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OPTIMALISASI JARINGAN LOCAL AREA NETWORK DENGAN MENGGUNAKAN METODE VIRTUAL ROUTER REDUDANCY PROTOCOL DI PT IFORTE DAAN MOGOT

TUGAS AKHIR

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FAKULTAS ILMU KOMPUTER
UNIVERSITAS MERCU BUANA
JAKARTA
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2022

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Menyetujui,

(Ir. Emil R. Kaburuan, Ph.D., IPM)
Dosen Pembimbing

Mengetahui,

(Wawan Gunawan, S.Kom, MT)	(Ir. Emil R. Kaburuan, Ph.D., IPM.)
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KATA PENGANTAR

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Jakarta, 31 Juli 2022

Khoirur Riza

DAFTAR ISI

NASKAH JURNAL

LOCAL AREA NETWORK OPTIMIZATION USING VIRTUAL ROUTER REDUNDANCY PROTOCOL METHOD AT IFORTE DAAN MOGOT LTD

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ABSTRACT

In industrial era that is advanced as today, the availability of an internet network is one of the supporting factors so that performance can always be well maintained in various companies, and iForte Daan Mogot Ltd is no exception, as an Internet Service Provider, internet network is very important so that task such as monitoring devices on servers and customers can always be controlled. High internet network availability needs to be supported by device performance that can always work. The purpose of this study is to create network redundancy using the VRRP (Virtual Router Redundancy Protocol) method to maintain the availability of the internet network in the event of interference with the main device so as to minimize internet network downtime. The results of the application of VRRP (Virtual Router Redundancy Protocol) and tested using a failover technique, when a disturbance occurs on the main device, the backup device will automatically activate and replace the performance of the main device so that the internet connection will be passed through the backup device so as to minimize downtime.

Keywords: *VRRP, Redudancy, Backup Link, Network, Failover*

1. INTRODUCTION

iForte Solusi Infotek Ltd (Iforte) is a provider of telecommunications services and infrastructure services in Indonesia. Until now, iForte provides internet connectivity and data communication services in 1,500 companies and telecommunication operators in Indonesia. iForte already owns and operates more than 80,000 KM of fiber optic lines and has successfully connected more than 15,000 towers with its fiber optic network in Indonesia. iForte also operates more than 6,000 VSAT sites. At one of the branch offices of iForte Ltd, namely iForte Daan Mogot Ltd internet access is an important aspect to support user performance, for example to monitor network traffic for iForte Ltd customers' devices, to report on the performance of the hub server every few hours, as a means of communication both in the company's internal coordination and communication to customers. These activities require internet access that is always available and maintained so that the work can run well and smoothly. But the problem that sometimes appears in a week is the loss of internet access availability due to system failure on the router device or on the network gateway.

To overcome the problems that occur, two or more internet path (link) are needed so that when a problem occurs on the path that is being used, the other path as a backup can provide internet network connectivity so that users will not feel significant interference rather than the absence of a backup path, to create a backup path can use one of the routing protocol methods, namely VRRP (Virtual Router Redudancy Protocol) which is part of FHRP (First Hop Redudancy Protocol).

FHRP (First Hop Redundancy Protocol) is a protocol that is useful so that the network is always alive by providing redundancy paths on two or more physical devices configured into one virtual device, one of the devices will be the main or active path and the other standby or backup path if the main path is down, for example: two devices that become one virtual interface, the two devices agree that there is only one gateway on the two paths, and on the path there is an active and a backup. And those included in the FHRP protocol are VRRP, HSRP, GLBP. [1]

Virtual Router Redundancy Protocol (VRRP) is a type of open standard redundancy

protocol (RFC 3768) from the Institute Of Electrical And Electronics Engineers (IEEE). VRRP combines several routers to become a virtual router so that the internet gateway will have several services. There are two types of VRRP roles including master router and backup router. Hot Standby Router Protocol (HSRP) is a standard gateway protocol from Cisco (RFC 2281) by providing network redundancy. There are 2 types of roles in HSRP, namely active router and standby router. The router with the highest priority is selected to be the active router to transmit the current data, and the router with the lower priority becomes the standby router. GLBP is a Cisco protocol that only Cisco devices can use the protocol. GLBP consists of an active virtual gateway (AVG) whose role is to head all routers in a GLBP group and an active virtual forwader (AVF) which will represent the AVG router, when the AVG main router dies. [2]. Among the three routing protocols, FHRP and GLBP are Cisco's routing protocols and are limited to Cisco devices. Since the network at the iForte Daan Mogot Ltd office uses a router with the Mikrotik brand, VRRP is a routing protocol that can be used as its implementation, because the routing protocol can be used by various vendors.

