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Research Original Article

Implementation of VRRP for Internet Optimization at Class I Sultan Iskandar Muda Meteorological Station - Banda Aceh

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Abstract
Class I Sultan Iskandar Muda – Banda The Aceh Meteorological Observatory is an environmental engineering implementing agency for observation and data processing, under the responsibility of the Meteorology, Climatology and Geophysical Agency. When using a government agency`s Internet network, failures such as unstable connections, failures, errors, and broken main routers often occur. If the main router goes down, no backup is available. To avoid this, a backup router must exist. Therefore, in this study, we apply an implementation of the virtual redundant router protocol to optimize the Internet network. The reseacrh aims explore to investigate the quality of WiFi network services. Researchers use her QoS analysis using packet loss, delay, and jitter parameters. Testing was conducted using Wireshark software during peak office hours in January and February 2023. The latency parameter findings were 3.49 ms in January and 4.89 ms in February on the main router (very good). The average jitter parameter was 3.49ms in January and 4.89ms in February (very good). The packet loss parameter is 2.05% (good) in February, while the overall average value in January is 0.83%. Overall, the calculation of the three parameters according to the TIPHON standardization is within a good range. His implementation of VRRP at the Sultan Iskandar Muda Weather Observatory proves the effectiveness of his VRRP in improving network availability and reliable backup systems.
Keywords: Packet Loss; Delay; Jitter; Virtual Router Redundancy Protocol

Introduction
In the current era, performing tasks without the use of networks has become nearly impossible, with network usage dominantly encompassing various daily activities in both institutions and companies (Sunyaev & Sunyaev, 2020), (Ghosh et al., 2018). While many institutions and companies establish robust network infrastructures, it does not guarantee immunity from various forms of disruptions. For instance, issues with routers can lead to disruptions in communication processes between clients and servers, resulting in decreased performance and reliability for an institution or company (Aceto et al., 2018). The Sultan Iskandar Muda Class I Meteorology Station in Banda Aceh is a non-departmental government agency under the Ministry of Transportation, responsible for meteorology, climatology, air quality, and geophysics. The station plays a crucial role in daily weather forecasting, early warning for natural disasters, monitoring earthquakes, tsunamis, and more. Therefore, a stable network infrastructure is essential for improving performance and facilitating fast data transmission. The Sultan Iskandar Muda Class I Meteorology Station in Banda Aceh, Aceh Province, currently lacks a backup system in case of router issues. Therefore, implementing a backup system is highly effective in enhancing the reliability and efficiency of the station's performance.

Router problems, whether internal or external, frequently occur, and the impact of router malfunctions is substantial. Such issues can halt all communication processes, including those between clients and servers, potentially impeding the overall performance of the institution (Hall et al., 2008). To address this challenge, many institutions and companies use a backup system with a switchover method. However, manual switchover requires administrator intervention, resulting in a time-consuming process (Kuswanto & Rahman, 2019). To overcome this challenge, the implementation of the Virtual Router Redundancy Protocol (VRRP) is proposed. VRRP operates similarly to a switchover system but can automatically switch from the main system to the backup system without requiring administrator intervention (Jamuna et al., 2021), (Brar, 2021), (Sheghdara & Hassine, 2020). Through virtualization, greater utility from available physical components can be obtained. VRRP serves as a virtual router protocol responsible for running backup router functions when the main router experiences failure in the network. To assess the optimal performance of the automatic backup system using VRRP, an analysis must be conducted using the Quality of Service (QoS) method (Pratama et al., 2018), (Julia et al., 2020), (Firmansyah et al., 2019).

QoS, or Quality of Service, is a measurement method assessing the effectiveness of a network. It aims to define the characteristics and nature of a network system to provide reliable services by managing bandwidth and addressing jitter and delay (Giyana et al., 2023). QoS is designed to help end-users enhance productivity by delivering reliable performance for web-based applications. QoS refers to a network's ability to provide better service for specific network traffic using various technologies. It focuses on the speed and reliability of data delivery in the provided network (Ramdhani, 2022).

The research findings propose the construction of an automatic backup system using VRRP at the third layer, i.e., the router layer, to maintain secure and uninterrupted connections between clients and servers. This is achieved without the need for intervention or involvement from administrators to address link disruptions. Recognizing the crucial role of the router gateway in managing different IP addresses that can be interconnected, an additional router is required to immediately back up and take over the main router's tasks in the event of a network failure. This research implements an automatic backup system using VRRP, and data analysis employs QoS parameters such as Jitter and Delay. Based on the outlined issues, the title of this research is "Implementation of VRRP for Internet Network Optimization at Sultan Iskandar Muda Class I Meteorology Station - Banda Aceh."

