DVOR & DME Building Power Network Monitoring Labuan Bajo Sub-Branch Uses Telegram API Bot Notifications Through Netwatch Mikrotik

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Abstract

The development of information technology in tandem with the flow of globalization has brought major changes to the way humans access and disseminate information. One of the impacts is to make the internet a primary need, both in the world of work, education, and government. Easy access and instant communication are indispensable in the management of information systems, especially in network infrastructure monitoring. Telegram is one of the cloud-based instant messaging applications that is open source. The app not only offers basic communication features, but it also supports the development of advanced functions through the Telegram Bot API. This feature allows developers to create automation systems, including in terms of network monitoring. On the other hand, Netwatch is one of the features of the Mikrotik RB2011UiAS-RM device that functions to monitor network connections to certain destination addresses on a regular basis. When a connection interruption occurs, Netwatch may take automated actions, such as sending notifications or executing certain scripts. By combining Netwatch and Telegram's Bot API, a network monitoring system can be built to provide real-time notifications to network administrators. One of the implementations of this system was carried out at the DVOR & DME Building of the Labuan Bajo Sub-Branch which is located on a hill, about 500 meters to the north of the Tower Building. Access to the location is quite difficult because it is not equipped with street lighting, has rocky and steep terrain, and can only be passed by two-wheeled vehicles, especially during the rainy season. In these conditions, a network monitoring system that is able to provide up/down internet status information directly through Telegram is very important. This notification can be an indicator of whether the power grid at the location is still active or has been out, so that technicians can respond faster without having to check directly to the location.

Keywords: ***Bots, Telegram, API, Netwatch, Mikrotik***

Introduction

The electricity distribution network is an important part of the energy infrastructure that supports the operational sustainability of various public facilities, including flight navigation facilities. A Low Voltage Network (JTR) is an end distribution network that conducts electricity from the distribution transformer to the customer (Sutisna, 2017). The key components in a JTR system such as cables, support poles, and customer connections greatly determine the stability of the electrical energy supply, especially in areas with challenging geographical conditions.

One example of such challenges is found in the Labuan Bajo Sub-Branch DVOR and DME Building, which is part of the flight navigation system under the management of UPBU Komodo. This building gets a 3-phase electricity supply from the Main Power House (MPH) through a twisted cable installation with the construction of a Medium Voltage Overhead Line (SUTM) that passes through hilly areas and land owned by individuals. This condition causes the installation to be quite vulnerable to natural disturbances such as rain, strong winds, and other external disturbances (Purnomo & Siregar, 2020).

Technicians on duty at the Labuan Bajo Capem, such as CNS-D and ESS, carry out periodic inspections and maintenance using two-wheeled vehicles because the terrain conditions do not allow other vehicles to pass. However, limitations in real-time network monitoring, especially outside airport operating hours (07.00 WITA - 20.00 WITA), cause delays in responding to outages, especially during peak electricity loads at night or during extreme weather. Meanwhile, monitoring media such as CCTV and HT Airband are still limited in use and are only available in Tower Buildings or Head Offices (Handoko, 2019).

Facing these challenges, it is necessary to innovate in real-time power grid monitoring systems by utilizing the latest information technology. One potential solution is to integrate the Telegram Bot and Netwatch features on the Mikrotik RB2011UiAS-RM device. Telegram is a cloud-based instant messaging application that is open source and has a Bot API that supports automation of direct messaging (Telegram API Docs, 2024). The Netwatch in Mikrotik can be configured to monitor the status of the connection to the internet, which in this context can be an indirect indicator of the status of the power grid. When the internet connection is down, the system will send a notification via Telegram indicating that the power network is out, and vice versa, when the internet is up, it means that the power has been turned back on.

By forming a Telegram group consisting of 4 technician personnel and 1 monitoring bot, this system is able to deliver disruption notifications automatically and instantly, without waiting for a physical inspection by a technician. This innovation is expected to improve work efficiency, accelerate response to disturbances, and provide critical information for decision-making in emergency situations, especially when extreme weather impedes access to the site.

The use of technologies such as IoT (Internet of Things), cloud messaging, and API-based monitoring systems have been widely applied in various sectors to monitor critical infrastructure in real-time (Putra & Santoso, 2021; Nugroho et al., 2023). The integration of the Telegram Bot system with Mikrotik Netwatch is a simple implementation of a cost-effective, yet effective IoT approach in increasing the operational resilience of flight navigation equipment in remote areas. (Hamdani et al, 2020).