This research aims to create a backup link when a router or link experiences device failure or problems using the VRRP (Virtual Router Redundancy Protocol) method, which is expected to maintain internet network availability and minimize downtime.

2. METHOD ANALYSIS

In this research, the method that will be used is the PPDIOO method. Is a service life cycle method for the development of computer networks or technologies developed by Cisco. There are six stages of analysis in the PPDIOO method, namely: (1) prepare, (2) plan, (3) design, (4) implement, (5) operate, (6) optimize. Here is the PPDIOO flow, [3]

Figure 1. PPDIOO Flow

Details of the stages that will be carried out by the author using the PPDIOO (Prepare, Plan, Design, Implement, Operate, and Optimize) method are as follows:

2.1 Prepare

This stage is the preparation phase, this step is checking what hardware and software are needed.

Table 1. Hardware

No	Name	Description
1	Router	RB951Ui-2HnD
2	Router	RB951Ui-2HnD
3	PC	i5 8th, RAM 8GB
4	PC	i5 7th, RAM 8GB

Table 2. Software

No	Name	Description
1	Winbox	Version 3.32
2	Wireshark	Version 3.6.5
3	PRTG	Version 22.1.74.1869+
4	Jperf	Version 2.0.2
5	PingPlotter	Version 5.23.2.8766
6	Command Prompt	Version 10.0.19043.1706

2.2 Plan

The planning stage is the network identification stage based on the goals and needs of the organization. At this stage describe and analyze the characteristics of a network that aims to assess the network, also to determine whether the existing system infrastructure, and operational environment can support the proposed system.

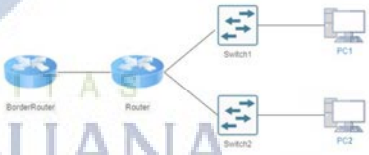


Figure 2. Network Topology without VRRP

In the current topology, the internet path is passed on one router, then forwarded to switch1 and switch2, then distributed to end devices. If the current router experiences device failure or interference, the internet network can be disconnected for a long time, therefore an

additional router will be configured as a backup so that the internet path can be forwarded to the end device even if the main router experiences device failure or interference.

2.3 Design

This stage is the phase of designing the network topology based on the technical requirements of the planning stage that has been carried out. The network design specification is a comprehensive and detailed design that meets today's technical and business requirements. The following is the initial network topology proposed using the VRRP (Virtual Router Redundancy Protocol) method:

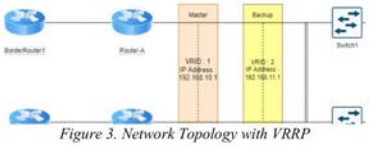


Figure 3. Network Topology with VRRP

Table 3. IP Address List

Device	Interface	IP Address	IP Network
Router1	Ethernet1	192.168.100.10/24	192.168.100.0
	Ethernet4	192.168.10.2/24	192.168.10.0
	Ethernet5	192.168.11.2/24	192.168.11.0
	VRID 1	192.168.10.1	192.168.10.1
	VRID 2	192.168.11.1	192.168.11.1
Router2	Ethernet1	192.168.101.10/24	192.168.101.0
	Ethernet4	192.168.10.3/24	192.168.10.0
	Ethernet5	192.168.11.3/24	192.168.11.0
	VRID 1	192.168.10.1	192.168.10.1
	VRID 2	192.168.11.1	192.168.11.1
PC1	Ethernet	192.168.10.10 - 192.168.10.254	192.168.10.1
PC2	Ethernet	192.168.11.10 - 192.168.11.254	192.168.11.1

In the proposed topology, each router will be configured to be the master on each interface that connects the switch. So Router-A will be the master on the first path, and Router-B will be the backup. While in the second path, Router-B becomes the master and Router-A becomes the backup. So that the two routers will work as master on a different path, and the other router will be a backup.