Literature Review

Internet network

The internet network is a collection of one or more networks that connect various devices into a common or global scope that functions as a facility for exchanging information using communication protocols with communication media in the form of cables or wireless, both receiving and sending. The application of computer networks to an agency or organization can provide convenience in better and more effective management performance. The extension of the internet itself is an interconnecting network (Retno et al., 2023).

The workings of the internet network system itself can be known from computer network parts, such as computers that provide services or services referred to as servers. And for computers that request services or data are clients. The computer network that covers the whole world which is very famous is the internet, through the internet people around the world can connect with each other, exchange data / information, play together and so on (Afrillia, 2021)

VRRP

The Virtual Router Redundancy Protocol (VRRP) is one of the open standard protocols declared in Request For Comment 2338. VRRP operates in a manner similar to HSRP, with a notable distinction being that HSRP is proprietary to Cisco. Another fundamental difference between VRRP and HSRP is that while HSRP uses a virtual IP address for the default gateway, VRRP can utilize either a virtual IP address or the interface address of the primary router. The functionality of VRRP involves selecting the router with the highest priority and designating it as the master, while the other routers are assigned as slaves or backup routers .VRRP offers advantages such as the ability to configure multiple routers as default gateway routers, reducing the risk of a single point of failure in a network. It can be configured in such a way that traffic to and from LAN clients can be shared among multiple routers, thereby distributing the available traffic load more evenly among the routers. The redundancy scheme of VRRP allows for the creation of a pre-established virtual backup router that takes over from a failed virtual master router, having a higher priority than the available backup virtual router. This provides a method to ensure the best virtual master router from the VRRP routers for a VRRP group by adjusting priorities based on Object Tracking status, such as interface or IP route states. (Usanto et al., 2022).

To perform VRRP configuration, the following information must be applied to each switch:
The virtual router ID (VRID) that identifies the VRRP router group, must specify the same ID across all virtual routers in the group. One or more virtual IP addresses assigned to the virtual router group. These are IP addresses that are not directly connected to a specific interface. Incoming packets sent to a virtual IP address are routed to a physical network interface (*Virtual Router Redundancy - VRR and VRRP | Cumulus Linux 4.2*, n.d.)

QoS

Quality of Service (QoS) also refers to the service quality of network mechanisms that enable a network infrastructure to operate or perform as expected. QoS is designed to assist end-users or clients in obtaining reliable performance from a network infrastructure. The goal of QoS is to meet various service requirements while still utilizing the same infrastructure. QoS often serves as a benchmark for network parameters. Parameters measured in a network include Delay, jitter, packet loss, and throughput. (Huda & Kom, 2019).

Throughput

Throughput is the speed (rate) of data transfer of data measured in units of bps (bits per second). Throughput is the total number of successful packet arrivals observed at the destination within a certain time interval divided by the duration of that time interval (Wijaya & Rasmila, 2018)
Throughput calculation equation:

$$Througput = \frac{\text{Data packets received}}{\text{Length of Observation}} \quad (1)$$

Table 1. Category throughput value

Category	Throughput (bps)	Value
Very good	100	4
Good	75	3
Medium	50	2
Poor	<25	1

Packet Loss

Packet loss describes a condition of total packet loss that can occur due to collision and congestion on a network, it can affect the level of efficiency on the network as a whole. The following are packet loss categories according to TIPPHON version (Wijaya & Rasmila, 2018).
Packet loss calculation equation:

$$Packet\ Loss = \frac{(\text{Data packet sent} - \text{Data packet received}) x\ 100\%}{\text{Data packets sent}} \quad (2)$$

Table 2. Category Value Packet loss

Category	Packet Loss	Value
Very good	0%	4
Good	3%	3
Medium	15%	2
Poor	25%	1

Delay

Dellay (Latency) is the time it takes for data to travel the distance from origin to destination. Delay can be influenced by distance, physical media, congestion or also long processes (Wijaya & Rasmila, 2018).
Delay (Latency) calculation equation

$$Average\ delay = Total\ delay / total\ packets\ received \quad (3)$$

Table 3. Category Value Delay

Category	Delay	Value
Very good	< 150 ms	4
Good	150 ms s/d 300 ms	3
Medium	300 ms s/d 450 ms	2
Poor	> 450 ms	1

