so that the results were as shown in the table below.

Table 4.Test vpn l2tp active status

Test	Deleay / Latency
Trial 1	58.1 ms
Trial 2	46.1 ms
Trial 3	56.1 ms
Average Result	53.43 ms

From the delay/latency value of experiment 1, experiment 2 and experiment 3 if averaged the value becomes 53.43 ms. According to the TIPHON index, the delay in online games is categorized as very good. Next did a test with the status of disabling vpn l2tp, doing it by opening the website url https://speed.cloudflare.com/ .
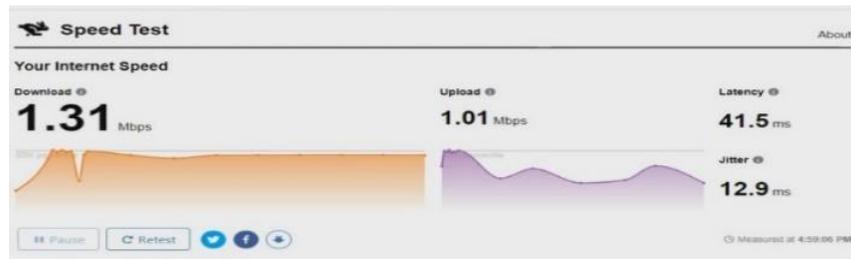
Figure 10. Latency test after activating vpn l2tp

In Figure 10 the online game latency test is performed 3 times and the results of the speedtest latency test after the VPN GAME L2TP is activated.

Table 5.Test VPN l2tp disabled

Test	Deleay / Latency
Trial 1	77.7 ms
Trial 2	41.5 ms
Trial 3	56.1 ms
Average Result	56.1 ms

Table 5 shows that the results of the delay/latency of experiment 1, experiment 2 and experiment 3 are averaged to 56.8 ms. According to the TIPHON index, the delay in online games is categorized as very good. In-game trial scenario At this stage, a trial scenario is carried out using the mobile legend online game and the freefire online game with the status activating l2tp vpn and disabling l2tp vpn. Experiment using mobile legends online games

At the testing stage using mobile legends and freefire online games, it is done by comparing when l2tp vpn is activated and l2tp vpn is deactivated. At this first experimental stage, a trial was carried out by activating the L2TP VPN when playing the Mobile Legend online game.

Figure 11.Testing online games

In Figure 11, it can be seen that the Mobile legend online game test took 7 minutes to play, and the signal on the mobile legend game bar was optimal at 82ms. Second try without activating vpn l2tp.

Figure 12. VPN is disabled.

In figure 12 the mobile legend online game before activating the l2tp vpn, the signal bar in the mobile legend game shows a decrease to 130ms. Trial using the freefire online game The first trial using the FreeFire online game by activating the l2tp vpn. First try on freefire online game by activating vpn l2tp.

Figure 13 Test VPN l2tp enabled

It can be seen in Figure 13 that a test was carried out by activating the L2TP VPN, and the results of the signal bar in the Freefire online game showed 64ms. Where the 64ms signal is a good category in playing online games. Second try testing on online games without activating vpn l2tp.

Figure 14.Test by disabling vpn l2tp

It can be seen in Figure 14 that the test scenario when playing online games by disabling VPN L2TP, where the results of the Freefire online game signal bar increase to 139ms, Analysis and test results, The analysis of the test results that have been carried out before activating l2tp vpn and after l2tp vpn activating are as follows:

1.) The results of the successful trial on the hotspot user are 15 users and the latency test trial is 3 times when the L2TP VPN service has not been activated, as shown in table 6.