2.4 Implement

The implementation phase is the configuration phase according to the design specifications that have been made. By using the VRRP (Virtual Router Redundancy Protocol) method, 2 routers are configured with one of them being the master and the other being the backup to provide network redundancy, so that when a device failure or interference occurs on the master router, the backup router will take over the default gateway, so that the internet network can always be available.

2.5 Operate

At this stage, an experiment was carried out to test the VRRP configuration that had been carried out. The test is done by failover on the master router which simulates when the master router experiences a disturbance, then the backup router automatically replaces the performance of the master router.

Quality of Service (QoS) will also be checked on a new topology that has been configured such as packet loss, jitter, and throughput parameters, whether these parameters can produce an assessment index that is in accordance with user needs.

The Table 4 shown an index category of level network degradation according to TIPHON (Telecommunications and Internet Protocol Harmonization Over Networks). [4]

Table 4. Network Degradation Index Category

Category	Packet Loss	Jitter	Index
Very Good	0 – 2 %	0 – 74 ms	4
Good	3 - 14 %	75 - 124 ms	3
Medium	15 - 24 %	125 - 224 ms	2
Bad	> 25 %	> 225 ms	1

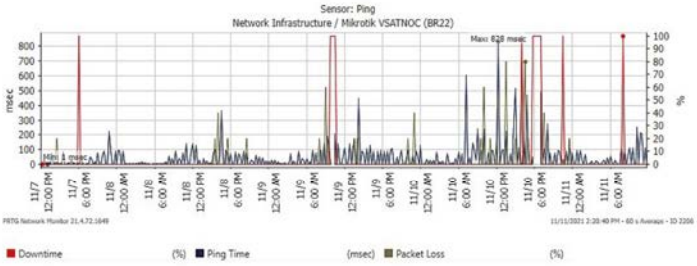
2.6 Optimize

The last phase of the PPDIOO method is Optimize, this phase allows for modification or optimization in case of network problems that arise after the network operates. The results of the failover test, the two routers that have been configured with VRRP will become network redundancy, which if the main router experiences a device failure or interference, the backup router will take over the function of the main router as the default gateway.

3. DATASET AND CONFIGURATION

3.1. Dataset

The author conducts observations, interviews, literature studies to obtain the necessary information. The author conducted interviews with informants who have positions as Hub Operator Leaders at the iForte Daan Mogot office who reported that sometimes there was a loss of internet connectivity while monitoring customer devices. The author also makes observations based on data from the log system to find out how often interference occurs, so that the causes of interference and solutions can be known.



In Figure 4 which is the log (historical data) of the previous topology router ping taken from the PRTG application, it is known that there was a downtime that occurred on November 9, 2021 at 9:51 am and November 10, 2021 at 5:47 pm from data taken on 7 – 11 November 2021. After re-checking, network disturbances that occur due to system failure, namely when the router experiences an error and needs to be rebooted to restore router performance.

Figure 4. Log Ping Router Existing

3.2. VRRP Configuration

At this stage, VRRP configuration is carried out on both routers, by providing a name, vrid, and priority.

Figure 5. VRRP Configuration on Router-A

Configured 2 vrids with different names and different functions, in Group-1 Router-A will function as master router, and in Group-2 Router-A will function as backup router.

Figure 6. IP Configuration VRRP Router-A

Configure the IP address on the VRRP Router-A interface, that IP is a virtual IP which will be the default internet gateway for end devices.

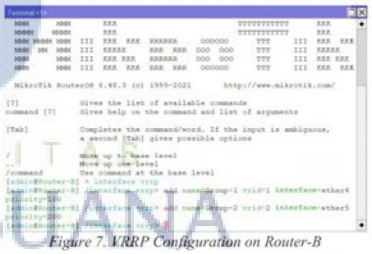


Figure 7. VRRP Configuration on Router-B

Router-B is also configured with 2 vrid with different names and different functions, in Group-1 Router-B will function as a backup router, and in Group-2 Router-B will function as a master router.