Jitter

Jitter is caused by variations in queue length, in data processing time, and also in packet reassembly time at the end of the jitter journey. Jitter is commonly called a variation of Delay, related to latency (Pamungkas & Pramono, 2018).
Jitter calculation equation:

$$Jitter = \frac{\text{Total delay variation}}{Total\ packages\ received} \quad (4)$$

Table 4. Category Value Jitter

Category	Jitter	Value
Very good	0 ms	4
Good	0 – 75 ms	3
Medium	75 – 125 ms	2
Poor	125 – 225 ms	1

Materials & Methods

This research was conducted at the Sultan Iskandar Muda Class I Meteorology Station in Banda Aceh during the period from January 9, 2023, to February 20, 2023. The research focuses on the implementation of the Virtual Router Redundancy Protocol (VRRP) in the network infrastructure with an analysis of the Quality of Service (QoS) data from clients using the VRRP-related network. The overall system overview was designed to build VRRP on the network infrastructure, and the designed system was implemented, including the configuration of VRRP with two MikroTik routers as master and backup. Data from the Sultan Iskandar Muda Class I Meteorology Station were used for QoS analysis on the network usage with VRRP. The network topology involved clients connected to a switch, and two MikroTik routers were designated as master and backup for VRRP.

The implementation of VRRP was to ensure a smooth transition process from the master router to the backup in case of failure, minimizing service disruptions. The backup router takes over in case of a disruption to the master router. Virtual

Router Identifier (VRID) and IP addresses were used to identify the master and backup routers. Testing was conducted on parameters such as delay, jitter, and packet loss on the main and backup routers, along with failover performance to ensure internet optimization. The VRRP workflow was explained using a flowchart, detailing conditions such as IP address configuration, VRID settings, and the selection of the master router. Testing was performed on parameters such as delay, jitter, and packet loss on the main and backup routers, along with failover performance by disconnecting the connection path from the master router. The objective of this research is to enhance the resilience and performance of the network using VRRP, specifically at the BMKG Provincial Office in Aceh, with a focus on QoS and service reliability.

At this stage, data collection techniques are needed for the results of the study as a sample by carrying out several stages. The stages of data collection used in this study are as follows, system Design is applied to get the results of the overall system description that will be implemented to build a Virtual Router Redundancy Protocol on the network infrastructure. System Development is used to build a system that has been designed previously including the Virtual Router Redundancy Protocol. Data Collection is carried out to obtain the results of the system that has been built.