Literature Review

2.1 Power Grid Monitoring System

Power grid monitoring is the process of continuously monitoring the condition of supply and stability of electrical current to detect disturbances early and prevent equipment damage. In aviation navigation systems, electrical stability is crucial because it has a direct impact on the safety and operation of navigation aids such as DVOR (Doppler VHF Omnidirectional Range) and DME (Distance Measuring Equipment). According to Purnomo and Siregar (2020), real-time electricity monitoring is indispensable in areas with difficult geographical access and extreme unpredictable weather.

2.2 Mikrotik and Netwatch Features

Mikrotik is a router device used for network management based on the RouterOS operating system. One of its flagship features is Netwatch, which allows administrators to monitor connectivity to destination IPs on a regular basis. When a host unreachable or host reachable condition occurs, the system can automatically execute certain scripts in response to that change in status (Mikrotik Wiki, 2023).

In the context of power grid monitoring, Netwatch is used as an indirect detection tool. If a Mikrotik device loses its connection to the internet, this can be used as an indicator that the power is out (assuming the device does not have a standalone backup power), and conversely, the reconnection indicates that the power has been turned on.

2.3 Telegram and Bot API

Telegram is a cloud-based instant messaging app that provides a Bot API, an interface that allows users to create automated bots to send and receive messages. Telegram bots have been used in a variety of automation applications including system monitoring, server notifications, and IoT equipment control (Putra & Santoso, 2021). The Telegram Bot API is perfect for use in notification systems because it is lightweight, fast, and supports sending real-time messages to groups or individual users. By creating a Telegram group of technicians and bots, administrators can receive live reports when there is a change in the state of network connectivity, which reflects the state of the power grid.

2.4 Mikrotik and Telegram Bot Integration for Monitoring

Previous research and implementation have shown the effectiveness of the integration between Netwatch Mikrotik and Telegram Bot in building a notification-based monitoring system. Nugroho et al. (2023) developed a server room temperature monitoring system based on Mikrotik and Telegram, and concluded that the system provides a fast response, is accessible remotely, and is easy to implement without large costs.

Research Methods

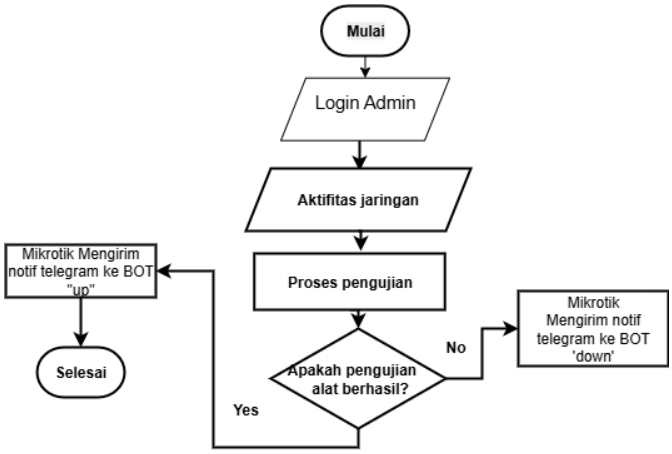

Figure 1. *Research Flowchart*

3.1 Types of Research

This study uses an experimental research approach, which is predictive, which aims to predict the consequences of a treatment or manipulation of bound variables (Latipun, 2016, p. 8). Experimental research is a scientific method used to test the cause-and-effect relationship between two or more variables, in which the researcher deliberately treats the independent variable and observes changes in the bound variables by eliminating or minimizing the influence of external variables (Arikunto, 2019, p. 9).