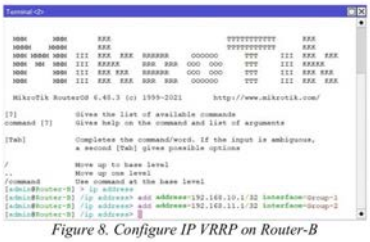


Figure 8. Configure IP VRRP on Router-B

Same as Router-A, the IP address configuration in Figure 8 is a virtual IP which will be the default internet gateway for end devices, so there is no need to manually change the gateway IP on the end device when the gateway is moved from Router-A. to Router-B, or vice versa when a problem occurs.

3.3. Failover Configuration

In this failover configuration, the author performs a failover configuration with the netwatch parameter, which is a tool in winbox. Netwatch configuration on Router-A and Router-B as follows.

Figure 9. Netwatch Configuration

In this netwatch, automatic checks will be carried out continuously by pinging the destination host, the script will be active if there is a change in the ping status from reply to request time out (RTO) or from RTO status to reply. The host that will be checked periodically is Google DNS, which is 8.8.8.8 with an interval of 3 seconds, in that 3 second interval when the ping to the host has no reply, then the script down will be active, then if the ping to the host has been replied back then the script up will be active.

Figure 10. Up Script Router-A

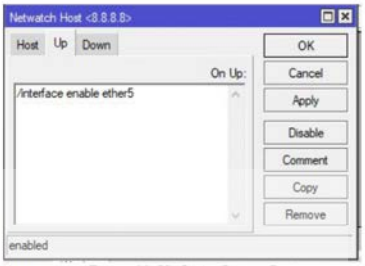


Figure 11. Up Script Router-B

In the up script, the condition that occurs is when the ping status to the destination host changes from RTO to reply, then Ethernet4 will be activated on Router-A, while on Router-B Ethernet5 will be activated.

Figure 12. Down Script Router-A

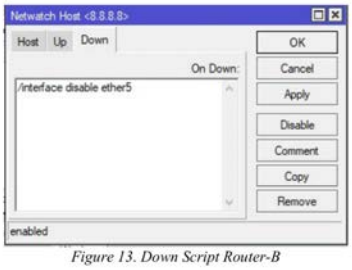


Figure 13. Down Script Router-B

In the down script, if the ping status to the destination host changes from reply to RTO, then Router-A will disable Ethernet4, while Router-B will disable Ethernet5 so that VRRP will be active, and the router that acts as a backup will change functions as a master router.

4. RESULTS AND DISCUSSION

4.1. Failover Test

For monitoring the failover test which will be divided into 2 scenarios, an application of a command prompt and PingPlotter will be used simultaneously.

The first test scenario was carried out on the previous network topology where there was no VRRP, the test was carried out for 60 seconds and the router would reboot at the 10th seconds via winbox application.

Figure 14. Monitoring PingPlotter without VRRP

The results of monitoring using the PingPlotter application with host 8.8.8.8 (google dns) show the absence of an internet connection after the router experiences downtime which is marked by an empty red graph where there is no reply from the host, and after completion, the jitter result is 1.18 ms and packet loss is 50.847%.

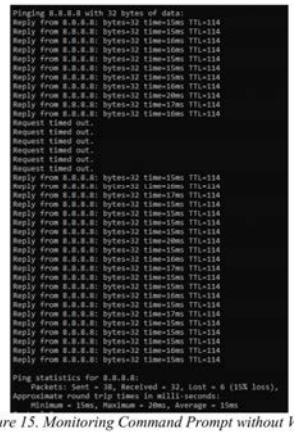


Figure 15. Monitoring Command Prompt without VRRP

Other results obtained from the command prompt showed that out of 38 packets sent, only 32 packets were received, with a packet loss of 15%.