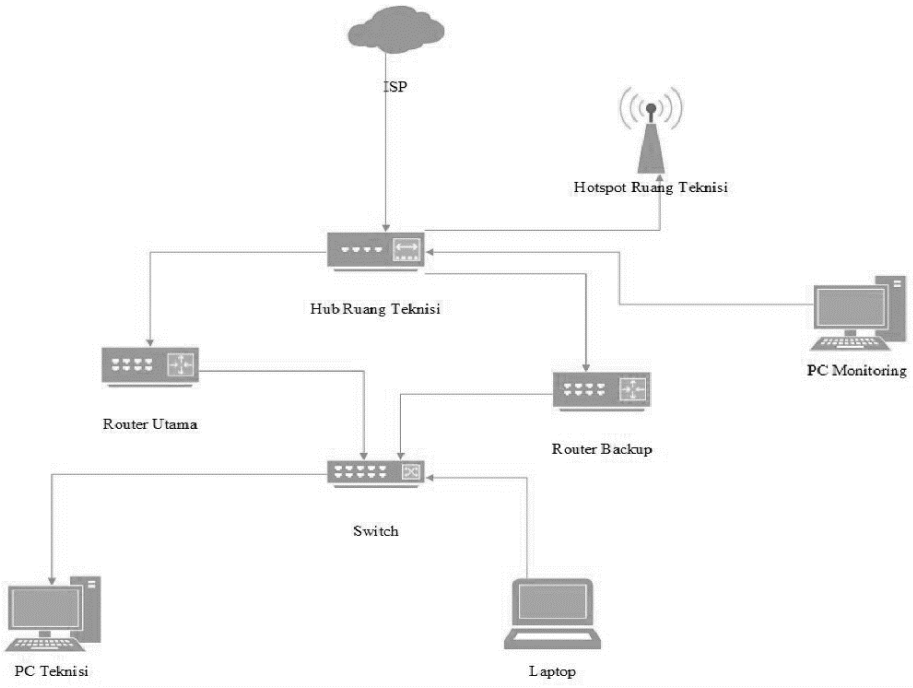

Figure 1. Topology of the network

Results and Discussion

The values obtained in the QoS calculation using software with the parameters Delay, jitter and packet loss can be concluded that for testing in each month it is not too significant between routers, both before system implementation, and after system implementation. In January, the Main Router had an average delay of 3.49 ms, while the Backup Router had an average delay of 2.81 ms. This shows that the Backup Router has better performance with lower delay compared to the Main Router during January. During February, the Main Router had an average delay of 4.89 ms, while the Backup Router had an average delay of 3.98 ms. Although both have increased compared to January, the Backup Router still shows better performance with a lower delay than the Main Router during February. In both months, the Backup Router consistently has a lower average delay than the Main Router, which indicates that as a backup option, the Backup Router can be a more reliable choice in managing network traffic with lower delay. When viewed from the TIPHON assessment standard, the network at the Class I Sultan Iskandar Muda Meteorological Station office - Banda Aceh is still classified in the excellent category with an index value of 4 or <150ms.

Table 5. average Delay every month

Month	Average Delay Primary Router	Average Delay Router backup
January	3,49 ms	2,81 ms
February	4,89 ms	3,98 ms

During the month of January, the Primary Router had an average delay of 3.49ms, while the Backup Router had an average delay of 2.81ms. This shows that the Backup Router has better performance with lower delay than the Main Router during January. During February, the Main Router had an average delay of 4.89 ms, while the Backup Router had an average delay of 3.98 ms. Although both have increased compared to January, the Backup Router still shows better performance with lower delay compared to the Main Router during February.

Table 6. average Jitter every month

Month	Average Main Router Jitter	Average Jitter Backup Router
January	3,49 ms	2,81 ms
February	4,89 ms	3,99 ms

In January, the Primary Router had an average jitter of 3.49ms, while the Backup Router had an average jitter of 2.81ms. This shows that the Backup Router has better performance with lower jitter than the Main Router during January. During February, the Main Router had an average jitter of 4.89ms, while the Backup Router had an average jitter of 3.99ms. For the assessment standard according to TIPHON, the jitter obtained from the test results at the Sultan Iskandar Muda Class I Meteorological Station office - Banda Aceh received a good category with an index of 0 – 75ms.

Table 7. average Packet Loss every month

Month	Average Packet Loss Primary Router	Average Packet Loss Backup Router
January	0,83%	0,10%
February	2.05%	9,17 %

Packet loss during the month of January, the Primary Router had an average packet loss of 0.83%, while the Backup Router had a much lower average packet loss of 0.10%. This shows that the Backup Router performed much better in avoiding packet loss during the month of January. However, in February, there was a significant increase in packet loss for both. The Primary Router experienced an average packet loss of 2.05%, while the Backup Router experienced a higher average packet loss of 9.17%.

Conclusions

After testing the main router in January the delay obtained was 3.49ms and in February the value obtained was 4.89ms. When testing on the backup router, the value obtained was 2.81ms in January while in February a value of 3.98ms was obtained. From the results of these calculations, Delay at the Aceh Province BMKG office is included in the very good category, which is below 150ms for the TIPHON assessment standard. The results of the calculation of Jitter carried out on the main router in January obtained a value of 3.49ms and 4.89 in February, when the calculation was carried out on the backup router the value obtained in January was 2.81ms and 3.99ms in February, which value is already in the very good category according to the TIPHON assessment standard. After processing the data for the Packet Loss value on the main router in January, a value of 0.83% and 2.05% was obtained in February. When switching to the backup router, the value obtained was 0.10% in January, the results obtained in February increased slightly from the previous month, sure 9.17%. So from these results, the Packet Loss value at the BMKG Aceh Province office is in the good category for the TIPHON assessment standard. From the results of measuring the performance of the Virtual Router Redudancy Protocol at the BMKG Aceh Province office, it can be used to overcome device failure on one of the networks and can stabilize the performance of the network.

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References

Aceto, G., Botta, A., Marchetta, P., Persico, V., & Pescapé, A. (2018). A comprehensive survey on internet outages. *Journal of Network and Computer Applications*, *113*, 36–63.