3.2 Research Framework

In order for the implementation of the research to run systematically, a framework (work frame) was prepared that explained the stages of the activity in a sequential manner. Each stage has an important role in supporting the success of the research. The stages of the framework used in this study are as follows:

1. Literature Studies: This initial stage aims to dig up information and expand understanding of the topic being researched. The study was carried out through the search of various sources such as books, scientific journals, proceedings, and other references obtained through physical and digital libraries (search engines and online databases). This stage is important to build a theoretical foundation and identify relevant research gaps.
2. System Analysis: At this stage, the identification of problems that occur in the existing (running) system is carried out. The analysis aims to understand the needs of users, the weaknesses of legacy systems, as well as the technical challenges that must be overcome in the research. The methods used can include observation, interviews, documentation, and system flow mapping.
3. System Design: This stage involves new system design activities that will be developed based on the results of previous analysis. System design includes system architecture, flowchart design, user interface, and communication design between system components. This design aims to provide a comprehensive technical overview of the system to be implemented.
4. System Implementation: After the system design is completed and approved, the implementation process is carried out, namely the construction of the system according to the design that has been made. At this stage, the system begins to be developed technically using predetermined software, hardware, and technology. Implementation is carried out in stages according to the work plan.
5. System Testing: The final stage is testing the system that has been built. The goal is to evaluate the system's functionality, reliability, and suitability with the user's needs. If errors or deficiencies are found, the debugging and repair process is carried out. This testing is important to ensure that the system can function optimally and stably in the actual operational environment.

3.3 Stages of Implementation of the DVOR & DME Building Power Grid Monitoring System

To build a real-time power grid monitoring system using Netwatch Mikrotik and Telegram Bots, a series of systematic technical steps are needed. The explanation of the stages of system implementation is as follows:

1. Start (System Initialization): The initial stage in the implementation of the monitoring system begins with the process of planning and initializing the device used. At this stage, hardware such as Mikrotik RB2011UiAS-RM will be used as the main monitoring tool. In addition, a Telegram application is also prepared which will be a medium to send notifications to technicians. This process includes collecting data on system needs, determining the location of the monitored network (i.e. the DVOR & DME Building), and identifying Capem Labuan Bajo technician personnel who will be members of the monitoring system. This initialization stage is important to ensure that all the initial components are ready for the integration process.
2. Network Activities: After the system is ready, an initial configuration is carried out in the form of creating a Telegram group called "LBJ Network Monitoring" consisting of all Capem Labuan Bajo technicians. The group is also integrated with the Telegram Bot that will be used as an automatic notification sender. On Mikrotik routers, the Netwatch feature is used to monitor connections to certain IP addresses that function as indicators of whether or not the power network is active or not. Then

an automatic script is added to Netwatch that will send a command when the network status changes: when the connection returns to normal (UP), a "DVOR ON" notification will be sent, and when the connection is lost (DOWN), a "DVOR OFF" notification will be sent. This stage is the basis for the monitoring process based on changes in network connections.

3. Mikrotik Testing: Once the configuration is complete, a test is performed on the system to ensure that the Netwatch functionality and integration with the Telegram Bot are running as intended. The test was carried out using Mikrotik RB2011UiAS-RM by simulating the network conditions in UP and DOWN states. The results of the test are displayed in the form of real-time notifications that appear in Telegram groups. This test is important to determine if the system is able to provide a quick response when there is a change in connection status, while ensuring the accuracy of the messages sent to the technician.
4. Network Data on Mikrotik RB2011UiAS-RM: Mikrotik acts as a center for collecting and processing network connectivity data. Any network activity detected by Mikrotik devices—in particular connection changes to the destination IP—will be processed and used as the basis for sending notifications. Mikrotik will run an automatic script based on the UP or DOWN state, and then execute the message delivery to the Telegram Bot API. Thus, Mikrotik becomes an important bridge between the status of the physical network and the cloud-based digital notification system.
5. Telegram Bot API: The Telegram Bot API is a connecting tool between Mikrotik and Telegram groups. This bot was previously created through the official Telegram service (BotFather), and is configured to receive commands from Mikrotik via HTTP requests. Every command sent from Mikrotik will be translated by the Bot into a text message which is then sent to the Telegram group. This Bot API functionality allows the system to send messages automatically and quickly without manual intervention from the user.
6. Telegram Notifications: Notifications sent by Bots to Telegram groups are the main output of this monitoring system. Messages that technicians receive, such as "DVOR ON electricity" or "DVOR OFF electricity", provide real-time information regarding the network connectivity status in the DVOR & DME Building. Since internet connectivity is highly dependent on the electricity supply, this message also represents the status of electricity on site. With this notification, technicians can immediately find out the network condition even if they are outside the work site.
7. Network Topology Design: To support documentation and technical understanding, a network topology design was created that describes the relationship between the DVOR & DME Building and the Tower Building. This topology includes internet connection paths, Mikrotik router positions, data transmission flows, and the position of SUTM cables and poles used to distribute electricity and networks. This design helps engineers understand the system flow thoroughly, facilitates troubleshooting, and serves as a reference when repairing or developing the network in the future.