Then the second test scenario is carried out on the proposed topology with VRRP configured, testing is carried out on the Group-2 vrid which is carried out for 60 seconds by rebooting Router-B at the 10th second via the winbox application which causes downtime. When Router-B experiences downtime, VRRP will be active and Router-A as a backup will take over Router-B's function as an internet gateway so that the connection remains available. When Router-B is working again, it will function as an internet gateway again.

Figure 16. Monitoring PingPlotter with VRRP Configuration

The results of monitoring using the PingPlotter application with host 8.8.8.8 (google dns) show that there is a ping that RTO (request timeout) when switching functions from Router-B to Router-A marked with an empty red graph, and

obtained jitter results of 0.94 ms and packet loss of 5.085%.

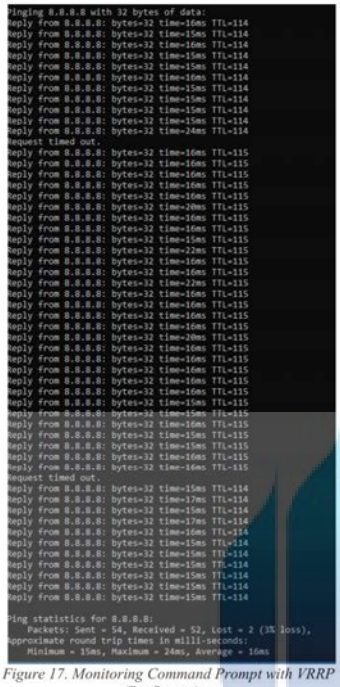


Figure 17. Monitoring Command Prompt with VRRP Configuration

Monitoring results from the command prompt application show that there are 52 packets received out of a total of 54 packets sent, with 3% of packet loss.

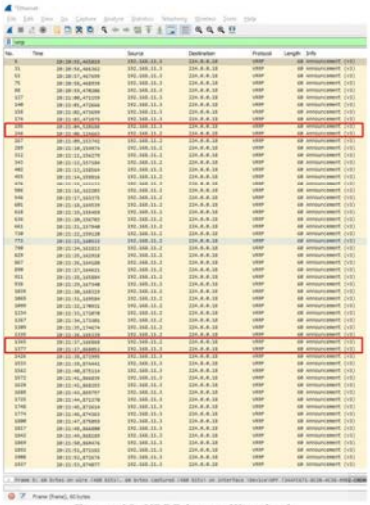


Figure 18. VRRP log on Wireshark

Then the VRRP protocol log data is taken using the wireshark application which shows an IP address change from 192.168.11.2 to 192.168.11.3, then changes again to 192.168.11.2, which means that VRRP Router-A is active when Router-B is experiencing downtime, then VRRP Router-B will be active again as master if it is functioning again.

Table 5. Comparison of Failover Scenarios on PingPlotter

Methods	Packets Sent	Packets Received	Packets Failed	Packet Loss	Jitter
Without VRRP	59	29	30	50,847 %	1,18 ms
VRRP	59	56	3	5,085 %	0,94 ms

Table 6. Comparison of Failover Scenarios on Command Prompt

Methods	Packets Sent	Packets Received	Packets Failed	Packet Loss	Jitter
Without VRRP	38	32	6	15%	1,19 ms
VRRP	54	52	2	3%	1,48 ms

The difference in packet loss and jitter results between PingPlotter and the command prompt is due to the difference in the number of packets sent, received, and lost so that the percentage and time are different.

Table 7. Assessment Index

Description	Index	
	Packet Loss	Jitter
Without VRRP (PingPlotter)	1	4
With VRRP (PingPlotter)	3	4
Without VRRP (Command Prompt)	2	4
With VRRP (Command Prompt)	3	4

4.2. Throughput Test

The second test was conducted to determine the throughput, which was carried out using jperf application with PC1 as client and PC2 as server. Testing is done for 60 seconds which is divided into 4 scenarios. The testing graph of all scenarios that have been carried out can be seen in Figure 19.