Afrillia, D. D. Y. (2021). Implementasi Augmented Reality Terhadap Tujuh Keajaiban Dunia Menggunakan Metode Marker Based Tracking (MBT) Berbasis Android. *Jurnal Teknovasi : Jurnal Teknik Dan Inovasi*, *Vol 8*, *No 1 (2021): TEKNOVASI APRIL 2021*, 57–64.

Brar, D. (2021). *Traffic Load Balancing Techniques*.

Firmansyah, F., Purnama, R. A., Mustofa, M., & Dewi, S. (2019). Quality of Service Gateway Load Balancing Protocol Message Digest algorithm 5 Authentication For Network Quality Enhancement. *Journal of Telematics and Informatics*, *7*(1), 9–16.

Ghosh, A., Chakraborty, D., & Law, A. (2018). Artificial intelligence in Internet of things. *CAAI Transactions on Intelligence Technology*, *3*(4), 208–218.

Giyana, R. F., Kusuma, A. A. N. A., & Hamdani, M. (2023). VRRP-Based WAN Redundancy Protocol for Dual Gateway Cable Based Tsunameter (INA-CBT). *2023 International Conference on Radar, Antenna, Microwave, Electronics, and Telecommunications (ICRAMET)*, 18–23.

Hall, J., Rapanotti, L., & Jackson, M. (2008). Problem oriented software engineering: Solving the package router control problem. *IEEE Transactions on Software Engineering*, *34*(2), 226–241.

Huda, M., & Kom, M. (2019). *Open Systems Interconnection: Lapisan Data-Link* (Vol. 2). bisakimia.

Jamuna, C. J., Kumar, R. A., & Belvadi, S. S. (2021). Strategic Framework for Campus Network Environment Using Virtual Switching System. *3rd International Conference on Integrated Intelligent Computing Communication \& Security (ICIIC 2021)*, 322–330.

Julia, I. R., Suseno, H. B., Wardhani, L. K., Khairani, D., Hulliyah, K., & Muharram, A. T. (2020). Performance evaluation of first hop redundancy protocol (FHRP) on VRRP, HSRP, GLBP with routing protocol BGP and EIGRP. *2020 8th International Conference on Cyber and IT Service Management (CITSM)*, 1–5.

Kuswanto, H., & Rahman, T. (2019). Failover Gateway Menggunakan Protokol Virtual Router Redundancy Protocol (VRRP) pada Mikrotik Router. *JUSTIN (Jurnal Sistem Dan Teknologi Informasi)*, *7*(1), 60–66.

Pamungkas, S. W., & Pramono, E. (2018). Analisis Quality of Service (QoS) Pada Jaringan Hotspot SMA Negeri XYZ. *E-JURNAL JUSITI: Jurnal Sistem Informasi Dan Teknologi Informasi*, *7*(2), 142–152.

Pratama, E. K., Hasan, F. N., & Asteroid, K. M. (2018). Pemanfaatan Redudancy Router Dengan Fitur VRRP Mikrotik Pada Jaringan Thin Client. *Akrab Juara: Jurnal Ilmu-Ilmu Sosial*, *3*(2), 21–28.

Ramdhani, S. (2022). *Analisis Dan Implementasi First Hop Redudancy Protocol Pada Jaringan Topologi Star*. Universitas Andalas.

Retno, S., Rosnita, L., & Anshari, S. F. (2023). Sistem Informasi Pelayanan Cuti Berbasis Web Pada PT Pupuk Iskandar Muda Menggunakan PHP dan MySQL. *TECHSI-Jurnal Teknik Informatika*, *14*(1), 33–41.

Sheghdara, M., & Hassine, J. (2020). Automatic retrieval and analysis of high availability scenarios from system execution traces: A case study on hot standby router protocol. *Journal of Systems and Software*, *161*, 110490.

Sunyaev, A., & Sunyaev, A. (2020). *Internet computing*. Springer.

Usanto, U., Nurlaela, L., & Purwono, P. (2022). Penerapan Metode Virtual Router Redudancy Protocol (VRRP) Pada Yayasan Masjid Al-Ikhlas. *JEIS: Jurnal Elektro Dan Informatika Swadharma*, *2*(1), 69–78.

Virtual Router Redundancy - VRR and VRRP | Cumulus Linux 4.2. (n.d.).

Wijaya, A., & Rasmila, R. (2018). Analisa Kehandalan Jaringan Internet Dengan Pendekatan Quality Of Service Pada RS. Kusta dr. Rivai Abdullah Palembang. *Jurnal Ilmiah Matrik*, *20*(1), 1–10.