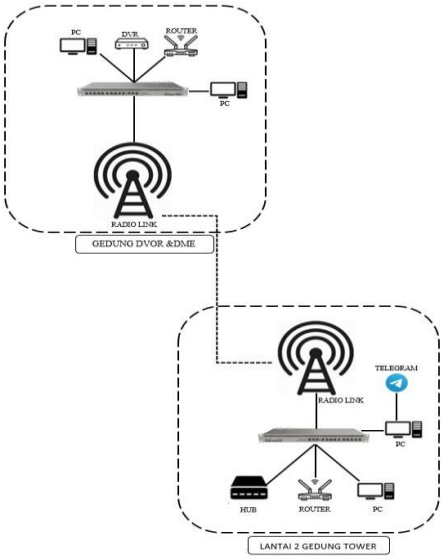

Figure 2. Network Topology Design Explained

The network topology design in the monitoring system of the DVOR & DME Building of the Labuan Bajo Sub-Branch is designed to support stable connectivity and real-time monitoring of the condition of the Low Voltage (JTR) power grid. Here are the main components and their functions in the topology:

1. Radio Link

Radio links are wireless communication lines used to provide internet access from the central building (such as the Tower) to the DVOR & DME Building. This radio link is the backbone of connectivity between geographically separated locations. Through radio links, the internet network can reach Mikrotik devices, routers, and PCs in remote locations such as the DVOR & DME Building. The existence of radio links is very important because the location is on a hill with limited physical access and is difficult to reach with conventional cable infrastructure.

2. Mikrotik

The Mikrotik device serves as the center of the monitoring system configuration. It runs the Netwatch feature, which periodically monitors the status of network connectivity. Through the script configured on Netwatch, Mikrotik is able to recognize the up (active internet connection) and down (internet connection drops) status, then send notifications to Telegram through the API. Mikrotik also serves as a link between routers and other monitoring devices, making it a core component in this system.

3. Router

Routers are used to distribute internet connections inside the DVOR & DME Building. In addition to deploying local networks (LAN), this router is also a target of monitoring by Mikrotik. This means that if the router is not responding or is not connected to the internet, then this condition is an indicator of a power outage (because the router is not protected by UPS). In other words, the on or off status of the router reflects the power supply conditions in the DVOR & DME Building indirectly.

4. PC (Personal Computer)

A PC is used as a client to access Mikrotik, usually through the Winbox application. Through the PC, technicians can perform initial configurations such as IP address settings, Telegram Bot installation, Netwatch script programming, and system testing. This PC also functions to analyze and verify network status based on logs generated by Mikrotik. In addition, the PC is a tool to make repairs if there is a problem with the system.

5. Telegram

Telegram is used as a notification communication platform in this monitoring system. With the help of Telegram's API Bot, the system is able to send automated messages to the established Telegram group of engineers. Telegram is a medium for delivering real-time information to technicians when there is a change in network connection status (up/down). Telegram's advantages in speed, reliability, and open API support make it an ideal choice for this automated notification system.

Result and Discussion

In this chapter, the implementation process of the Low Voltage (JTR) electricity network monitoring system of the DVOR & DME Labuan Bajo Sub-Branch Building is discussed, which is integrated through the Mikrotik device and the Telegram application. The main purpose of this system is to provide real-time notifications to technicians via Telegram when there is a change in the status of the internet connection as an indicator of the power supply. The implementation process starts from creating Telegram API Bots to testing connectivity between devices.