The first scenario (green line) is done without VRRP configuration and then failover is done by rebooting at the 10th second through winbox, and it appears that data transmission will stop and fail. The second scenario (gray line) is done without VRRP configuration and without failover. The third scenario (red line) is done with the VRRP configuration then failover is performed by rebooting at the 10th second via winbox, and it can be seen that data transmission was stopped but will continue with the backup router. The fourth scenario (white line) is done with VRRP configuration and without failover.

The results of testing all scenarios are attached in the following table.

Table 8. Throughput Scenario Comparison

Scenario	Data Transfer	Bandwidth
No VRRP + Failover	124	34
No VRRP	680	94.7
VRRP + Failover	616	86.1
VRRP	676	94.5

Then the results are made to diagram to make it easier to observe by adjusting the colors on the graph.

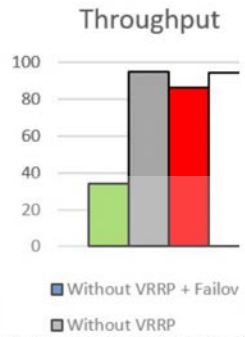


Figure 20. Diagram of Throughput Testing Results

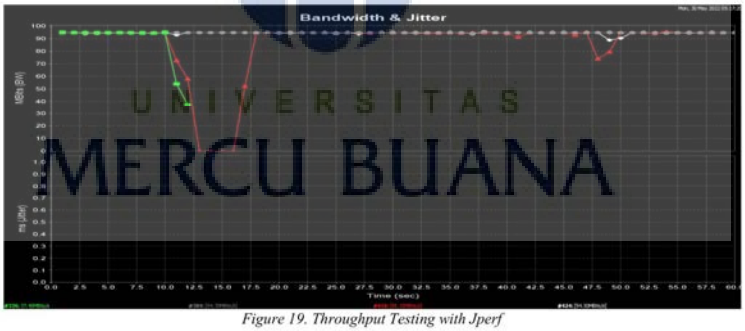


Figure 19. Throughput Testing with Jperf

5. CONCLUSION

Based on failover testing, the VRRP method worked well to reduce packet loss, this is shown from the scoring index in Table 7. which increased to index 3 with a good category. As for the jitter, there is no change in the index value before and after using the VRRP method with index 4, which is very good.

For the results of throughput testing, it can be concluded that in the absence of interference on the internet network, there is no significant difference between VRRP and without VRRP, but if there is interference on the internet network, VRRP can maintain throughput stability and data transfer as shown in Table 8.

Evaluation after failover and throughput testing, this VRRP method can be a solution to maintain network availability on iForte Daan Mogot Ltd local area network when there is a device failure or disruption to the main line, so that there is still a backup path that will provide internet network connectivity for users.

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KERTAS KERJA

Ringkasan

Kertas kerja ini merupakan material kelengkapan artikel jurnal dengan judul Optimalisasi Jaringan Local Area Network Dengan Menggunakan Metode Virtual Router Redudancy Protocol di PT Iforte Daan Mogot yang berisi semua material hasil penelitan Tugas Akhir yang tidak dimuat atau disertakan di artikel jurnal. Dalam kertas kerja ini akan dijelaskan mengenai literature review, dataset yang digunakan, serta langkah-langkah perancangan, tahapan implementasi dan hasil pengujian penelitian.

Pendahuluan

PT iForte Solusi Infotek (Iforte) adalah penyedia layanan telekomunikasi dan layanan infrastruktur di Indonesia. Hingga saat ini iForte menyediakan konektivitas internet dan layanan komunikasi data di 1.500 perusahaan dan operator telekomunikasi di Indonesia. iForte telah memiliki dan mengoperasikan lebih dari 80.000 KM jalur serat optik dan berhasil menghubungkan lebih dari 15.000 menara dengan jaringan serat optiknya di Indonesia. iForte juga mengoperasikan lebih dari 6.000 situs VSAT. Pada salah satu kantor cabang PT iForte, yaitu di PT iForte Daan Mogot akses internet menjadi aspek penting untuk mendukung kinerja *user*, contohnya untuk memantau lalu lintas jaringan perangkat milik pelanggan PT iForte, untuk melakukan laporan kinerja perangkat *server* setiap beberapa jam, sebagai sarana komunikasi baik dalam koordinasi internal perusahaan maupun komunikasi kepada pelanggan. Aktivitas – aktivitas tersebut memerlukan akses internet yang selalu tersedia dan terjaga agar pekerjaan dapat berjalan dengan baik dan lancar. Tetapi permasalahan yang terkadang muncul dalam seminggu yaitu hilangnya ketersediaan akses internet akibat kegagalan sistem pada perangkat router atau pada *gateway* jaringan.