Table 6. Test results of hotspot users before L2TP VPN is activated

No	User Hotspot	Bandwith Upload	Download	Testing Latency Testing 1	Testing 2	Testing 3
1	22567	300K	1250K	58.1 ms	77.7 ms	51.2 ms
2	22568	300K	1250K	84.3 ms	56.8 ms	48.1 ms
3	33579	300K	1250K	54.1 ms	67.6 ms	67.9 ms
4	12587	300K	1250K	45.7 ms	42.3 ms	66.0 ms
5	55897	300K	1250K	67.3 ms	77.2 ms	51.6 ms
6	54895	300K	1250K	44.0 ms	59.3 ms	69.8 ms
7	52890	300K	1250K	42.6 ms	52.4 ms	77.2 ms
8	35789	300K	1250K	46.5 ms	66.1 ms	45.6 ms
9	34789	300K	1250K	52.0 ms	47.8 ms	42.9 ms
10	66563	300K	1250K	48.8 ms	54.8 ms	42.2 ms
11	88375	300K	1250K	53.8 ms	45.5 ms	58.2 ms
12	34982	300K	1250K	53.2 ms	57.2 ms	42.8 ms
13	34609	300K	1250K	44.0 ms	59.2 ms	77.8 ms
14	99854	300K	1250K	78.4 ms	73.0 ms	93.1 ms
15	85099	300K	1250K	89.6 ms	54.7 ms	68.7 ms
	Average Latency			**50.79 ms**	**52.56 ms**	**53.01 ms**

Table 6. shows the overall results of the average latency test for hotspot users in experiment 1 = 50.79 ms, experiment 2 = 52.56 ms and experiment 3 = 51.01 ms. And according to the TIPHON deley/latency index shows very good results.

2.) The results of the successful trial on the hotspot user are 15 users and the latency test trial is 3 times when the L2TP VPN service is activated, as shown in table 7.

Table 7 User hotspot test results after L2TP VPN is activated

No	User Hotspot	Bandwith Upload	Download	Testing Latency Testing 1	Testing 2	Testing 3
1	22567	300K	1250K	58.1 ms	46.1 ms	56.1 ms
2	22568	300K	1250K	54.3 ms	46.8 ms	58.5 ms
3	33579	300K	1250K	53.1 ms	47.6 ms	56.3 ms
4	12587	300K	1250K	52.8 ms	48.0 ms	56.8 ms
5	55897	300K	1250K	57.5 ms	47.9 ms	55.3 ms
6	54895	300K	1250K	42.4 ms	58.1 ms	61.3 ms
7	52890	300K	1250K	41.4 ms	58.7 ms	76.3 ms
8	35789	300K	1250K	56.7 ms	46.8 ms	45.4 ms
9	34789	300K	1250K	51.0 ms	47.2 ms	47.7 ms
10	66563	300K	1250K	46.4 ms	58.2 ms	56.1 ms
11	88375	300K	1250K	51.0 ms	42.9 ms	56.9 ms
12	34982	300K	1250K	42.3 ms	48.3 ms	46.7 ms
13	34609	300K	1250K	45.0 ms	58.3 ms	66.2 ms
14	99854	300K	1250K	45.5 ms	56.9 ms	63.2 ms
15	85099	300K	1250K	59.6 ms	56.7 ms	47.2 ms
	Average Latency			**44.59 ms**	**45.32 ms**	**50.18 ms**

Table 7 shows the overall results of the average latency test on hotspot users in experiment 1 = 44.59 ms, experiment 2 = 45.32 ms and experiment 3 = 50.18 ms. And according to the TIPHON deley/latency index shows very good results.

IV. CONCLUSION

Based on the results of trials that have been carried out several times, the following conclusions can be drawn:
1. Before the client connects to the VPN server using the L2TP protocol, the client will first enter the username and password that has been registered on the proxy server router, if the username and password are incorrect then the connection request will not run.
2. The results of the user-hotspot test show that the latency values before using L2TP VPN and after using L2TP VPN have different values.

3. By using L2TP VPN the latency speed becomes more optimal than without L2TP VPN so that the signal on the online game bar becomes more stable than without L2TP VPN.
4. ISP modem bandwidth becomes more efficient because it has been transferred to L2TP VPN.
5. It is necessary to test the performance of the L2TP VPN network using a public static IP to make it easier for Users not to change the settings on the router and add IPsec security to the network.

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