4.1 Create a Telegram API Bot

The first step in building this monitoring system is to create a Telegram Bot that will be used as a medium for sending automated messages from Mikrotik to the Telegram group of technicians. This bot acts as a communication bridge between the Netwatch Mikrotik system and users (technicians) through the Telegram application. To create a Bot, the BotFather service is used, which is the official account of Telegram which serves as a Bot generator and manager. The creation process begins with opening the Telegram application and searching for @BotFather account. Next, users need to type the /start command to start an interaction session with BotFather. After that, it is followed by the /newbot command to start creating a new bot. BotFather will ask the user to specify a unique bot name and username, ending with the word "bot" (example: MonitoringNetworkBot). If the name and username are valid, the system will automatically send a confidential API token. This token is very important because it will be used to connect Mikrotik with Telegram through an API endpoint.

The tokens obtained are then stored and later entered into the Netwatch script on Mikrotik. Whenever the network status changes (up/down), Mikrotik will send an HTTP request to the Telegram API address, including the token, group ID, and the body of the notification message.

In addition, it is necessary to create a Telegram group containing Capem Labuan Bajo technicians. A bot that has been created must be added to the group, and set up as an administrator in order to send messages. To get a group Chat ID, it can be used a third-party service such as getidsbot or done with live testing through the Telegram API.

With this Telegram Bot, the monitoring system can automatically send messages such as "Electricity DVOR ON" when the network returns to normal, and "Power *DVOR OFF"* when the network is disconnected. This bot ensures that technicians can receive notifications anytime and anywhere, without having to manually check the network conditions. The creation and configuration of the Telegram Bot is a crucial stage because it is the foundation for all notification mechanisms in the Mikrotik-based monitoring system. This integration shows how cloud services like Telegram can be leveraged for technical operational needs in a work environment with limited access.