Untuk mengatasi masalah yang terjadi, diperlukan dua atau lebih jalur internet agar saat terjadi masalah pada jalur yang sedang digunakan, maka jalur lainnya sebagai cadangan (*backup*) dapat memberikan konektivitas jaringan internet sehingga *user* tidak akan merasakan gangguan yang signifikan daripada

tidak adanya jalur *backup*. Untuk membuat jalur *backup* tersebut dapat menggunakan salah satu metode *routing protocol* yaitu VRRP (*Virtual Router Redudancy Protocol*) yang mana merupakan bagian dari FHRP (*First Hop Redudancy Protocol*).

FHRP (*First Hop Redudancy Protocol*) merupakan suatu protokol yang berguna agar jaringan selalu dalam kondisi hidup dengan cara menyediakan jalur redudansi pada dua atau lebih perangkat fisik yang dikonfigurasi menjadi satu perangkat *virtual*, salah satu perangkat akan menjadi jalur utama atau aktif dan yang lain s*tandby* atau jalur cadangan apabila jalur utama *down*, contohnya: dua perangkat yang menjadi satu *interface virtual*, dua perangkat tersebut setuju bahwa hanya ada satu *gateway* pada dua jalur (*link*), dan pada *link* tersebut ada yang menjadi aktif dan ada yang menjadi cadangan. Dan yang termasuk pada protokol FHRP adalah VRRP, HSRP, GLBP. (Djoko Suprijatmono & Andre Siswadi. 2019)

Virtual Router Redundancy Protocol (VRRP) adalah jenis protokol redundansi *open standard* (RFC 3768) dari IEEE (Institute Of Electrical And Electronics Engineers). VRRP menggabungkan beberapa router untuk menjadi suatu router *virtual* sehingga *gateway* internet akan memiliki beberapa layanan. Terdapat dua tipe peran dari VRRP diantaranya adalah router *master* dan router *backup*. *Hot Standby Router Protocol* (HSRP) adalah *standard gateway protocol* dari Cisco (RFC 2281) dengan menyediakan jaringan redudansi. Terdapat 2 tipe peran pada HSRP, yaitu router *active* dan router *standby*. Router dengan prioritas paling tinggi dipilih menjadi router *active* untuk mentransmisikan data yang sedang berjalan, dan router dengan prioritas lebih rendah menjadi router *standby*. GLBP merupakan protokol milik Cisco yang hanya perangkat Cisco saja yang bisa menggunakan protokol tersebut. Pada GLBP terdiri dari *active virtual gateway* (AVG) yang berperan untuk mengetuai seluruh router dari satu grup GLBP dan *active virtual forwader* (AVF) yang akan mewakili router AVG, saat router utama AVG mati. (I Putu Gede Krsna Yudha Dharma, Pande Ketut Sudiarta, & Widyadi Setiawan. 2021). Diantara ketiga *routing protocol* tersebut, FHRP dan GLBP adalah *routing protocol* milik Cisco dan terbatas hanya untuk perangkat Cisco. Dikarenakan jaringan pada kantor PT iForte Daan Mogot memakai router dengan *brand* Mikrotik, maka VRRP adalah *routing protocol* yang bisa digunakan sebagai

implementasinya, dikarenakan *routing protocol* tersebut dapat digunakan oleh berbagai *vendor*.

Penelitian ini bertujuan untuk membuat *link backup* ketika router atau *link* mengalami kegagalan perangkat atau masalah dengan menggunakan metode *Virtual Router Redundancy Protocol,* yang diharapkan mampu menjaga ketersediaan jaringan internet dan meminimalisir *downtime*.