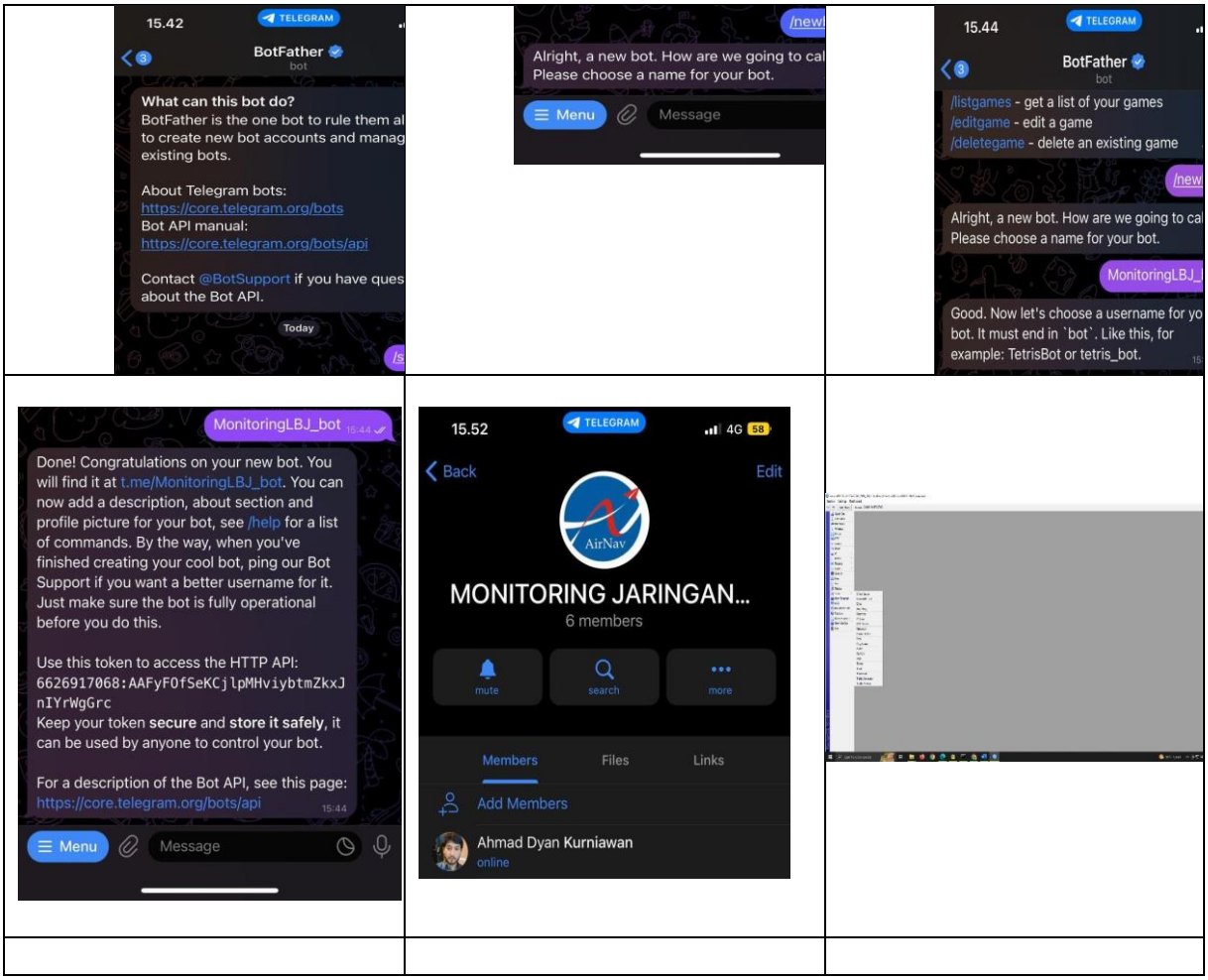

Figure 3. Telegram API Bot

4.2 Mikrotik Netwatch Configuration

After the Telegram Bot is created, the next step is to set up the Netwatch feature on the Mikrotik RB2011UiAS-RM device. Netwatch is used to monitor connectivity to specific IP addresses on a regular basis. In this system, the IP address of the router that is not connected to the UPS is used as an indicator of the electrical status. If the connection to the router is disconnected (status down), it is considered a power outage. Conversely, if the connection is active again (status up), then the electricity is declared on.

Configuration is done using the Winbox application. The trick is to open the Tools menu > Netwatch, then add the IP of the router you want to monitor. The check time can be set, for example every 5 seconds, so that the system responds quickly to changes in network status. After that, the user fills in the Up and Down fields with an automatic script to send a message to the Telegram group. After the configuration is complete, a test run is carried out by turning the router off and on. As a result, the system managed to send an automated message to the Telegram group when the connection changed. This proves that Netwatch and Telegram Bots can be used in real-time to monitor the status of the power grid. With this system, technicians do not always need to check the location directly. Electricity status information can be found remotely via Telegram. This solution is simple but effective, especially for locations like the DVOR & DME Building that are difficult to reach.

4.3 Open the Winbox Application on Personal Computer (PC)

Before configuring Netwatch on Mikrotik, make sure that the LAN (Local Area Network) connection between the PC and the Mikrotik device is properly connected. This connection is essential for the configuration process to run smoothly without network obstruction. Once the connection is confirmed to be active, the next step is to open the Winbox application on your

Personal Computer (PC). Winbox is an official graphical interface (GUI) from Mikrotik that is used to configure devices easily and quickly.

After the Winbox application is opened, users can log in to the Mikrotik device by filling in the MAC Address or IP Address, accompanied by the appropriate username and password. If the connection is successful, then the Mikrotik main menu display will appear. Next, to set up network connection monitoring, users can go to the Tools menu and select Netwatch. In this menu, users can add IP addresses that will be monitored as indicators of the status of the power network, as well as enter scripts in the Up and Down columns to send automatic notifications to Telegram groups through a pre-built Bot API.

4.4 Inserting Scripts into Winbox

Once the notification scripts are typed and customized in the Notepad app, including the Telegram Bot token and Telegram group Chat ID, the next step is to enter the script into Mikrotik through the Winbox app. Make sure that Mikrotik is connected to the PC via the LAN network. To insert a script, open the Winbox app, then go to the System menu, then select the Script submenu. In this menu, you will see a Script List that contains a list of scripts that already exist or can be added. Make sure the writing of the bot token and chat ID is correct without spaces or character errors, because if it is wrong, then the notification will not be sent to Telegram. This script will later be automatically invoked by the Netwatch feature when it detects a change in the network connection state.

4.5 Testing Scripts

Once all the script commands have been successfully entered, the next step is to perform tests to ensure that the script is working properly. The test is done by opening the System > Script menu in Winbox, then selecting the script that has been created (both for up and down conditions), and clicking the Run Script button.

If the configuration and parameters entered are correct, then a notification message will be sent immediately and appear in the Telegram group that has been created beforehand. For example, if the DVOR ON script is executed, a notification "ELECTRICITY DVOR ON" will appear in the Telegram group. Conversely, if the DVOR OFF script is executed, then the message "POWER DVOR OFF" appears.

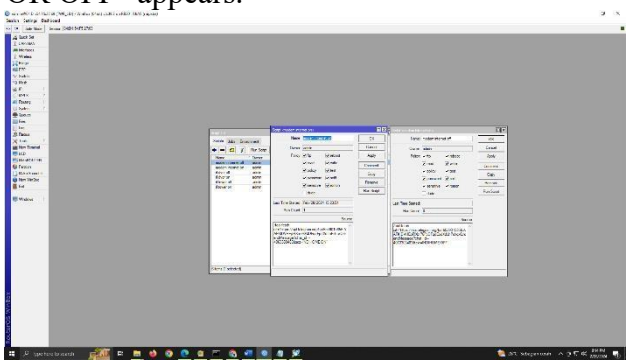

Figure 4. Script Testing

This test proves that the system successfully sends notifications automatically according to the connection status. Furthermore, the test can be extended by changing the IP address of the target in the Netwatch to monitor other connected equipment on the network, both from the Mikrotik Tower Building and the Mikrotik Building DVOR & DME. Thus, this monitoring system can be used flexibly to monitor various Low Voltage (JTR) power grid points spread across different locations.

4.6 Analysis and Discussion

Based on the results of research and testing of the power grid monitoring system of the DVOR & DME Building of the Labuan Bajo Sub-Branch using Netwatch Mikrotik and Telegram API Bot, there are several important points that can be analyzed as follows:

The Telegram and Netwatch-based monitoring system on Mikrotik has been proven to run well and stably. The main function of the system, which is to monitor the status of the Low Voltage network (JTR) and send automatic notifications when there is a change in connection status, is successfully implemented. The system is able to identify the "UP" status as an indicator that the power is on and "DOWN" as a sign that the power is out, through monitoring the IP address of the router that is not protected by the UPS. This suggests that the monitoring method using a network connection as an indicator of effective power supply is used, especially in locations with limited access.

Notifications are successfully sent to each technician's mobile device, provided that the device has installed the Telegram application and is connected to the internet. This proves that the integration between Netwatch Mikrotik and Telegram Bot has worked well as a real-time monitoring system, with a fast and practical communication process. Additionally, a significant advantage of using Telegram is that it's free, unlike some other messaging apps that charge for the automated notification API.

However, this system also has technical limitations that need to be considered. One of its main drawbacks is its dependence on electrical resources. If the Mikrotik in the Tower Building or the router in the DVOR & DME Building does not receive electricity supply at the same time, then this monitoring system cannot run. This is a major challenge in the development of sustainable systems in remote locations that are prone to power outages. To address this weakness, consider using a UPS or backup power system (such as solar panels) to keep the monitoring system active even if the power goes out.

There is a possibility that notifications are delayed or even not sent if the Telegram application is in the process of updating or experiencing service interruptions. This condition can cause information not to be conveyed in real-time, which has the potential to reduce the effectiveness of the monitoring system when needed in an emergency.

Conclusion

Based on the results of the research conducted using experimental methods, it can be concluded that the Low Voltage (JTR) power grid monitoring system at the DVOR & DME Building of the Labuan Bajo Sub-Branch has been successfully built and implemented. This system utilizes the Netwatch feature on the Mikrotik RB2011UiAS-RM device which is integrated with the Telegram API Bot as a medium for sending automatic notifications. Monitoring is carried out through the router's IP address which is not protected by the UPS system, so that when there is a power outage and the connection is lost, the system automatically sends a warning message to the Telegram group that has been created with the technician.

The notification delivery process is successfully sent in real-time to each personnel's mobile device, as long as the Telegram application is installed and connected to the internet network. This proves that the system runs effectively in conveying information on the condition of the power grid, without the need for direct inspection to the location. Another advantage of this system is the use of Telegram's API which is completely free, so the monitoring system can be run without adding to the burden of operational costs.

This system has limitations, especially in its dependence on electricity supply. If the Mikrotik device and router experience a power outage at the same time, then the entire monitoring system cannot function. In addition, when the Telegram application experiences a system update or service interruption, the notification delivery process can experience delays, and may not even be sent in real-time.

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